FIRE EFFECTS ON HIGH EFFICIENCY COMPACT FLUORESCENT LIGHTING

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ABSTRACT

The Energy Independence and Security Act of 2007 has mandated that most of the incandescent lights currently in use will be phased out by 2014 and replaced with more efficient means of producing light. Many manufacturers have begun producing compact fluorescent and LED lighting to replace the incandescent bulb. While this is a boon for energy conservation, what will it mean for the fire investigator? For years investigators have used heat distorted light bulbs to help determine the origin and intensity of fires. The purpose of this study is to establish a base of information on the effects of fire on new styles of lighting, and how the effects of fire can aid the investigator in his or her work.

HISTORY

The use of electric incandescent lights dates back to Thomas Edison's development of the first technically and commercially successful light in 1878[1]. Incandescent lights have been the most popular source of light for over a century because they are available in a variety of sizes; voltages (both AC and DC); and are easy to produce, install and use. Because of their popularity, and their tendency to distort during a fire event, the ubiquitous light bulb has been used for decades as a method of determining the direction and intensity of fire movement, and hence point to a fire's origin. The distortion of light bulbs is such a reliable indicator that it has been incorporated into many fire investigation texts.

> **NFPA 921-2011**
> ***6.2.15 Distorted Light Bulbs.*** *Incandescent light bulbs can sometimes show the direction of heat impingement. As the side of the bulb facing the source of heating is heated and softened, the gases inside a bulb of greater than 25 W can begin to expand and bubble out the softened glass. This has been traditionally, albeit misleadingly, called a pulled lightbulb, though the action is really a response to internal pressure rather than a pulling. The bulged or pulled portion of the bulb will be in the direction of the source of the heating, as shown in Figure 6.2.15.*
>
> ***6.2.15.1*** *Because they contain a vacuum, bulbs of 25 watts or less can be pulled inward on the side in the direction of the source of heating.*
>
> ***6.2.15.2*** *Often these light bulbs will survive fire extinguishment efforts and can be used by the investigator to show the direction of fire travel. In evaluating a distorted light bulb, the investigator should be careful to ascertain that the bulb has not been turned in its socket or that the socket itself has not turned as a result of coming loose during or after the fire.*[2]

A competing technology to the incandescent light is the fluorescent light, with the first practical lamp being invented in 1938. Although more energy efficient, fluorescent lamps were larger; more expensive; required more expensive; and complex fixtures and only operated on a limited range of AC voltages.

The helical (three-dimensional spiral) compact fluorescent lamp (CFL) was invented in 1976 by Edward Hammer, an engineer with General Electric in response to the 1973 oil crisis. Due to production expenses, the invention was shelved. The design eventually was copied by others, and in 1995 helical lamps became commercially available. Since that time production has steadily grown and improved designs have come to market. [3]

The Energy Independence and Security Act of 2007 was passed with the intention of reducing energy consumption and dependency of foreign energy sources. Title III of the act mandated improved energy efficiency for appliances and lighting. The target of the lighting provision is the incandescent bulb with bans on the manufacturing and importation of popular sizes beginning in 2012 and ending in 2014. The United States is not alone in this effort as such countries as Argentina, Australia, Brazil, Canada, China, Israel, Malaysia, Philippines, Russia, Switzerland, Venezuela and the European Union began similar programs as early as 2005. [4]

DEFINING THE PROBLEM

With bans on incandescent lighting taking place around the world, a reliable tool of the fire investigation industry is quickly disappearing. The question is this—can compact fluorescent lighting be used in a similar manner as incandescent light to track a fire's movement and help determine the area of origin?

INTENT OF STUDY

This research project was designed to determine, a) if compact fluorescent lights can survive similar conditions as their incandescent counterpoints, and b) if compact fluorescent lights can be used to as indicators of fire movement, intensity and origin.

TESTING

The test was designed to simulate conditions similar to what might be found in a typical compartment fire. The intention was to create a small scale compartment with a vertical fire plume, a horizontal ceiling jet, and an upper layer hot enough as to be capable of softening glass.

The interior chamber dimensions were 1.46 m (57.5 in.) long x 0.85 m (33.5 in.) wide x 1.22 m (48 in.) high. Top and bottom panels were constructed from 12.7 mm (½ in.) reinforced cement board, and side walls were constructed from two layers of 12.7 mm (½ in.) gypsum board. Porcelain fixtures were placed at various locations on the ceiling and walls to provide different orientations and exposures to the fire plume and ceiling jet. *(See Fig. 1.)*

For the first round of tests fixtures were positioned relative to the front wall where the fire plume was was located. Positions of the fixtures were as follows:

Ceiling 1 (C1) – 204 mm (8 in.) from front wall, centered
Ceiling 2 (C2) – 610 mm (24 in.) from front wall, offset 102 mm (4 in.) to the right
Ceiling 3 (C3) – 940 mm (37 in.) from front wall, offset 102 mm (4 in.) to the left
Left Wall (L1) – 760 mm (30 in.) from front wall, offset 102 mm (4 in.) from the ceiling
Right Wall (R1) – 760 mm (30 in.) from front wall, offset 152 mm (6 in.) from the ceiling

The fire plume was created using two propane torch burners aimed up and parallel to the front wall of the chamber. Control of the fire was achieved by the use of flow

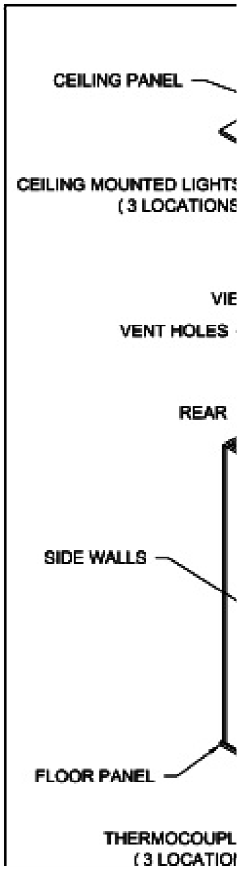
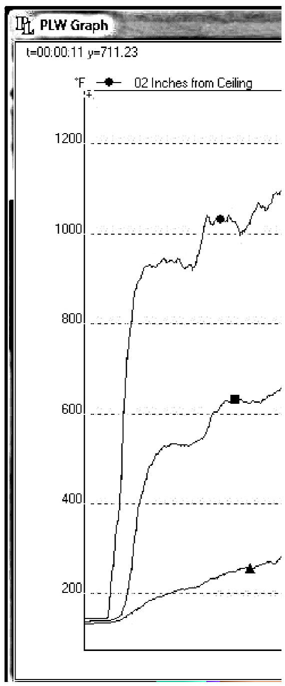


Figure 2.
Test Chamber Exterior, pr

Experimentation showed that a mi
thermocouple) for at least 5 minute
control and baseline for the testing.

After test perimeters were establish
under similar conditions using com
The first was the helical integrated
The second type was a helical inte
shape of traditional incandescent b
types of CFL's exist in the ma
incandescent lights.



Ty

Figure 5.
Helical Integrated

After the initial tests were complete
“in parallel”, so results could be co
fixtures were placed on the ceiling
slightly closer due to spacing issue
wall and offset 102 mm (4 in.) from

During the parallel tests, three heli
center fixture) were placed into the
the effects of the heat could be obs
After allowing the chamber to cool
chamber reheated to a higher ten
destroyed.

Note a

ANATOMY OF A LIGHT BULB

Incandescent and compact
most important to this study, in th
resistant glass and metals, fluoresce
such as plastics, paper circuit boar
they generate less heat, typically
lighting[3] while producing the same
types of lights.

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.

Figure 8a.
Incandescent light.

OBSERVATIONS

Incandescent Lights

Damage only occurred to
adjacent to the fire plume. *(Positic*
on the side walls of the chamber,
located on a side wall of the chamb
a higher temperature in the center
softening temperatures for glass ir
thermocouple mounted mid-ceiling.

(In the following illustrations, a BLAC
denotes significant details.)

Figure 9.
"Pulled" bulb.
Position C1, in fire plume.

Helical Integrated CFL'S

The helical compact fluore
incandescent light studies. Unlike
were damaged during this study.
burned, compromising the structu
remained in the porcelain fixture.
ballast) could be found on the floor
the impact with the floor.

Although little of the helical CFL's
some of the fixtures which could
heating, the cooler side of the light
to soften and had the opportunity to
could burn away or remain intact af

(In the following illustrations, a BLAC
denotes significant details.)

Figure 11.
Ceiling mounted helical CFL's post fir
test chamber.) Note increasing resi

Figure 13.
Remains of helical CFL on
Glass tube and electronic components

Figure 14b.
Same wall mounted helical CF
Note un-charred side of housing away

Another interesting phenomenon se
from the ceiling jet. The shadow v
polycarbonate material being depos
removed by touching. In general, t
shadow.

It was later discovered that the sha
round of testing the porcelain fixtur
tan-gray dust a dark residue stain h
This effect was consistent for both
was of a higher temperature and/or

(In the following illustrations, a BLAC
denotes significant details.)

Figure 15a.
Fixture showing shadow aft

Type A CFL'S

The Type A compact fluor
both the incandescent and helical c
the Type A CFL's were damaged du

The Type A lights displayed a wic
higher mass of the light and its abil
of a ceiling mounted Type A CFL
16). The softening of plastic co
completely free of the cap *(Fig. 1*
mostly intact, with some melting a
Type A CFL remained fairly intac
position C3). Damage to the Type
(Fig. 20 and 21, positions L1 and R

(In the following illustrations, a BLAC
denotes significant details.)

Figure 16.
Ceiling mounted Type A CFL, p
Only the cap remains in the

Figure 18.
Remains of Type A CFL o
Many components survived, includin
tube.

No residue shadows were noted du
conditions and not differences in
likely the result of a leaner fuel mix
During later testing, both the helica

*(In the following illustrations, a BLAC
denotes significant details.)*

Figure 20.
Wall mounted Type A CFL po
Charring is heavier on side facing

Parallel Test Results

In the first round of tests or
were similar, they were not identica
Type A CFL's were tested side by
parallel testing confirmed what was
damage sooner than incandescent l
of their greater mass, were at first
quicker to fall apart due to their l
visible effects and patterns after the

CONCLUSIONS

The incandescent light as
much rarer than it is today. More e
world and compact fluorescent li
investigators will have to adapt to th

Because of their construction and
and at lower temperatures than tra
melt and burn at temperatures th
ballasts—made up of circuit b
components—are also less able to s
fire.

This does not mean, however, that compact fluorescent light should be completely discounted in fire investigations. Although they may be severely damaged during a fire, CFL's can still yield valuable information about the direction and intensity of fire travel. Fire effects can be left behind which are still able of indicating the proximity of the light to the fire, and from where the fire came. Melted tails, residue "shadows", charred and un-charred remnants can all be used in the place of the traditional melted glass light. A fire investigator, using proper care and caution, can use compact fluorescent lights to determine a fire's origin in much the same way we once used incandescent lights.

Further detailed testing and research is planned.

ABOUT THE AUTHOR

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ENDNOTES

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