

Fire Investigation Essay

**Title: Fires Caused by
Lighting**

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Essay – Fires Caused by Lighting

One of the most common potential sources of fire ignition is the light globe. It must not be overlooked since light globes can become extremely hot objects.

Bulbs of low wattage generally do not produce enough heat for the surface temperature of the globe to become hot enough to ignite common combustible materials. As the wattage is increased (especially with bulbs in fittings that restrict ventilation), temperatures can build up to very high temperatures.

Potentially a large light bulb can start a fire if it is placed in contact with a suitable fuel. Even small light bulbs can generate enough heat to ignite paper, cloth, sawdust, etc, if they are buried or wrapped in insulating material. These events are very uncommon not due to the lack of temperature that is reached, but more due to the fact that the bulb must be in contact with something that is easily flammable, which rarely occurs. It has however been known to happen in places such as basements, storage rooms, and roofs.

The breakage of any bulb while lit, even low wattage ones introduces two additional sources of possible ignition.

i) The filaments of most globes can reach over 1500°C. As soon as oxygen contacts the filament the filament begins to burn and then breaks. Though the filament also begins to cool as soon as the circuit is interrupted by a failure of the filament, it will retain more than adequate heat to ignite any flammable vapours or liquids that comes in contact with the filament shortly after it breaks.

ii) In addition to the temperature of the filament, the brief arc (spark), produced by the filament on breaking, has the same risk if igniting any flammable gases or vapours in the vicinity.

In the rest of this essay I will discuss some of the different types of lighting, and the hazards they involve, as well as two case studies involving halogen torchiere lamps and halogen spotlights.

Incandescent Lighting

The most common form of domestic lighting is the incandescent light globe. It consists of a fine, coiled, tungsten filament that is raised to white heat by passing an electric current through it.

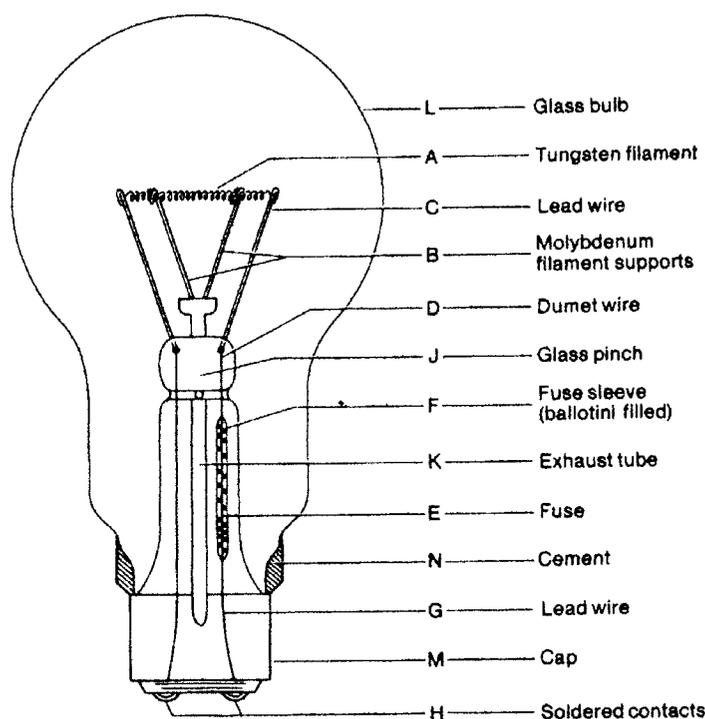
The filament is held in place by two support posts which are insulated and supported by a glass base. The glass envelope of the globe retains an inert atmosphere around the

tungsten filament so it does not burn. The gas used is often argon. The temperature of the glass envelope normally reaches between 100°C and 300°C, but temperatures can be greatly increased if the glass is being insulated, which reduces any heat loss.

The glass envelope temperature of high intensity lights, such as the incandescent spot lights will not necessarily be any higher than those of normal light globes, although several shop and dance fires have been attributed to spot lights in contact with paper decorations.

The surface temperature of a bulb is generally not high enough to ignite cellulosic materials. It can however scorch small amounts of paper or fabric. Larger quantities of paper or cloth tend to have an insulating effect on the globe, leading to a significant increase in the surface temperature of the globe, resulting in ignition of the material.

If the globe is broken the filament will remain glowing for a few seconds, though in the presence of air the tungsten begins to burn forming tungsten oxides that are generally yellow. It is possible for the hot filament to ignite material in contact with it, which is particularly significant in road accidents when spilled petrol can be ignited by the filament of a broken globe.



Construction of an incandescent lamp

Figure 1 - Reference 4, page 156.

Fluorescent Lighting

Fluorescent lights consist of a sealed tube filled with mercury vapour at a low pressure, and has the internal part of the tube coated with a mixture of compounds which fluoresce

in ultra-violet light. The circuit for fluorescent lights often has what is known as a “choke” present which helps in starting the light and helps to prevent a dangerous rise in voltage.

When we switch the lamp on, a starter circuit operates causing a voltage surge that has enough energy to begin a discharge in the mercury vapour of the fluorescent tube. The discharge results in the emission of light, particularly in the ultra-violet region. This ultra-violet light strikes the coating on the inside of the tube, which fluoresces, emitting visible light. This method of producing light from electricity, is extremely efficient.

Unlike incandescent lights, fluorescent lights do not produce much heat, and the surface temperature of the light is unlikely to exceed 60°C, except in the area of the cathodes where the temperature may get as hot as 80°C. The most likely danger of fire, is that the choke can overheat. A number of fires have been attributed to this cause.

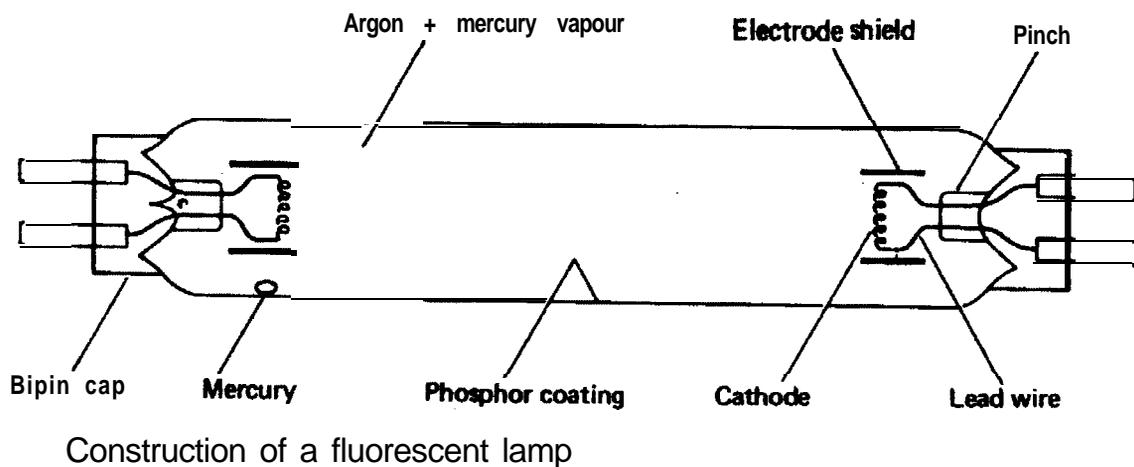


Figure 2 - Reference 4, page 183.

Tungsten Halogen Lighting

A tungsten halogen lamp is different from a conventional inert gas-filled incandescent globe in that a halogen gas such as iodine or bromine is present at low partial pressure. The tungsten vapour which would normally be deposited on the inside of the globe, combines with the halogen to form volatile halides and the surface temperature of the globe is kept hot enough to prevent these halides from condensing. The halides disassociate in the vicinity of the incandescent filament and a state of equilibrium is reached.

The globe envelopes for halogen lights are generally constructed of vitreous fused quartz or Vycor, which are able to withstand the high temperatures needed in these lights. The halogen globes are much smaller than incandescent globes. This means that the reduced volume of a tungsten-halogen lamp allows economic use of more expensive but much more effective gases such as krypton and xenon, instead of argon. The smaller size of the envelope also means that the globe has improved mechanical strength, and thus the gas in

the globe can be present at a much higher pressure. This reduces evaporation and increases filament life.

Tungsten halogen bulbs operate with surface temperatures of the globe reaching 600-900°C. Flammable materials in contact with a quartz globe at these temperatures are likely to ignite in a very short time.

As the tungsten halogen globes operate under such a high internal pressure, it possible for these globes to explode under certain circumstances. Traces of sweat left on the quartz envelope can cause the bulb to fail, and some display lights need to be arranged within 5° of horizontal otherwise they may eventually shatter as a result of differential migration of the halide. Several fires in shop windows have been attributed to this effect.

Tungsten halogen lamps

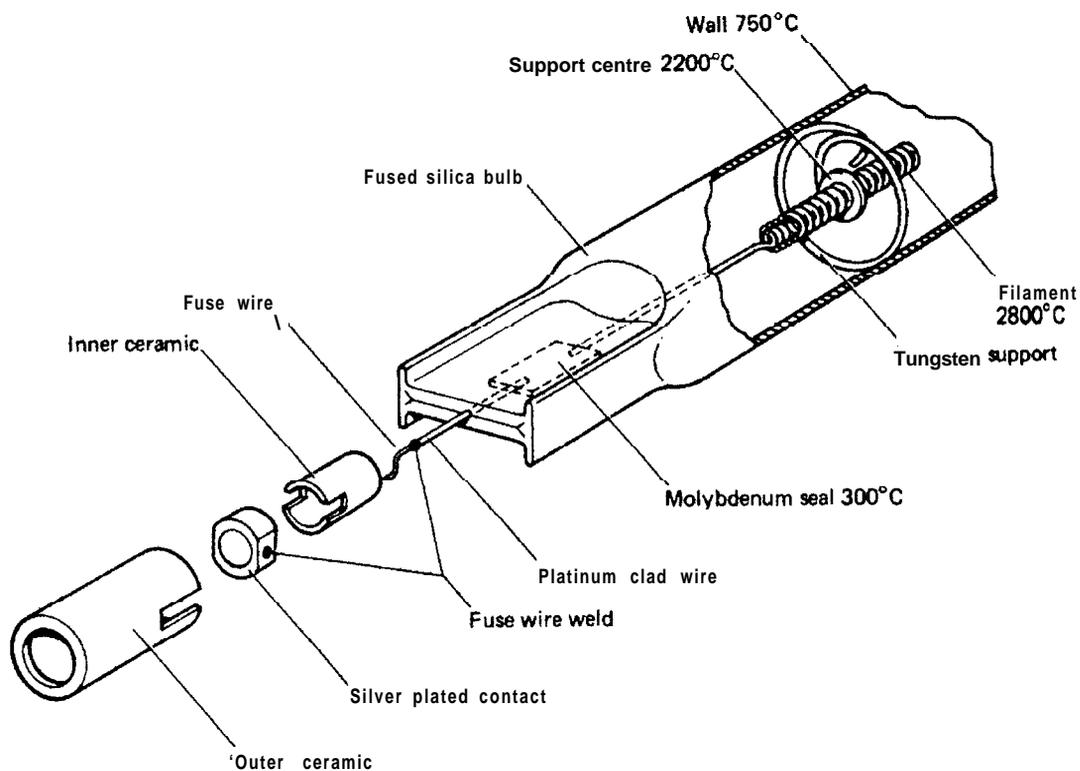


Figure 3 - Reference 4, page 176.

Naked Flame Lighting

Though most lighting that we encounter is electrical, naked flame lights persist in certain applications. Most people have candles in case there are power cuts and for lighting at dinner parties or festivities such as birthdays. Oil lamps and pressurised butane lamps are used by campers and by householders where there is no electricity supply.

Though not frequently used, naked flame lights can cause fires by misuse. Few people now use candlesticks and as a result, when candles are used, they are stuck to saucers with

wax or wedged into the necks of bottles. This can often lead to the candle becoming unstable and can cause a fire by falling onto or against a flammable material.

Oil and pressurised lamps are generally designed with stability in mind, and when overturned are unlikely to cause fires.

One of the big dangers with naked flame lights are when they are placed close to or underneath a flammable object such as a curtain. At Christmas candles may be included into decorative arrangements which can include crepe paper and evergreen foliage. Few people today use candles to illuminate Christmas trees, but if a dry spruce tree is ignited at a low level, the rate at which the flame is spread up the tree is extremely fast.

It is possible to fill a kerosene lamp with an incorrect fuel such as methylated spirits or petrol, and this was the cause of many fires in the early part of the 20th century. Now most people are familiar with the smell and properties of the liquids and such accidents are rare. It is however, still possible to fit the wrong type of butane gas cartridge to a pressurised gas lamp. Several manufacturers market lamps designed to accept a particular cartridge. Some of the cartridges are gas released by operation of a valve, while others are pierced by a protruding blade inside a gas-tight rubber seating.

If the wrong type of cartridge is used or an acceptable cartridge is incorrectly fitted, a sudden release of butane can occur, resulting in a fire or explosion.

Case Studies

Case Study 1 - Halogen Torchiere Lamps

Halogen torchiere lamps are freestanding lamps with a shallow bowl-shaped light fixture mounted on the top of a (i-foot pole and illuminated by a tubular halogen bulb.

The U.S. Consumer Product safety Commission (CPSC) is aware of at least 350 fires, 114 injuries and 14 deaths, and millions in property damage since 1992, involving halogen torchiere lamps. It is estimated that in the United States that there are approximately 40 million of the torchiere (or pole) lamps containing tubular halogen bulbs. The lamps first became available in 1963 and sales have grown significantly in the 1990's.

Tests conducted by the CPSC showed tubular halogen bulbs of 250, 300 and 500 watts, installed in torchiere lamps, could start a fire in nearby combustible material. Incandescent bulbs of 75 and 150 watts bulbs operate at 120 and 170°C respectively. Tubular halogen bulbs in torchiere lamps of 300 and 500 watts, operate at 520 and 650°C respectively.

Halogen torchiere lamps have become extremely popular due to the fact they are cheap and give out a good strong light. They are especially popular with students in dorm rooms

where there is often poor lighting, which is not sufficient for studying. In a study at Harvard University it was found that there was nearly one halogen torchiere lamp per student among Harvard's 2nd, 3rd and 4th year students. Average use was 39 hours per week. In many rooms, they were consuming more electricity than the refrigerator.

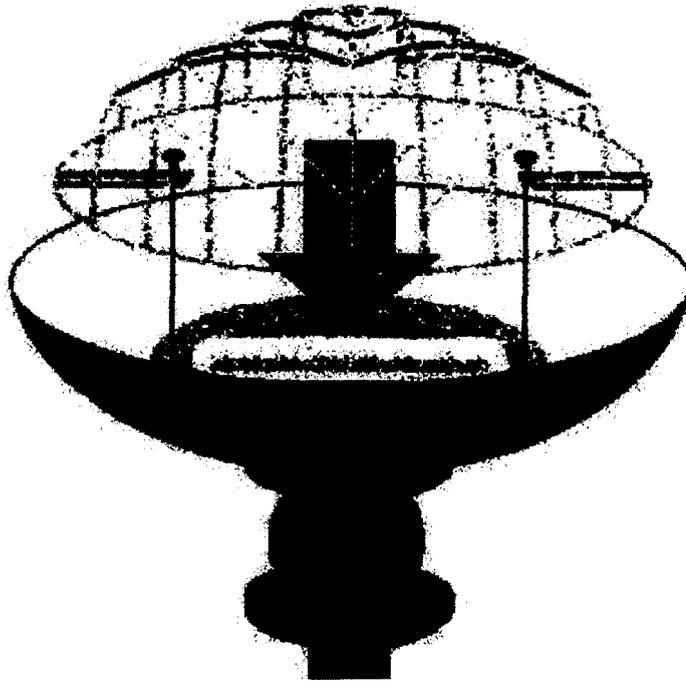
Tests were conducted in New York using a 300watt halogen torchiere lamp. It was found that when a piece of pine wood was placed on top of the lamp it ignited after 73 seconds. A piece of cardboard took 77 seconds, a paper air plane took 56 seconds and a t-shirt (80% polyester/20%cotton) burned through the two layers over the top of the lamp in only 24 seconds.

On July 29th 1996, the Consumer Product Safety Commission issued a warning a warning to consumers on the dangers of the torchiere-style halogen lights.

Underwriters Laboratories, an industry funded group which sets the voluntary safety standards for halogen floor lamps, has made the following recommendations.

- 1) They have issued a warning to manufacturers to stop selling the floor lamps with 500 watt halogen bulbs.
- 2) From February 1997 all halogen floor lamps will be required to carry a warning label attached to the power cord or other location visible during set up.
- 3) The initial warning to stop selling 500 watt halogen bulbs will be a requirement from the 2nd May, and new halogen torchiere lamps will be required to have glass bulb guards or a heat sensitive cut-off switch.

On August 21st 1997, the CPSC announced that together with the halogen lamp industry they were co-operatively recalling for in-home consumer repair, some 40-million halogen torchiere floor lamps. Consumers who own torchiere floor lamps without a glass or wire guard over the glass bulb can receive a free wire guard with installation instructions from certain retail stores.



Installation of wire guard

Figure 4 - Reference 16.

The U.S. Consumer Product Safety Commission and Underwriters Laboratories have given the following safety tips for torchiere-style halogen lamps.

- **Never allow torchiere halogen lamps to be placed where the tubular bulb could come in contact with curtains or other cloth window treatments.**
- **Never leave a torchiere halogen lamp on when you leave a room or are not at home.**
- **Never drape clothes over a torchiere halogen lamp.**
- **For torchiere halogen lamps equipped with a dimmer switch, set the lamp at a setting lower than the maximum whenever possible**
- **Keep halogen torchiere lamps away from elevated beds such as bunk beds where bedding may get too close to the tubular bulb.**
- **Place torchiere lamps in locations where they cannot be tipped over by children, pets, or a strong gust from an open window.**
- **Never touch halogen bulbs with bare fingers. The oils in your skin can cause “spots” on the glass envelope that may result in premature failure of the bulb.**
- **The lamps are required to use particle containment barriers to keep glass inside the lamp – this barrier should be in place at all times when the lamp is operational.**

Case Study 2 – Fires Caused by Heat from Built-in Halogen Spots

Low-voltage halogen lighting is becoming very popular at home, in the office, and on the shop floor. The low-voltage lights can be bought in do-it-yourself packages and often lay people who think it looks easy, to try and install them themselves. This however can be extremely dangerous.

It has been found that if the halogen spots are installed in the ceiling, where the lights are covered by thermal insulation, enough heat can build up from the lights to ignite the insulation.

Lights installed in the ceiling must have a safety gap between the halogen spotlights and loose-fill insulation or ignition can easily occur. It is important that low-voltage halogen lighting should only be installed by experts in compliance with safety regulations.

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