HIDDEN DANGERS OF HALOGEN LIGHT FIXTURES

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The dangers or perils of halogen type light fixtures (to include torchiere type fixtures) have been well documented in the fire literature.[1,2] We present a "not so obvious" fire cause that can be associated with these fixtures. Testing of the halogen bulbs by both the writers and others has shown bulb temperatures between 1100 and 1200° F. The bulb temperature alone on conventional halogen bulbs is capable of causing the ignition of some combustible atmospheres, given the proper stoichiometry.

Testing of light fixtures used on construction sites (work lights) and for permanent mounting was carried out to document both temperature and any infiltration of substances. In addition, the contact surfaces of several fixtures were examined, showing the arcing that can develop at the electrical contacts, also serving as an ignition source. We outline here our findings.

BACKGROUND

Halogen light fixtures have become popular in the past 15 years as a means for producing bright light. The halogen atmosphere has the effect of insuring a longer filament light life. Prior to our work, there have been numerous papers written on the dangers of these fixtures. Manufacturers of these fixtures must now include metal screens as part of torchiere lamps so as to reduce combustion hazards from direct contact with flammable materials. In addition, a curved shield is now placed over the bulbs on the torchiere fixtures, to help reduce the hazards of a shattering bulb. On permanently mounted fixtures and on work lights, a glass shield has always been standard so as to provide protection against the hazard of a fragmenting bulb.

Our investigation was brought on after a painter was injured from an explosion and flash fire. The painter was using "volatiles" (lacquer and thinner), and had made use of a 500 watt halogen lamp fixture. The glass shield on the light fixture had been subject to over-spray to the point that it was no longer usable. Thus, the painter had removed the glass shield.

TESTING

Several new fixtures were purchased, in both a work light configuration and fixtures meant for permanent mounting. *(Photo 1)* We noted that the two "permanent" fixtures (rated at 150 and 500 watts) were not intrinsically tight or intrinsically rated. They are listed for use in wet locations, however. On the work light (rated 500 watts), there was a gasket around the glass shield and also around the switch compartment giving some appearance of being intrinsically safe. A pilot hole was drilled in the body, and air pressure applied. We noted that despite the gaskets, the work light is not airtight—air leaked out at the gaskets and at the switch cavity. Thus, none of the fixtures we examined were airtight, and all would be conducive to igniting atmospheres that are within limits of explosivity and which have auto ignition temperatures of approximately 1200° F. or less.

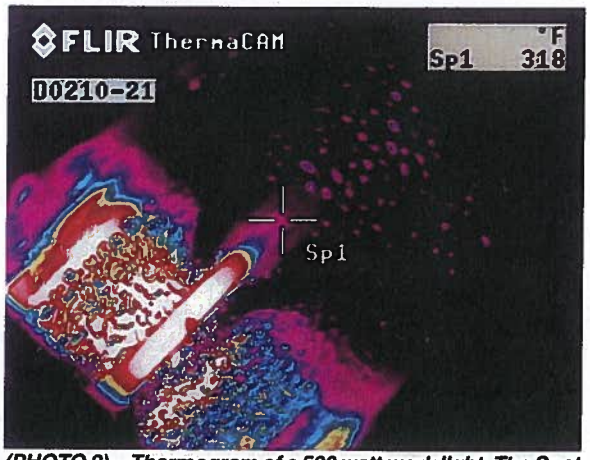
PHOTO 1

We measured the temperature of both of the 500 watt bulbs on the surface, and measured approximately 1266 and 1200° F. The bulb temperature for the 150 watt bulb was approximately 1200° F. (all bulbs tested at 120.0 VAC, provided by a HP 6813A source). A Stanford Research Systems model 630 thermocouple monitor and 30 awg type K thermocouples were used to measure the temperatures.

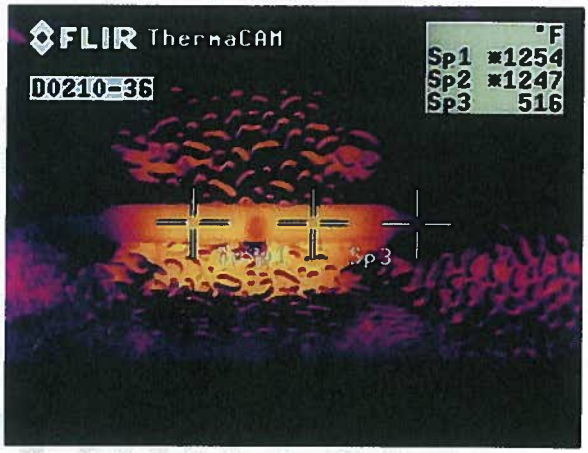
We also examined the 500 watt work light with an infrared camera, FLIR/AGEMA 595. The thermogram is shown as photo 2. The Spot Temperature *(Sp 1)* was measured at 318° F; its importance will soon become apparent. The second thermogram *(Photo 3)* shows bulb envelope temperature at two different points *(Sp 1 and Sp 2)*. The temperatures are 1239 and 1255° F, respectively. These temperatures are approximate measurements.

ANALYSIS

The first and most obvious conclusion is that halogen lamp fixtures can serve as competent ignition sources, given the right atmosphere. This statement is not said in a condemning fashion, but rather as a fact—the bulbs are inherently hot. While one does not ordinarily think of the bulb as causing ignition, the bulb is not much different than the "glow bar" that is now commonly used to ignite gas ovens. With the correct atmosphere, there can be a fire or explosion. Perhaps



(PHOTO 2)—Thermogram of a 500 watt work light. The Spot Temperature (Sp 1) was measured at 318° F.



(PHOTO 3)—Shows bulb envelope temperature at two different points, Sp 1—1239° F and Sp 2—1255° F.

an underlying issue is the "human factors" associated with these types of bulbs. Many people have routinely worked on cars or painted while using conventional (incandescent and fluorescent) fixtures and no hazard was noted. Given this background, the user may be very surprised to learn that the halogen fixture is capable of causing ignition of certain atmospheres. Our evaluation of numerous halogen fixtures shows that none of them are intrinsically safe.

An additional hazard, which is even more obscure, is that of arcing contacts. It is difficult to design an inexpensive, mass production light fixture where the electrical contact temperature for the bulbs will run several hundred degrees. In the thermogram, we noted a contact temperature of 318° F; which was also verified with a 30 AWG type K thermocouple. The gradient from bulb temperature (nominal 1255° F, to contact temperature 1255° F, is 932° F. This gradient is achieved in less than 1 inch. The high working temperature for the electrical contact, the gradient, and the high excursion temperature for the bulb envelope led us to suspect that the electrical contacts may be prone to arcing.

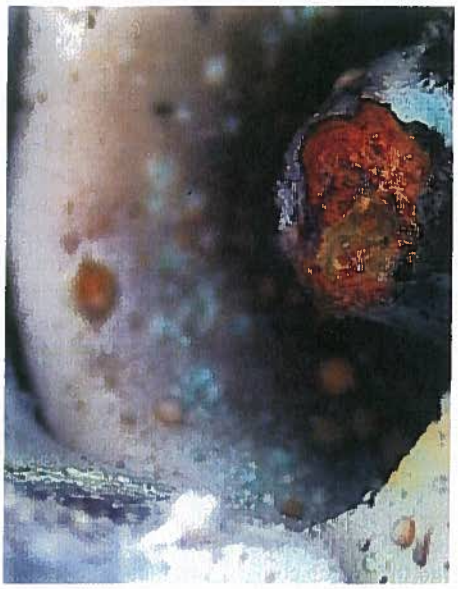
Photo 4 shows the copper splatter associated with a 300 watt fixture; the contact at the right end of the fixture was beginning to arc, spewing off molten copper. Photo 5 is a microscopic view of the end of a contact of a 500 watt fixture. As is obvious from these photos, the contacts can and do arc. While the arc by-products (splattering copper) will be contained by the glass shield, the arc is once again capable of igniting volatile atmospheres.

The readers have no doubt examined natural or propane gas explosions in residences, and the question is always asked—what could have ignited the mixture? The main issue is, of course, what leaked the gas? Ignition could have been brought on by a light switch, a pilot light, a relay on a TV, or the contacts of a thermostat or start relay on a refrigerator. Usually, we never know exactly what caused ignition, and in many cases, it does not matter. In one instance where we did come to the correct conclusion regarding ignition, a man smelled gas in his house and turned on the window AC unit to ventilate the house—he did not survive the resultant blast.

Given the measurements and documentation done as part of this study, a halogen light fixture has the propensity to ignite volatile atmospheres by way of actual heat or by arcing. Hence, these types of lights should never be used without the glass shield and they should not be used in volatile environments.

Given that these fixtures are not intrinsically safe, further research is necessary to determine if vapor infiltration could have occurred, so as to allow ignition. The best way to determine this is empirically. Every light fixture will have its own characteristics regarding "air changes" in and around the bulb. The gasket will be different among fixtures, as will be air currents in a room. Bulb temperature will even vary slightly with line voltage. Thus, having a lit bulb in an ignitable atmosphere may or may not cause ignition, depending on the characteristics of the fixture—testing must be carried out to prove or disprove the theory.

(PHOTO 4)—Shows a contact at the right end of a 300 watt fixture beginning to arc, spewing off molten copper.



(PHOTO 5)—Microscopic view of the end of a contact of a 500 watt fixture showing arc by-products.

SUMMATION

We have shown two modes whereby a normally operating halogen light can cause ignition of ignitable atmospheres. However, in these cases, there is no "catastrophic failure;" rather, the bulb and fixture are operating as intended. The halogen fixture in these cases is not operating defectively, but rather is just bringing about ignition to an atmosphere, through normal usage, that is prone to ignite. ●

References

1.) Lowe, Robert and Lowe, James, "Halogen Lamps II," Fire and Arson Investigator, April 2001.

2.) "Tips to Promote Halogen Light Safety," Canadian Association of Fire Investigators, March 1998.