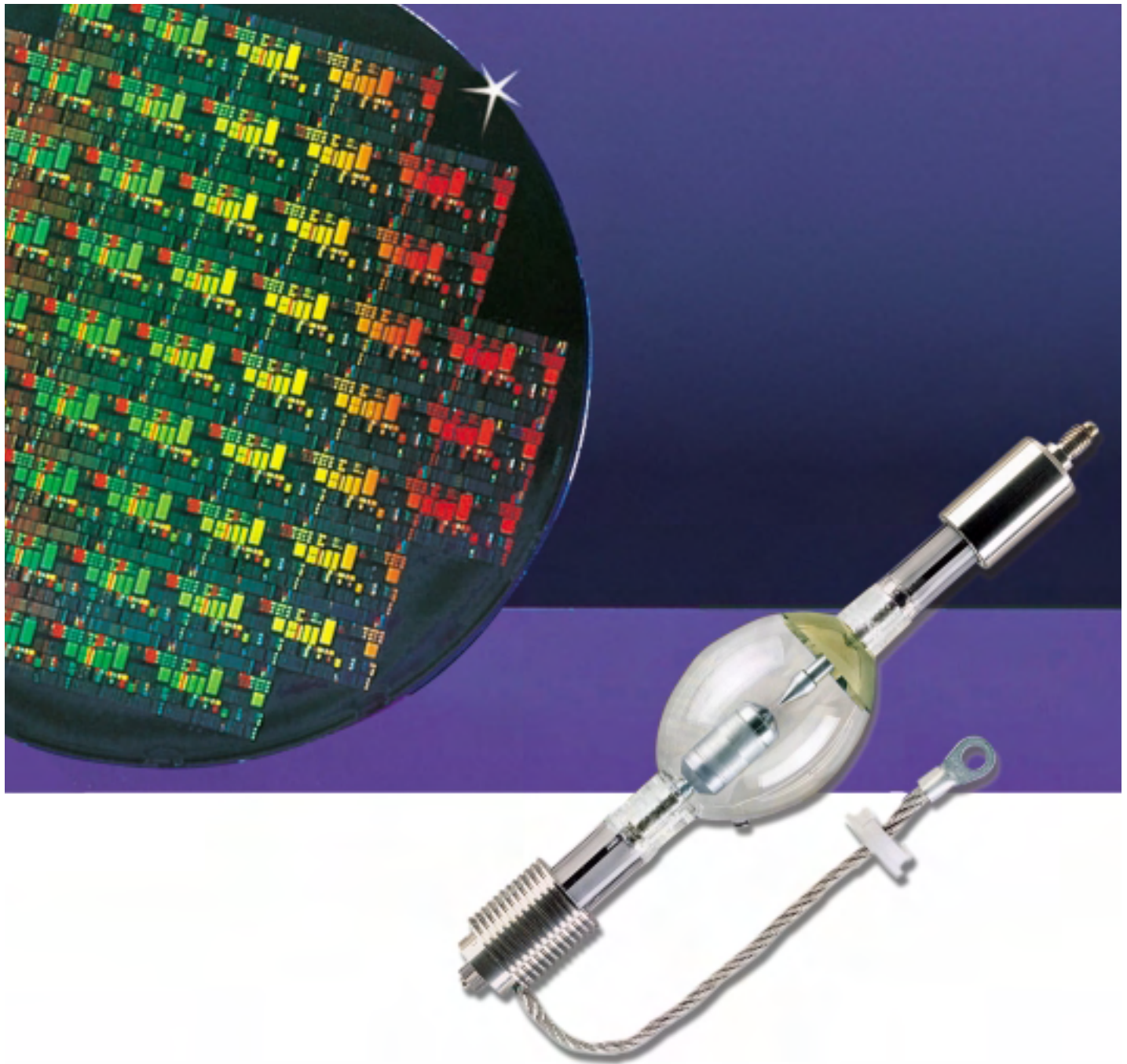


TECHNOLOGY AND APPLICATION GUIDE 2000/2001

HBO[®] MERCURY SHORT ARC LAMPS FOR MICROLITHOGRAPHY



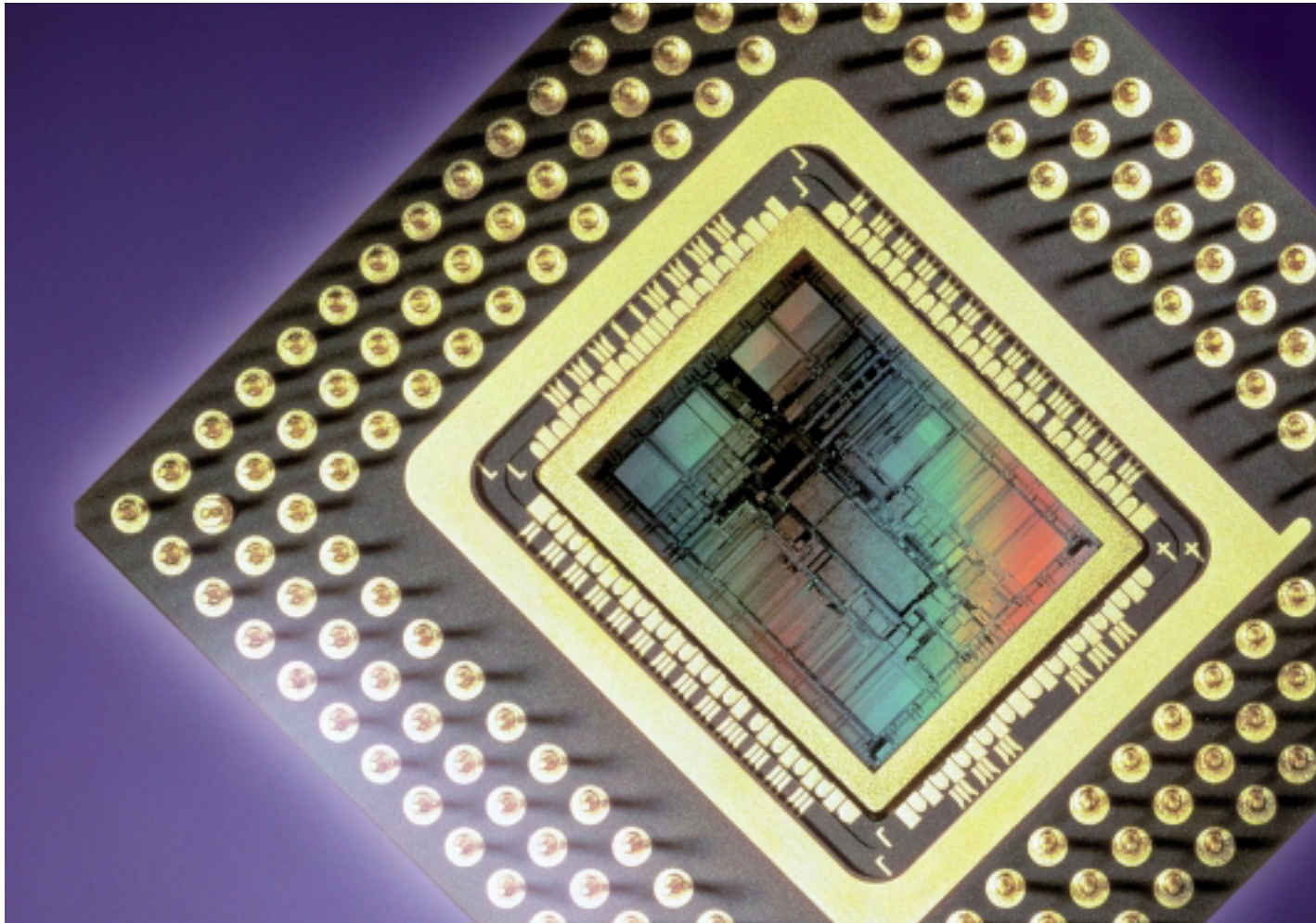
THERE IS LIGHT. AND THERE IS OSRAM.

OSRAM

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OSRAM HBO® MERCURY SHORT ARC LAMPS FOR MICROLITHOGRAPHY



Mercury short arc lamps are used as light sources in the semiconductor industry because of their strong radiation in the blue, violet and ultraviolet spectral range. OSRAM, as the world market-leader in special-purpose discharge lamps, has been developing, manufacturing and marketing HBO® short-arc mercury lamps for more than 65 years. Our certification for DIN EN ISO 9001 guarantees the highest possible levels of quality and regulated procedures in all areas.

QUESTIONS?
HBO-IC@OSRAM.COM

The major technological innovations for OSRAM HBO® lamps for microlithography are:

- Development of increased wattage lamps
- Optimized g-line and i-line emission
- Development of pulse-mode lamps
- Introduction of longlife and extended longlife lamps
- Introduction of new IOFR (improved Ozone-free) quartz technology for i-line lamps to further reduce undesirable low UV radiation
- Introduction of super high performance lamps (SHP-series).

Our future goal at OSRAM is to focus on innovations in HBO® lamp technology. This will include the continued development of higher lamp wattage, increasing service life and optimizing lamp maintenance.

By using materials from our own production facilities, thereby allowing for complete quality control, we are able to achieve extremely high stability in our OSRAM HBO® lamps. OSRAM's use of quartz with the highest optical purity provides for extremely homogeneous and stable radiation properties with excellent lamp maintenance. In addition, we carefully optimized the geometry of the lamp and the electrodes to ensure an efficient conversion of electrical power into radiant power for your applications.



REG. NO. 19 496-01
OSRAM GmbH

A quality audit carried out by the German Society for the Certification of Quality Management Systems (DQS) demonstrated that the quality assurance system operated by OSRAM GmbH meets the requirements of
DIN EN ISO 9001



1. INTRODUCTION

Mercury short arc lamps (also referred to by their abbreviation HBO®) with a power consumption of between 200 and 8,000 Watts are used primarily as a light source in the manufacture of microchips, Liquid Crystal Displays (LCD) and Printed Circuit Boards (PCB).

As one of the three largest lamp manufacturers in the world, OSRAM is committed to its customers to produce the highest quality products possible and to provide comprehensive information about those products.

By presenting this publication, it is our intention that our customers will have a useful and convenient reference regarding OSRAM HBO® lamp products and lamp technology for microlithography applications. We expect to answer many questions regarding the design and use of OSRAM HBO® lamp types.

HBO® lamps with a power consumption of more than 200 W are used almost exclusively in microlithography for the production of electronic semiconductors, LCD (Liquid Crystal Displays) and PCB (Printed Circuit Boards). Depending on the respective production, various types of equipment (stepper, scanner, mask aligner, etc.) are used, whereby the common feature is that they are all used for exposure. For this reason, they will be referred to as "exposure units" in the chapters below.

This brochure addresses primarily users of lamps for exposure systems. As the lamps are used for specific exposure equipment of various manufacturers, we dispensed with a detailed description of the igniter devices and control gear required for the operation. These units will be described in detail in the brochure titled "HBO® Mercury Short Arc Lamps: Technology and Application."

Apart from the physical and lighting fundamentals which the emission-generating process of the mercury short arc lamps (HBO®) is based upon, the practical requirements which have to be met for a safe and beneficial operation of the lamps shall have priority here.

Mercury short arc lamps are direct-current short-arc gas discharge lamps in which the electric arc of the discharge takes place in a high-pressure mercury atmosphere.

The first HBO® lamps were developed by OSRAM in the 1930s. The short-arc lamps were primarily used for ultraviolet light pens in the beginning. In the following years the lamps were continuously further developed. As more and more new applications like fluorescent microscopy and UV-curing (photo polymerization) were added, the high power lamps would mature as a light source for the production of semiconductor structures with ever increasing numbers and designs since the 1980s.

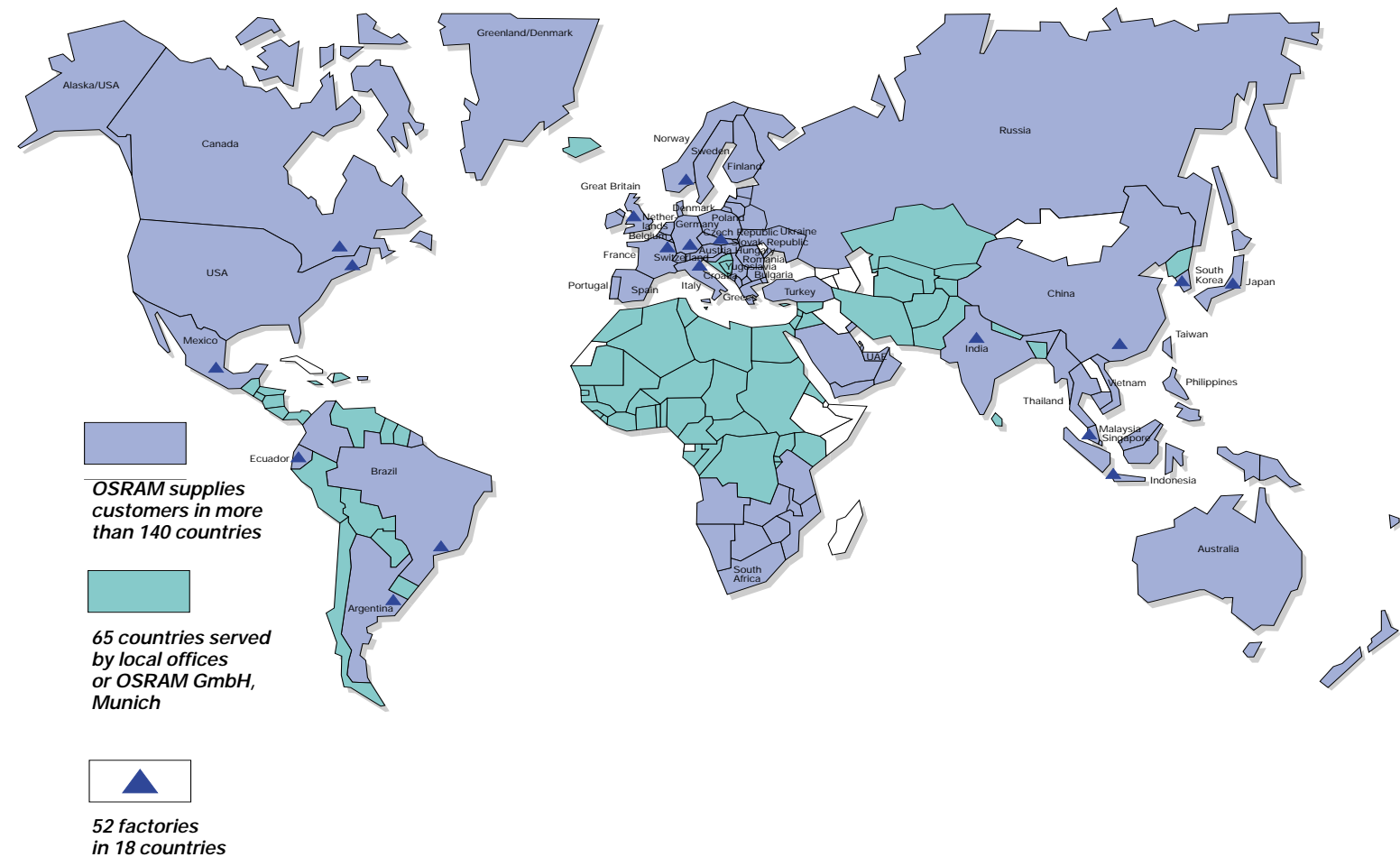
Initially in semiconductor component manufacturing, lamps with a power consumption of 200 W and 350 W were used depending on the application. A large share of the lamp's emission spectrum and/or selected spectral lines was employed for wafer exposure. Later, with increased miniaturization of wafer circuit structures required, lamps up to a power consumption of 1,000 W

optimized to the g-line (436 nm) of the mercury and lamps optimized to the i-line (365 nm) were used. The electrical power of today's lamps can amount to 3,500 Watts and more.

Some equipment uses lamps with the emission spectrum optimized in the deep ultraviolet (DUV) region. Other systems require lamps with a power consumption of over 3,500 W, employed primarily in the production of LCD and PCB. In these applications, the primary lamp feature is not the illumination of very small structures on a small surface, but rather the fast exposure of large surfaces. The reliability and the life-time behavior of OSRAM mercury short arc lamps have been improved continuously since the beginning with continued developments in the lamp components and the production processes. For this reason, a range of high-quality products can be offered today divided up into a multitude of power ranges and designs so that each of the numerous applications is correctly illuminated.

OSRAM is represented by local agents in all countries in the world, in which semi-conductors, LCD or PCB are manufactured. Thus, OSRAM can offer its customers prompt product availability, excellent consultation and expedient warranty support. OSRAM's optimized customer services systems ensure high-tech customers fast support for demanding applications.

1.1 Historical overview



1.2 Quality and the environment

OSRAM products provide high quality and environmental protection.

The high quality product demand of OSRAM is reflected in the corporate principle of "Total Quality Management" (TQM), which defines the quality principles applicable in the worldwide company. These quality principles represent the basic attitude and objectives for all employees.

OSRAM was the first manufacturer of lamps for microlithography to be awarded certification in compliance with standard DIN EN ISO 9001 by the Deutsche Gesellschaft zur Zertifizierung von Managementsystemen GmbH (DQS) in 1994. This certification, which has been verified continuously since 1994, has ensured a continuous improvement of our products and especially our customer services.

OSRAM decidedly accepts its global obligation to act environmentally responsible. The impact on the environment caused by our products production and sales operations are to be kept as low as possible at all times. Our guiding principle in all actions is to prevent or reduce to a minimum all environmental burdening, even beyond the legal stipulations if possible, by means of a continuous improvement process, and the use of the latest technology. This OSRAM philosophy is supported by our environmental management system, validated since 1995 in compliance with standard DIN EN ISO 14.001 and the European EU eco-audit regulations (EU Directive No.1836/93).



Fig. 1: Environmental management system certificate

2.1 HBO® technology

2. GENERAL DESCRIPTION OF HBO® LAMPS

Mercury short arc lamps (HBO®) belong to the large family of gas-discharge lamps. These lamps contain a rare gas (such as argon, xenon, etc.) and liquid mercury. The liquid mercury changes into a gaseous state under high pressure due to the temperature produced when the discharge is begun.

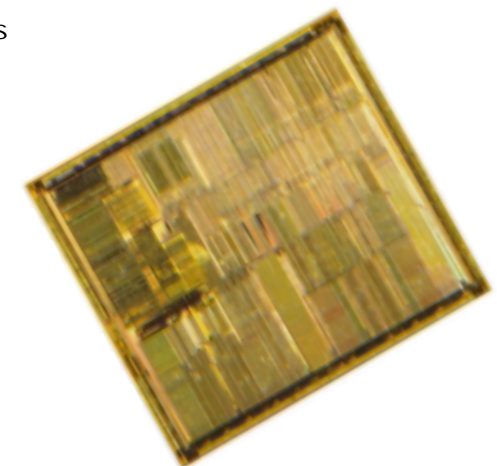
The discharge arc occurring between the two electrodes in the mercury vapor atmosphere produces the light (radiation). By collision with the electrons and the rare gas atoms, the mercury atoms gain energy. They enter into an "excited" state. Based on physical laws, this higher energy level can be liberated by a quantum of radiation, and the atom then returns into a lower state. The wavelength of the emitted quantum of radiation depends on the previous difference of energy levels involved. As discrete energy conditions only are possible, a spectrum is produced which consists primarily of the widened spectral lines of the mercury, depending on the pressure (cf. chapter 4.5). The arc gap (the spacing between the two electrodes during the operation of the lamp) is only a few millimeters in length. Thus, the lamps approach the ideal optical condition of a point emitting illumination source.

2.2 Fields of application

A variety of associate equipment designs can apply very different demands on the light source employed. OSRAM is in co-operation with the device manufacturers or end-users to ensure proper product capacity for customer applications. Consequently, a large variety of mercury short arc lamps have been developed which generate the right radiation for virtually any application.

The fields of application are versatile:

- Microlithography
- Production of LCD
- Production of PCB
- Microstructure, nanotechnology
- Printing technology
- And many more fields



Intel® Pentium® processor

3. LAMP CONSTRUCTION

3.1 Terminology

OSRAM Photo Optic would like to give the reader a brief insight into the background and the significance of our registered trade name and lamp description acronyms in use.

The three letters preceding the power data refer to the type of lamp. In the case of the mercury short arc lamps these are the letters HBO® (an OSRAM registered trade name), in which:

H stands for *hydrargyrum* which is from Greek/Latin meaning mercury (Hg)
 B stands for high luminance (B = symbol for luminance)
 O stands for unforced cooling (original meaning, no longer applicable today)

The letters following the data on the power consumption (including "W" for Watt) refer to certain special features of the respective lamp types.

P = for exposure units of ASML Company (previously a Philips subsidiary)
 C = for exposure units of Canon Company
 N = for exposure units of Nikon Company
 S = for exposure units of Karl Suss Company
 G = for exposure units of GCA Company
 MR = for exposure units of MRS Company
 L = long-life version
 EL = extended long-life version
 I = optimized for the i line (365 nm)

*Exceptions to these notations are:
 HBO® 250 W/BY, HBO® 1000 W/D or HBO® 4000 W/PL.
 OSRAM HBO® lamp identifications are most accurately described when the complete lamp designation is noted. The absence of one single letter may lead to mistakes.

3.2 Design characteristics

As versatile as the fields of application of the mercury short arc lamps may be, the design structure follows certain basic elements in principle – a double-ended arc-tube which is further processed to a lamp by corresponding modifications (geometry, base). However, in detail each lamp is individually optimized for the respective case of application. The most important elements are shown in Fig. 2 and 3.

Fig. 2: Picture of HBO® 1500 W/PIL

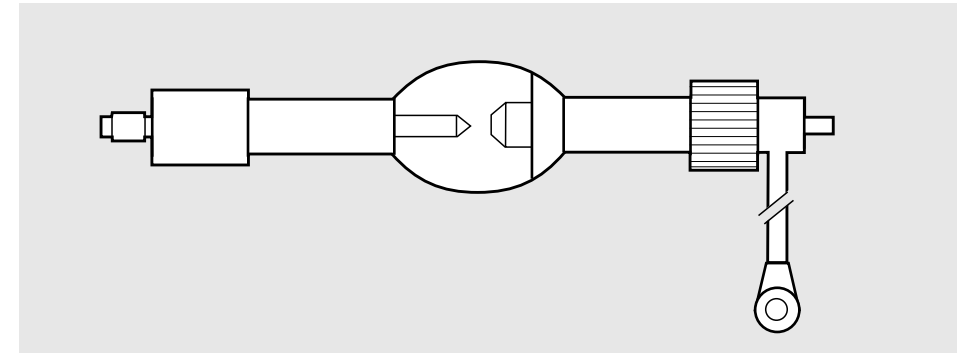
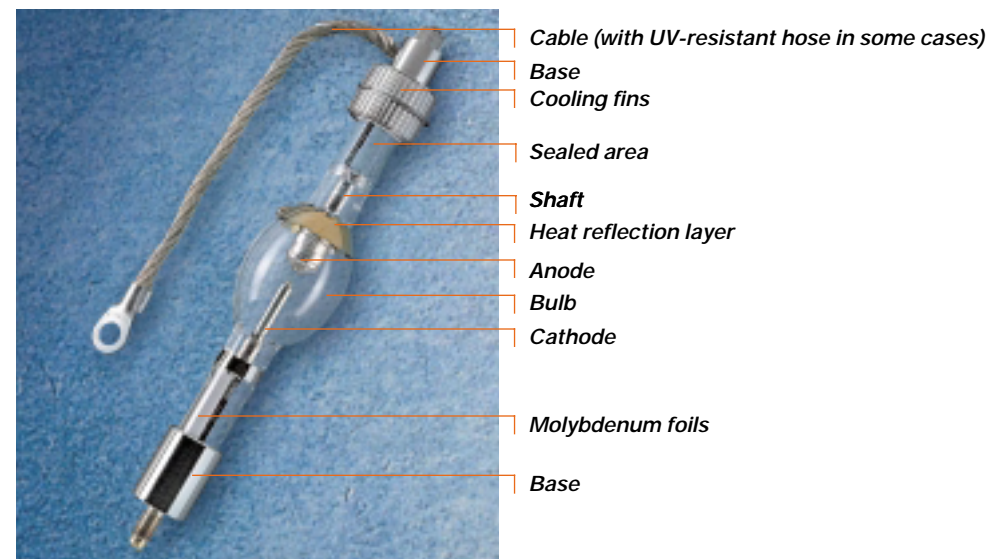


Fig. 3: Schematic structure of HBO® 1500 W/PIL
 The lamp bulb made of quartz glass in the function of a discharge tube encloses the electrode system and contains the constituents of the fill. The lamp bulb passes into the lamp shafts. The discharge arc occurs between the two tungsten electrodes which are located in the lamp axis and protrude into the bulb – they are located opposite each other at a certain distance, the so-called electrode gap.

3.3 Geometric tolerances

OSRAM HBO® lamps provide precise positioning of the arc relative to the reference base. Consequently, HBO® lamps are used as point-source lamps in high-quality optical systems without any major adjustment required.

3.4 Base

The nickel-coated brass base of the HBO® lamps are used to establish the electrical contact from the power source (in applications requiring non-cabled types) and also for the physical mounting of the lamp. By means of "non-out-gassing", temperature-resistant adhesive cement, the lamp shaft is secured in the base in such a way that the position of the arc is adjusted with extreme precision. The maximum permissible temperature measured at the base surface is 200 Celsius (392 F) for all i line lamps and lamps with a power consumption of more than 1,000 W. A maximum temperature of 230 Celsius (446 F) is applicable for all other HBO® lamps.

In the production process, the lamp is exactly aligned in the base in such a way that a precisely defined position of the discharge is produced when operated in the exposure unit. This positional reference represents one of the most important quality criteria of HBO® lamps.

3.5 Seal

Each OSRAM HBO® lamp has two seals contained in opposite ends of the lamp's shafts. The seals provide a hermetic, gas-tight connection for the electric current between the outside and the inside of the lamp.

Tungsten has a relatively high coefficient of expansion when heated (a standard feature in metals). Quartz glass however expands very little when heated. For this reason the tungsten electrodes cannot be sealed in the quartz glass directly because the significantly greater thermally expanding tungsten would shatter the minimally expanding quartz glass. The production of an airtight connection between electrode and base is established by using molybdenum foils (cf. Fig. 4). The molybdenum foil is only some 1/100 mm in thickness and etched at the edges. Because of this, design forces induced by temperature changes remain so small they do not damage the vacuum tight metal-glass seal.

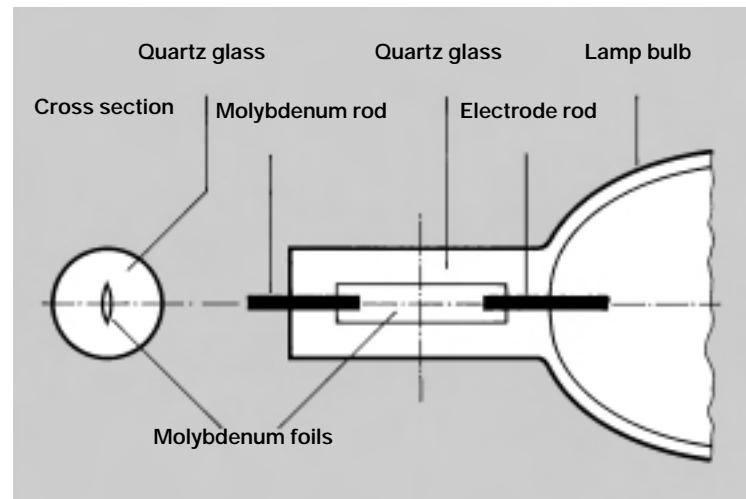


Fig. 4: Schematic diagram of a foil seal

3.6 Electrodes

(a) General aspects

The electrodes of the HBO® lamps are made by OSRAM in their own production plants from tungsten powder. The electrodes are significantly responsible for the properties of the lamp. OSRAM's Research and Development Teams provide special attention to the optimization and continuous development of these components. In the production process, OSRAM quality specialists ensure consistent high quality manufacturing.

(b) Direct-current operation

The smaller electrode, the **cathode**, is connected to the negative polarity of the power supply. The temperature of the cathode tip has to be high enough to release a sufficient amount of electrons. Therefore, the shape of the cathode is defined in such a way that it can achieve and withstand temperatures in the operative range of typically 2,500 to 3,000 °C (4,532 to 5,432 °F). Furthermore, the cathode electrode tip must have a fine pointlike geometry to stabilize the plasma while being able to emit specified lamp currents without "burning back" (cathode electrode flattening), reducing service life.

The **anode electrode** acquires the electrons emitted by the cathode. The entry energy of the electrons is converted into heat, which has to be dissipated by radiation, convection and thermal conduction. In order to keep the temperature of the anode electrode as low as possible to attain long service life, it has to be large and of high density.

To improve the radiation properties for infrared radiation, the anode electrode surface is often treated, presenting a gray or silver paste-like appearance to the human eye. Apart from the shape, the anode's material composition and the material structure are decisive for how long it can withstand the electron impact. Traditionally pure tungsten materials of highest density were used in anode electrode construction. Nowadays, material composition and a strictly defined thermal and mechanical processing of the metal can produce specific internal structure distributions. These modern metallurgic techniques produce considerably better anode properties. In all cases the decisive criterion is how long the face of the anode can retain its shape. The anode electrode erosion process depends considerably on the operating conditions (pulse operation, overloading) of the lamp.

(c) Carburization

The task of the cathode electrode is to emit electrons. For the emission of electrons by the cathode tip, a certain amount of energy (the so-called work function) is required to trigger the process, which is 4.53 eV (electron Volt) for pure tungsten.

A significant improvement of the emission behavior of the cathode can be achieved if the tungsten surface is coated with a monatomic thorium layer. In this case the work function is reduced to approximately 2.86 eV only. The work function is provided primarily by the thermal energy (cathode temperature). Therefore, coated cathode electrodes can be operated at lower temperatures extending their service life.

The construction of reduced thermal loading cathode electrodes requires a dopant of a small amount of thorium oxide. Controlled reduction of the oxide during the operation of the lamp has to be ensured. For this purpose the cathodes are carburized. Carburization is a process in which a thin layer of tungsten carbide is applied to a certain specified area of the cathode electrode. The carbon continuously reduces the thorium oxide to thorium required to maintain the monolayer on the cathode tip.

The control of the temperature-related reaction and diffusion processes has been the subject of extensive examinations. It is a detailed understanding of these processes which permits the utilization of the effect of carburization for lamp operation.

The advantages of carburized cathode electrodes are many. The reduction of the work function of the electrons results in:

- A lower temperature of the cathode electrode
- Reduced cathode electrode burn back
- Consistent cathode electrode geometry during service life
- Increased arc stability
- Improved maintenance of the lamp
- Enhanced light flux

(d) Super High Performance Technology (SHP)

OSRAM is strongly committed to continuous improvement in lamp development. Optimized lamp performance does significantly increase throughput in wafer production – and this is a most desired effect in the semiconductor industry.

OSRAM has developed a new SHP anode surface treatment technology (patents pending), resulting in enhanced thermal heat dissipation from the anode surface. This leads to significantly reduced anode surface temperatures and therefore to improved suppression of tungsten evaporation from the anode resulting in a significantly reduced blackening of the lamp. OSRAM's new **Super High Performance (SHP)** technology greatly extends machine performance and lamp service life.



3.7 Lamp bulb

The discharge tube of the HBO® lamps consists of quartz glass. Only quartz glass can withstand the high mechanical loads caused by the high operating pressure as well as the high thermal loading (surface temperatures of up to 800 °C / 1,472 °F).

Depending on lamp type and the dominant application, a more oval or spherical cross-sectional bulb shape is chosen. The thickness of the quartz glass wall is only a few millimeters and has been specified precisely for each type of lamp. In order to achieve a high optical projection quality, selected types of quartz glass free from bubbles and scratches are used. A special further-developed quartz glass is used for i-line optimized lamps. This quartz technology ensures that the ozone-generating part of the mercury emission spectrum does not emerge from the lamp (cf. chapter 9.4) and is termed "IOFR". For the user, this means that ozone-related problems such as "fogging" (the reaction with HMDS vapors) are a thing of the past.

Strict quality control of the raw materials as well as of the produced bulb ensures that only perfect material is used for the production of lamps. An inert gas is filled into the bulb (for safe ignition and start) as well as a precisely metered amount of mercury. This mercury is calculated in such a way that depending on the power output and the bulb shape, the lamps can have a pressure of up to 75 bar (1,087 psi) in the operating condition. Typically, OSRAM HBO® lamps are slightly below atmospheric pressure and do not pose a risk of rupturing in a cold condition. There are exceptions however, for example the HBO® 201 W/HS-D2. This type of lamp has a positive cold pressure and a representative safety advisement is noted on the outside of its safety cover. The quartz glass body of such lamps has been designed in a way with respect to material and shape that the highest level operational safety is supported.

During an HBO® lamp's production the lamp is subjected to numerous heat treatments, especially the sealing-in of the electrodes carried out at the very high temperatures required to soften the quartz. After these heat treatments, internal tensions may remain in the glass caused by the inhomogeneous heating during the manufacturing processes. For maximum safety against rupturing, these residual tensions have to be removed. This is done by a process called tempering where the finished lamp (prior to base fitting) is re-heated uniformly up to a point at which the viscosity of the quartz is lowered so much that the internal tensions are decreased. A uniform cooling process subsequently prevents the formation of new tensions.

3.8 Heat reflection

A heat-reflecting layer on the quartz glass bulb in the vicinity of the anode or cathode supports the starting process and contributes to achieving a stable thermal balance. Depending on the type of lamp, a gold or palladium layer is used for this purpose. The type and size of the heat reflector is determined by the operation and cooling in the respective exposure unit. The optimization of the size of the heat reflector is an important step during the development of a lamp.

4.1 Lighting parameters

4. LIGHTING AND OPTICAL PROPERTIES

We have dispensed with a detailed description of all radiometric and photometric parameters of mercury short arc lamps at this point as they are dealt with in detail in other publications. We will now present only the lamp characteristics relevant for the applications mentioned.

To achieve the properties of the light on the exposing level (the wafer) required for the production of microchips, the lamp properties have to be taken into consideration in the design of the lens systems in the exposure units. Apart from the intensity, the arc stability and the local distribution of the light (luminance), the spectral purity of the radiation used (line width) and the beam characteristics of the lamp are decisive in calculations for the lens systems. For these reasons, lamp properties have to be part of the quality assurance plan to ensure consistency from lamp to lamp.

4.2 Luminous flux

The luminous flux, all the light emitted by a lamp in all directions (total luminous flux Φ_L), depends directly on the lamp input power. For OSRAM HBO® lamps, the luminous flux ranges between some 1,000 and over 100,000 lm.

4.3 Luminous intensity

The luminous intensity (dimensional unit: candela "cd") is defined as being the luminous flux (lumens "lm") relative to the solid angle area Ω (Omega) (measured in steradians "sr") radiated through in a given direction. Please see Fig. 5.

If the solid angle area is reduced more and more, the luminous intensity of the light source in a certain beam direction is obtained as a limiting value.

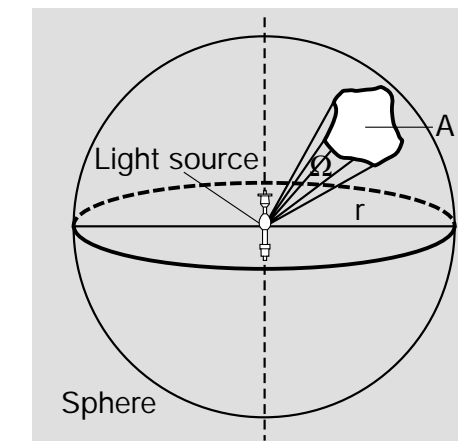


Fig. 5: On the definition of luminous intensity

The polar diagram ("the butterfly") of light distribution around a lamp in a given level is referred to as indicatrix, in which the length of the arrow from the lamp to the curve is an indication for the luminous intensity in this direction. Figs. 6 and 7 show the axial or radial light distribution respectively of an HBO® 2001 W/CIL lamp. Relative to the lamp axis, the light distribution (with exception of the pump stem area) is almost rotationally symmetrical. As can be seen in Fig. 6, the intensity of the light is concentrated on a certain angle range. For this reason, the light source distribution is an important part regarding the ideal performance of an exposure unit.

4.4 Luminance

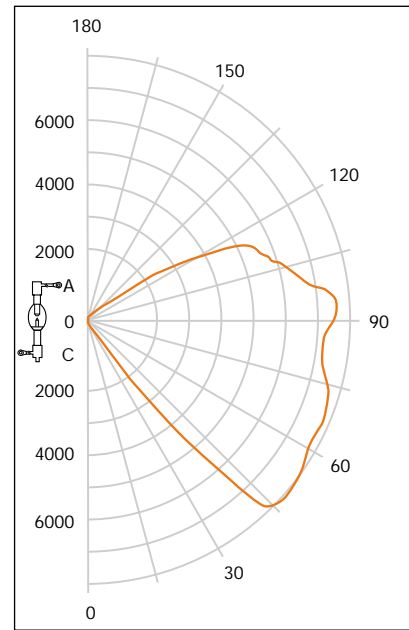


Fig. 6: Axial luminous intensity distribution of HBO® 2001 W/CIL operated at rated power

One of the most important characteristics of HBO® lamps is their high luminance. The luminance of a light source is a measure of how bright the light appears to the human eye from an area emitting, reflecting or receiving light. The more light concentrated in a given area, the higher the luminance and the brighter the source is to the eye. The numerical value of luminance, cd/cm^2 is obtained by dividing the luminous intensity, cd of a source by the perceived area (cm^2).

The intensity of the lamp radiation in the ultraviolet and infrared spectral band (invisible to the human eye) is described by the radiance. Radiance is calculated from the radiation power in Watts emitted by the spectral area observed relative to the shining surface in square meters. This area distribution of the light in an arc is an important aspect for the calculation of the lens system in an exposure unit. As can be seen Fig. 7, the highest luminance is concentrated in the vicinity of the cathode tip (cathode hot spot). Many exposure units prefer to use this cathode spot.

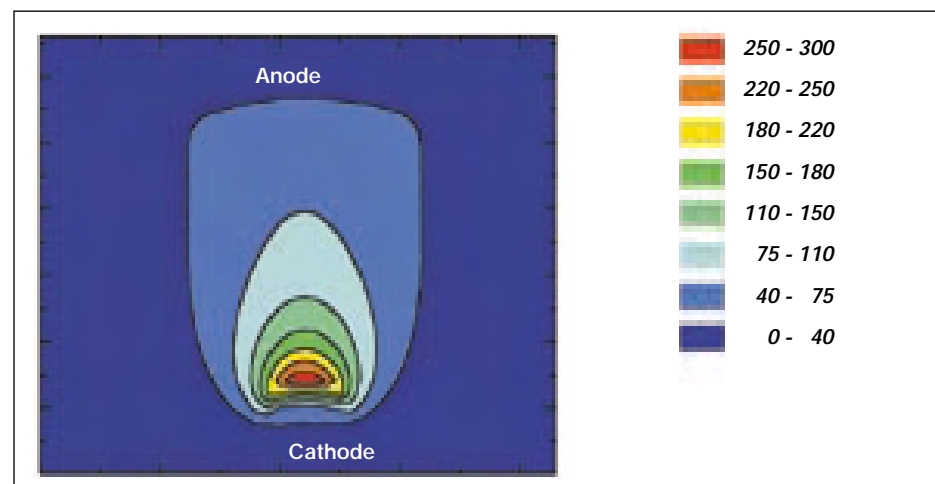


Fig. 7: Typical luminous intensity distribution in the arc of an HBO® 2001 W/CIL operated at rated power.

Fig. 7 represents the typical luminous intensity distribution in the discharge arc of an HBO® 2001 W/CIL. In direct current operated lamps, the maximum luminance is found in front of the cathode tip (referred to as the "cathode hot spot") which can be clearly seen in Fig. 8 in the longitudinal section of the luminous intensity distribution through the arc axis.

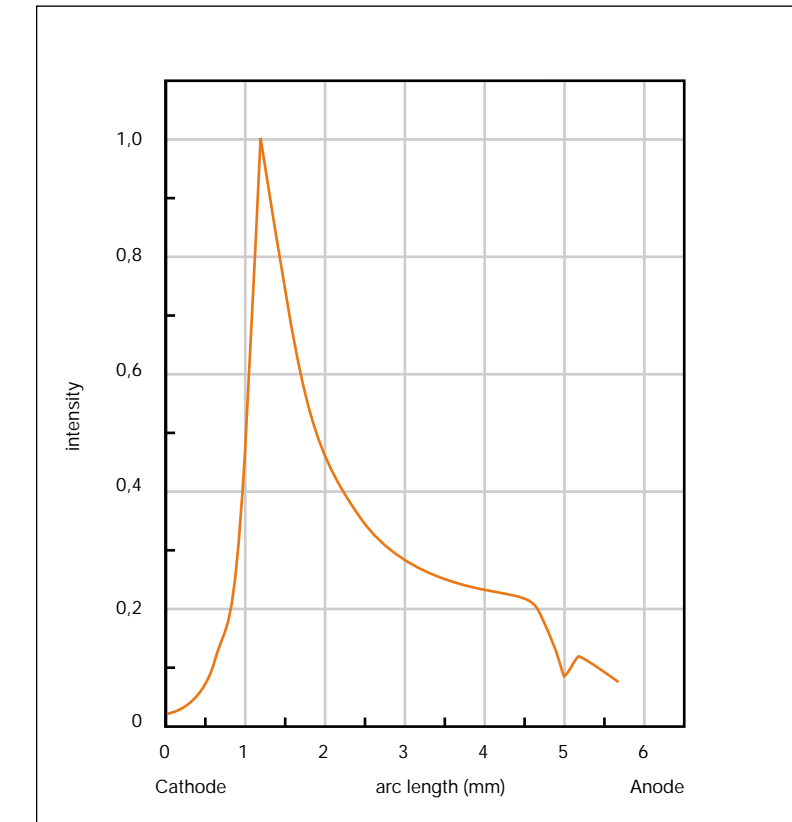


Fig. 8: Luminous intensity distribution along the arc axis of HBO® 2001 W/CIL operated at rated power

4.5 Spectral distribution of intensity

The mercury vapor column of the arc in between the electrodes reaches temperatures of up to $10,000\text{ }^\circ\text{C}$ ($18,032\text{ }^\circ\text{F}$) in operation. By collision, the mercury atoms are converted to high-energy excitation conditions. This attained potential energy is released (in relatively complicated process steps) in the form of radiant energy when returning to lower energy levels. During this phase, the radiation consists of intensive spectral lines of mercury and a continuous spectrum (cf. Fig. 9a, 9b and 9c). The continuous spectrum portion of the radiant energy increases with the increasing power concentration in the arc.

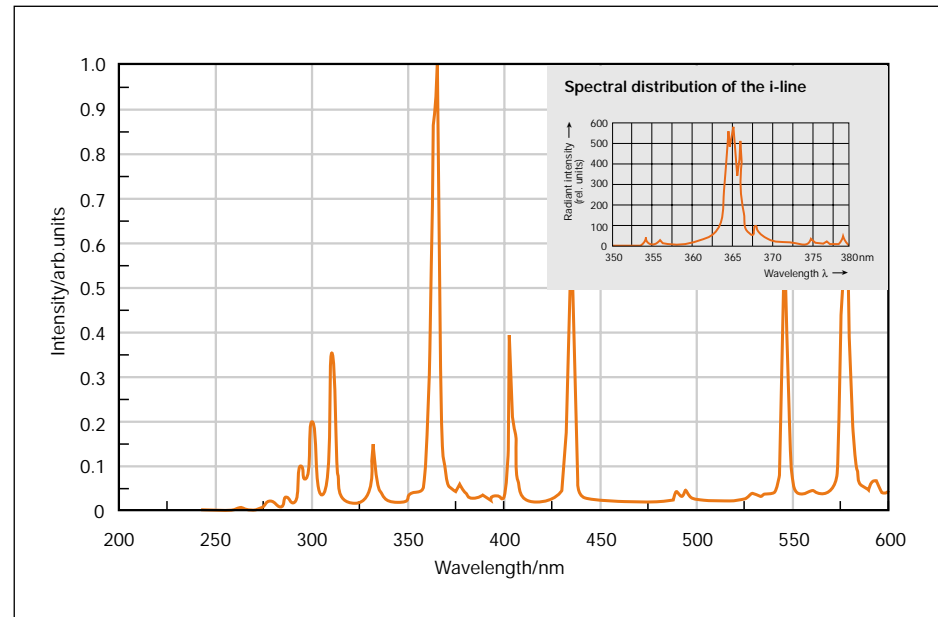


Fig. 9a: Spectral distribution i-line lamp

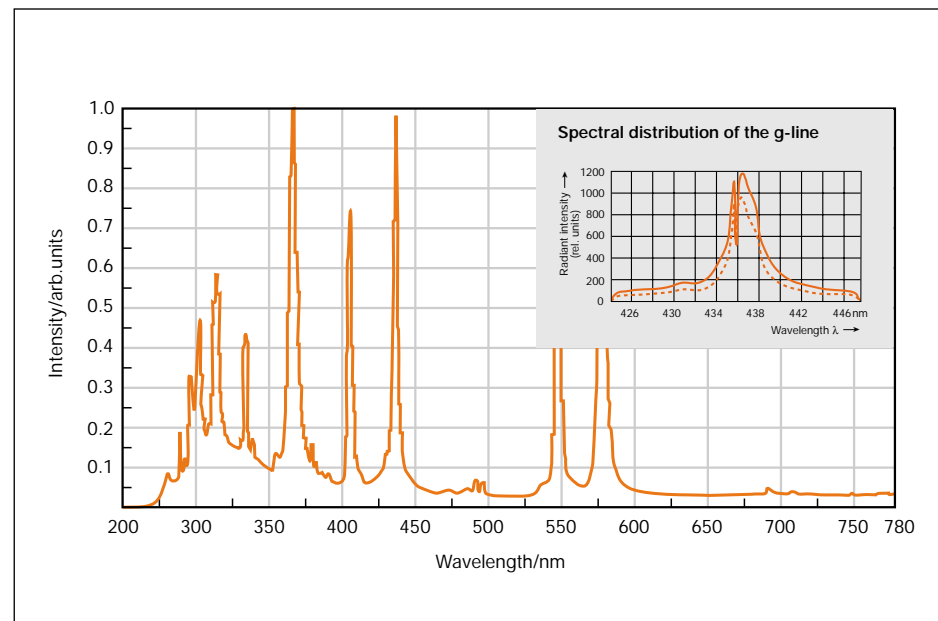


Fig. 9b: Spectral distribution g-line lamp

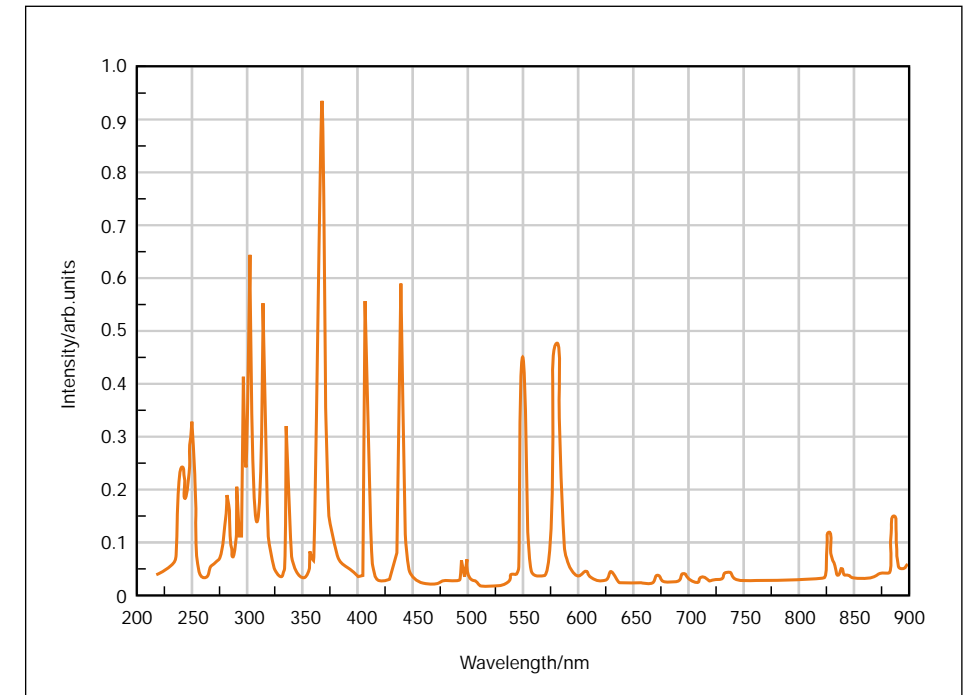


Fig. 9c: Spectral distribution DUV-lamp

Due to the high gas pressure, the spectral lines of the mercury atoms are considerably widened. The ultraviolet light, which is emitted by the internal part of the arc, is partially absorbed in the external colder gas layers of the bulb. This condition causes decreases of the spectral power (self-absorption) in the line center (365 nm) as shown in Fig. 9a.

Due to the interaction of ultraviolet radiation with wavelengths below approximately 250 nm, the atmospheric oxygen of the surrounding air is partially converted into ozone (O_3) especially during an HBO® lamp's run-up phase. During this time the plasma is almost transparent for UV-radiation. Maximum ozone production occurs when the spectral range of 175 - 200 nm is exposed to oxygen. For more detailed information regarding HBO® lamps and ozone generation, please see related section 9.3, on page 35.

5. OPERATING PARAMETERS

5.1 Operating position

HBO® lamps may be operated only within the operating position as noted in the product specification for the respective exposure system. However, the specified operating position has to be taken into consideration in any product modification or new development of exposure systems.

5.2 Lamp start

HBO® lamps used for the mentioned applications have to be started by means of discrete ignition devices. During the ignition process, the insulating gas column is ionized by means of high voltage generated by the starting device (DC or HF ignition) initiating arc formation. At the point of ignition, the minimum rated current of the lamp has to be available without delay for safe arc formation. Due to the discharge of the filtering capacitors, a starting current occurs. The starting current is used to operate the lamp until the lamp voltage is increased and the lamp operational current is established.

5.3 Starting behavior

The time spent between the ignition of the lamp and reaching steady-operating conditions is referred to as the “start or lamp run-up” phase. During the run-up, the lamp’s electrical and photometry values are reached. Depending on the type of lamp and the amount of starting current, the run-up time may vary in amounts of five to twenty minutes. Thereafter, the lamp is considered to be in thermal balance.

After ignition, a discharge in the ground gas occurs and decreases along with the increasing mercury vapor pressure forming a defined arc of high luminance. HBO® lamps have reached their operating vapor pressure when the entire amount of mercury has evaporated, resulting in a nearly constant lamp voltage.

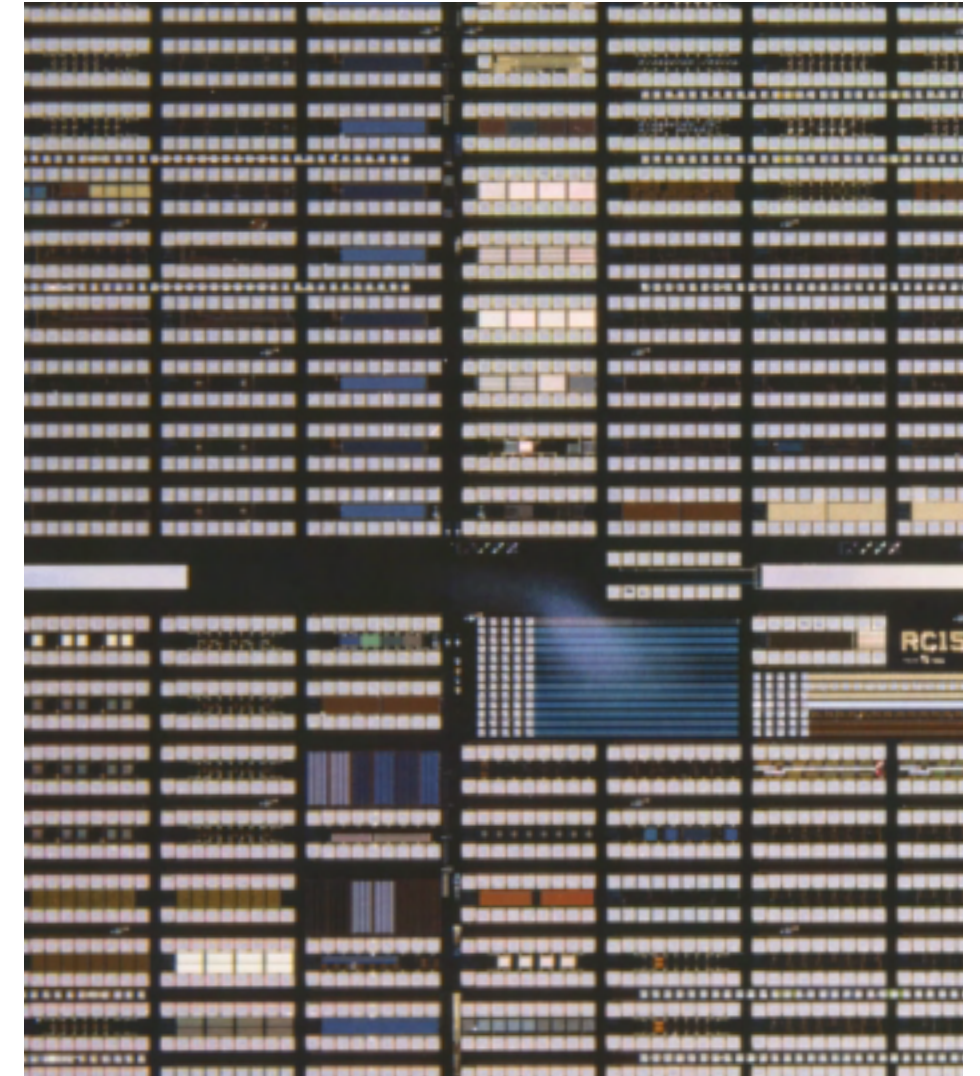
5.4 Cooling

HBO® lamps must always be fitted in an enclosed housing, the so-called lamp house, because of the danger of glare, the radiation in the ultraviolet band and the high mercury vapor pressure occurring during the operation. The lamp house should be provided with screened ventilation openings not permitting any internal particle emission. The lamp house should be sufficiently large, and should provide ventilation shutters in such a way that no direct external light exposure or direct external observation of the operational lamp is possible. The lamp housing should maintain lamp connector base temperatures below the maximum value (cf. chapter 3.4) at rated operational lamp power. High wattage lamps may require dedicated cooling for their connector bases to maintain correct temperatures.

If the base temperature of 200°C/392°F (230°C/446°F for lamps below 1000 W) can only be achieved by means of a forced cooling system, the cooling flow has to be directed mainly onto the base of the lamp (not the bulb). Otherwise, partial condensation of the mercury might occur and thus a reduction of the spectral intensity could result. As a rule, the lamp’s operating voltage will change with incorrect cooling; thus a lamp’s voltage can be an indicator of impermissible cooling. Certain exposure systems have additional cooling fins added by the manufacturer to support cooling of the lamp base. Mechanical lamp fitting and mounting has to be made in such a way that no forces are transmitted to the lamp during expansion due to lamp heating. For this reason, HBO® lamps may be fitted tightly to one base only. The connection to the other socket has to be flexible and strain relieved.

5.5 Duty cycle

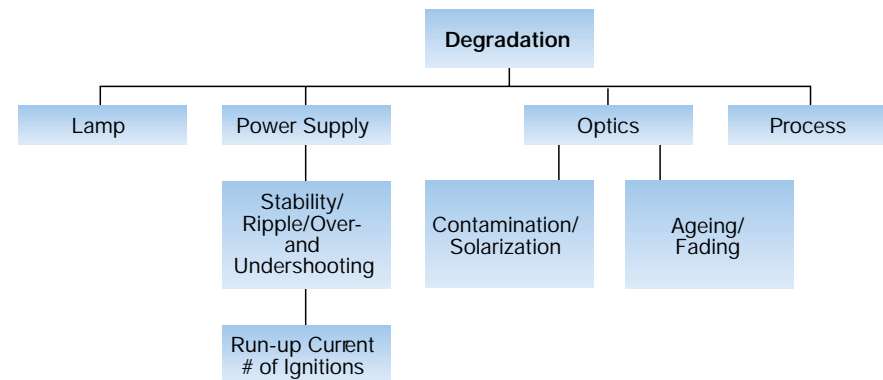
The average service life of HBO® lamps is decisively determined by the lamp’s construction and its ON/OFF duty cycle. In typical applications (continuous operation), the lamps have been designed for a few number of ignitions *only*. Lamp performance is reduced with increasing switching cycles.



6. LAMP BEHAVIOR

6.1 Service life and performance

The average service life of HBO® lamps used in semi-conductor manufacturing applications is defined in the following terms: the lamp's initial intensity in the corresponding wavelength range used by the exposure system may not degrade by more than thirty percent from its initial value during the lamp's published average life hours. As previously mentioned, the amount of ON/OFF cycles can have a strong influence on lamp degradation. With typical applications operating the lamp continuously, average lamp life can be reduced with increased switching cycles.



The Overall degradation, the loss of intensity in the lighting level, is the sum of the lamp degradation and the system degradation of the exposure unit. The overall degradation depends on a number of influences:

- First of all, a differentiation has to be made as to whether the lamp is operated with the nominal power mentioned or with a varied (lowered) electrical input power. The following may apply within certain limits: The lower the power consumption of the lamp, the lower the lamp degradation. For this reason, comparisons of degradation curves of various lamps and machines are valid only in case of appliances with identical power consumption.
- Reliable cooling of the lamp in compliance with the instructions of the lamp manufacturer will provide for optimized behavior of the lamp in operation. If too little cooling is provided, an overheating of the lamp may be possible which could cause premature lamp failure. If too much cooling is provided, a partial condensation of the mercury in the lamp may occur and thus will lead to a loss in intensity on the surface of the object to be exposed. The careful setting of the cooling system is a significant prerequisite for maximum service life and performance of the lamp. This is particularly valid in cases of lamps with respectively large mercury content (such as HBO® 2002 W/MA or lamps used for the production of LCDs).
- Not only the lamp and the cooling conditions determine the overall degradation. The exposure unit contributes significantly as well. The transmission properties of the optical components (lenses, filters, lens systems, etc.) under ultraviolet irradiation deteriorate in the course of the time with respect to the age of the machine. For example, i-line steppers can contribute up to three percent per month to the overall degradation.

After the installation, lamp and optical system adjustment error have the potential to also add to the overall degradation. Consequently, depending on the type of exposure unit, the user will typically notice a decrease in intensity throughout lamp service life intervals of five to thirty percent.

For most exposure units, OSRAM offers the same type of lamp with different service life specifications. This reflects the continuous further development of the HBO® product line supporting developments in semi-conductor technology. For example, "standard lamps" with a service life of 750 hours were available only for i-line exposure units in the beginning. In a short time, OSRAM was able to provide 850 hours of service life. Later, OSRAM offered revolutionary 1,500 hours average service life lamps. OSRAM also "safeguards" its customers by providing a 100 percent credit note, independent of the hours operated, if the lamp does not make the specified service life.

Just recently, OSRAM's continuous development initiatives demonstrated impressively once again OSRAM's technical leadership with the introduction of the "three-month lamp (2,250 h)" for selected i-line exposure units. OSRAM's position as a market leader enables the customer to receive the best price-to-performance ratio, and thus to keep his costs of ownership as low as possible.

Statements on the service life of individual lamps and examples for the typical overall degradation of the most popular types can be found in the catalog section (pages 38-51).

6.2 Arc stability

Narrow spacing between the electrode tips as well as their optimized geometry and material composition provide HBO® lamps with extremely stable discharge arcs. HBO® lamps ensure maximum stability in spatial fluctuation as well as temporal variations in intensity.

In order to permit a characterization of the arc stability, OSRAM has developed highly sensitive measuring processes, which permit a measurement of the spatial fluctuations of the arc directly in front of the cathode tip.

6.3 Uniformity

Uniformity refers to the homogeneity of illumination of the exposure field in the wafer plane. A good uniformity is necessary for stable lithography processes. Uniformity is influenced by numerous factors:

Adjustment of the lamp

When a lamp is installed, it is first adjusted. The arc of the lamp has to be within the focusing range of the optical mirror system. As a rule, the precise location is determined by the search for maximum intensity with the best uniformity. Maximum intensity sometimes does not coincide with the best uniformity. Compensative adjustments can depend on a customer's choice and/or priority.

Change of cathode shape

In the course of the lamp's service life, a slow change of uniformity will be noticed. This can be traced back to the changes in the arc's position on the cathode electrode. The main reasons for this condition are electrode burn back and the resulting change of electrode shape. This process can effect uniformity.

Arc flickering

In very rare cases, a fast increase and decrease of the uniformity can be observed. In such cases, arc flickering may be the reason. The arc is no longer stable with respect to time and the position of the arc moves in the area of the cathode tip. In this case, it is first recommended to check that the lamp has not been operated in excess of its nominal service life.

Stepper (exposure unit)

Each stepper's lens system has minor individual deviations from an ideal system. The minimum uniformity is basically provided by the adjustment of the individual lenses in the system (stepper and scanner only). This means that a low system uniformity cannot be improved by the lamp. The best uniformity can only be achieved first and foremost by the stepper. Other effects are superimposed or added to the basic uniformity.

Soiling and degradation of stepper's lens systems including filter

The degradation of the lens systems in steppers, especially of filters (i-line filter) deteriorates the uniformity in the course of time.

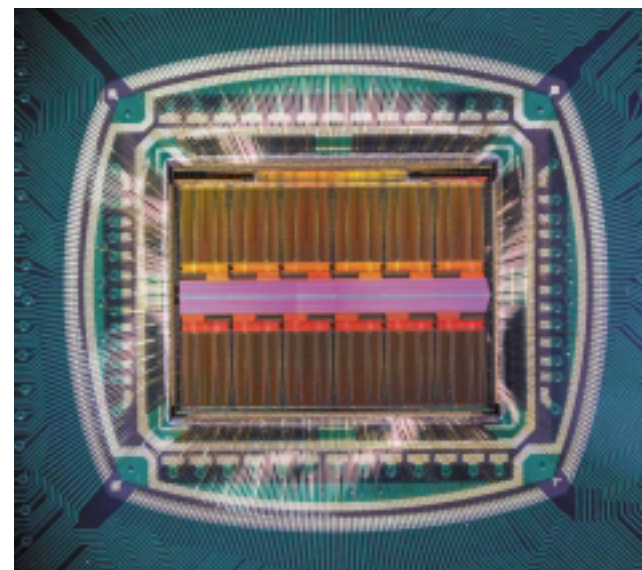
Frequently, the replacement of degraded filters will considerably improve the uniformity. The loss of uniformity can progress at very different rates from machine to machine and may also depend on the purity of the air. Due to these conditions, the equipment's optical system efficiencies for intensity and uniformity values depreciate on average from one lamp to the next.

Misalignment of the lamp

In rare cases, an erratically changed uniformity can be traced back to a misalignment of the lamp in the optical system. By providing a correct re-alignment and installation, this phenomenon can be excluded.

Exposure mode

Numerous steppers have various exposure modes. The uniformity to be achieved depends on the exposure mode used. Only the values of like exposure modes are comparable.



XPLA-array

7. HANDLING

7.1 Mechanical installation

HBO® lamps are sturdily constructed; however they are made of glass, and thus require proper handling to protect against impact, shock, and brute forces. For this reason, HBO® lamp handling should be subject to certain care criteria. *For details, see section 9, "Safety/Warning Instructions."*

On no occasion should the lamp be subjected to force during the installation. As a common practice, lamps should only be touched at the metal connector bases.

The lamp connector bases and/or connection cables should be free from dirt and corrosion. The exposure equipment's electrical connection/sockets must also be free from dirt and corrosion. If they are not, they will need to be cleaned or replaced in order to ensure safe operation of the lamp.

Double-sided base lamps

In order to allow for expansion of the housing and torsion, the lamp may be fitted tightly at one end only. The other end requires a flexible support (cable) in order to permit expansion in the direction of the longitudinal axis of the lamp without any obstructions.

7.2 Electrical connection

The electrical connection of the lamps requires the same care as the mechanical handling. If electrical polarity is connected incorrectly to the lamp, the lamp's cathode electrode geometry will be destroyed, immediately rendering the lamp unusable. Most of the exposure units in the market do not allow a wrong connection.

Discoloration, surface pitting and or corrosion of the lamp or exposure equipment's connectors and cables, indicate a previous thermal overload. Components exhibiting these conditions have to be cleaned or replaced or the service life of the lamp can be negatively affected. For example, increased contact resistance and the improper heat removal Fig. 10 shows the typical discoloration of a lamp base relative to the base temperature.

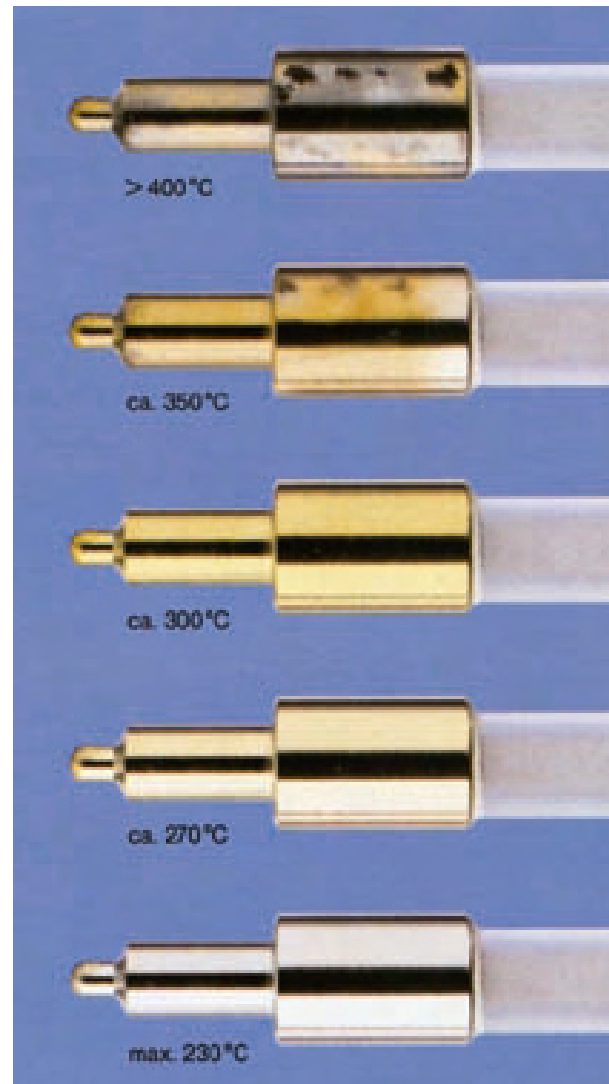


Fig. 10: Typical annealing colors on a lamp base after average service life as a function of the base temperature.

Caution: Please note, equipment sockets (electrical connections) and contact surfaces can wear and deteriorate with use. Please ensure clean and secure contact surfaces only to provide the best operating conditions for your system.

7.3 Cleaning the lamp

HBO® lamps may be touched at the bases only. If it happens that the bulb or the shafts of the lamp have been touched inadvertently, the fingerprints have to be removed immediately. Use a quality cloth (lint-free, such as for cleaning eyeglasses) sprinkled with isopropanol or ethanol, purity 90 % or higher. If the fingerprints are not removed, they will burn into the quartz glass surface during the operation and constitute a source for a constantly spreading recrystallization of the glass. The quartz glass will lose its stability resulting in a possible premature failure of the lamp by rupture of the bulb or shaft.

7.4 Packaging

In order to prevent damage of HBO® lamps during transportation, OSRAM has developed special packaging systems that take the construction of the lamps into consideration and ensure optimum protection. Packaging instructions within OSRAM's quality assurance guidelines and the continuous improvement of technology and material in packaging provides for a high standard of safety and reliability.

7.5 Transport

Dust-free packaging of OSRAM HBO® lamps provides effective protection against damage during transportation (damage is understood as impermissible mechanical impact which makes the lamp useless for the customer) as well as clean-room friendly containment.

To provide proper protection of the lamp, the OSRAM clean-room packaging is subjected to intensive drop and vibration tests. In this way, OSRAM ensures that the product and the packaging meet the requirements of international transportation.

OSRAM HBO® lamp packaging is designed in such a way that typically no damage of the lamp can occur during transport from the influence of mechanical vibration and or impact.

OSRAM HBO® lamps are outstanding because of their high standard of quality. However, to reduce transport and storage damage, please adhere to the following requirements:

- Transport all lamps in their original packaging (including the outer packaging).
- Remove the transport packaging just before installation of the lamp.
- Avoid vibrations and pressure on the packaging and/or lamp, especially if the outer packaging has been already removed.

Transportation of HBO® lamps in other than OSRAM dedicated packaging can result in lamp damage. Non-OSRAM packaging does not offer sufficient safety against damage. Returns to OSRAM (in the case of new lamps, samples or complaints) have to be transported in original packaging for the reasons mentioned, otherwise all guarantee claims are voided.

OSRAM demonstrates its leadership in the market also with respect to transport monitoring and safety. In a first step, high wattage lamps with heavy anodes have been subject to a special transport monitoring system installed recently between the factory and the local subsidiaries: the outside and inside packaging has been fitted with Shockwatch® indicators, which ensure that specified maximum loads on the lamps are not exceeded. If, however, these excessive loads have occurred nonetheless, this is clearly recognizable from outside already.

Procedure in the event of transport damage

HBO® lamps contain mercury. In the event that the lamps have been damaged during the transportation (e.g. bulb broken, quartz glass cracked, electrodes broken off), please proceed as follows:

- Do not open the damaged packaging.
- If lamp damage is discovered after the packaging has been opened, use commercially available absorbing agents to bind and remove any leaked mercury. *Please observe all safety instructions as given in Section 9, "Safety/Warning Instructions."*
- Please contact your sales representative for further instructions.

OSRAM warranty terms

The transportation of HBO® lamps shall be permissible in the original packaging only. If non-original OSRAM packaging is used for transportation of HBO® lamps, any claims for warranty by OSRAM shall become void. Potential warranty claims shall also become void if mishandled in transit.

7.6 Storage

HBO® lamps can be stored for an unlimited period of time. However, they must be stored in non-aggressive environmental conditions, i.e. no storage temperatures exceeding 50 °C / 122 °F, no condensation (relative humidity 10-80%) and a non-corrosive atmosphere. In these conditions, the material properties of the quartz glass and the metals used change very slowly so that an aging of the lamp is not noticeable. If storage effects do occur, they will be noticeable primarily on the "outer" lamp parts, such as the bases. However, as R&D continues, very old lamps do not represent the latest state of the art.

7.7 Disposal of spent HBO® lamps

HBO® lamps can not be discarded as domestic waste; they must be considered as hazardous waste. The lamps contain environmentally active and harmful substances (such as mercury). HBO® lamps should be disposed of as hazardous waste in accordance with applicable federal, state and local regulations. In Germany, this has to happen in compliance with the waste classification 35326 "Mercury, Mercury-containing Residue, Mercury Vapor lamps, Fluorescent lamps, High voltage Tubular lamps", in other countries, the respective national regulations have to be adhered to.

Please read carefully the instructions given in section 9, "Safety/Warning Instructions."

Mercury fill of OSRAM HBO® mercury short arc lamps

Power level	Mercury fill [mg]
200 W versions	maximum 120
350 W versions	maximum 300
500 W versions	maximum 500
1,000 W versions	maximum 600
1,500 W versions	maximum 800
2,000/2,500 W versions	maximum 5000
3,500 W and bigger	maximum 12,000

8. PROBLEMS – FAULT ANALYSIS – TIPS AND REMEDIES

This chapter will provide a description of common application issues in the operation of HBO® lamps. Typical and frequently occurring items will be described in detail; tips and suggestions will be given to help the customer ensure reliable and trouble-free operating conditions. If additional information is needed, you may contact our Semiconductor Lamp Representatives or OSRAM Photo Optic Customer Technical Services.

8.1 Ignition failure

There are two stages to the starting of OSRAM HBO® lamps. The first requires ignition or ionization of the lamp's noble gas. Step one provides a completed conductive path for lamp current and establishes conditions for internal pressurization. Step two is the actual warm-up of the lamp where the mercury lamp filling changes from a liquid to vapor and the lamp stabilizes to its actual operating values. If there are problems in lamp starting we must first differentiate between ignition failure and start failure; for example, if no ignition spark is noticeable between the electrodes or if a spark is noticeable but no discharge develops.

In direct-current operation, the following parameters have to be adhered to for the ignition of HBO® lamps:

If the lamp ignites with difficulty or not at all, the following tests should be carried out:

Ignition Problems

- Does the high voltage get lost on the way from the ignition device to the lamp by corona discharge?
- Has the auxiliary ignition wire been fitted correctly and is it undamaged (applies only for lamps, for which an auxiliary ignition wire is supplied)?

Starting Problems

- Does the lamp flash inside when trying to start or begin to start and extinguish (ignition step completed)? Is the power supply's open circuit voltage present and of correct value?
- Is the current lead-in interrupted?
- Has the lamp been damaged (e.g. cracks in the glass, loose electrodes)?
- Is there an ideal electric contact between the lamp base and socket (no discoloration, no oxidation)?

8.2 Degradation

HBO® lamps will age in the course of their service life, which will also include the blackening of the bulb caused by material deposits from the electrode tips and the deposition of the vaporized tungsten on the inside wall of the bulb.

In the case of prematurely blackened lamps, the following tests should be carried out:

- Are the lamp's operational current and voltage values correct or being effected (lowered) by system cooling?
- Is the starting behavior of the lamp normal (about five to ten minutes)? Severe blackening will be caused by a hold in the starting phase.
- Was the lamp switched on more frequently? A higher switching rate will reduce the service life and increase the blackening process.

8.3 Overheated connector base and/or cables

HBO® lamps for semiconductor applications operate at high currents and wattages. A large share of the electric power has to be dissipated as heat through convection/cooling and radiation. The metal connector bases (nickel-coated brass as a rule) are of special consideration. While the bulb has to reach a high temperature to vaporize the mercury filling, the bases have to be cooled to avoid internal sealing oxidation. Oxidation of the base and its internal components could destroy electrical contact and sealing integrity. Base cooling is usually achieved by forced cooling and/or thermal conduction to the socket. Good mechanical contact to a socket free of surface corrosion is mandatory. Electrical connections to the lamp must also be sufficient and secure to maintain lamp current flow. Faulty electrical connections causes contact resistance which obstructs lamp current leading to damaging, extra heat generation. The base temperature is a very good indicator for a correct and balanced temperature system. If the permissible upper limit of 200-230 °C / 392-446 °F is exceeded, the base will discolor due to oxidation. With minimal excess temperature, the discoloration is slightly yellow progressing into straw yellow, yellowish orange, brown, and finally blue with increasing temperature. A table with the tarnishing colors of bases versus temperature can be found on page 26.

In order to prevent lamp connector base thermal overloading, the following measures have to be observed:

- Do not use lamps with tarnished bases – check the lamp’s cooling (fan failed, convection air flow openings blocked, forced air outlet misaligned).
- In order to prevent contact resistance, the connection between base and socket should be positive locking.
- The equipment’s lamp socket can experience wear and deterioration from use and should be inspected/serviced at regular intervals. If the socket has signs of discoloration or if it has a severely oxidized or corroded surface it should not be fitted with a new lamp, but it should be replaced with a new socket. Even a perfectly new lamp would fail prematurely due to a damaged socket. Prior to the installation of a new lamp, the lamp housing and especially the lamp sockets should always be checked.



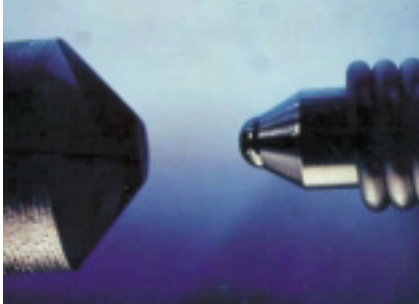

8.4 Too little light

HBO® lamps are renowned for their high luminance, large ultraviolet radiation and good luminous efficacy. Due to the high power concentration in the arc, the luminous flux or radiation flux can be utilized ideally for demanding applications. As per our specifications, a lamp may have a maximum of thirty percent decrease in initial intensity when reaching a specified service life. If there is too little light, please check as follows:

- Has the electrode spacing changed considerably as compared to when the lamp was new? Are the electrode tips severely deformed?
- Is the lamp bulb considerably darkened or opaque on the outside?
- Does the optical system of the associate equipment appear to have a coating or film on its optical surfaces?
- Has the optical adjustment been optimized in the unit?

8.5 Problems and solutions

There are a number of reasons why a lamp may not give satisfactory performance. The following may help you to locate and correct the more common problems that can cause failure, and ensure longer life for the replacement lamp.

	Symptom	Fault	Remedy
1	 Connector base discolored	Connector base overheated above 230°C due to: <ul style="list-style-type: none"> - Faulty electrical connection - Improper lamp cooling - Improper operating current 	Check electrical connections and cooling conditions: <ul style="list-style-type: none"> - Tighten or renew - Check operating current - Check cooling system (ventilator or convection)
2	 Base cement blackened	Connector base overheated; improper lamp cooling	Check electrical connections and cooling conditions
3	 Severe electrical damage on cathode, electrode tip melted spherical	Reversed polarity due to: <ul style="list-style-type: none"> - Electrical feed incorrectly supplied to lamp - Faulty wiring - Wrong lamp installed 	<ul style="list-style-type: none"> - Check polarity, transpose connection if necessary - Check equipment and set-up - Check lamp type
4	 Abnormal deformations of the electrode tips	<ul style="list-style-type: none"> - High current ripple - Lamp operated outside current control range (overshooting) 	<ul style="list-style-type: none"> - Check current setting - Ensure proper quality current (low current ripple) - Check rectifier/power supply

9. SAFETY/WARNING AND OPERATING INSTRUCTIONS

In accordance with ANSI/IESNA Standard RP-27, HBO® lamps are a Risk Group 3 product. Read this entire statement before using any OSRAM HBO® lamp.

9.1 Rupture & radiation (UV-visible) hazards

The discharge vessel of HBO® lamps is constructed of quartz glass that is filled with a quantity of mercury and either Argon or Xenon gas. Most HBO® lamps are not at positive pressure when cold (not operating, at room temperature). However, there are several HBO® lamps that DO have a positive internal pressure of up to approximately 8 bar (or approximately 120 psi) in the cold (room temperature) state. The printing of the following **bold** warning statement on their individual packages identifies them as positive-pressure lamps:

WARNING: HIGH PRESSURE HANDLE WITH CARE

Government-approved (OSHA-approved in the U.S.A.) safety glasses, facemask (with neck protector), chest protector, and gauntlets must be worn when handling lamps to avoid personal injury from lamps rupture. See complete warnings and instructions inside package.

These positive-pressure lamps may unexpectedly rupture resulting in the discharge of quartz and/or metal fragments as well as exposing the surrounding area to mercury. In the event of such a rupture, there is a risk of personal injury or property damage. Therefore these positive-pressure lamps should be handled in accordance with the following safety instructions:

All HBO® lamps have high internal pressures (400 – 1100 psi or 30 to 75 bar) during operation and may unexpectedly rupture resulting in the discharge of hot fragments (approximately 800°C / 1472°F) of quartz and/or metal particles, as well as the release of mercury/mercury vapor. In the event of such a rupture, there is a risk of personal injury, burns, and fire.

All HBO® lamps generate intense ultraviolet (UV) and visible radiation during operation. This radiation can cause permanent damage to the eyes (including blindness) and serious injury to the skin (including burns and blistering). To avoid eye damage, other personal injury, and/or property damage, the lamp **MUST** be operated in a suitable fixture.

A suitable fixture is one that will prevent the arc from being viewed directly while operating, and in the event of a lamp rupture, will prevent hot (up to 800°C / 1472°F), flying fragments of quartz and/or metal from escaping into the area.

Fixtures for lamps that produce ozone during operation should be ventilated and filtered to the outside for ozone removal. To minimize the risk of a lamp rupture, replace the lamp at or before the end of rated life (see OSRAM product catalog for rated life) or when the lamp shows signs of blackening.

Broken lamps (mercury vapor release and disposal)

In the event of a lamp rupturing during operation, all personnel should leave the area immediately to avoid the inhalation of mercury vapor. The area should then be thoroughly ventilated for a minimum of 30 minutes or until the mercury vapor in the area is below the ACGIH TLV (American Conference of Governmental Industrial Hygienists Threshold Limit Value). Inhaling vapor or small particles of mercury or its compounds can be harmful to lungs, kidneys, and nervous system. Penetration of the skin or ingestion can also be harmful.

To avoid mercury vapor getting into air conditioning systems, instruments/equipment using lamps of 350 watts or greater should be connected to separate air exhaust systems through mercury vapor-absorbing filters. When the lamp housing has cooled, **mercury residue may be picked up with special mercury adsorptive agents or a mercury vacuum cleaner (available from laboratory safety equipment suppliers) and disposed of in accordance with local, state, and federal regulations.** There should be no direct skin contact with and/or inhalation of mercury residues that may be residing in lamp housing, optics or lamp parts. If a cold (room temperature) lamp is broken, proceed with clean-up and disposal as indicated in the **bold, italic** statement above.

9.2 General safety & installation tips

Installation

Do not use if lamp is scratched, cracked, or damaged in any way. To prevent electric shock, shut off main power to the fixture before attempting to service or replace lamp. To avoid damaging the quartz and causing premature lamp failure, do not handle lamp with bare hands. Only handle lamp with safety-appropriate, clean gloves. See special, bolded warning for using OSHA-approved safety equipment when handling positive-pressure lamps. If the quartz parts are inadvertently touched, clean fingerprints off with denatured alcohol and wipe dry with a soft, clean, lint-free cloth. Do not use cleaning rags or material that can leave a residue. To prevent skin burns, allow lamp to cool before handling.

To avoid breakage, mounting of the lamp must be free of mechanical stress during installation and during operation by allowing for thermal expansion along its axis. For this reason, HBO® lamps should be fixed at one end only and the electrical connection on the other end must be flexible enough so that no stress is placed on the lamp. HBO® lamps should not be subjected to force/stress during installation. Replace all fixture covers and shields after replacing lamp to prevent eye damage, other personal injury, or property damage. Use only in instruments/equipment specifying this light source.

Make sure lamp is properly installed into socket/connector to obtain good electrical and thermal contact and avoid damaging lamp and/or socket/connector. Electrical connections should be free from dirt and corrosion. Socket/connector condition may affect lamp life. Replace socket/connector or lamp if deterioration (pitting, scorching, corrosion, etc.) of either is observed.

Operation

Some HBO® lamps are designed for operation on only AC or only DC while some are designed for operation on either AC or DC. Note: all HBO® lamps with power consumption of 350 W and higher are only suited for DC operation. Make sure that the polarity is correct before turning power on. Incorrect polarity can destroy the lamp in a matter of seconds. Operate with compatible power supply and fixture only.

To ensure that AC-suited lamps operate at correct power during AC operation, connections on the ballast/choke in the power supply should be made to the voltage taps that are marked the same as the marking on the lamp base (L1 or L2). Some power supplies are equipped with a switch (or taps) for selecting L1 or L2. For correct and safe lamp operation, use only those ballasts/power supplies that have been approved or meet minimum requirements as specified by OSRAM. See your OSRAM dealer for list of approved equipment.

HBO® lamps need 5 to 20 minutes (depending on lamp type and cooling conditions) before they reach their operating temperatures. To ensure proper ignition on the following start-up, lamps should not be switched off during the warm-up period.

The average service life of high wattage HBO® lamps (>350 watts) is determined by their ON/OFF-duty cycle. These lamps have been designed for a limited amount of ignitions only (less than 10). Lamp performance is reduced with increased duty cycle.

Operating position

HBO® lamps may only be operated in the operating positions described in the OSRAM Photo Optics product catalog.

Some HBO® lamps are designed to operate horizontally (mainly low wattage types in the power range of 50 to 200 W) and others, vertically (all lamp types with power consumption of 350 W and higher). Greater arc stability is obtained in vertically operating lamps when they are operated as close to vertical as possible. See catalog for permissible operating positions and electrode positions.

Ozone generation

During operation, HBO® lamps produce a spectrum that ranges from about 150 nm in the ultraviolet region to the infrared region.

If the quartz glass bulb is transparent in the ultraviolet region between 180 and 220 nm, this short-wave radiation will convert a small quantity of atmospheric oxygen (O₂) surrounding the lamp into ozone (O₃). Moreover, the oxygen molecules will link together with the nitrogen (N₂) in the air, thus creating so-called nitrogen oxides (NO_x).

Ozone is a gas. Like nitrogen oxide, ozone is toxic when inhaled in high concentrations over long periods of time. Ozone levels can be measured and monitored with commercial measuring equipment. Always keep ozone levels below the applicable TLV (threshold limit value).

The production of ozone and nitrogen oxide can be suppressed by using doped quartz glass, which absorbs the ozone-producing ultraviolet radiation. The quartz glass used in high wattage i-line (365nm) enhanced HBO® lamps only transmits wavelengths above 250 nm, which provides effective, ozone-free lamps. Please be advised that the OSRAM HBO® 4000 W/PL lamp is designed to generate UV wavelengths below 250 nm. Consequently, this lamp will generate ozone in operation and should be externally ventilated.

An "ozone smell" (or smell of nitrogen oxide) may be detected shortly after ignition. There are two probable causes for this condition. O₃ and NO_x production is caused by the (short-duration) radiation of the spark gap used for lamp ignition. Or, the cold condition of the quartz glass bulb has slightly shifted its UV-absorption characteristics thus permitting a small amount of radiation in the very short-wave ultraviolet range to be emitted by the bulb. Typically, after the lamp has run up to its operating temperature range, virtually no ozone is produced by the lamp, as a rule, due to the quartz glass absorption and the self-absorption of the plasma.

Lamp cooling

To prevent premature failure, lamp base temperatures must be kept below 230°C (446°F) for 50 to 350 watt lamps and below 200°C (392°F) for all lamps with power consumption of more than 350 W. Discoloration, surface pitting, and/or corrosion of the lamp connections indicates a thermal overload. Components exhibiting these conditions must be cleaned or replaced. If convection cooling is insufficient and additional cooling is required, cooling fins may be applied to the bases and/or forced air may be used. If forced air is used, care must be taken to direct airflow at the bases only. Striking elsewhere on the lamp with the airflow will result in poor lamp performance or premature failure.

Lamp removal

Turn off power to the lamp and allow lamp to cool (forced or convection) for a minimum of 30 minutes prior to shutting main fixture power and opening fixture. Do not remove lamp until it has cooled. See special, bolded warning for using OSHA-approved safety equipment when handling positive-pressure lamps.

Lamps should be placed in their original OSRAM packaging for temporary storage until disposal and/or transportation to a disposal location. See "lamp transportation" and "lamp disposal" sections below for relevant information.

Lamp transportation

All HBO® lamps should be transported ONLY in their original packaging. Transportation in non-original packaging can damage the lamp and void warranty. U.S. Federal regulations require mercury-containing lamps to be shipped ONLY in DOT-compliant packaging. Original OSRAM packaging is DOT-compliant. When transporting positive-pressure lamps, the bolded warning found in the "rupture & radiation hazards" section MUST be placed on outside surface of the shipping carton and the warning instructions must also be placed inside the shipping packaging.

Mercury is referred to by its chemical symbol, Hg, which is derived from the Greek and Latin *hydrargyrum*, a silvery shining liquid metal at room temperature. In humid air it is covered with a gray oxide skin. Of all metals it has the highest vapor pressure which increases exponentially with rising temperatures. For this reason, mercury is volatile at room temperature. The colorless and odorless vapors produced are poisonous and heavier than air. The inhalation (respiration) of mercury or mercury compounds as vapor or dust will lead to the damage of lungs, kidneys, and the nervous system. Apart from inhalation, mercury can be transmitted through the skin (penetration) or through the gastro-intestinal tract (ingestion), which is also harmful.

The threshold limit value for mercury is 0.1 mg/m³ in compliance with the German Technical Regulations for Dangerous Substances TRGS 900. In Japan this value is 0.05 mg/m³, in the USA 0.075 mg/m³. The threshold limit value is a measure for the maximum concentration in case of repeated and long-time exposure until the general health of a worker is impaired.

Threshold limit values (TLVs) are **not** fine lines between safe and dangerous concentrations but are guidelines to assist in the control of health hazards. They represent the maximum exposure to substances, both short-term and long-term, that a person may experience without resulting in health-related problems. Therefore, the TLV for mercury should never be exceeded.

Analytical detection of mercury vapor is possible by means of gas/vapor detector tubes (rough measurement) or air-monitors that absorb mercury vapor.

9.3 Mercury fill of HBO® lamps

OSRAM HBO® lamps have the following mercury contents:

Power level	Maximum Mercury content (mg)
50 – 200 W	20
350 W	300
500 W	500
1,000 W	600
1,500 W	800
2,000 – 2,500 W	5,000
3,500 W and higher	12,000

Properties of Mercury:

Chemical symbol:	Hg
Atomic number:	80
Molecular weight:	200.59
Density:	13.6g/cm ³ @ 20°C / 68°F
Melting point:	-39°C / -38.2°F
Boiling point:	357°C / 674°F
Vapor pressure:	160 Pa @ 20°C / 68°F 370 Pa @ 30°C / 86°F 823 Pa @ 40°C / 104°F
Concentration in air:	13.6 mg/m ³ @ 20°C / 68°F 29.6 mg/m ³ @ 30°C / 86°F 62.7 mg/m ³ @ 40°C / 104°F
CAS registry number:	7439-97-6
RCRA waste number:	U151
Other names:	Hydrargyrum, Colloidal mercury, Kwik, Mercure, Mercurio, Metallic mercury, Quecksilber, Quick silver, Liquid Silver

9.4 Lamp disposal

Disposal of spent lamps must be in accordance with applicable national, federal, state/provincial, and local regulations. Some U.S. states differ in their disposal requirements for lamps containing mercury. Lamp users in the USA may obtain information concerning relevant agencies and disposal regulations from the Federal Superfund Hotline (Resource Conservation & Recovery Act) at 800-424-9346. Information may be available as to the appropriate state agencies to contact regarding disposal issues. In other countries please contact your local sales office.

Special disposal note for cold, positive-pressure lamps (see "rupture & radiation hazards" section for applicable lamps)

There is a risk that these lamps could rupture because of their high internal pressure when hot (during operation) and when cold (at room temperature when not operating). A lamp rupture could result in personal injury or property damage from flying fragments of quartz and/or metal. Therefore, spent (end-of-life) lamps should ALWAYS be stored in the packaging in which they originally came.

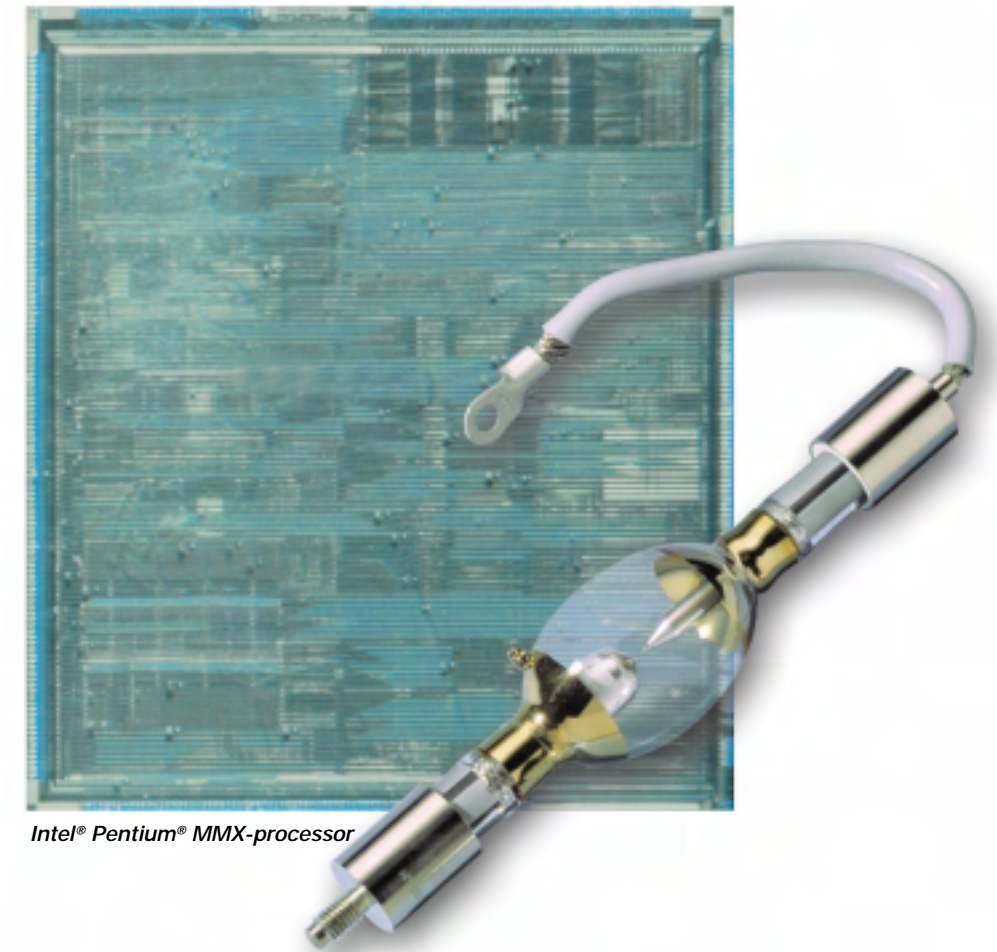
10. QUALITY CONTROL

The quality of our products is ensured and safeguarded by extensive monitoring in our quality control system. We resolutely adhere to the parameters specified with our customers and defined in our publications.

All manufacturing equipment used is continually tested for its ability to operate within process controlled levels. In our manufacturing we utilize complete product test planning. Our test plan determines which tests have to be carried out on the initial, semi-finished, and finished product.

A one hundred percent test at the end of production comprises the measurement electric parameters, geometry (such as Light Center Length (LCL), axially, electrode spacing and concentricity. For example, apart from a visual inspection, parameters and processes are assessed critically by product and process audits. Potential faults can be identified by a recorded tracing system down to root cause and eliminated by expedient counter measures. To continuously obtain data on the service life behavior of the lamps, representative checks are carried out in our measuring laboratory on life test lamps accompanying the production.

In the unlikely event of an application problem, our technical service personnel in co-operation with the specialists from the production and development departments can solve problems competently and by accommodating arrangements with our customers.



Intel® Pentium® MMX-processor

11. THE OSRAM PRODUCT RANGE

Lamps for ASML Equipment

Lamp type	Service life [h]	Equipment	page
HBO 350 W	600	PAS 2500/10, /30, /40	40
HBO 450 W/GS	600	PAS 2500/10-PEP, /30-PEP, /40-TEP	40
HBO 500 W/A	800	PAS 5000/50, PAS 5500/60, /80-500 W	40
HBO 500 W/B	800	PAS 5000/50, /45A, /55A	40
HBO 1003 W/PI; PIL	850; 1500	PAS 5500/60B, /80B, /100, /100B	41
HBO 1003 W/PIL	1500	PAS 5000/45B, /55B, PAS 5000-SPRINT	41
HBO 1500 W/PI; PIL	850; 1500	PAS 5000/22, /100C, /100D, TFH 100	41
HBO 2500 W/PI; PIL	850; 1500	PAS 5500/200	41
HBO 3500 W/PI	850	PAS 5500/200B, /250C	41
HBO 3500 W/PIL (SHP-series)	1500	PAS 5500/200B, /250C	41
HBO 3501 W/PI	850	PAS 5500/400B, /400C	41
HBO 3501 W/PIL (SHP-series)	1500	PAS 5500/400B, /400C	41

Lamps for Canon Equipment

Lamp type	Service life [h]	Equipment	page
HBO 500 W/A	800	FPA 112 FA, 141	42
HBO 500 W/B	800	FPA 1500	42
HBO 1000 W/CL; /CEL	1500; 2500	FPA 1550 Mark I, II	42
HBO 1002 W/CL; /CEL	1500; 2500	FPA 1550 Mark III, IV	42
HBO 1500 W/CIL; /CIEL	1500; 2250	FPA-2000 i1 & FPA-2500 i2, i3	43
HBO 2001 W/CI; /CIL; /CIEL	850; 1500; 2250	FPA-3000 i4, i5, i5+(step1), iW, MR-type	43
HBO 2002 W/MA	1000*	MPA-500, 501, 600 FA(b) / SUPER, MPA 1500 (LCD)	43
HBO 2700 W/CIL	1500	FPA-3000 i5+ (step2)	43

Lamps for Nikon Equipment

Lamp type	Service life [h]	Equipment	page
HBO 250 W/BY	1000	Edge bead exposure	44
HBO 500 W/B	800	NSR 1505 G, G3, NSR 1010 i3	44
HBO 1000 W/NL; /NEL	1500; 2500	NSR-1505 G3,G4,A,B,C,D	44
HBO 1002 W/NL; /NEL	1500; 2500	NSR-1505 G5,G6,7,8,L	44
HBO 1002 W/NI; /NIL	850; 1500	NSR-1505 i6A,7A,8A, NSR 1755 i7A/B	45
HBO 2000 W/NIL	1500	NSR-2005 i8A	45
HBO 2001 W/NIL; /NIEL	1500; 2250	NSR-2005 i9C,i10; NSR-2205 i11C, D	45
HBO 2002 W/NIL	1500	NSR-2205 i11SHRINC 3	45
HBO 2011 W/NIL	1500	NSR-2205 i12 C, D; NSR -TFH i12	46
HBO 2501 W/NIL	1500	NSR-4425i	46
HBO 2510 W/NIL	1500	NSR-2205 i14E, i14E2	46
HBO 4300 W/N	850	FX-501 D3, D4, 601F	46

*initial input wattage ≤ 1,700 W



Lamps for Süss Equipment

Lamp type	Service life [h]	Equipment	page
HBO 200 W/DC	1000	MJB3	47
HBO 350 W/S	600	MA4, MA6, MA 8, MA 150, MJB3, MJB 21, UV 300/500	47
HBO 1000 W/D	1000	MA150, MA200, MA4, MA6, MA8	47

Lamps for GCA Equipment

Lamp type	Service life [h]	Equipment	page
HBO 350 W	600	DSW 4800-5000	48
HBO 450 W/GS	400	DSW 6000	48
HBO 1000 W/G	750	DSW 8000 G, Maximum 2000	48
HBO 1002 W/G	750	ALS, Auto stop pulsed	48
HBO 1000 W/GI	750	DSW 8000 I	49

Lamps for SVGL Equipment

Lamp type	Service life [h]	Equipment	page
XBO 150 W/CR OFR	3000	Micrascan II Alignment lamp	50
HBO 4000 W/PL	1000	Micrascan II	50

Lamps for MRS Equipment

Lamp type	Service life [h]	Equipment	page
HBO 3500 W/MR	1000	Series 4500 Panel Printer	50



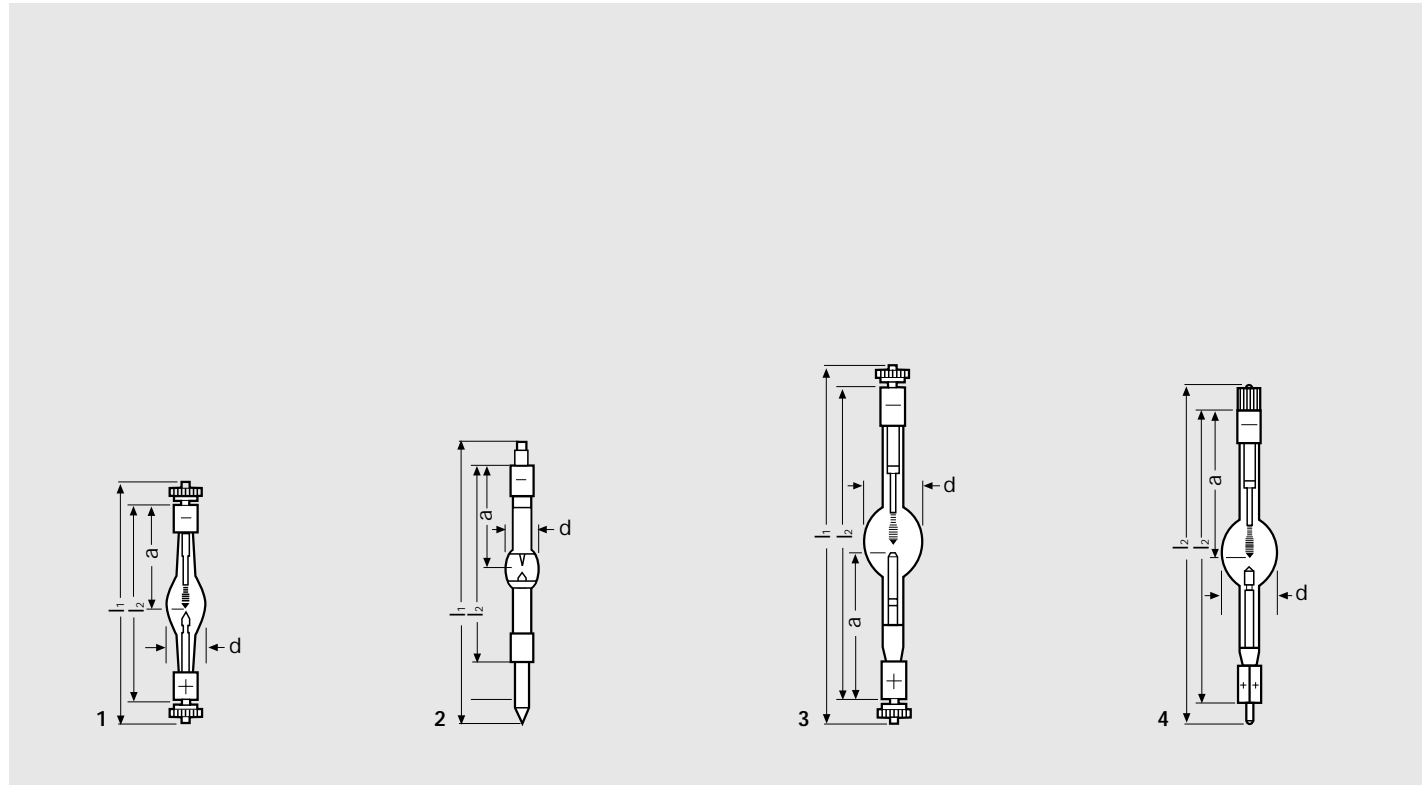
Others

Lamp type	NAED	Service life [h]	Equipment	page
HBO 201 W/HS-D2	¹⁾	1000/2000*	TEL equipment, Mark 7/8	-
HBO 250 W/HS	^{1) 2)}	1000/2000*	TEL equipment, ACT 8	-
64602	54138	1000	Halogen 12 V, 50 W for Nikon body 8, 11	51
HLX 64623	54052	1000	Halogen 12 V, 100 W for Nikon body 14E	51
64637	54165	1500	Halogen 12 V, 100 W for Canon i4, i5, iw	51
64743 HT	54584	300	Halogen 120 V, 1000 W FEL for Fusion Gemini Asher	51
64773	54588	200	Halogen 120 V, 2000 W for Gasonics Asher	51
HBO 50 W/AC (L1/L2)	69213/69214	100	Wafer Inspection, microscopes	51
HBO 100 W/2	69217	200	Wafer Inspection, microscopes	51
HBO 103 W/2	69182	300	Wafer Inspection, microscopes	51
HBO 250 W/BY	69246	1000	Edge bead exposure (Nikon, Ushio)	44
LF 62YELLOW 18, 36 and 58 W			Yellow fluorescent for cleanrooms	51

*1000 h maintenance, 2000 h explosion

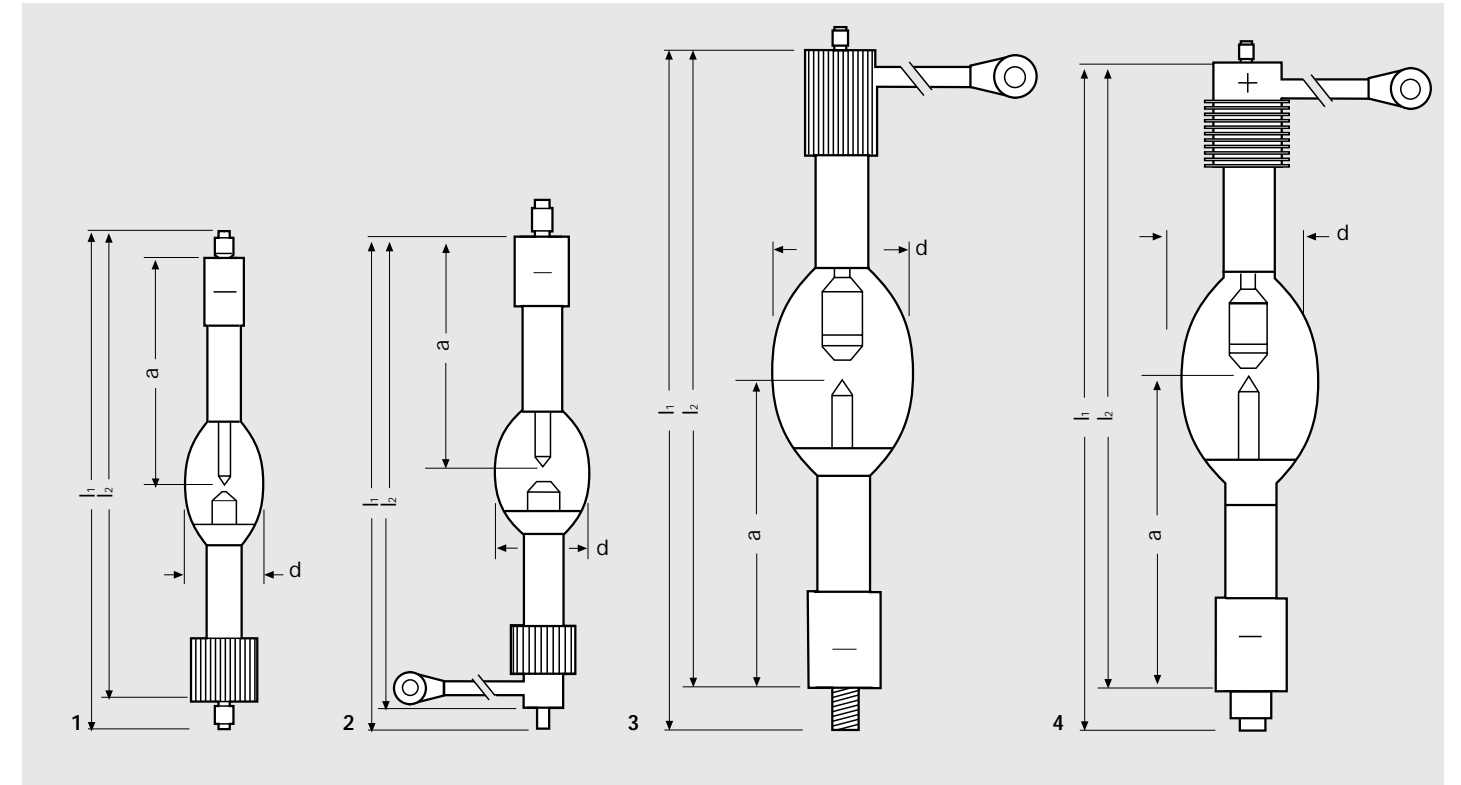
¹⁾ Not available at print, please ask your local sales office

²⁾ Introduction: 10/2000



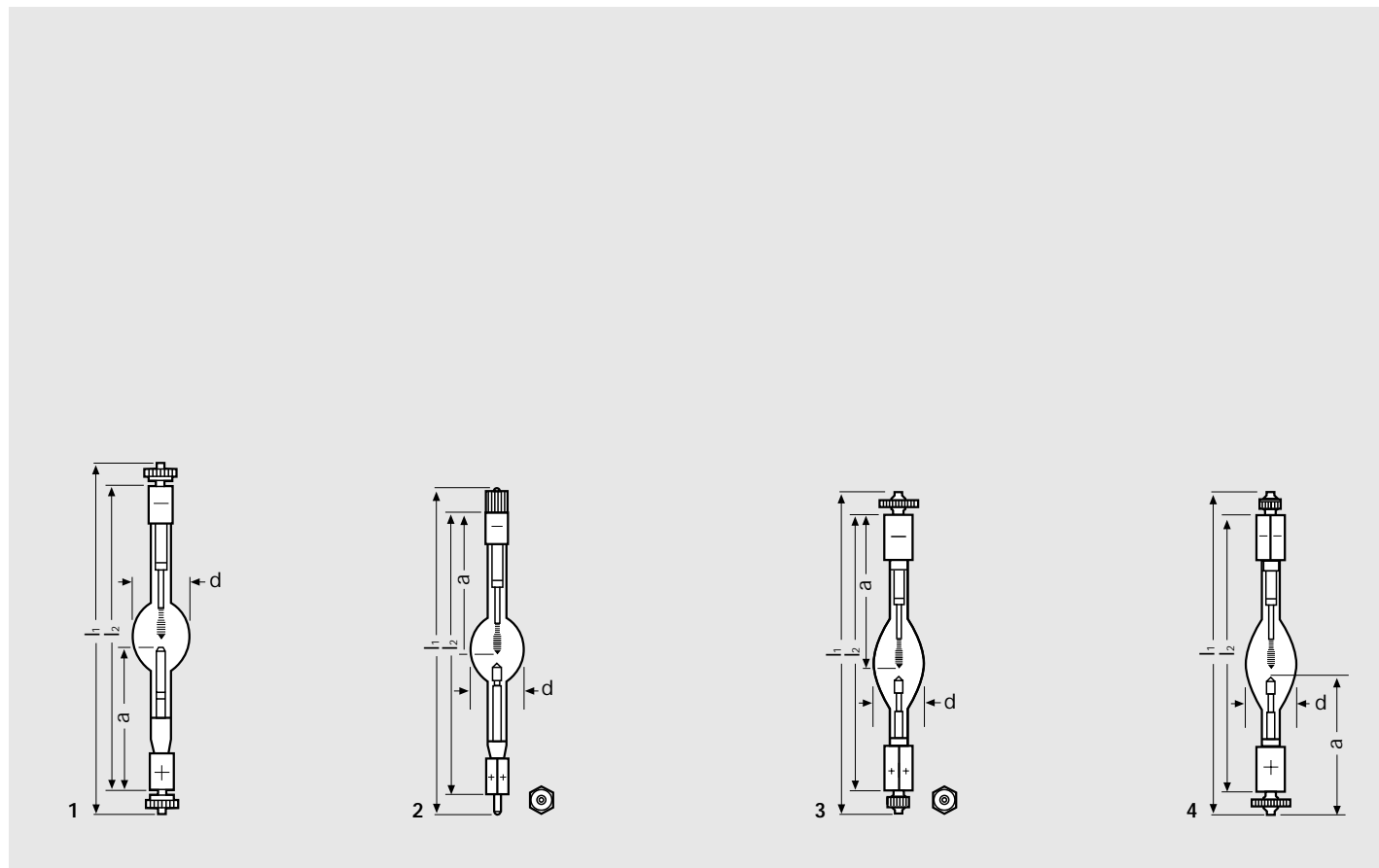
Equipment type	PAS 2500/10, /30, /40	PAS 2500/10-PEP, /30-PEP, /40-TEP	PAS 5000/50, PAS 5500/60, /80-500 W	PAS 5000/50, /45A, /55A
Lamp type	HBO 350 W ³⁾	HBO 450 W/GS	HBO 500 W/A	HBO 500 W/B
NAED code (USA only)	69226	- ⁴⁾	69205	69206
Type of current	DC	DC	DC	DC
Rated lamp wattage	W 350	450	500	500
Lamp voltage (rated value)	V 67.5	50	60	48.5
Lamp current (rated value)	A 5.3	9	8.3	10.3
Radiant power in 350 ... 450 nm range	W 46	-	61	60
Radiant intensity in 350 ... 450 nm range	mw/sr 4600	-	6200	5800
Average lamp life	h 600	600	800	800
Cooling ²⁾	convection	convection	convection	convection
Operating position	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath
Diameter d	mm 20	22	29	29
Length l ₁ max.	mm 128	150	190	180
Length l ₂ nominal/max.	mm 100/102	105	160/161.5	150/151.5
Distance a ¹⁾	mm 45	52	73	78.5
Electrode gap cold	mm 2.9	2.2	4.5	3
Base	anode SFcY 10-4 with thread 8-32 UNC-3A	SFcy 13-5	SFcy 13-5 with thread M 5x 0.9	SFcy 13-5/20 hexagon base with thread M 5x 0.9
	cathode SFcY 10-4 with thread 8-32 UNC-3A	SFcy 13-4 with thread 8-32 UNC-3A	SFcy 13-5 with thread M 5x 0.9	SXFc 13-5/20 with thread M 5x 0.9
Fig. No	1	2	3	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
 2) Maximum permissible base temperature 200 °C
 3) HBO 350 W/G was substituted by HBO 350
 4) Not available at print, please ask your local sales office



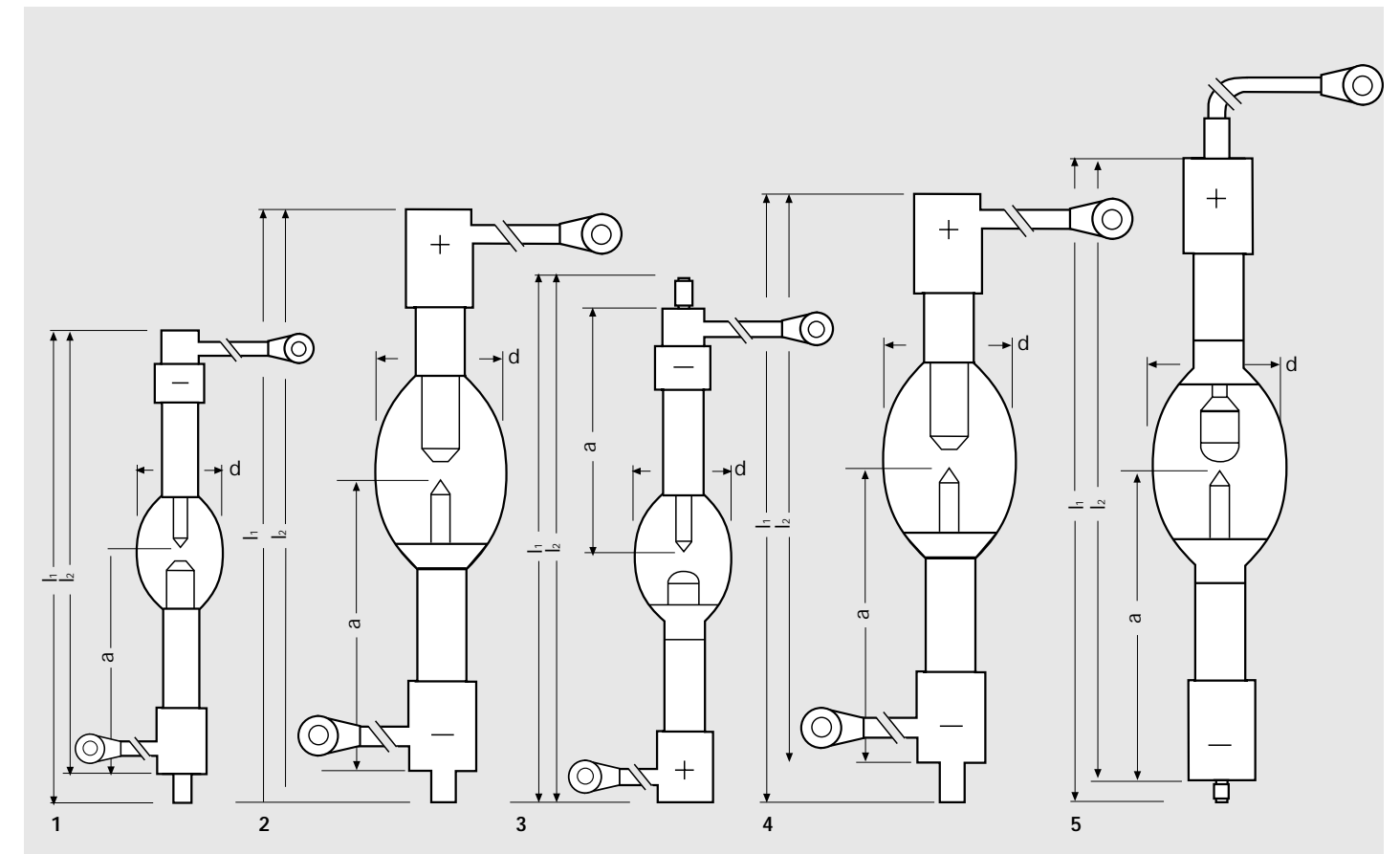
Equipment type	PAS 5500/60B, /80B, /100, /100B PAS 5000/45B ⁶⁾ , /55B ⁶⁾ PAS 5000-SPRINT ⁶⁾	PAS 5500/100C, /100D, TFH 100	PAS 5500/200	PAS 5500/200B, /250C	PAS 5500/400
Lamp type	HBO 1003 W/PIL ³⁾	HBO 1500 W/PIL	HBO 2500 W/PIL	HBO 3500 W/PIL ⁵⁾	HBO 3501 W/PI ⁵⁾
NAED code (USA only)	69180	69181	69172	69169	- ⁴⁾
Type of current	DC	DC	DC	DC	DC
Rated lamp wattage	W 750 (700/1000)	1500	2500	3400	3400
Lamp voltage (rated value)	V 27.1	23	28	23	23
Lamp current (rated value)	A 25.8	65.2	90	148	148
Radiant intensity in the wavelength range 365 +/- 2.5 nm	mW/sr 2400	4850	8200	9000	9000
Average lamp life	h 1500 ³⁾	1500 ³⁾	1500 ³⁾	1500 ³⁾	1500 ³⁾
Cooling ²⁾	forced base cooling, cooling fins on anode base	forced base cooling, cooling fins	Forced base cooling	Forced base cooling	Forced base cooling
Operating position	vertical, anode underneath	vertical, anode underneath	vertical, anode up	vertical, anode up	vertical, anode up
Diameter d	mm 29	46	62	77	77
Length l ₁ max.	mm 195	273	350	360	360
Length l ₂ nominal/max.	mm 167.5/169.5	240/242	312.5/315	312.5/315	312.5/315
Distance a ¹⁾	mm 85	118	149	154	154
Electrode gap cold	mm 3	4	6.7	4.5	4.5
Base	cathode SFc 15-6/25	SFc 27-10/35	SFc 30-6.5/50	SFc 32.5-6.7/50	SFc 32.5-6.7/50
	anode SFcX 14-6/25 with cooling fins	SFc 30-6/25 with cooling fins and cable connection (M8)	Sfa 30-6/50 with cable connection (M10)	SfaX 40-6/50 with cable connection (M10)	SfaX 40-6/50 with cable connection (M10)
Fig. No	1	2	3	4	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
 2) Maximum permissible base temperature 200 °C
 3) Also available with 850 h (HBO 1003 W/PI: NAED 69195, HBO 1500 W/PI: NAED 69319, HBO 2500 W/PI: NAED 69178, HBO 3500 W/PI: NAED 69174, HBO 3501 W/PI: NAED 69127)
 4) Not available at print, please ask your local sales office
 5) HBO 3500 W/PIL, HBO 3501 W/PIL: SHP-series, see page 13 for details
 6) Only HBO 1003 W/PIL



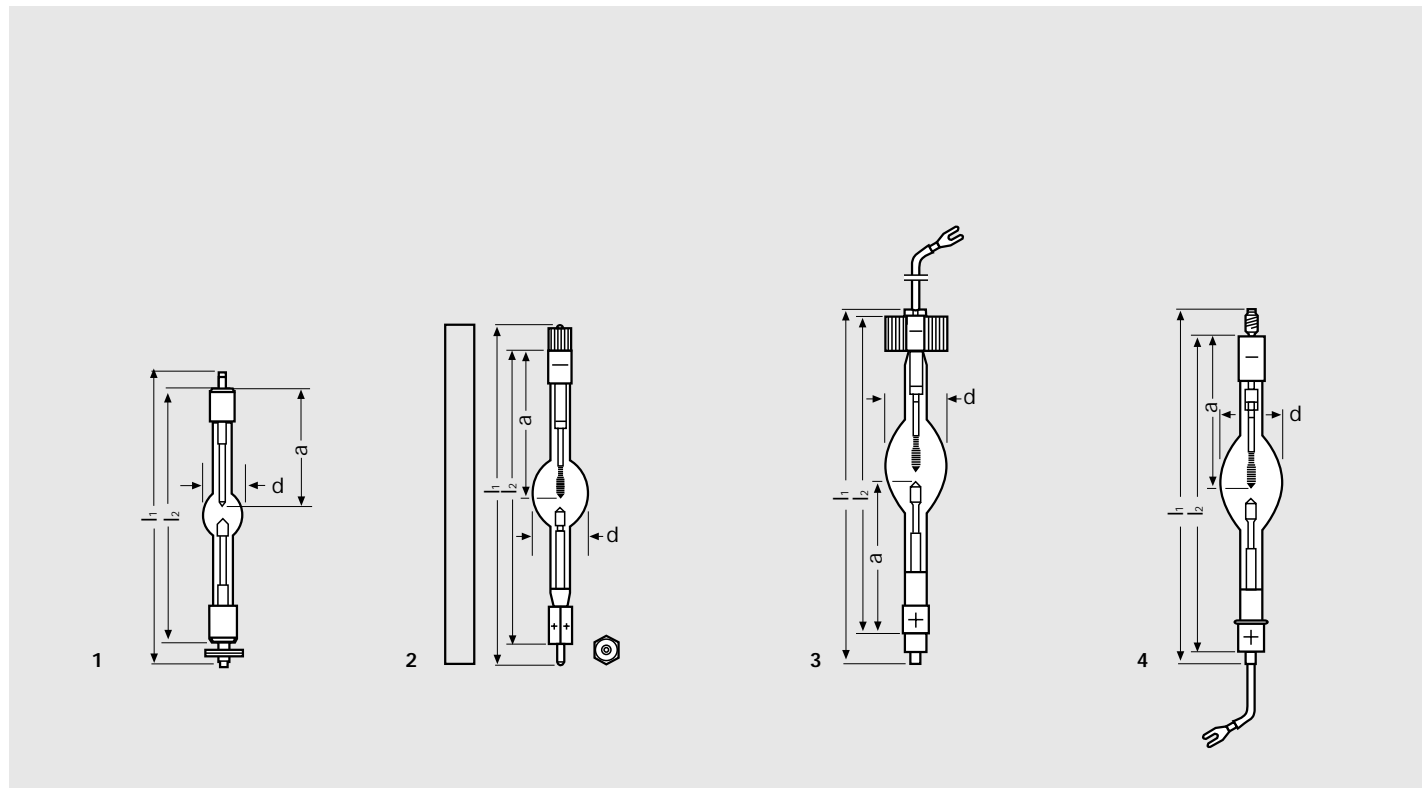
Equipment type	FPA 112 FA, FPA 141	FPA 1500	FPA 1550 Mark I, II	FPA 1550 Mark III, IV
Lamp type	HBO 500 W/A	HBO 500 W/B	HBO 1000 W/CEL ^{3) 4)}	HBO 1002 W/CEL ^{3) 4)}
NAED code (USA only)	69205	69206	69175	69177
Type of current	DC	DC	DC	DC
Rated lamp wattage W	500	500	750 (700/1000)	750 (700/1000)
Lamp voltage (rated value) V	60	48.5	47	47
Lamp current (rated value) A	8.3	10.3	16	16
Radiant power in 350 ... 450 nm range W	61	60	85	85
Radiant intensity in 350 ... 450 nm range mw/sr	6200	5800	8300	8300
Average lamp life h	800	800	2500 ³⁾	2500 ³⁾
Cooling ²⁾	convection	convection	convection	convection
Operating position	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath
Diameter d mm	29	29	28	28
Length l ₁ max. mm	190	180	175	175
Length l ₂ nominal/max. mm	160/161.5	150/151.5	155/157	155/157
Distance a ¹⁾ mm	73	78.5	78.5	78.5
Electrode gap cold mm	4.5	3	3	3
Base	anode	SFCY 13-5 with thread M 5x 0.9	SXFc 13-5/20 hexagon base with thread M5	SXFc 15-6/20 sleeve base with thread M6
	cathode	SFCY 13-5 with thread M 5x 0.9	SFCY 13-5/20 with thread M 5x 0.9	SFc 15-6/20 sleeve base with thread M6
Fig. No	1	2	3	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
 2) Maximum permissible base temperature 200 °C
 3) Also available with 1500 h (CL-Type), (HBO 1000 W/CL: NAED 69192, HBO 1002 W/CL: NAED 69193). 750 h lamp (C-type) obsolete



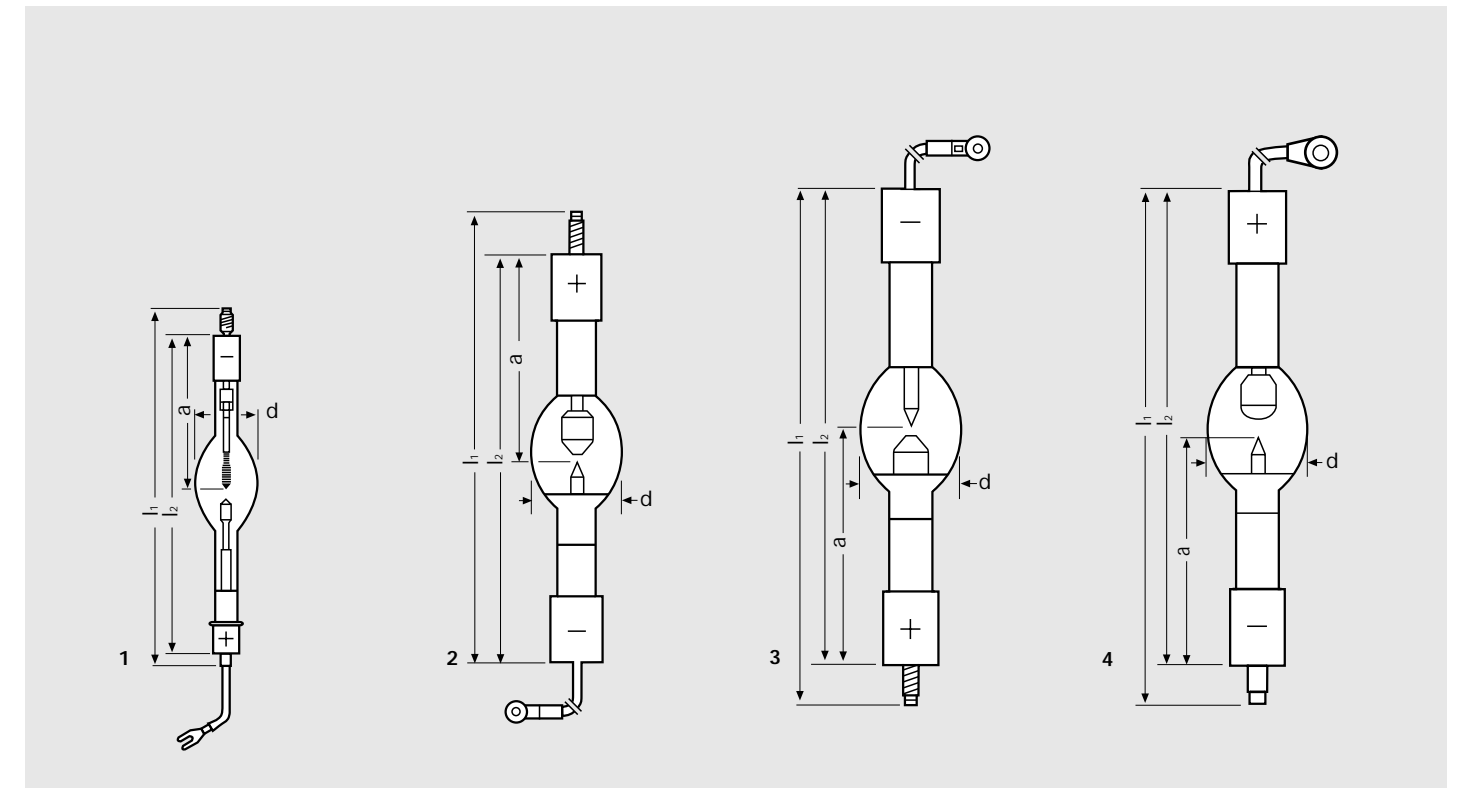
Equipment type	FPA-2000 i1 & FPA-2500 i2, i3	FPA-3000 i4, i5, i5+(step1), iW, MR-type	MPA-500, 501, 600 FA(b) / SUPER, MPA 1500 (LCD)	FPA-3000 i5++ (step2)	MPA-5000 (LCD)
Lamp type	HBO 1500 W/CIEL ³⁾	HBO 2001 W/CIEL ⁴⁾	HBO 2002 W/MA	HBO 2700 W/CIL	HBO 5000 W/C
NAED code (USA only)	69171	- ⁶⁾	69199	- ⁶⁾	- ⁶⁾
Type of current	DC	DC	DC	DC	DC
Rated lamp wattage W	1500	2000	max. 2400	2700	max. 5500
Lamp voltage (rated value) V	23	26	37	24.5	56
Lamp current (rated value) A	65.2	77	54	110	77
Radiant intensity in the wave-length range 365 +/- 2.5 nm mW/sr	4850	6050	4200	7900	
Average lamp life h	2250 ³⁾	2250 ⁴⁾	1000 ⁵⁾	1500	750
Cooling ²⁾	Forced base cooling	Forced base cooling	Forced base cooling	forced base cooling	forced base cooling
Operating position	vertical, anode underneath	vertical, anode up	vertical, anode underneath	vertical, anode up	vertical, anode up
Diameter d mm	52	62	62	62	82
Length l ₁ max. mm	262	329	292	334	353
Length l ₂ nominal/max. mm	240/242	307/309	270/272	307/309	328/330
Distance a ¹⁾ mm	122	148.75	138.5	148.75	157.5
Electrode gap cold mm	4	4	3		5
Base	cathode	SFa 27-20/22 with cable connection (M8)	Sfa 33.5-10/50 with cable connection (M6)	Sfa 27-10/35 with cable connection (M8)	SFa 33.5-14/50
	anode	SFa 27-10/35 with cable connection (M10)	SF 33.5/50 with cable connection (M8)	Sfa 27/35 with cable connection (M8)	SFa 33.5/50 with cable connection (M8)
					SFa 33.5-24/33 with cable connection (M10)
Fig. No	1	2	3	4	5

1) Distance from end of base to tip of anode or cathode, resp. (cold)
 2) Maximum permissible base temperature 200 °C
 3) Also available with 1500 h (HBO 1500 W/CIEL: NAED 69179). 850 h (CI-Type) obsolete .
 4) Also available with 850 h (HBO 2001 W/CI: NAED 69219) and 1500 h (HBO 2001 W/CI: NAED 69189)
 5) If initial input wattage ≤ 1700 W, for details please contact your local sales office
 6) Not available at print, please ask your local sales office



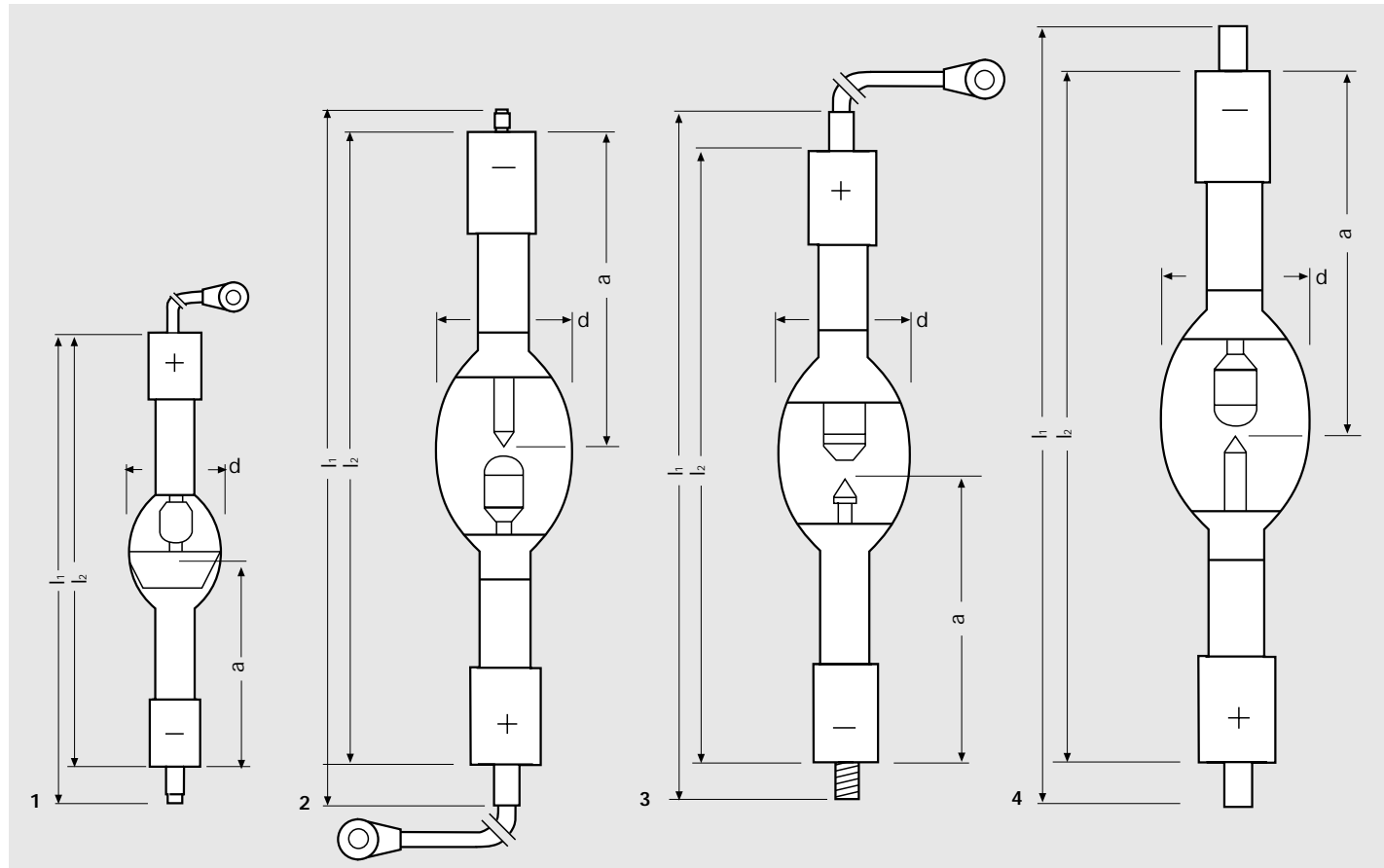
Equipment type	Edge bead exposure	NSR 1505 G	NSR-1505 G3, G4, A, B, C, D	NSR-1505 G5, G6, 7, 8, L
Lamp type	HBO 250 W/BY	HBO 500 W/B	HBO 1000 W/NEL	HBO 1002 W/NEL
NAED code (USA only)	69246	69206	69176	69273
Type of current	DC	DC	DC	DC
Rated lamp wattage	W	250	750 (700/1000)	750 (700/1000)
Lamp voltage (rated value)	V	40	47	47
Lamp current (rated value)	A	6.5	10.3	16
Radiant power in 350 ... 450 nm range	W	-	60	82
Radiant intensity in 350 ... 450 nm range	mw/sr	-	5800	8300
Average lamp life	h	1000	800	2500 ³⁾
Cooling ²⁾	forced base cooling	convection	convection, cooling fins on cathode base	convection
Operating position	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath
Diameter d	mm	20	29	28
Length l ₁ max.	mm	152	180	190
Length l ₂ nominal/max.	mm	-/125	150/151.5	166/168
Distance a ¹⁾	mm	62	78.5	84.5
Electrode gap cold	mm	2	3	3
Base	anode	SFc 13-5/20	SFc 13-5/20 hexagon base with thread M 5x 0.9	SFa 15-5/16 sleeve base without thread
	cathode	SFc 13-5/20	SFcY 13-5/20 with thread M 5x 0.9	SFaX 14-5/21 cooling fins cable connection (M5)
				SFaX 14-5/21 sleeve base with cable connection (M5)
				SFc 15-6/25 sleeve base with thread M6
Fig. No		1	2	3

1) Distance from end of base to tip of anode or cathode, resp. (cold)
 2) Maximum permissible base temperature 200 °C
 3) Also available with 1500 h (HBO 1000 W/NL: NAED 69196, HBO 1002 W/NL: NAED 69194). 750 h lamp (N-type) obsolete



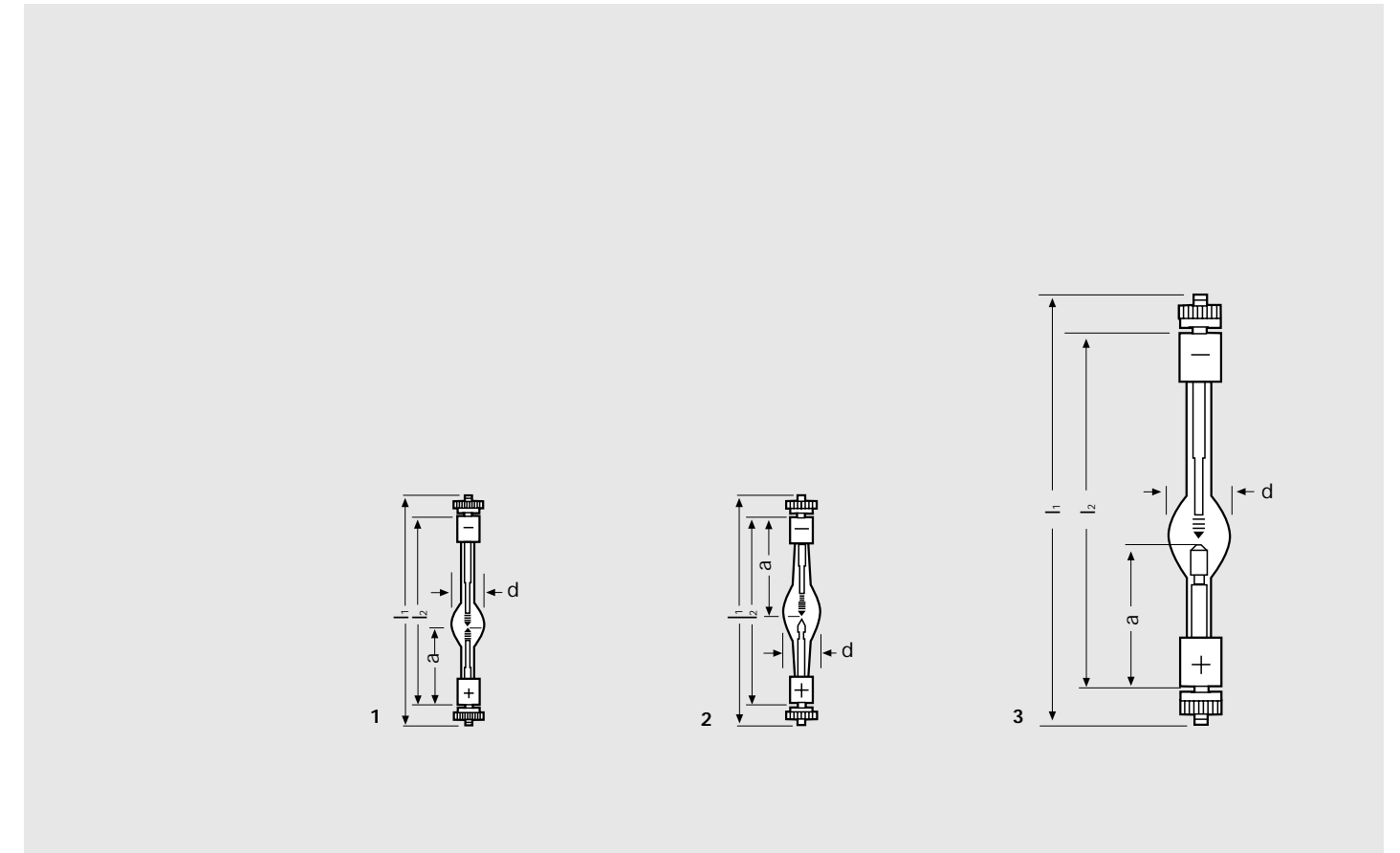
Equipment type	NSR-1505 i6A, 7A, 8A	NSR-2005 i8A	NSR-2005 i9C, i10; NSR-2205 i11C, D	NSR-2205 i11 SHRINC 3
Lamp type	HBO 1002 W/NIL	HBO 2000 W/NIL	HBO 2001 W/NIEL	HBO 2002 W/NIL
NAED code (USA only)	-	69303	69306	69287
Type of current	DC	DC	DC	DC
Rated lamp wattage	W	750 (700/1000)	1750	1750
Lamp voltage (rated value)	V	25.8	26	26
Lamp current (rated value)	A	27.1	67	67
Radiant intensity in the wave-length range 365 +/- 2.5 nm	mW/sr	2400	5200	5500
Average lamp life	h	1500 ⁴⁾	1500	2250 ³⁾
Cooling ²⁾	forced base cooling	Forced base cooling	Forced base cooling	Forced base cooling
Operating position	vertical, anode underneath	vertical, anode up	vertical, anode underneath	vertical, anode up
Diameter d	mm	29	52	52
Length l ₁ max.	mm	187	251	251
Length l ₂ nominal/max.	mm	166/168	219/221	229/231
Distance a ¹⁾	mm	78.5	112.25	112.25
Electrode gap cold	mm	3	4.5	4.5
Base	cathode	SFcX 15-6/25 with thread M6	SFc 27-7/35 with cable connection (M8)	SFc 27-7/35 with cable connection (M8)
	anode	SFaX 14-5/21 with cable connection (M5)	SFc 27-12/35	SFc 27-10/35
				SFc 27-10x1.25/35
Fig. No		1	2	3

1) Distance from end of base to tip of anode or cathode, resp. (cold)
 2) Maximum permissible base temperature 200 °C
 3) Also available with 1500 h (HBO 2001 W/NIL: NAED 69317). 850 h (NI-Type) obsolete.
 4) Also available with 850 h (HBO 1002 W/NIL: NAED 69187)



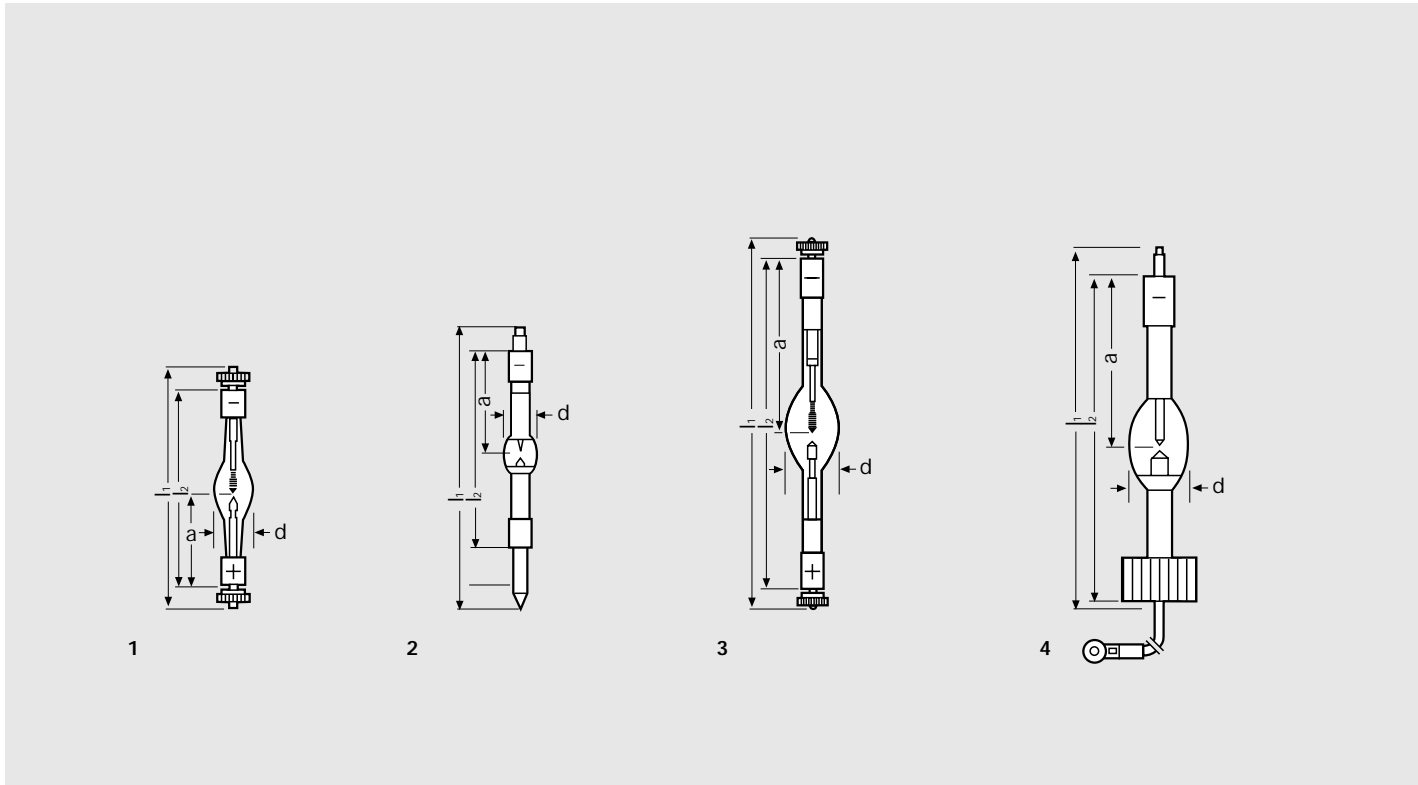
Equipment type		NSR-2205 i12 C, D; NSR -TFH i12	NSR-4425i	NSR-2205 i14E, E2	FX-501, 601F
Lamp type		HBO 2011 W/NIL	HBO 2501 W/NIL	HBO 2510 W/NIL	HBO 4300 W/N
NAED code (USA only)		69288	69289	69299	-
Type of current		DC	DC	DC	DC
Rated lamp wattage	W	2000	2500	2500	4300
Lamp voltage (rated value)	V	25	23	23	45
Lamp current (rated value)	A	80	110	109	96
Radiant intensity in the wave-length range 365 +/- 2.5 nm	mW/sr	5700	7800	7800	-
Average lamp life	h	1500	1500	1500	750
Cooling ²⁾		Forced base cooling	Forced base cooling	Forced base cooling	Forced base cooling
Operating position		vertical, anode up	vertical, anode underneath	vertical, anode up	vertical, anode up
Diameter d	mm	52	70	70	80
Length l ₁ max.	mm	256	367	367	387
Length l ₂ nominal/max.	mm	234/236	325/327	325/327	335/337
Distance a ¹⁾	mm	107.75	157.75	157.75	177.5
Electrode gap cold	mm	4.5	4.5	4.5	5
Base	cathode	SFc 27-12x1.5/35	SFc 33.5-14/50	SFc 33.5-14/50	SFc 33.5-12/50
	anode	SFc 27-7/35 with cable connector (M8)	SFc 33.5-8/50 with cable connector (M8)	SFc 33.5-8/50	SFc 33.5-14/50
Fig. No		1	2	3	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C



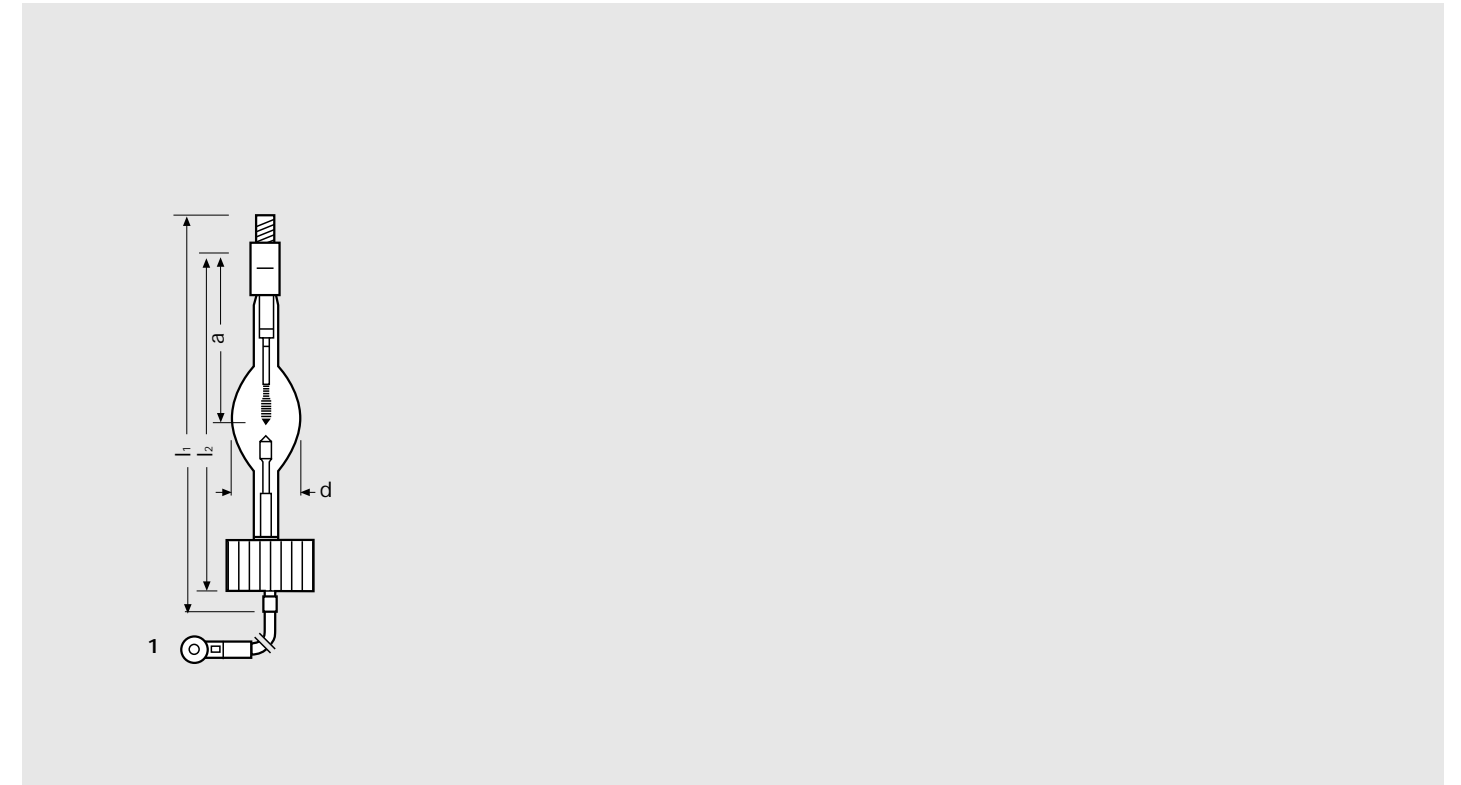
Equipment type		MJB3	MA4, MA6, MA8, MA150, MJB3, MJB21, UV 300/500	MA150, MA200, MA4, MA6, MA8
Lamp type		HBO 200 W/DC	HBO 350 W/S	HBO 1000 W/D
NAED code (USA only)		69225	69228	69200
Type of current		DC	DC	DC
Rated lamp wattage	W	200	350	1000
Lamp voltage (rated value)	V	57	68	37.7
Lamp current (rated value)	A	3.5	5.15	26.5
Radiant power in 350 ... 450 nm range	W	-	50	105
Radiant intensity in 350 ... 450 nm range	mw/sr	-	4700	10.8
Average lamp life	h	1000	600	1000
Cooling ²⁾		convection	convection	convection
Operating position		vertical, anode underneath	vertical, anode underneath	vertical, anode underneath
Diameter d	mm	17	20	40
Length l ₁ max.	mm	128	127	240
Length l ₂ nominal/max.	mm	100/102	101/103	206/208
Distance a ¹⁾	mm	40	52.5	89.5
Electrode gap cold	mm	2.5	3	3
Base	anode	SFc 10-4	SFcY 10-4 with thread 8-32 UNC-3A	SFc 15-6/25
	cathode	SFc 10-4	SFcY 10-4 with thread 8-32 UNC-3A	SFc 15-6/25
Fig. No		1	2	3

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C



Equipment type	DSW 4800-5000	DSW 6000	DSW 8000 G, Maximum 2000	ALS, Auto stop pulsed
Lamp type	HBO 350 W ³⁾	HBO 450 W/GS	HBO 1000 W/G	HBO 1002 W/G
NAED code (USA only)	69226	-	69208	-
Type of current	DC	DC	DC	DC
Rated lamp wattage	W 350	350	750 (700/1000)	750 (700/1000)
Lamp voltage (rated value)	V 67.5	50	47	47
Lamp current (rated value)	A 5.3	7	16	16
Radiant power in 350... 450 nm range	W -	43.8	85	85
Radiant intensity in 350... 450 nm range	mw/sr -	4500	8300	8300
Average lamp life	h 600	600	600	600
Cooling ²⁾	convection	convection	convection	convection, cooling fins on anode base
Operating position	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath
Diameter d	mm 20	20	28	28
Length l ₁ max.	mm 128	127	197	190
Length l ₂ nominal/max.	mm 100/102	101/103	167.5/169.5	167.5/169.5
Distance a ¹⁾	mm 45	52.5	85	85
Electrode gap cold	mm 2.9	3	3	3
Base	anode	SFcY 10-4 with thread 8-32 UNC-3A	SFcY10-4/15	SFcX 14-6/25 with thread 8-32 UNC-3A
	cathode	SFcY 10-4 with thread 8-32 UNC-3A	SFcY10-4/15	SFcX 15-4/20 with thread 8-32 UNC-3A
Base				SFcX 15-4/20 with thread 8-32 UNC-3A
				SFcX 14-6/25 with cooling fins and cable connection (M4)
Fig. No	1	2	3	4

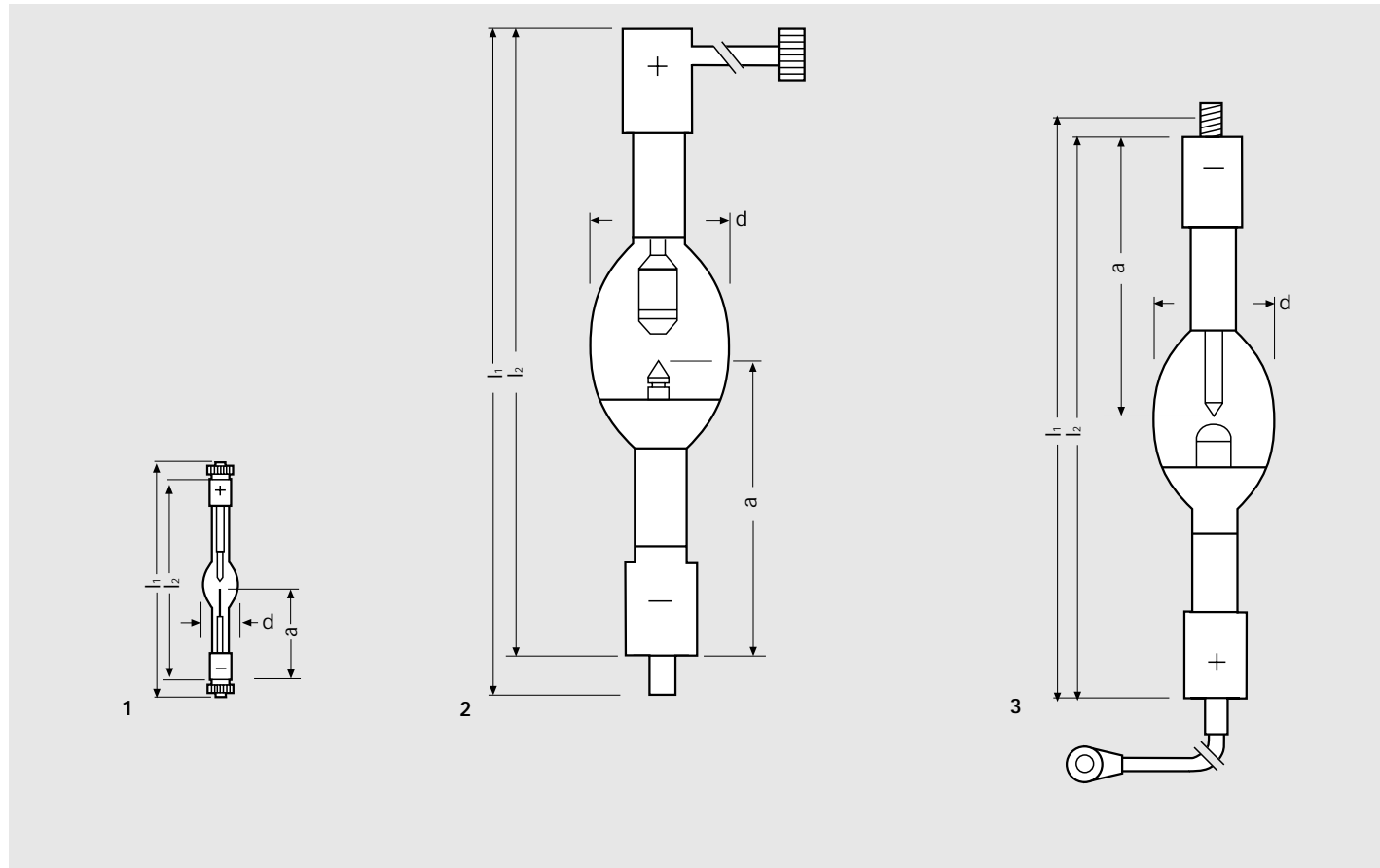
1) Distance from end of base to tip of anode or cathode, resp. (cold)
 2) Maximum permissible base temperature 200 °C
 3) HBO 350 W/G was substituted by HBO 350



Equipment type	DSW 8000 I	
Lamp type	HBO 1000 W/GI	
Type of current	DC	
Rated lamp wattage	W 700 (700/1000)	
Lamp voltage (rated value)	V 26.8	
Lamp current (rated value)	A 26.1	
Radiant intensity in the wave-length range 365 +/- 2.5 nm	mW/sr 2400	
Average lamp life	h 850	
Cooling ²⁾	convection, cooling fins on anode base	
Operating position	vertical, anode underneath	
Diameter d	mm 29	
Length l ₁ max.	mm 197	
Length l ₂ nominal/max.	mm 167.5/169.5	
Distance a ¹⁾	mm 85	
Electrode gap cold	mm 3	
Base	cathode	SFc 15-6/25
	anode	SFcX 14-6/25 with cable connection (M5)
Fig. No	1	

1) Distance from end of base to tip of anode or cathode, resp. (cold)
 2) Maximum permissible base temperature 200 °C

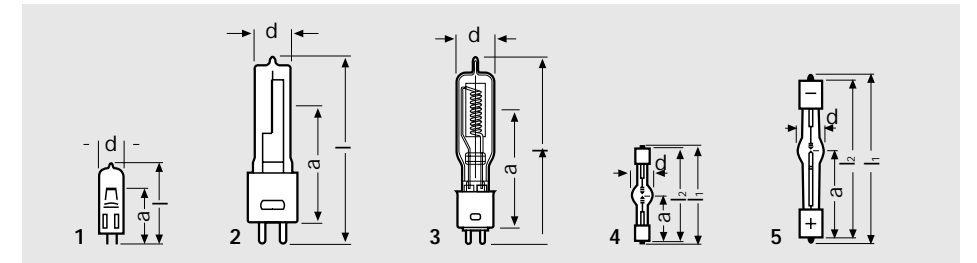
SVGL and MRS



Equipment type	SVGL Micrascan II Alignment lamp	SVGL Micrascan II	MRS Series 4500 Panel Printer
Lamp type	XBO 150 W/CR OFR	HBO 4000 W/PL	HBO 3500 W/MR
NAED code (USA only)	69237	69290	69173
Type of current	DC	DC	DC
Rated lamp wattage	W 150	3500 / 4000	3500
Lamp voltage (rated value)	V 17.5	38	56
Lamp current (rated value)	A 8.5	92.5	62
Average lamp life	h 3000	1000	1000
Cooling ²⁾	convection	forced base cooling	forced base cooling
Operating position	vertical, anode up	vertical, anode up	vertical, anode underneath
Diameter d	mm 20	77	70
Length l ₁ max.	mm 150	363	317
Length l ₂ nominal/max.	mm 125/127	338/342	290/292
Distance a ¹⁾	mm 57	158	141.7
Electrode gap cold	mm 1.9	5	6.6
Base	anode SFcX 12-4	SF 33.5/50 with cable connection	SFc 27-5/35 with cable connection (M8)
	cathode SFc12-4	SFc 33.5-10/50	SXFc 27-8/35
Fig. No	1	2	3

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C

Lamps for other applications in semi-conductor industry

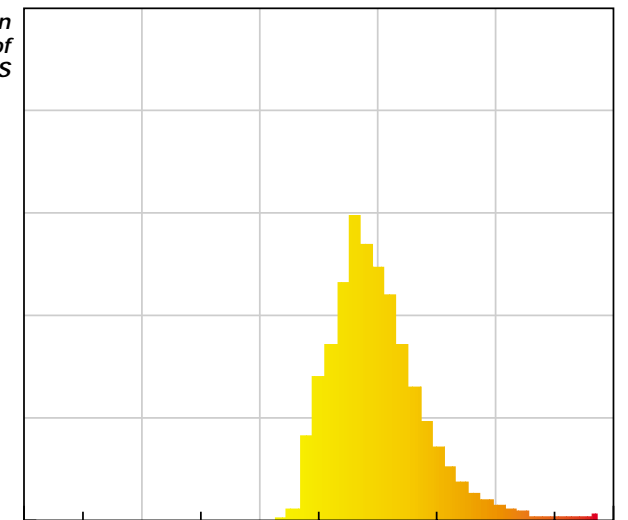


Lamp reference	64602	HLX64623	64743 HT	64773	HBO 50 W/AC	HBO 100 W/2	HBO 103 W/2
ANSI code	-	EVA	FEL	-	-	-	-
NAED code (USA only)	54138	54052	54570	54588	69213/69214	69217	69182
Type of current					AC	DC	DC
LIF code	M/134	M/28	CP/ 77	-	-	-	-
Lamp voltage	V 12	12	120	120	37/42 (L1/L2)	20	22.5
Wattage	W 50	100	1000	2000	50	100	100
Current	A				1.45/1.3 (L1/L2)	5.0	4.3
Base	G6.35	G6.35	G9.5	G9.5	-	-	-
Base anode					SFa8-2	SFa9-2	SFa9-2
Base cathode					SFa6-2	SFa7.5-2	SFa7.5-2
Average/service life	h 1100	2000	300	200	100	200	300
Luminous flux	lm 100	2800	27500	-	2000	2200	3000
Luminous efficacy	lm/W				40	22	30
Luminous intensity	cd				230	260	300
Average luminance	cd/cm ²				30000	170000	170000
Luminous area w x h	mm				0.3 x 1.00	0.25 x 0.25	0.25 x 0.25
Bulb Type	-	-	T-6	-	-	-	-
Color temperature	-	-	3200	3200	-	-	-
Operating position	s90	p90/15	any	any	s45 anode underneath	s90 anode underneath	s90 anode underneath
Diameter d	mm 11.5	9	20	27	8.5	10	10
Length l/max	mm 44	35	101	101	53	90	90
Length l ₂ /max	mm -	-	-	-	47	82	82
Distance a	mm 30	27	60.3	60.3	22	43	43
Filament dimensions w x h	mm 3.0 x 3.0	4.7 x 2.7	7 x 18	-			
Standard pack	pcs 100	100	12	12			
Fig. no.	1	1	2	3	4	5	5

The perfect light for clean-room manufacture

UV-STOP LF 62 YELLOW has been specially developed for use in areas in which the UV and blue components of the spectrum are prohibited. It is therefore used primarily in microchip fabrication plants for clean-room lighting and in print shops for exposing printing plates.

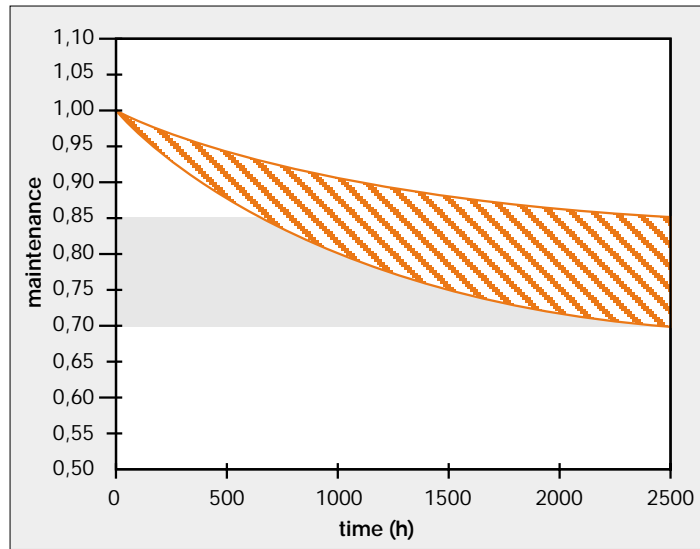
Spectral radiation distribution of LF 22-940 UVS



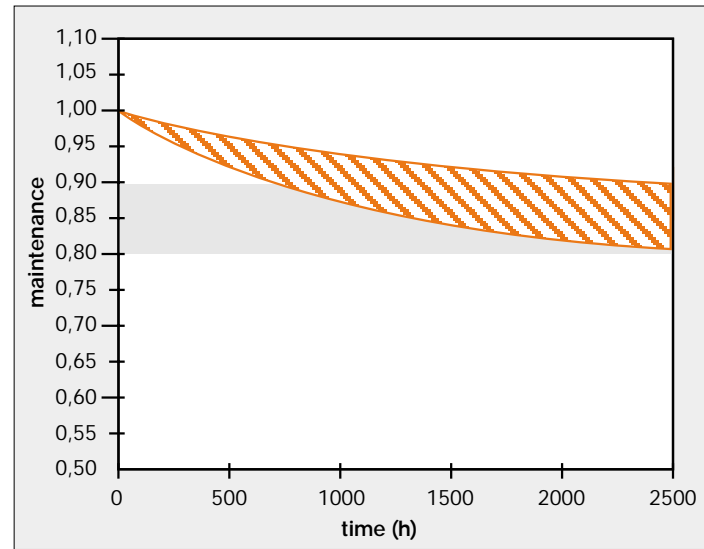
LF 62 YELLOW (UV-STOP)

Lamp reference	L 18 W/62	L 36 W/62	L 58 W/62
Luminous flux	980 lm	2300 lm	3700 lm
Light colour	62 YELLOW	62 YELLOW	62 YELLOW
Length	590 mm	1200 mm	1500 mm
Diameter	26 mm	26 mm	26 mm

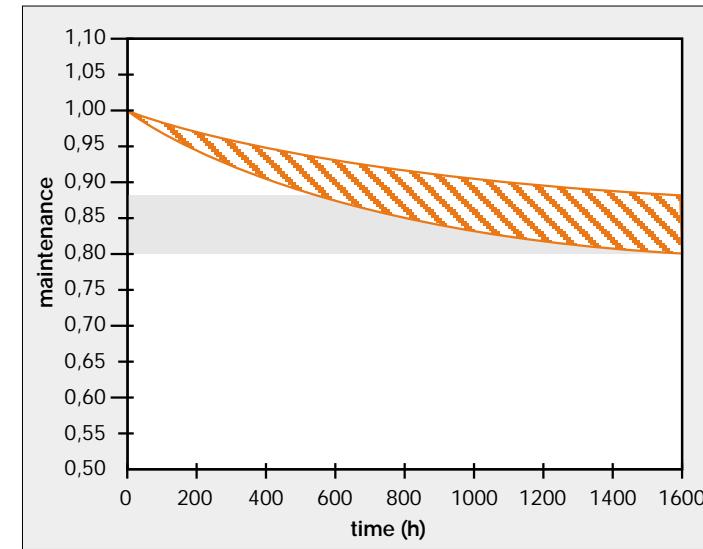
12. TYPICAL DEGRADATION OF LAMPS IN THE EXPOSURE SYSTEM



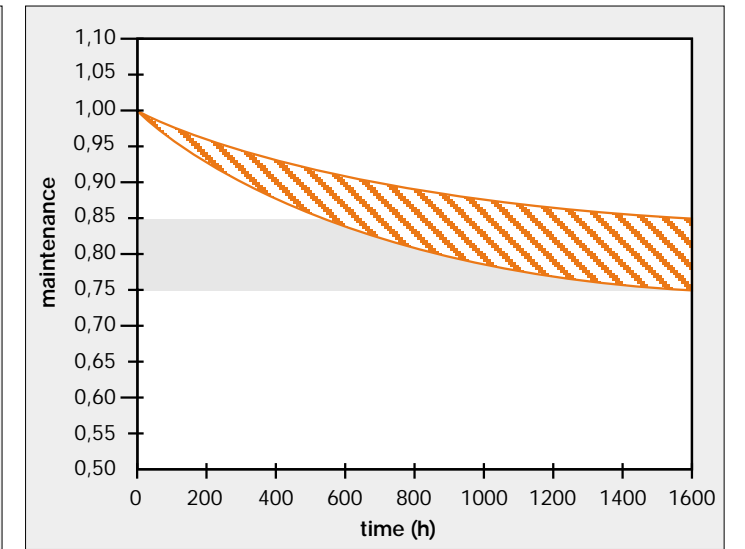
HBO 1000 W/NEL



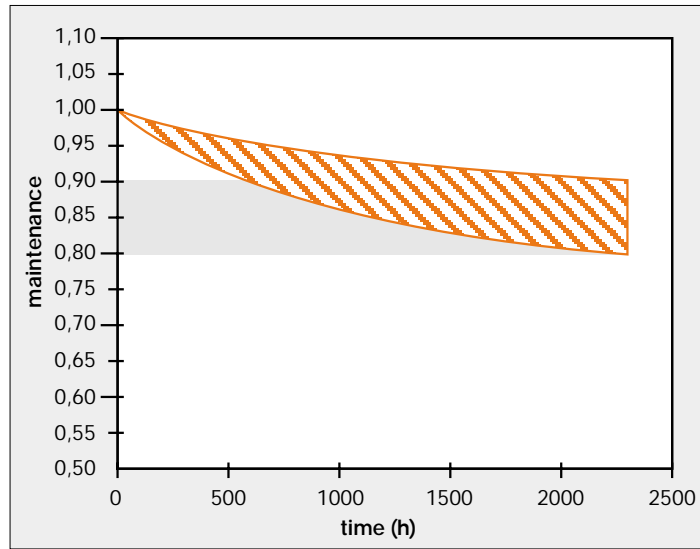
HBO 1002 W/CEL



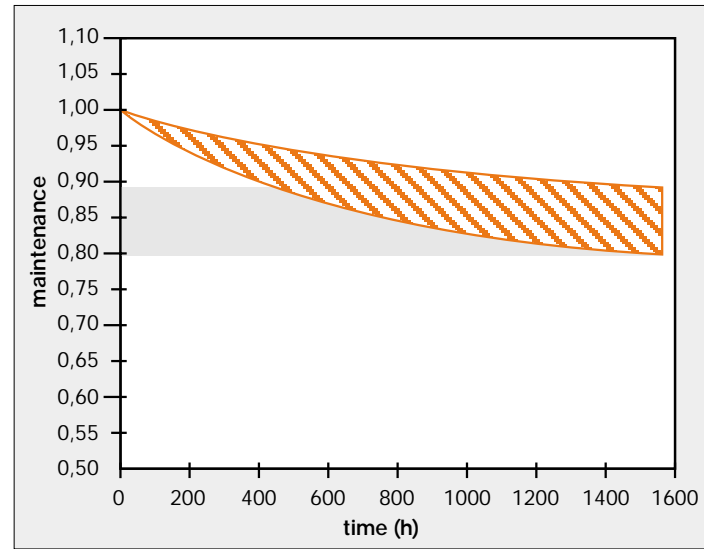
HBO 2002 W/NIL



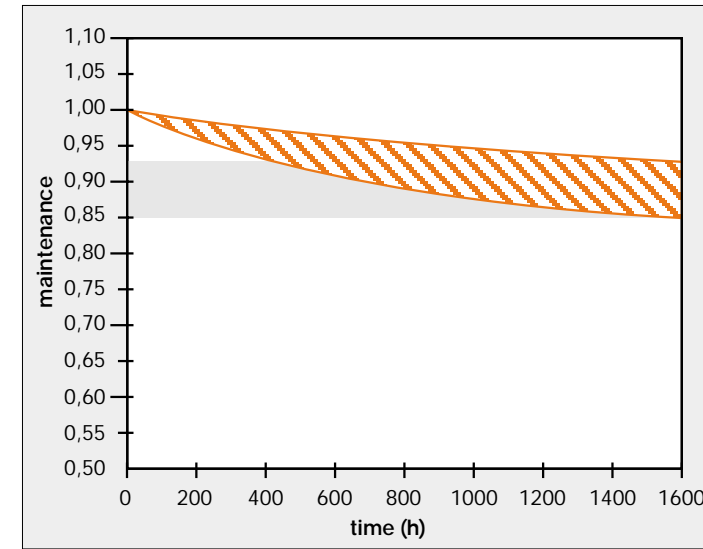
HBO 2011 W/NIL



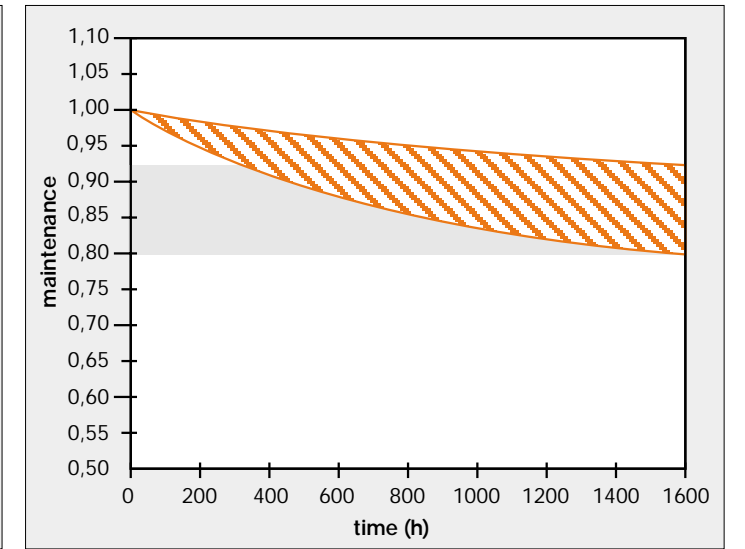
HBO 1500 W/CIEL



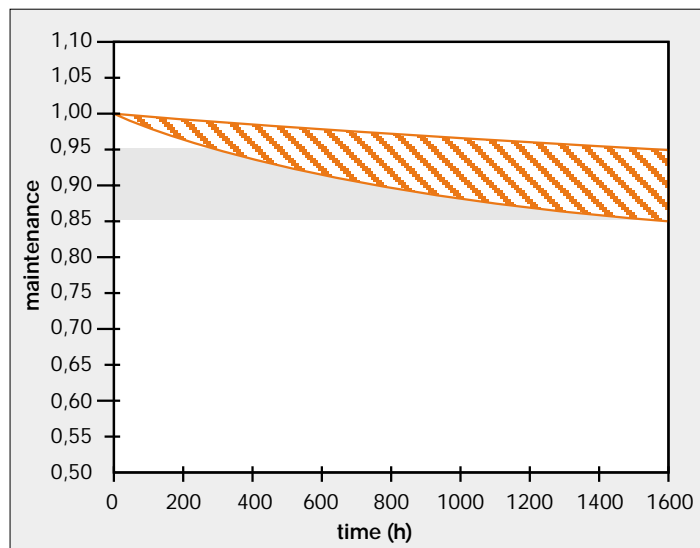
HBO 2000 W/NIL



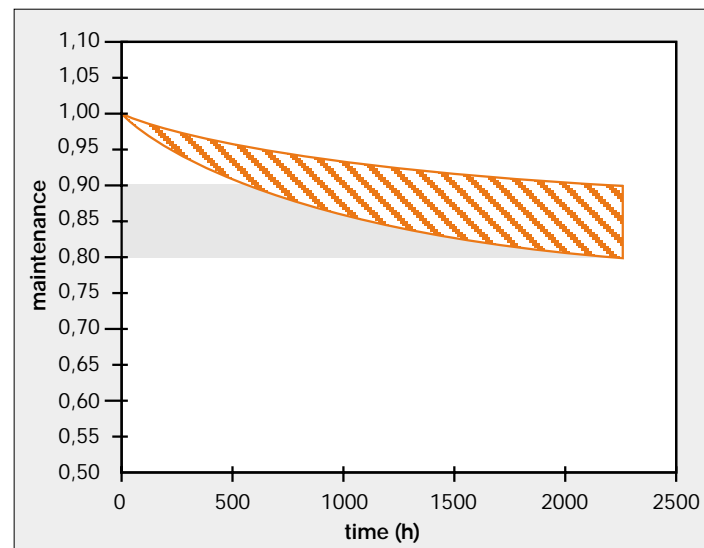
HBO 2501 W/NIL



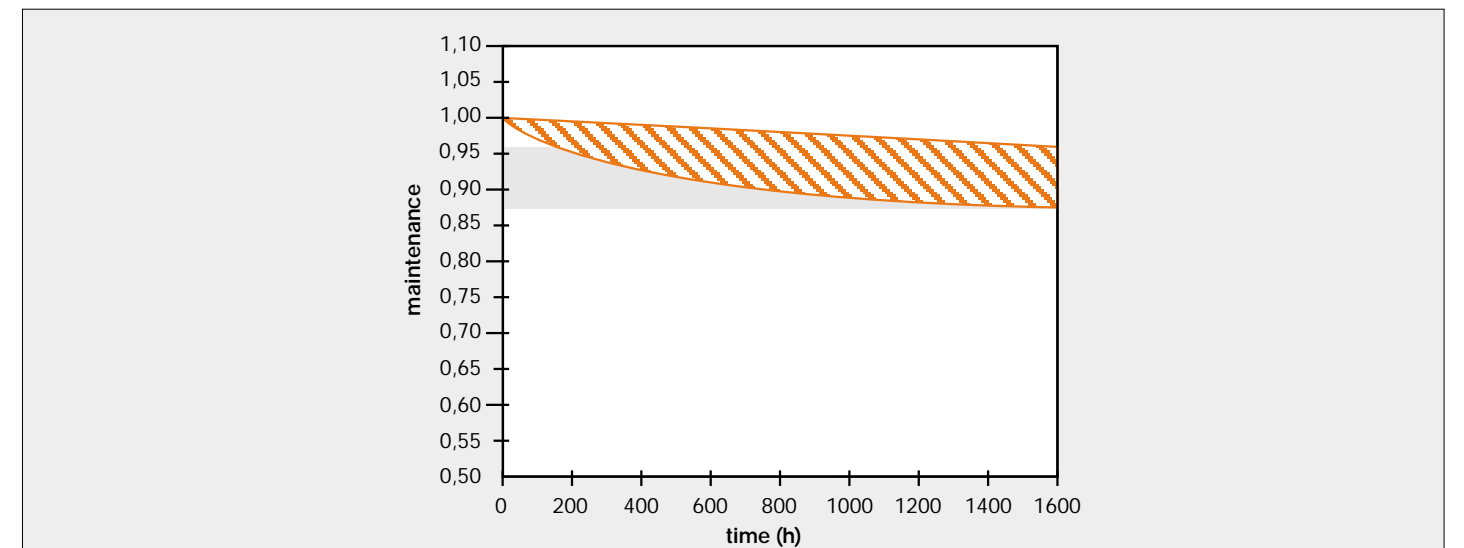
HBO 2510 W/NIL



HBO 2001 W/CIL



HBO 2001 W/NIEL



HBO 3500 W/PIL SHP-series at nominal wattage

13. FINAL REMARKS

The demands on light sources for the dynamic semiconductor industry present rapidly changing and developing lamp requirements. OSRAM HBO® lamps are continuously improving, setting new performance standards in the market with their high innovation rates. The preceding information represents our current lamp status. All of the enclosed technical lamp data is subject to change to support our new and / or developing microlithography lamp applications.

We sincerely appreciate your interest in OSRAM HBO® products and are most interested in your comments regarding the presented information. We encourage and support an active dialog with our customers. With this type of communication, we are best prepared to provide you future oriented lamp products in the most rapid developmental cycle time, for your applications. Thank you for using OSRAM HBO products.

The data and information given in this brochure represents the most actual information. It replaces information, given in previous catalogs or datasheets.



14. ADDITIONAL LITERATURE

For additional information regarding HBO® and other OSRAM specialty lamps, please refer to the following publications that can be ordered by using the address information on the back cover:

- Photo-Optic Lighting Products
- Technology and Application - Halogen-Metal Halide Lamps/Photo-Optics
- Technology and Application - XBO® Theater Lamps
- Technology and Application - Tungsten Halogen Low Voltage Lamps/Photo-Optics
- Guidelines for Control Gear and Igniters for Halogen Metal Halide Lamps/Photo-Optics
- Guidelines for Control Gear and Igniters for Xenon Short Arc Lamps/Photo-Optics



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