

## FAQ on the X-CITE 120 System

The following frequently asked questions were developed to help you learn about the X-Cite™ 120 fluorescence illumination system. We believe the more you know about it, the more you'll appreciate the value of the product.

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*How can the X-Cite 120 lamp give 1500 hours of service when HBO lamps are rated for only 200 to 300 hours?*

In an HBO lamp, the burning electrodes deposit sputtered electrode material on the bulb. The carbon deposits absorb light, decreasing lamp intensity and creating hot spots that eventually cause the lamp to overheat and, on occasion, to explode. This is why HBO lamps should not be operated beyond their rated lifetime. In addition, as the electrodes burn, the gap between the electrodes increases, reducing the light-generation efficiency of the plasma in the arc gap. This is why the intensity of an HBO lamp deteriorates so quickly.

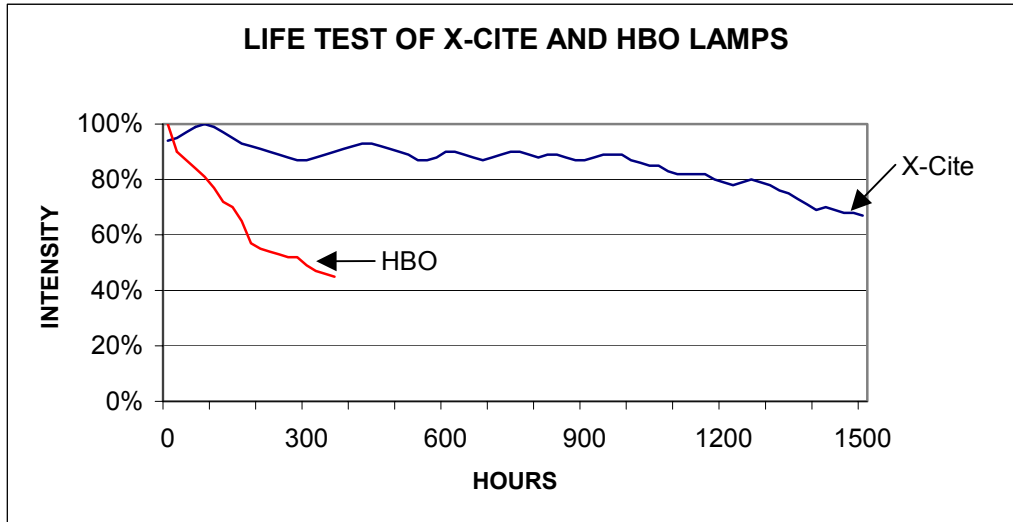
X-Cite 120 features a metal halide lamp that contains halogens, such as iodine and bromine, in addition to mercury. The halogens prevent the tungsten electrodes from blackening the quartz walls of the lamp in a process known as the tungsten/halogen cycle. During the tungsten/halogen cycle, tungsten evaporated or sputtered from the electrodes is deposited on the cooler walls of the arc tube. Then the halogens react with the deposited tungsten, removing it from the walls of the tube and re-depositing it back onto the hot electrodes – forming a cycle. The process helps to maintain the shape of the electrodes and extend the useful lamp life.

*The intensity of the HBO lamp declines continually, so that at the end of life, the intensity typically is only 50% of the initial value. Does the X-Cite 120 lamp exhibit the same characteristic?*

The X-Cite 120 lamp remains within roughly 60% of its maximum intensity over the life of the lamp for three main reasons.

- 1] No carbon deposits are formed to reduce intensity.
- 2] The halogen cycle slows down the deterioration of the electrodes, which in turn slows down the widening of the arc gap (described above).
- 3] The X-Cite 120 lamp utilizes Electronic Control Gear (ECG) technology to maintain constant power throughout the life of the lamp. As the electrodes wear, the electrode gap increases, causing a decrease in current. The ECG automatically increases voltage as this occurs to maintain constant power (power = voltage X current).

The chart below compares the intensity of the X-Cite 120 and HBO lamps for the rated lifetimes of the lamps. It is representative of the life cycle and does not use data from a specific lamp test.

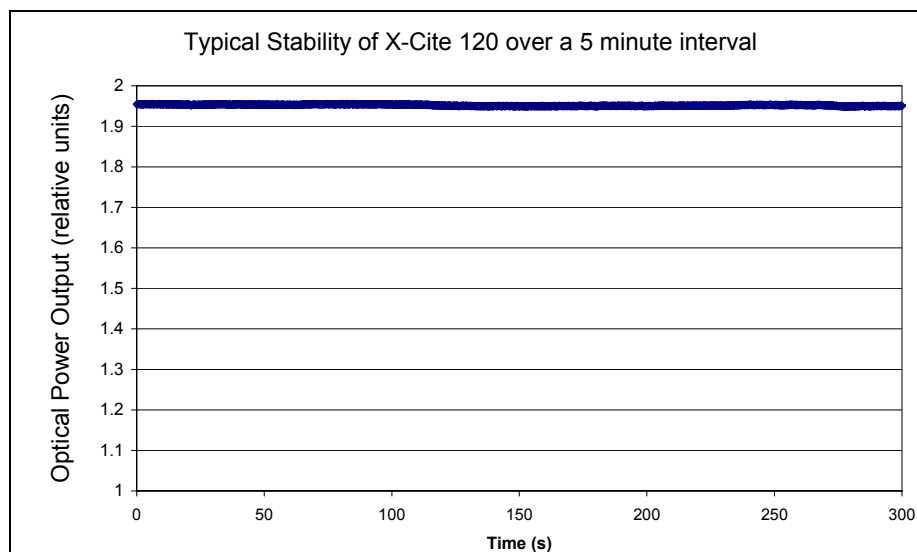


*With no carbon deposits to reduce intensity and cause hot spots, what causes the eventual failure of the X-Cite™ 120 lamp?*

As discussed above, ECG maintains power by increasing voltage as the current decreases over time. Obviously, there is a limit on how much the voltage should be increased. When the final safe limit is reached, ECG shuts down the lamp. Typically the lamp will still be within 60% of its peak intensity level at this point; ECG ends the life of the lamp as a safety feature. The lamp simply shuts down and it is not possible to restart it. This is the most frequent end of life condition.

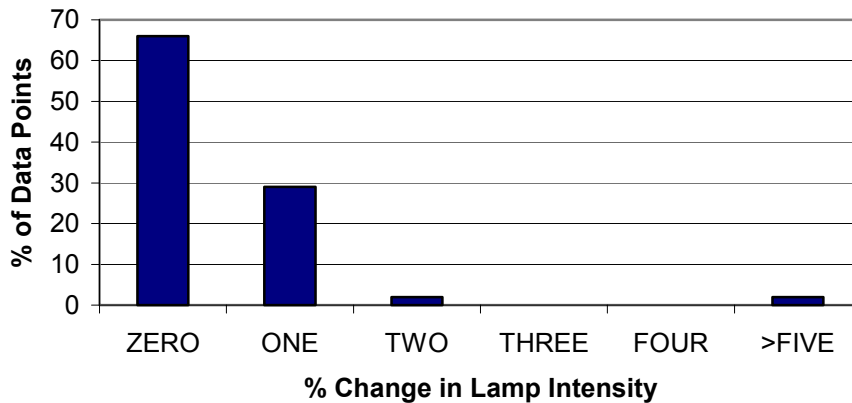
*How stable is the output of the lamp over a short period of time?*

The ECG technology which maintains constant power over the lifetime of the lamp also works to maintain a very stable lamp output over short periods of time. The graph below shows a typical 5 minute sample of the X-Cite 120 output power. Even though the lamp will undergo normal degradation over its lifetime, the output during short sample periods is very constant.



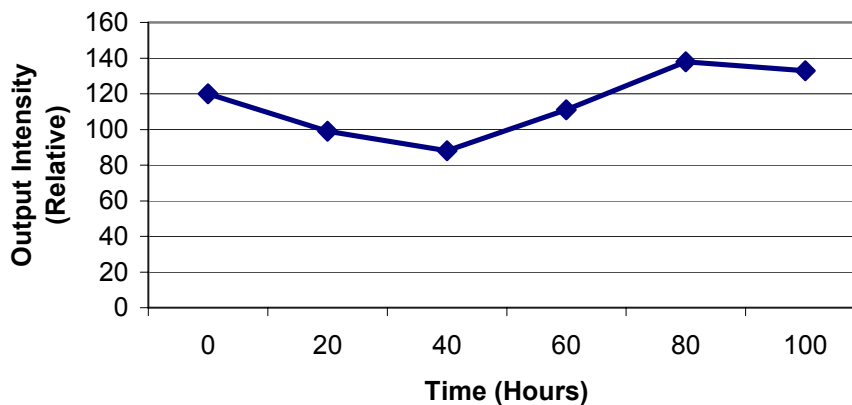
*How stable is the output of the lamp over long periods of time?*

The X-cite 120 is very stable over short periods of time. Over longer periods of time, metal halide lamps are subject to a phenomenon called arc wander. This is the tendency of the arc to occasionally move to a new position on the electrodes, which can cause a change in intensity, either up or down. During life testing, we have sampled intensity every 5 minutes for the life of the lamp. The graph below shows a typical distribution of changes recorded by comparing the change in intensity after each 5 minute interval.



The chart demonstrates that during the lifetime of the lamp, 95% of the time there is 1% or less change in intensity over a 5 minute interval. There were changes of 5% or greater 2% of the time. Of the changes greater than 5%, there was an average change of 9%.

These changes are not visible to the naked eye, since our eyes can only perceive large variations in intensity which are usually measured on a logarithmic scale. However, these changes in intensity could possibly affect quantitative measurements, depending on the length and nature of the experiment. When intensities are measured over long periods of time, the changes can become additive. The chart below shows typical changes measured over 20 hour sampling periods.



We recommend that intensity readings should be taken before and after any quantitative experiment to determine if any change in intensity may have occurred during the experiment.

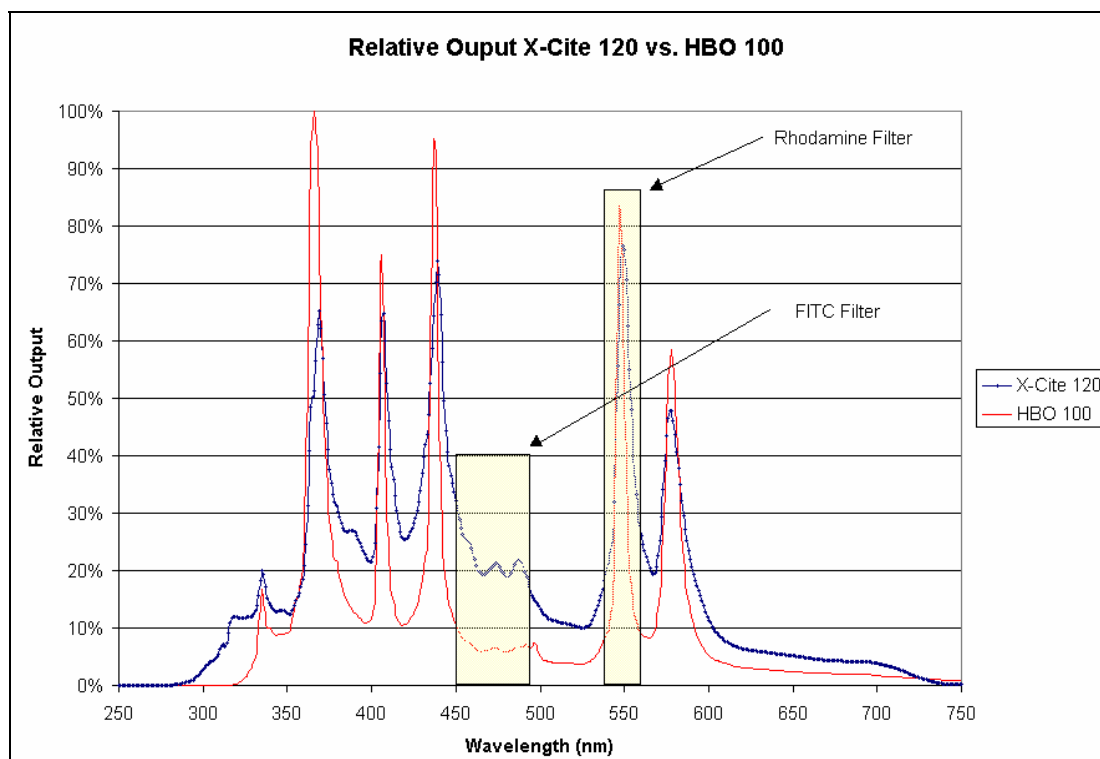
*Does the X-Cite 120 work well for quantitative experiments such as calcium ratio analysis?*

We have received many positive reports regarding the use of X-Cite for quantitative work. An example is the following report from Dr. Phil Haydon's laboratory at the University of Pennsylvania:

*Installing the X-Cite 120 illumination system was extremely easy. The excellent design meant that there was no need to align the lamp and the included light guide minimized heating of our shutter system, a problem when using our previous arc lamp. We have been using the X-Cite 120 illumination system for live cell calcium imaging using Fluo-4 and FRET-based Cameleon proteins. The brightness of the illumination system for these applications is phenomenal, and coupled with the iris adjustment wheel, provides superb control of the intensity of illumination compared to neutral density filters alone. The intensity of the illumination is such that I would consider the iris adjustment wheel to be almost indispensable. I routinely operated the unit at 12-25% of the total illumination with one neutral density filter. The light output was very stable. Overall, the X-Cite 120 appears to be far superior to our old xenon lamps; has excellent performance characteristics and convenient features such as a light guide and iris adjustment mechanism. The greatly extended bulb lifetime is an added bonus.*

*Will my fluorescent image be as bright and uniform with X-Cite 120 as it is with the HBO?*

The chart below compares the intensities of the X-Cite 120 and HBO lamps across the full spectrum. The X-Cite 120 lamp is about 50% more powerful, providing 3.7 W of power over the entire spectrum, compared to 2.4 W of power for the HBO lamp.

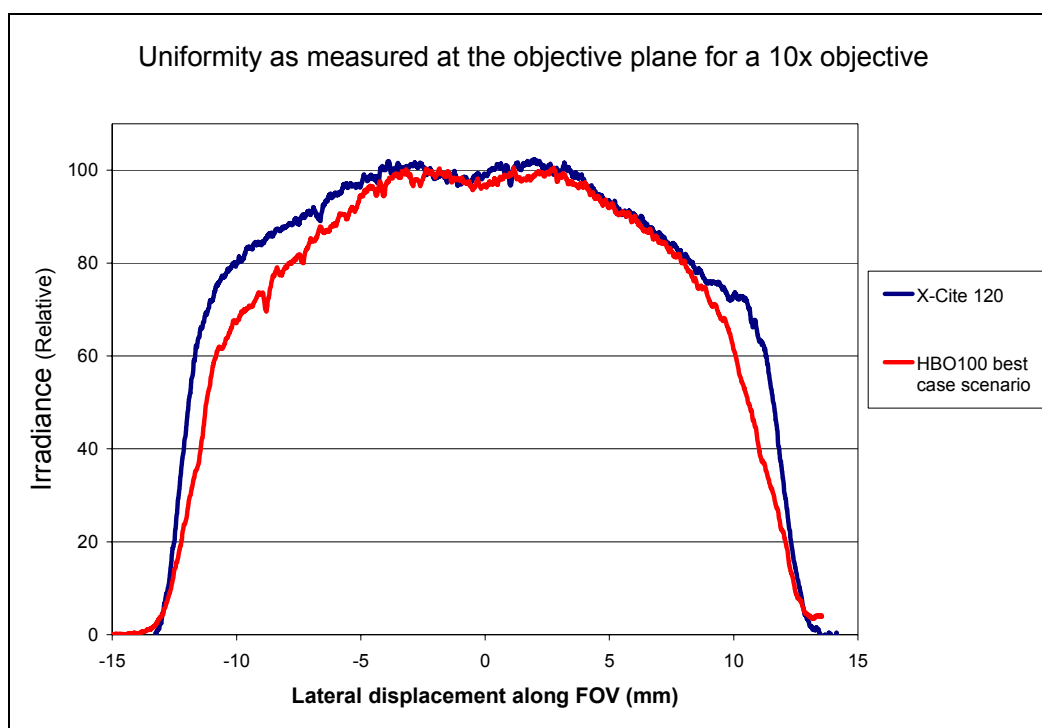


The HBO lamp contains more mercury and as a result has higher spectral peaks, while the X-Cite™ 120 lamp has more energy between the mercury peaks. The intensity for any filter is a function of the area under the curve for the spectral range of the filter.

The filter overlays in the chart above are for the FITC filter, with a range of 450 to 490 nanometers, and the rhodamine filter, which has a narrow band near 546 nanometers. For the FITC filter, note that the area under the X-Cite 120 curve clearly is greater than the area under the HBO curve. Therefore, users should experience brighter FITC images with X-Cite 120. Because the rhodamine filter hits a mercury peak at 546 nanometers, the HBO lamp provides optimum performance. Note that the X-Cite 120 lamp also has a good peak at 546 nanometers, so it provides excellent brightness for rhodamine as well. Overall, X-Cite 120 will provide comparable or superior brightness for the full range of filters on the latest microscopes.

In addition, our laboratory testing has shown that the X-Cite 120 image is slightly more uniform than the HBO image. This is difficult to perceive with the human eye, but it is apparent with digital cameras.

The chart below shows the uniformity of the X-Cite 120 versus an HBO 100. Because alignment of the HBO 100 lamp will affect the uniformity, we have used our optical test equipment (likely not available at a customer site) to insure the best possible alignment of the HBO 100, therefore the best possible uniformity. The X-Cite 120 lamp does not require alignment so the chart below shows the typical uniformity of the X-Cite 120.



*Can the power be turned down on X-Cite 120 if there are photobleaching concerns?*

The X-Cite 120 system is available with an optional iris that allows the intensity to be attenuated in discrete steps: 100% transmission, 50%, 25%, 12.5% and 0. Alternatively, neutral density filters can be used for the same purpose.

*The X-Cite™ 120 system does not require alignment. How is this possible?*

The X-Cite 120 adapter that connects to the microscope contains a collimating lens specifically designed to optimize the light path through the optics in the particular microscope being used. There are different adapters for the different microscope models. Therefore, with the correct collimating adapter, the X-Cite 120 is pre-aligned for these microscopes. For this reason it is important to specify the model of microscope to be used with the X-Cite 120 at the time of purchase.

*What microscopes does the X-Cite 120 system work with?*

In order for the X-Cite 120 to obtain the highest possible image quality with no alignment required, there is an extensive qualification process to be performed with the specific microscope models. The list of qualified microscopes is continually updated and can be found online at: [www.exfo.com/products/EPSPD/120microscopes-ang.pdf](http://www.exfo.com/products/EPSPD/120microscopes-ang.pdf).

*Will the X-Cite 120 work with older microscopes?*

We have not tested X-Cite 120 with all the microscopes that are in the field, but the image might not be as good in older models using the current adapters. If there is strong customer interest in retrofitting the X-Cite 120 to older microscopes, we can design new adapters to optimize performance for the most popular choices. Then we will offer a different adapter for these older microscopes.

*Will the X-Cite 120 work with a shutter / filter wheel attached to the microscope?*

Our testing has shown that the optical power and uniformity of the X-Cite 120 was maintained when the X-Cite 120 was used in conjunction with a 3<sup>rd</sup> party shutter and filter wheel. In comparison to an HBO 100W illuminator, the X-Cite 120 still provides the same uniformity and power coupling advantages to the microscope when used with a shutter and filter wheel.

*How does the Intelli-Lamp feature prolong lamp life?*

Hot starts (turning the lamp back on while it is still hot from previous use) decrease the lifetime of both HBO and X-Cite 120 lamps. Therefore, on the X-Cite 120 lamp we have added a chip that monitors lamp temperature and keeps track of hours of use. If someone tries to restart the lamp while it is still too hot, the Intelli-Lamp will pause the process until it is safe to restart the lamp. In addition, the Intelli-Lamp feature allows you to see how many hours of use have been logged on the current lamp.

*What is the life expectancy of the liquid light guide that connects the X-Cite 120 unit to the microscope?*

The liquid light guide has a rated lifetime of three years. Lifetime of the light guides is very dependent upon temperature conditions during use and storage. The X-Cite 120 is designed to maintain temperatures below those specified to insure maximum lifetime of the light guide. The typical failure mode is a small bubble that forms in the light guide, reducing the light intensity.

More information on the life expectancy of light guides can be found online at:  
<http://documents.exfo.com/products/epsd/LightGuideInfo.pdf>

*What are the projected cost savings due to the long life of the X-Cite 120 lamp?*

The X-cite 120 system will result in a 40% cost saving for lamps. We arrive at this figure through the following calculations.

The HBO lamp rated for 300 hours typically sells for about \$165, resulting in a cost to the customer of \$0.55 per hour. The X-Cite 120 lamp rated for 1500 hours sells for a price of \$500, resulting in a cost to the customer of \$0.33 per hour. Therefore, the X-cite 120 lamp is 40% less expensive than the HBO lamp on a cost per hour basis. The following chart summarizes the savings an annual basis, assuming the lamps are used 40 hours per week, 50 weeks per year. If the lamps are turned on and off frequently, which reduces HBO lamp life, the savings will be even greater, because the Intelli-Lamp feature protects the X-Cite™ 120 lamp from early failures due to hot starts.

<b>Lamp</b>	<b>List Price</b>	<b>Rated Hours</b>	<b>Cost/Hr</b>	<b>Hours of Use</b>	<b>Annual Cost</b>	<b>Annual Savings</b>
X-Cite 120	\$500	1500	\$0.33	2000	\$660	<b>\$440</b>
HBO 100	\$165	300	\$0.55	2000	\$1,100	

*Is X-Cite 120 more expensive to purchase than the HBO alternative?*

Initially, an X-Cite 120 system including the lamp costs slightly more than the HBO alternative. However, the X-Cite 120 lamp is rated at 1500 hours. The HBO alternative requires the purchase of four additional lamps at a cost of \$660 during the lifetime of one X-Cite 120 lamp. Therefore, X-Cite 120 actually is the lower-cost alternative. The slightly higher initial cost of X-Cite 120 is recovered quickly by saving on lamps during the first year. You continue to save on lamps and operation (no alignments) for the life of the system.