



Flashlamp Lifetime

Model LKF-650 for Series 600 Lasers

Today's state-of-the-art materials and manufacturing processes produce krypton flashlamps that yield long performance lifetime and stable operation. Under normal operating conditions, krypton flashlamps in a well-maintained Series 600 Nd:YAG Laser will give many hours of satisfactory operation. Under some laser performance conditions, flashlamp lifetimes will exceed 1 billion (10^9) pulses.

The actual lifetime of a flashlamp is totally influenced by the manner in which the laser is operated. CW arc lamps in the Series 800 lasers burn continuously, so the conditions that contribute to long lifetime (primarily arc lamp current) can be closely controlled. However, the Series 600 flashlamp, Model LKF-650, is operated in the pulsed mode. The controls on the front panel of the power supply permit an almost infinite selection of pulse energy, pulse width and pulse rates (pulse intervals). Some of these combinations will yield long lifetime, while other conditions will produce short lifetime.

Laser parameters that produce long lifetime (can be $> 10^9$ pulses):

- Short pulse width, $< 100 \mu\text{s}$
- Moderate pulse rate, $< 1000 \text{ Hz}$ (pulse interval $> 1.0 \text{ ms}$)
- Moderate pulse energy (flashlamp voltage), $< 200 \text{ volts}$

Laser parameters that produce short lifetime (may be shorter than 10^6 pulses):

- Long pulse width, $> 1 \text{ ms}$
- High pulse rate, $> 1000 \text{ Hz}$ (pulse interval $< 1.0 \text{ ms}$)
- High pulse energy (flashlamp voltage), $> 200 \text{ volts}$

Another influence on flashlamp lifetime is lamp ignition itself. The more often the lamp is started, the shorter lifetime it will yield. Users that start and stop their lasers will experience shorter lifetime. Production-line operations wherein the laser is switched off only for periodic, routine maintenance (such as to change the flashlamp) can expect long lifetimes.

Another strong influence on arc lamp lifetime is the percent of the rated power of the lamp at which it is operated. Clearly a lamp that is operated at 75 % of its rated power level will yield longer lifetime than if operated at full (100 %) rated power.

The general maintenance condition of the laser is another major influence in flashlamp lifetime. Lasers that are well maintained in good condition always will provide longer lifetime. This means that the laser is serviced according to instructions that are contained in the Operation Manual, the optical resonator is maintained in good alignment (which allows the lamp to operate at a lower voltage level to achieve the desired beam output power), and the deionization water filter in the primary cooling system is changed periodically.

The conditions that result in early arc lamp failure of the Series 800 lasers, also will produce early failure of the LKF-650 flashlamp. Lee Laser technical bulletin, **Early Krypton Arc Lamp Failure**, discusses many of these conditions.

As an flashlamp ages, it will develop a white or gray residue inside of the glass envelope, particularly at the ends near the electrodes. This is caused by the sputtering of the arc lamp electrodes. The residue will reduce the lamp's efficiency to optically "pump" the YAG laser rod, so some gradual beam power reduction may be expected. Usually this beam power reduction can be compensated by an increase in flashlamp voltage.

Another indicator of flashlamp age is a noticeable increase in beam power instability. As the lamp ages, the sputtering of the electrodes causes uneven erosion at the tips of the electrodes. This uneven wear will cause the plasma arc to spatially wander about the tips of the electrodes, and result in an uneven optical pumping of the YAG rod. The uneven pumping results in beam power instability.

Because Lee Laser has no control over the operating and maintenance conditions of the laser, we cannot provide a general guarantee for lifetime of the LKF-650 flashlamp. We only can recommend to the user operating and maintenance conditions that will promote long flashlamp lifetime. For specific operating conditions, Lee Laser can provide an expectation of flashlamp lifetime.