

# In the field with Lighting Diagnostics...

## Solving a lighting mystery at a big box retail store

The *Lighting Diagnostics* team at NLPiP examined the lighting system in a big box retail store in the Albany, New York area to learn why fluorescent lamps used in a dimming system were experiencing shortened life. The system of 1350 luminaires (fixtures) and dimming ballasts had been installed as an energy-saving alternative.

The lamps have an average rated life of 30,000 hours. The lighting system is rarely turned off and had been operating for two years (approximately 17,500 hours).

Under ideal conditions, a lamp with a 30,000-hour average rated life would have an average life of 36,000 hours when operated continuously. Using the lamp manufacturer's published mortality curve, one would expect less than 3% failures at 17,500 hours of operation. The store experienced more than 7% failures. *Lighting Diagnostics* examined this dimming lighting system to determine the causes of the higher than expected failure rate.

### Setting

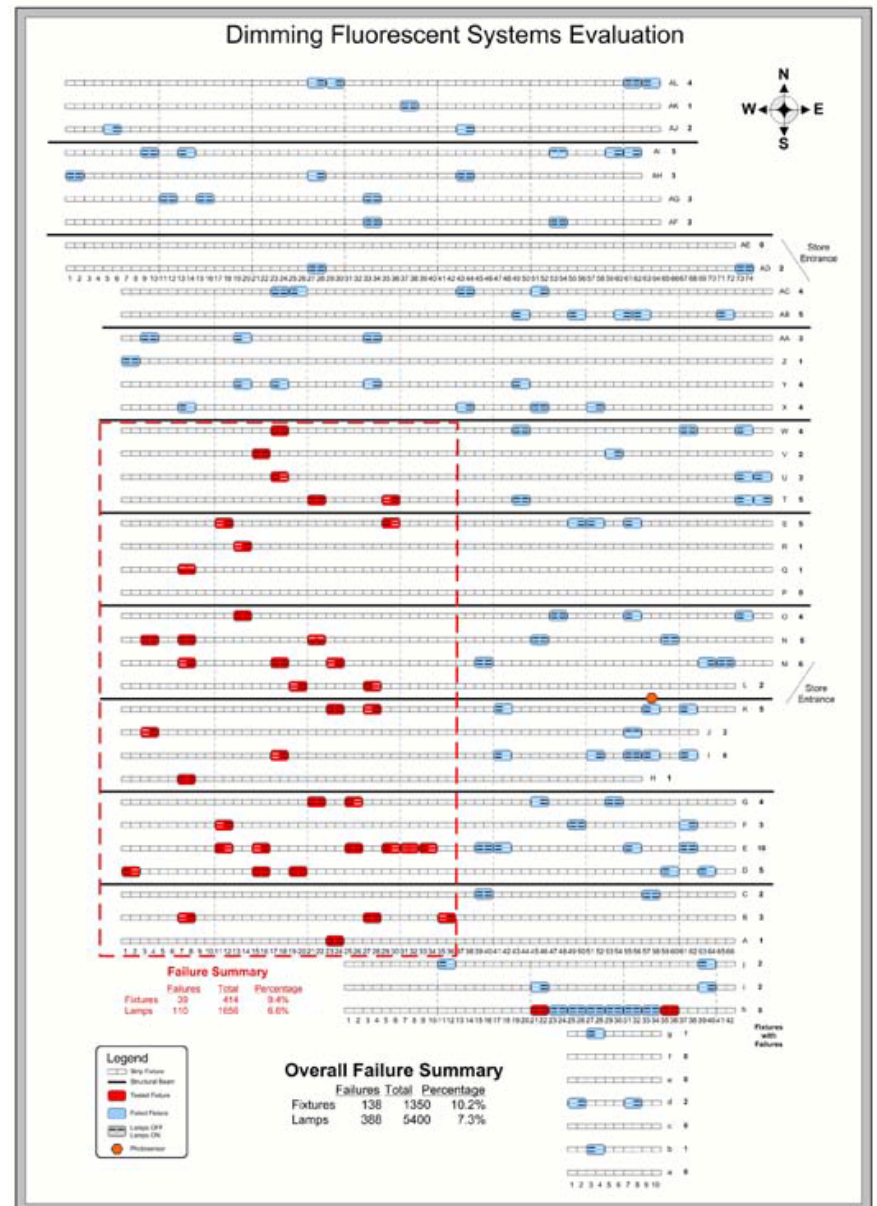
The store is two years old and features skylights and dimming fluorescent lighting. The lighting system includes 1350 luminaires with dimming ballasts and four lamps in each (5400 lamps total). Fixed-output luminaires were installed around the perimeter of the store's interior.

### Lighting System

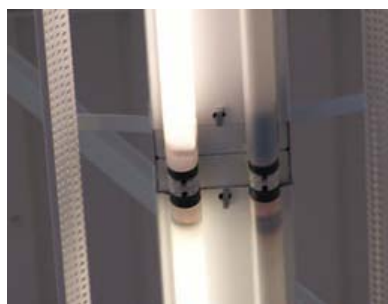
The store's dimming system used dimming ballasts with a range of 5%-100% light output, each operating four lamps on two circuits (two lamps per circuit). T8 lamps were rated at 30,000 hours life. The 8-foot luminaires had two 4-foot sections and featured quick connect plugs at each end for power and dimming wires. Lamp holders featured slide-on mounting systems and medium bi-pin connections. Top test ports in the lamp holders allowed testing for electrode heating voltage and lamp voltage.

### Procedure

NLPiP investigators first determined how many failures were in the store and where they were located. They then created a map of the luminaires (shown at right) and identified an area to investigate (marked in red) in order to minimize the impact of the investigation on customers and workers.



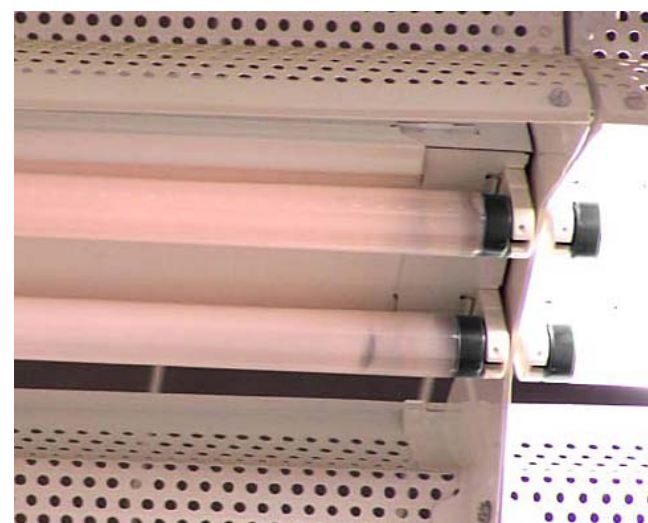
Map of lighting system (area tested shown in red)



Lamp end darkening



Pink lamps



## Symptoms

Symptoms found at the store included shortened lamp life, non-working lamps, lamps with severe end-darkening, pink lamps, and very low light output.

## Findings

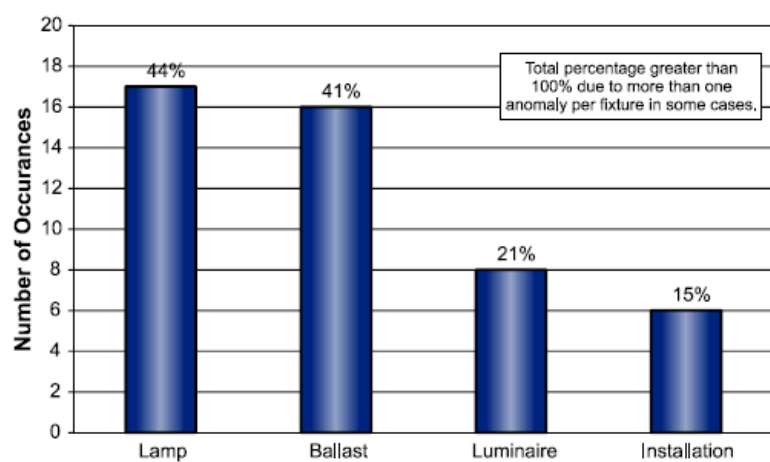
The investigation found several types of problems relating to the lamps, ballasts, luminaires, lamp holders, and the installations themselves.



Some of the problems identified by Lighting Diagnostics investigators are circled above.

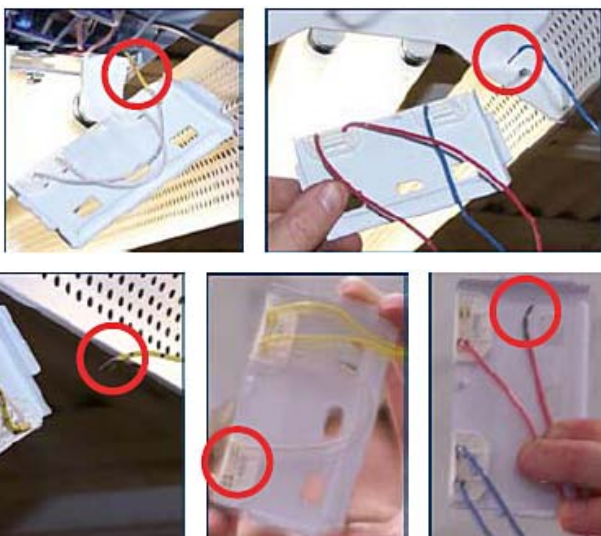
### Storewide:

- Problems appeared to be randomly distributed throughout the store.
- 10% of the luminaires contained lamps that had either failed or were inoperative.
- 7% of the lamps had failed or were inoperative.



### Types of problems found

Examples of wires not connected in luminaires



### Of the luminaires with at least one inoperative lamp:

- 44% had lamps with open electrodes. Not all of these lamps showed end darkening.
- 41% had ballast failures. These ballasts were cold to the touch, indicating they were not energized. Voltage was verified at the input to all ballasts and rechecked after turning the power off and on.
- 21% had luminaire anomalies such as wires not connected or wires connected improperly.
- 15% had installation anomalies such as lamps not inserted properly or rotated into holders, lack of continuity in electrode heating circuit, or luminaire covers not installed properly.

## Lessons Learned

Dimming systems are more sensitive to installation issues than full-output systems. Many of the problems would not present the same impact on full-output systems.

- Lighting Diagnostics investigators found a number of luminaires wired incorrectly.
- Expect open electrodes in all cases of incorrect wiring.
- The most likely cause of lamp failure is improper luminaire wiring or lamp installation. Both prevent electrode heating—crucial while dimming.
- Luminaire covers were in contact with lamps and created phosphor burns on the lamps. Lamps are sensitive to direct contact with grounded housings.
- Luminaire cover tabs were not installed correctly.
- Connectors were unplugged.
- Power wires were not connected.

## Common lighting problems and causes

Lighting problems do not always cause complete failure. Symptoms may include:

- Shortened lamp life
- Darkened lamp ends
- Pink lamps
- Low light output
- Buzzing
- Striation
- Unrealized energy savings

Many factors can contribute to lighting system problems. Lamps, luminaires (fixtures), ballasts, and installation can all play a part. Any one problem may not be noticeable. However, multiple problems together often become objectionable. A few examples of problem areas and their causes could include:

### Lamps

- Broken electrodes

### Installation

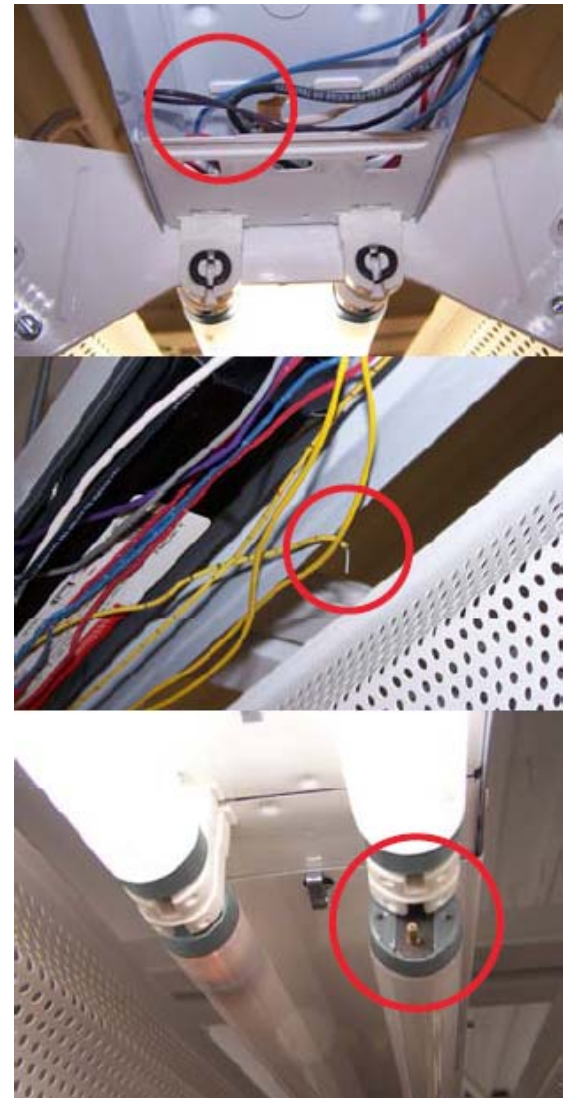
- Lamps not completely rotated into holders correctly
- Lack of continuity in electrode heating circuit
- Luminaire covers not installed properly

### Luminaires (Fixtures)

- Wires improperly connected
- Wires not connected

### Ballasts

- Failed (will be cold to the touch)
- Low input voltage
- No power to ballast



## Troubleshooting Dimming Fluorescent Systems

Dimming fluorescent systems are more sensitive to potential installation problems compared to non-dimming fluorescent systems. Many of the issues that have been identified are related to the removal of heating from the lamp electrodes, which become necessary when dimming, especially to low levels. If the dimming fluorescent systems are used at full light output, many of these problems will probably go unnoticed until the lamps are operated in the dimming condition for some time.

If you have lighting problems, begin by assessing the big picture. Examine the lamps, luminaires, and ballasts, including how those components were installed.

### Check luminaires

**Inspect** the lamp holders for damage. This could result in a discontinuity to the electrode heating circuit, thereby preventing proper electrode heating.

**Tug** on each ballast wire connected to the lamp holder to make sure the wires are installed correctly. If a wire is not connected securely, the lamp may operate, but electrode heating will not be applied.

**Check** to see if any part of the luminaire housing is in direct contact with any of the lamps. Contact with the lamp may provide an alternative path for lamp and/or electrode current.

**Measure** the electrode heating voltage at each lamp holder, if possible, to see if the voltage is within the manufacturer's limits. A voltmeter or oscilloscope with proper frequency response (> 300 kHz) is needed for this measurement, since the electrode heating voltage can be at a high frequency (20-100kHz).

### Check ballasts

**Check** if the ballast case is warm, if all lamps are out. If the case is cold, the ballast may not be getting any power, or there may be another issue.

### Check lamps

**Check** that lamps are properly installed in the luminaire. Both pins on each side of the lamps should be in electrical contact with the lamp holder. If the lamps are not installed correctly, proper electrode heating will not be provided during dimming.