Havis, Inc.
75 Jacksonville Road, PO Box 2099
Warminster, PA 18974
T 800-524-9900 F 215-957-0729
www.havis.com

Technical Bulletin: Generating Trouble
Diagnosing and Fixing Line Voltage Lamp Failures

Havis produces lighting fixtures of the highest quality, assembled in the USA using only the finest components available. For halogen fixtures, the single most critical component in the entire product is the lamp (light bulb.) Since there are no high-output lamps manufactured specifically for our market, we select the best general-market and specialty (e.g. stage and studio) lamps available for shipment with our fixtures. These lamps are all designed to operate under well-controlled conditions, and in particular, they inherently rely upon the precise regulated power we generally take for granted as supplied by our utility companies. Yet, a fire truck is far from a well-controlled environment, and the challenge for us as a fixture manufacturer is to control the environment for the lamp as much as possible.

The technology in our designs relates to maximizing the efficient distribution of light while keeping the fixture temperature as low as practical. However, there is no simple way for a halogen fixture to control the power provided to the lamp. The input power wires to the fixture are directly connected to the lamp, so any voltage spikes, fluctuations, or other power issues are simply passed directly to the lamp. In almost all cases, premature lamp failure is caused by defective/low quality lamps or by power issues. Below are some guidelines to help troubleshoot premature lamp failure.

I. Use a good lamp

Believe it or not, lamp quality is a primary cause of premature lamp failures. Havis qualifies lamps for use in our products, so if you purchase directly from us, you are assured of receiving the best quality lamp for your fixture. Regardless of where lamps are purchased, these are the key points that must be considered:

- Most lamps available to consumers in stores are lower quality than the lamps sold to the professional and commercial markets.
- Major manufacturers usually (but not always) provide better quality products.
- Specialty lamps, such as 350W and 900W GE HIR lamps, will be much more sensitive to environmental variation and will generally have a shorter life than non-specialty lamps.
- Good quality lamps generally cost a lot more than generic brands, and you do get what you pay for.

It is not always possible to look at a failed lamp and identify the cause of failure, but there are some general trends that provide an indication of possible causes of premature failure, as follows:

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- If a lamp fails with the glass turning white and bending, bowing, or bubbling, or if there is any cracking or burning of the lamp or lamp ends, those may be indications of lamp quality problems, and for specialty lamps, may also indicate high voltage.
- If the lamp shatters but does not have burning or other issues, then the lamp may have been touched before or during installation. Note that the glass portion of any lamp must never be touched, and any residue at all, including fingerprints, must be cleaned off with isopropyl alcohol, or the lamp can fail prematurely and shatter.
- If a lamp shatters and damages the fixture (e.g. breaks a lampholder end) at the same time, then there may be voltage spikes promoting failure, along with high voltage or other issues.
- If a good quality lamp simply fails prematurely with minimal visible damage (e.g. the filament is broken, but otherwise the lamp looks relatively normal), then the likely cause is too high input voltage. For an off-brand lamp, it could be quality issues. For specialty lamps, it may be normal, as some of these lamps have extremely short rated life.
- If the fixture performed well when it was new from the factory, but issues were noticed after the lamp was replaced, that is a strong indicator of lamp quality problems.

Using a good quality lamp will solve many issues. However, if the lamp is already a good quality lamp and there are still problems, then the input power must be checked.

II. Check voltage and frequency

Using a true-RMS digital voltmeter, measure the input voltage to the fixture as close to the lamp as practical. Note that a typical halogen light fixture does not have a specific voltage rating per se; it is the lamp used with the fixture that determines what the input voltage must be. In North America, all generators should be 60 Hz, and output power must always be well within 57-63 Hz at the extreme limit. Common lamp voltage ratings, along with recommended maximum variation permitted, are shown in the table below:

Lamp Rating	Minimum Extreme	Minimum Optimal	Maximum Optimal	Maximum Extreme	Note
120V	108V	114V	126V	132V	
130V	117V	124V	137V	143V	Energy saver
220V	198V	209V	232V	234V	
230V	207V	218V	242V	253V	Common/balanced

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240V	216V	228V	252V	264V	
277V	249V	263V	291V	305V	Rare/generator
347V	312V	330V	364V	382V	Rare/Canada

All lamps should normally be operated in the Optimal range, and that is critical for specialty lamps, such as GE HIR lamps. Standard lamps operated above the Maximum Extreme voltage will fail very quickly, and operated below the Minimum Extreme voltage will be very dim. Specialty lamps, such as GE HIR lamps, must not be operated outside the Optimal range; higher voltage will cause rapid failure, and lower voltage will cause low output.

When measuring voltage, note that the generator's voltage can vary significantly depending upon how much load is applied. So, voltage should be measured under no load and under full load, and ideally the voltage at each fixture should never go outside the Optimal range. If it is not possible to stay within the recommended range, then it is usually best to ensure that the voltage never goes above the maximum limits. In any case, the operating frequency should be between 57 Hz and 63 Hz at the extreme, with 59 Hz to 61 Hz preferred.

It is also important to note that the load on the generator must be properly balanced, or it may not operate properly. If any voltage or frequency issues are found, the first step is to ensure that the load is properly balanced, and to redistribute the load in order to ensure it is properly balanced. Even the best quality generator will not operate properly if the load applied to it is sufficiently imbalanced.

If both 120V and 240V power is used on the vehicle, then it will be necessary to verify both voltages separately. However, changing the set point of one voltage will generally change the other proportionally, so it may be difficult to set both 120V and 240V operation to the optimal range at the same time. In that case, it may be necessary to choose the lamp voltages carefully, such as using 130V lamps if the 120V line is running high. This will not normally be an issue for a good quality generator, but it can be a problem for many inexpensive models that are often specified because they are believed to be "good enough" for the job. Buying a good quality generator is highly recommended, as the performance of the generator is critical to the operation of any line voltage equipment connected to it. Please note that Havis does not offer 130V lamps, but they are commercially available, often marked as "long life" lamps.

Setting the generator voltage and frequency properly is essential to ensure optimal lamp life and output. With the generator output set properly, the load properly

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balanced, and good quality lamps installed in the fixtures, the vast majority of problems can be eliminated. If problems still occur even with a good quality generator with proper voltage settings, then voltage spikes are likely to blame.

III. Check for voltage spikes

Voltage spikes are always present and can never be fully eliminated. Small spikes that don't occur often are not necessarily a big concern, but frequent or large spikes can easily cause rapid and even catastrophic lamp failure. Spikes occur whenever electrical equipment is turned on or off, and can also be caused due to the design or quality of the generator and its voltage regulator. There is no substitute for using a good quality generator, and a bad generator may cause issues that can never be resolved. In addition, spikes and other power issues can be much more significant when a generator is overloaded. For a low-end or small (e.g. 3-4kV) generator, it is highly recommended that the generator not exceed 50% of its rated load in normal service. For high-quality larger (e.g. 10-12kV) generators, service loads could be as high as 80-85% of rated load. If there are any questions, contact the generator manufacturer for their recommendations specific to each application.

In order to check for voltage spikes, it is necessary to use a logging meter. Any true-RMS logging multimeter should be sufficient for the application, and it should be installed as close to the lamp of a troublesome fixture as possible. With the meter in fast logging mode, all of the lights and generator-powered equipment on the vehicle should be cycled on and off, typically in a pattern that would be as close to normal operation as practical. The test should last at least fifteen minutes. After the test is completed, review the data to see if there are any issues, such as spikes or large frequency shifts. If no issues are found, then it is best to keep the meter attached and logging while the vehicle is used on actual calls, until the problem is recorded by the meter.

Once a problem is identified in the power, it is important to identify the sequence of events that caused the issue. For example, it is possible that every time a particular exhaust fan is turned on, there is a large dip in power, followed by a large spike. In that scenario, the first possible remedy would be to power the trouble-causing fan from a different leg on the generator from the lighting. If that is not practical or not effective, then other options might include adding a voltage regulator to the fan, or even to simply ensure that the fan is always turned on before the lighting.

IV. Avoid problems in the first place

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There are some basic steps that will help ensure a successful, trouble-free installation:

- Use good quality lamps.
  - Never buy bargain brands.
  - When it doubt, remember that Havis sells top-quality lamps certified for our products.
  - Use lamps with consistent ratings. For example, don't mix 220V and 240V lamps on a truck if possible, or some lamps may be excessively dim, while others may fail prematurely.
- Use a good quality generator.
  - Never undersize the generator. Always plan on running a small or low-end generator at no more than about 50% of its rated load in normal operation, and a large high-quality generator at no more than 80-85% of its rated load.
  - Always buy a good quality generator. You do get what you pay for, and cheaper models will have poorer power regulation, thereby causing many issues. More expensive models also tend to be more efficient and lower maintenance, so they generally cost less in the long run anyway.
  - Always adjust the generator properly, observing the voltage guidelines listed above.
  - Note that both 240V and 120V operation will need to be verified, if both voltages are used on the vehicle.
- Install all electrical equipment properly.
  - Follow NFPA and all applicable codes and guidelines.
  - Ensure the load is always balanced on the generator.
  - Use suitable wire gauges to minimize voltage loss and other issues.
  - Avoid the use of electronic switches and/or contactors with generator power whenever possible for maximum reliability.

V. If All Else Fails

If this guide fails to resolve a problem, please contact Havis directly for assistance in troubleshooting.