Relighting the Church

A Simple DIY Guide

Steve Jones

Why update your lighting?

- Often churches do not pay attention to lighting unless:
  - Electric bills are too high
    - In churches, lighting can account for up to 50% of usage
  - Bad lighting becomes a safety or visibility issue
    - Sanctuary, stairs, hallways, bathrooms
    - People don’t notice it until it’s not there
- Better lighting has a psychological benefit
  - A brighter space = a happier space
  - More welcoming to visitors or new members or renters!

How can we update our lighting?

- We'll discuss how to identify inefficient lighting and make changes yourself.
- For those that can't, there are state or utility programs that can do it for you….AND can be cheaper than doing nothing.
- Typically, if you are replacing an existing fixture or switch, no permit needed. Adding NEW fixtures and wiring requires a permit. Always check first.
- You may have a fear of discovering problems….
  - Knob & tube wiring
  - Unsafe fixtures
  - Let an electrician handle these issues.

- My response: You don't know until you look!

Identifying Inefficient Lighting

These are your major opportunities for energy savings:

- Incandescent bulbs especially in hard-to-reach fixtures
- High wattage incandescent bulbs > 150 watts
- T12 fluorescent fixtures using magnetic ballasts
- High wattage halogen or HID fixtures for spot/ceiling lights
- Older incandescent or CFL EXIT signs
- Outdoor HID lighting

Identifying Inefficient Lighting

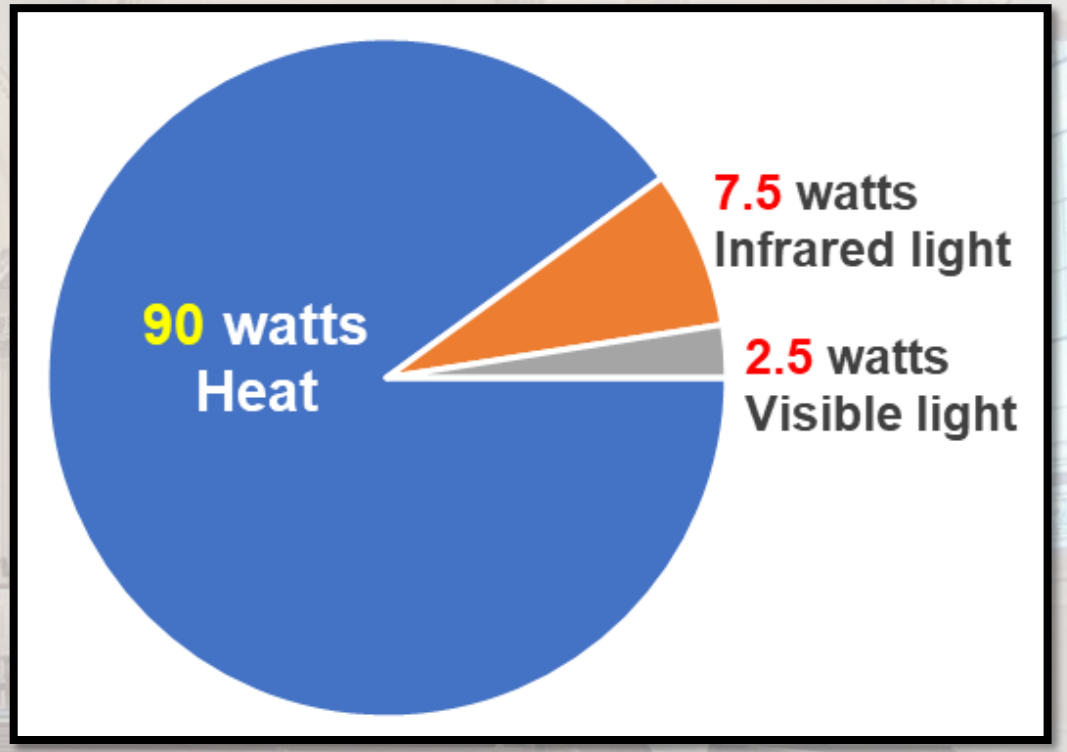
Do It Yourself Fixes

- Replace incandescents and CFLs with LED bulbs
  - CLEAN any bowls, shades, or lenses!
- Update fluorescent ballasts and tubes
  - These could need some expertise

Incandescent Bulbs

Still using any incandescent bulbs?

100 watt incandescent bulb uses 100 watts



Excuses I hear most often:

"The bulbs are cheaper."

"They're already paid for."

"We'll replace them as they burn out."

Look at the TOTAL COST of that bulb – purchase price + energy use!

Buying a new LED and burning it is still ⅓ – ¼ the total cost of burning the existing incandescent bulb.

LED Energy Savings

You need to look at the TOTAL COST of each type of bulb!

- **100 watt incandescent bulb lasts 900-1200 hours (~1 year)**

  Cost ~ $0.50 per bulb

  kWh rate = $0.10 / kWh

  Total lamp cost = $0.50 + (1,200 hrs * 0.100 kW * $0.10 / kWh)

  Total cost = $12.50 over 1 year

- **17 watt LED bulb lasts 10,000+ hours (~5 years)**

  Cost ~ $2.00 per bulb

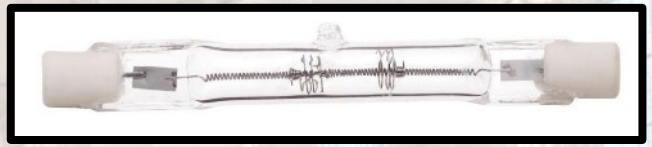
  Total lamp cost over 1 year = $2.00 + (1,200 hrs * 0.017 kW * $0.10 / kWh)

  Total cost = $4.04 over 1 year

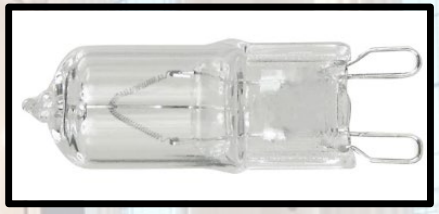
Savings: $12.50 - $4.04 = $8.46 over 1 year. That is 68% lower cost!

Halogen Bulbs

Halogen bulbs are dangerous!



Halogen bulbs burn at 970 – 1200 deg F



Fixtures are enclosed in a steel heat barrier

- **Some churches have found charred or blackened wood around the fixtures**

Over 150 watts, the LED replacement bulb is too large for the fixture.

For higher wattages, replace the fixture with an LED spotlight.

PAR56 “headlight” bulbs do have LED versions

Issues with Incandescent Fixtures

- My preference is to preserve original fixtures when possible.
- If you have older fixtures, check:
  - Condition of the wiring
    - If wiring insulation is brittle or unsafe have it rewired.
  - Size of the bulb socket
    - Many old fixtures used high wattage bulbs > 150 watts and may have MOGUL base sockets (1.5” diameter)
- LEDs use less current so that makes the circuit safer also.
- Can safely increase light level while reducing fixture wattage.
  - 100 watt incandescent >> 17 watt LED = same brightness

Light Socket Sizes & Adapters

- **Medium** base fixtures (Edison, 1” socket – E26)
  - 99% of all fixtures
- **Mogul** base fixtures (1.5” socket – E39)
  - Use a socket adapter - mogul-to-medium base
- **Candelabra** base (1/2” socket - E12)
- **GU** base
- **PL** base (compact fluorescent tubes)
- **EXIT** signs use an **INTERMEDIATE** base
- **Socket extenders**
  - Use with wider-base bulbs (CFLs)
  - Brings a floodlight bulb to the front of the shroud

Mogul to medium adapter

PL base fluorescent

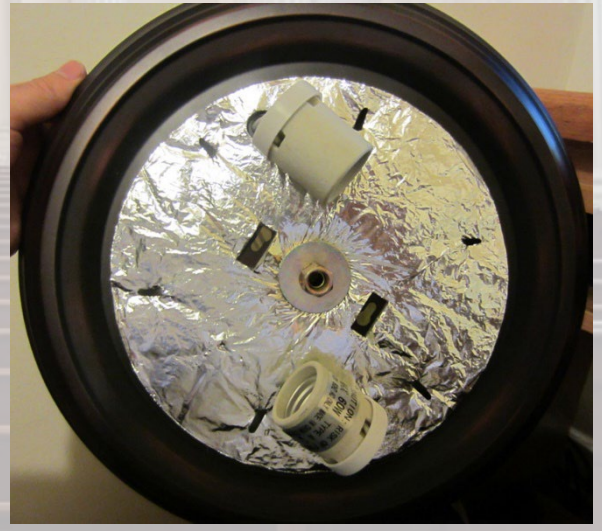
GU to medium adapter

Socket extender

Integrated LED vs Socket Fixtures

- Many new fixtures are “integrated LED” meaning the LED array is included.
- LED troffers, strips are integrated fixtures
- Advantages:
  - No bulbs to purchase
- Disadvantages:
  - If the array fails, you must replace the entire fixture
  - Typically not as bright (< 1000 lumens / 60w equivalent)
- A regular socket fixture is more flexible (IMHO)
  - Bulbs fails, replace bulb
  - Can use whatever brightness or color of bulb you want

Integrated LED ceiling fixture

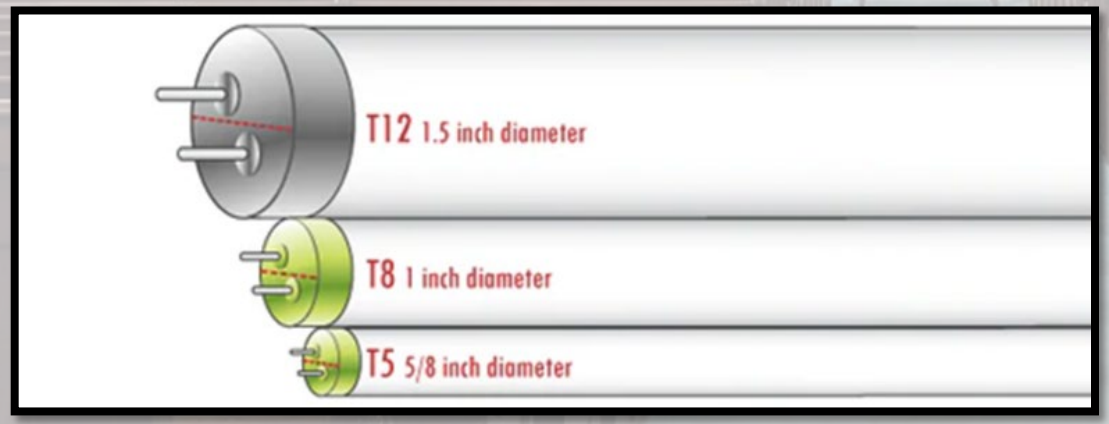


Traditional socket fixture

Issues with Fluorescent Fixtures

Fluorescent Tubes

- Pre-1990 fluorescent fixtures use T12 tubes and magnetic ballasts.
  - Manufacture of T12 tubes stopped on July 14, 2012
- T12 tube - 1.5” diameter, 4ft @ 40 watts, 8ft @ 60, 75, or 96 watts
- A single T12 tube contains 20-50 mg of mercury (Hg)
- Ends of tube turn black at the end of their functional life (lumen depreciation)
- Newer tubes are T8 – 1” diameter, 4ft @ 32 watts
  - T8s are designed for electronic ballasts, not magnetic ballasts
  - T8 tubes do NOT replace T12 tubes in an older fixture



Issues with Fluorescent Fixtures

Magnetic Ballasts

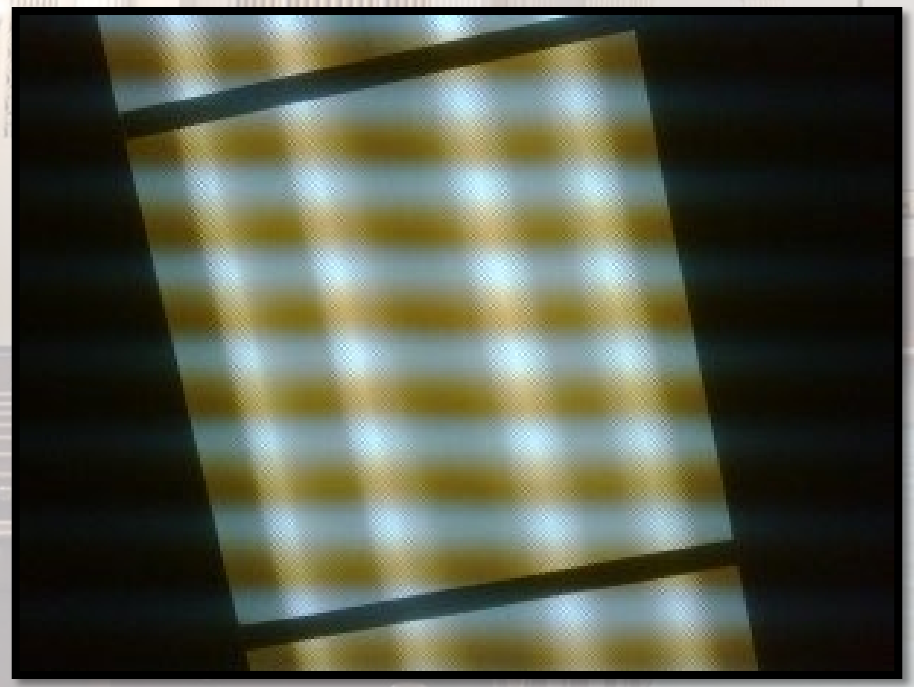
- Manufacture of magnetic ballasts stopped on November 14, 2014
- Magnetic ballasts starts slowly – “blink blink POP” and often make noise
  - They use 10 - 20% of the wattage for themselves
  - They still use energy even if there are no tubes in the fixture
- A magnetic ballast can only light up 2 tubes. So a 4-tube fixture has 2 ballasts
  - If you remove 1 bulb, the other one on that ballast goes out
- They get WARM and often leak oil.
  - Prior to 1987 the insulating material and internal capacitor contained PCBs
  - If the ballast label does NOT say “No PCBs”, then it must be disposed of as hazardous waste!

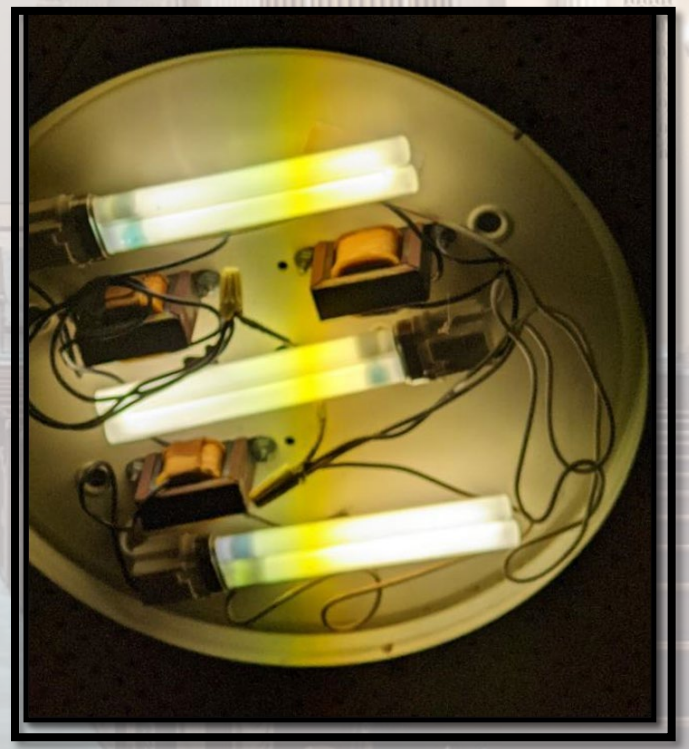
Electronic Ballasts

- Newer ballasts are electronic
- They are instant ON
- They are lighter and cooler, use much less electricity
- One ballast can light up 1-4 tubes
  - Can remove tubes and the rest stay lit
- In a church, use only “Commercial Use Only”, not “Residential Use” ballasts

Checking Fluorescent Ballast Types

- Your cell phone camera should detect yellow lines over a magnetic ballasted fixture. (due to 60 Hz flicker)

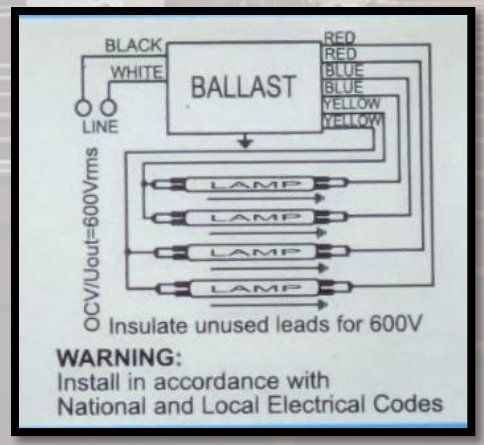


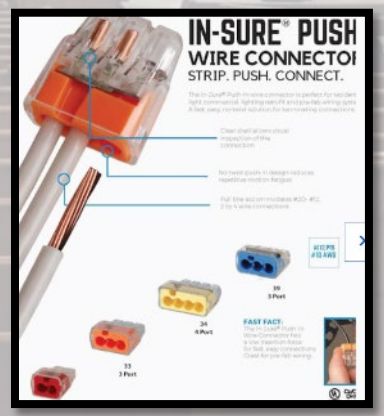


Reballasting Fluorescent Fixtures

- **If you are somewhat technical, you can replace a ballast yourself.**
- **Ensure power source is OFF before working!!**
- **All ballasts have wiring diagrams on the label and color-coded wiring.**
- **Video on relamping a T12 troffer to T8 elec ballast, and replacing tombstones**
  - https://www.youtube.com/watch?v=zLScPdm82M4
- **Article on fluorescent conversion options, with ROI calculator:**

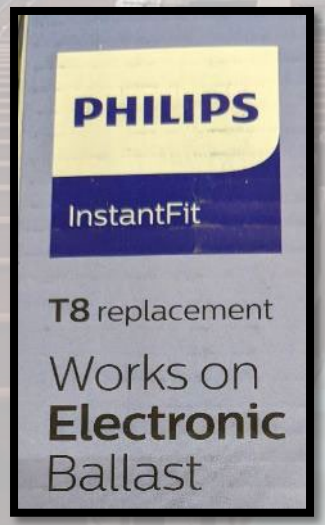
  Converting T12s to LED: Here are your replacement options (regencylighting.com)

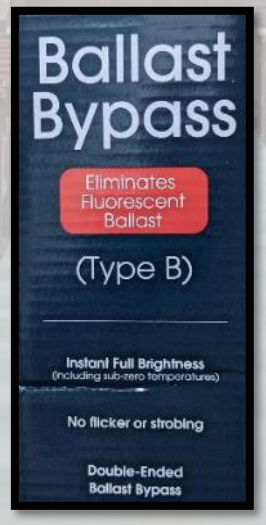




Upgrade Options for Fluorescent Fixtures

1. T8 electronic ballasts and T8 fluorescent tubes (traditional)
2. T8 electronic ballasts and Plug-and-Play LED tubes (Type A) ***
3. Change tubes to LED “Universal” plug-and-play tubes
4. Remove the ballasts and use Direct-wire LED tubes (Type B, ballast bypass)
5. Change the fixture to LED strip, wrap, or troffer.
   - If fixture is hardwired, may require an electrician





Energy Savings - Fluorescents

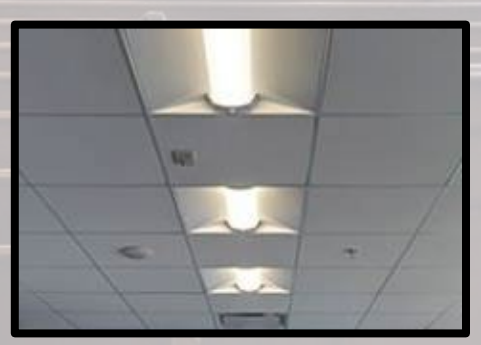
Significant energy savings from fluorescent upgrades also.

T12 (4) 40w tubes with 2 magnetic ballasts – 172 watts

T12 (4) 40w tubes with 1 electronic ballast – 134 watts

T8 (4) 32w tubes & 1 electronic ballast – 110 -128 watts

T8 (4) 17w LED plug & play tubes & electronic ballast – 68 watts



CREE ZR24 LED troffer –26 watts

Options for Fluorescent Fixtures

Keep in mind that LED tubes are directional – install properly!

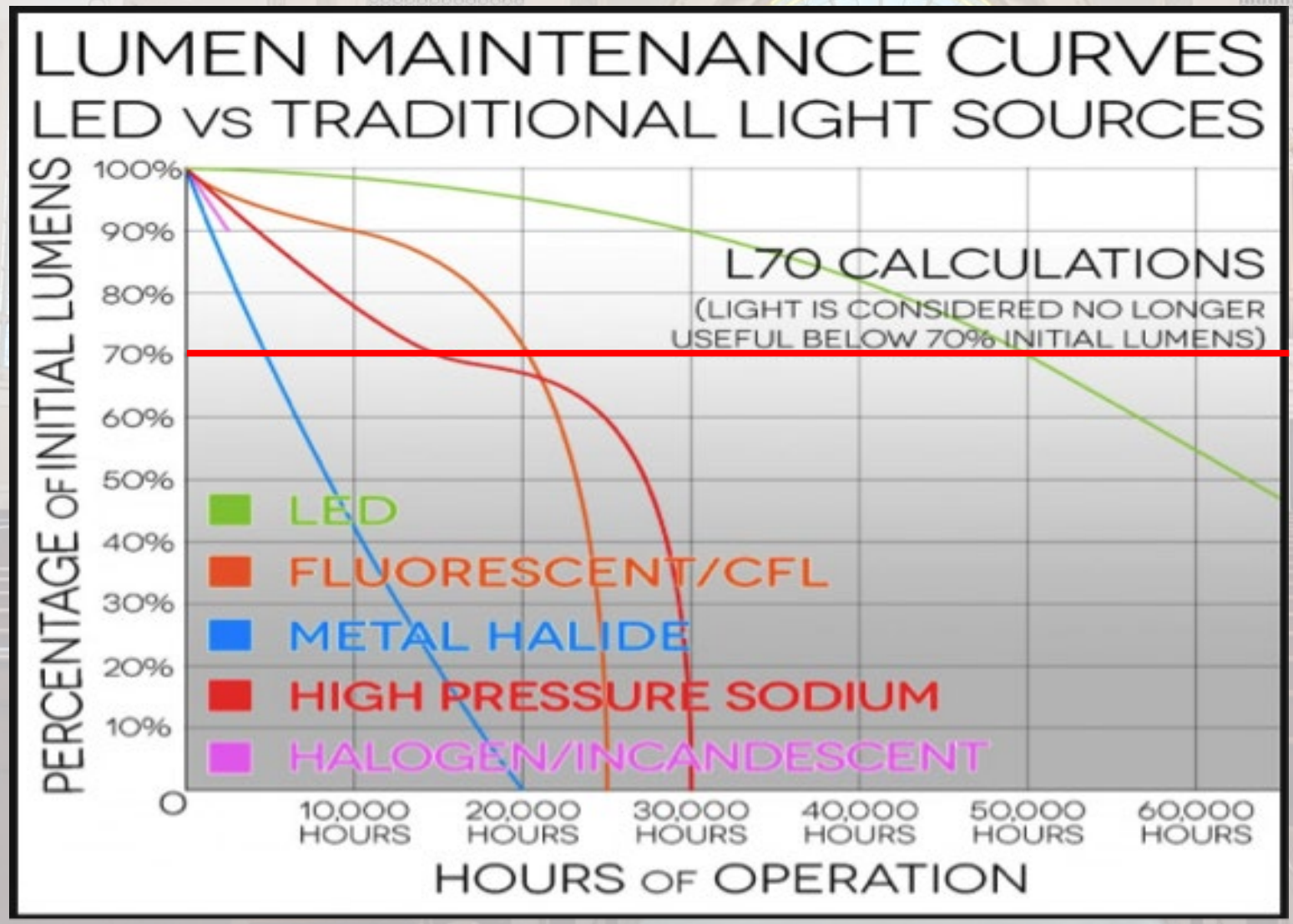
If you find broken “tombstones” in the fixture, you can replace them individually.

Light Bulb Issues

- Incandescent bulbs with separated bases.
- Compact Fluorescent Lamps (CFLs) have their own issues.
  - Fluorescent lamps are subject to Lumen Depreciation.
  - They get warm and break easily
  - I recommend changing them for LED
- LEDs can have longevity issues depending on the brand and application.
  - Closed fixtures – inside of a glass bowl / cover, heats up inside

Lumen Depreciation

- **Fluorescent & HID lamps are subject to Lumen Depreciation**



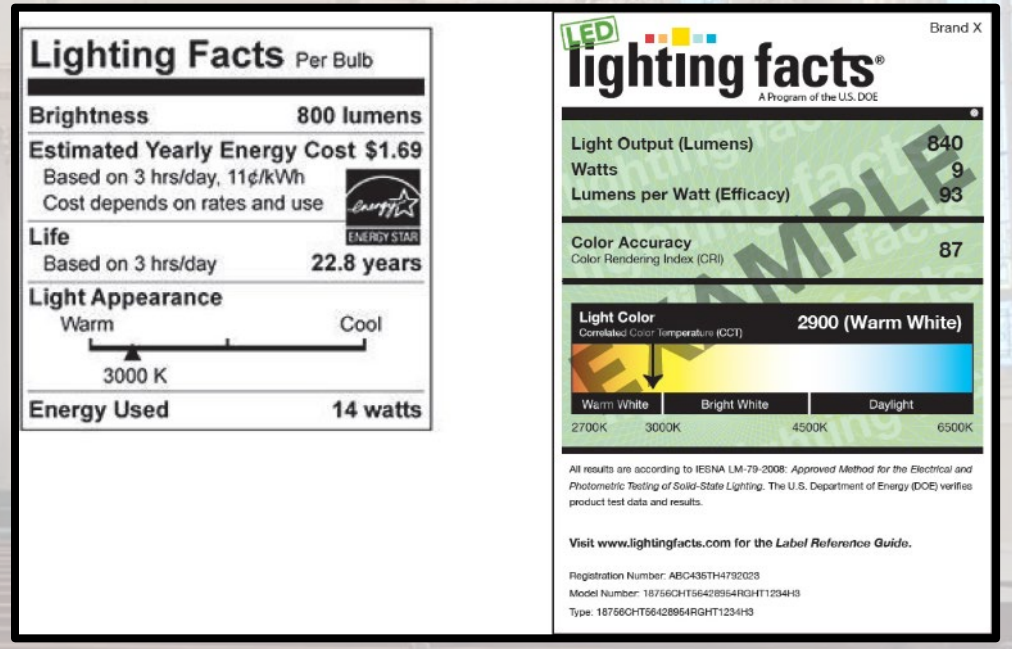
LED Bulbs – What to Buy

- I have had better success with these brands so far:
  - Ecosmart (Home Depot)
  - Feit Electric
  - Philips

- I avoid CREE, Sylvania, or GE bulbs
- For off-brands, check Customer Reviews
- I use 1000bulbs.com and Beeslighting.com for specialty bulbs, ballasts, and LED fixtures

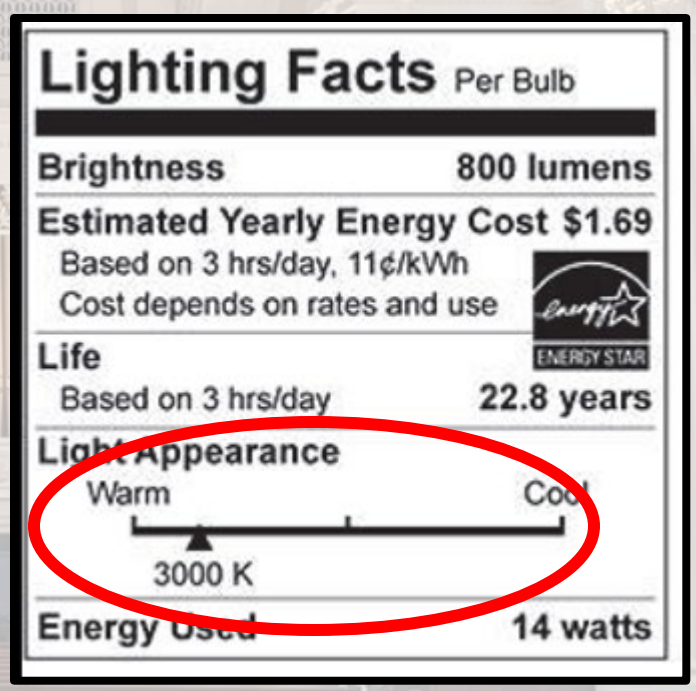
Choosing the Right LED Bulb

- **There are 3 things to look for in an LED bulb:**
  - **Color Temperature** (in Kelvin)
  - **Color Rendering Index** (CRI)
  - **Lumen Output** (brightness)
- **Labeling in the US is now standardized so you can check and compare bulbs**



Color Temperature

- Color Temperature is the color of the light output, in degrees Kelvin (K).
- Know your range:
  - 2700K – 3500K is incandescent white/yellow
  - 4000K is fluorescent “cool” white
  - 5000K – 6500K is daylight (stadium lighting)
- I prefer 3000K – 3500K



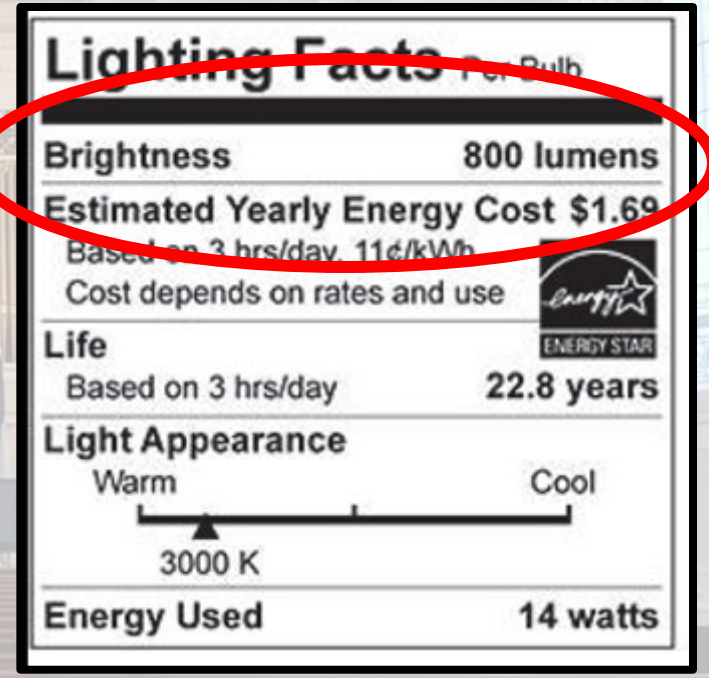
Color Rendering Index (CRI)

- Sunlight is 100 CRI (perfect color rendering)
- Fluorescent is 65 – 80 CRI
- Standard LEDs typically 80-82 CRI
- Can get LEDs in 90-93 CRI range
- Higher CRI means better photography and video
- Looks MUCH brighter than regular LED bulbs
- May need to research bulb CRI if not labeled

CRI of fluorescent bulbs depended on the Color Temperature. Not true for LEDs.

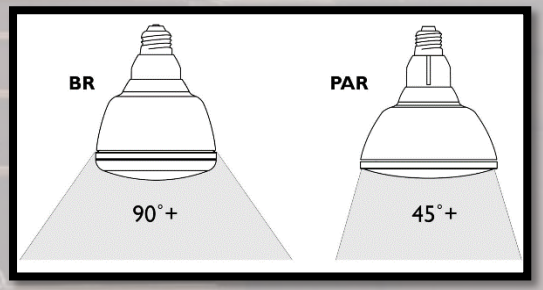
Lumen Output (brightness)

- Lumens measure the amount of light put out by a light source. (candlepower)
- Can compare different bulbs by lumen output:
  - 100 watt incandescent ~ 1700 lumens
  - 60 watt incandescent ~ 800 lumens
- For fluorescent fixtures:
  - Typical 4-tube ceiling fixture ~ 4000 effective lumens
  - LED strips, wraps, troffers – want at least 4000 lumens (2x4), 8000 lumens for an 8ft fixture



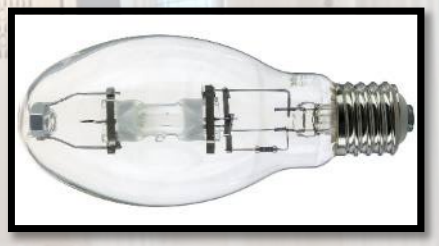
Choosing the Right LED Bulb

- LED bulbs are now available for every application
  - “regular” A19 bulbs (traditional bulb)
  - “Color selectable” bulbs
  - High Output A-shape bulbs (up to 300 w equivalent)
  - LED “filament” bulbs
  - Candelabra / torpedo bulbs (up to 100w equivalent)
  - Spotlights, floodlights (bulbs and fixtures)
    - Up to 250 watt equivalent
    - “narrow beam spotlights” - 25 degree beam for height
    - “R” vs “PAR” vs “BR” floodlights
    - “selectable” beam angle bulbs
  - 3-way bulbs
  - EXIT sign bulbs



High Intensity Discharge (HID) Lamps

- Include High Pressure Sodium, Metal Halide, Mercury Vapor
- Requires a ballast to operate
- Long warm-up time ~ 10-15 minutes
- Usually uses a mogul-base socket
- Used for outdoor lighting, large spaces, high ceilings
- There are now LED replacements for all of these fixtures (ballast bypass).
  - “Corncob” or “paddle” bulbs
  - “UFO” high bay fixtures



Motion Sensor Switches

- Replace light switches with a motion sensor which turns lights on & off automatically
- Potential to save 20-30% on electrical usage
- Pay attention to where the sensor is used and what it “sees”
  - Doorways and hallways may cause constant triggering
    - You can tape or block part of the “eye” to narrow the focus
  - Bathroom stalls are blind to wall switch sensors, so ceiling sensors may be needed
- Occupancy sensors use motion and doppler to detect presence
- They also make Timer Switches
- You can get switches now that do not require a neutral wire connection

Motion sensor switch

Occupancy sensor switch

Timer switch

Dimmer Switches

- **May need to change rheostat dimmers or eliminate if not needed.**
  - **Sometimes older rheostat dimmers were used for high wattage bulbs. LED bulbs use electronic drivers so the older rheostats may not work with the new bulbs.**
  - **Replace with a new compatible dimmer.**
  - **Make sure electronic dimmer is compatible with LED bulbs & total wattage**

Older Rheostat Dimmer Switch with heat sink

New Electronic Dimmer Switch

Energy Efficiency Programs

- Utility programs in other states usually provide a rebate for work done.
- In Connecticut: energizeCT.com
- In Massachusetts: masssave.com
- In Rhode Island: http://www.energy.ri.gov/policies-programs/programs-incentives/index.php
- In New York: check your local utility or NYSERDA
- Most utility programs offer:
  - Energy audit of the building is free
  - Can choose to accept and move forward, or not
  - Pre-screened contractors do the work
  - Fixtures and bulbs are pre-discounted
  - (CT) loan repayment terms up to 48 months and on-bill payment option
  - Often cheaper than doing nothing

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Savings through energy efficiency

Discussion photos

400w metal halide high-bay fixture replaced with new 150w LED “UFO” fixture, 3000K

Discussion photos

Auditorium space after installing the UFO fixtures.

150 watt, 3000K, 24000 lumens (400w MH equiv.)

Discussion photos

Sanctuary Chandelier

38 bulbs total

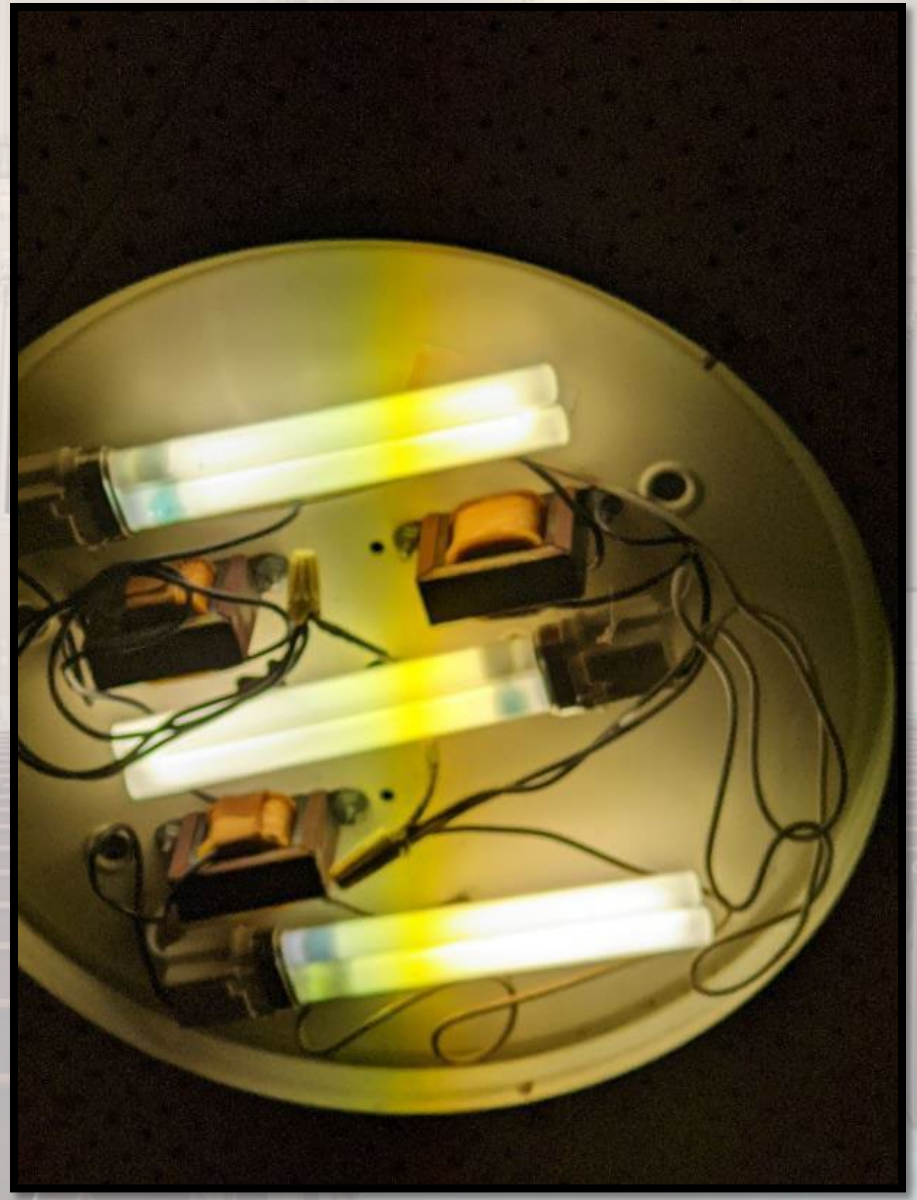
40 watt incandescent bulbs changed to 3.3 watt Feit Enhance LED

1520 total watts down to 125 watts total

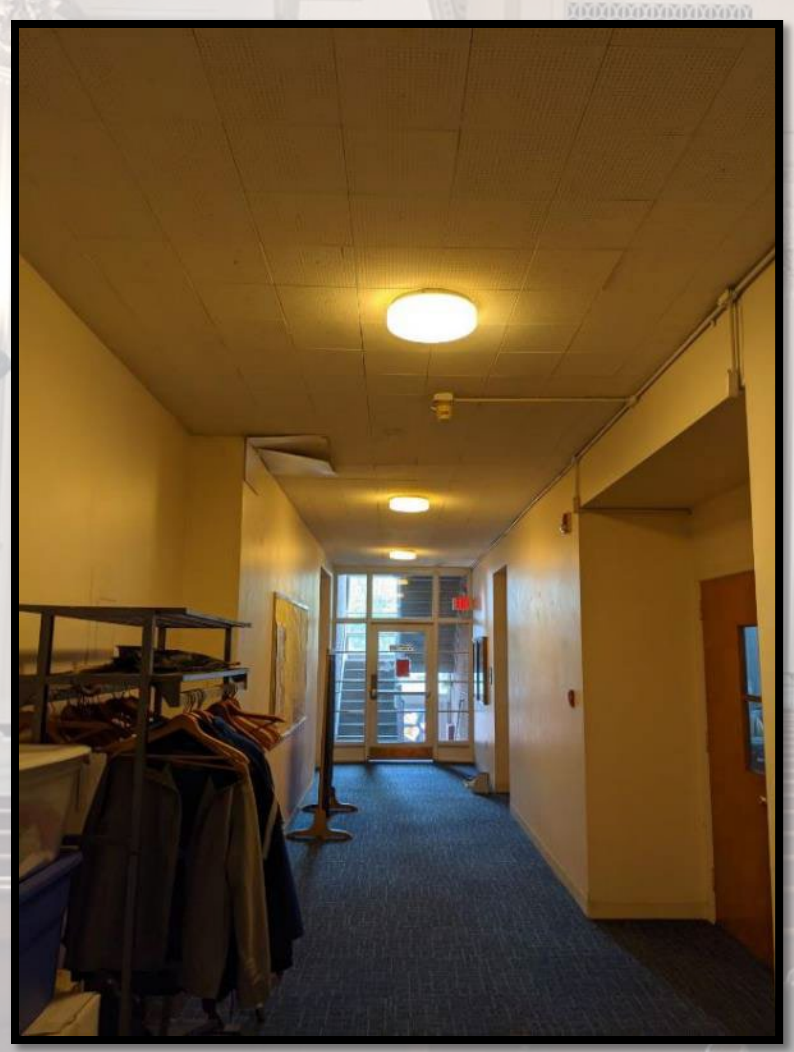
Discussion photos

Compact fluorescent PL bulbs.

Magnetic-ballasted fixtures.

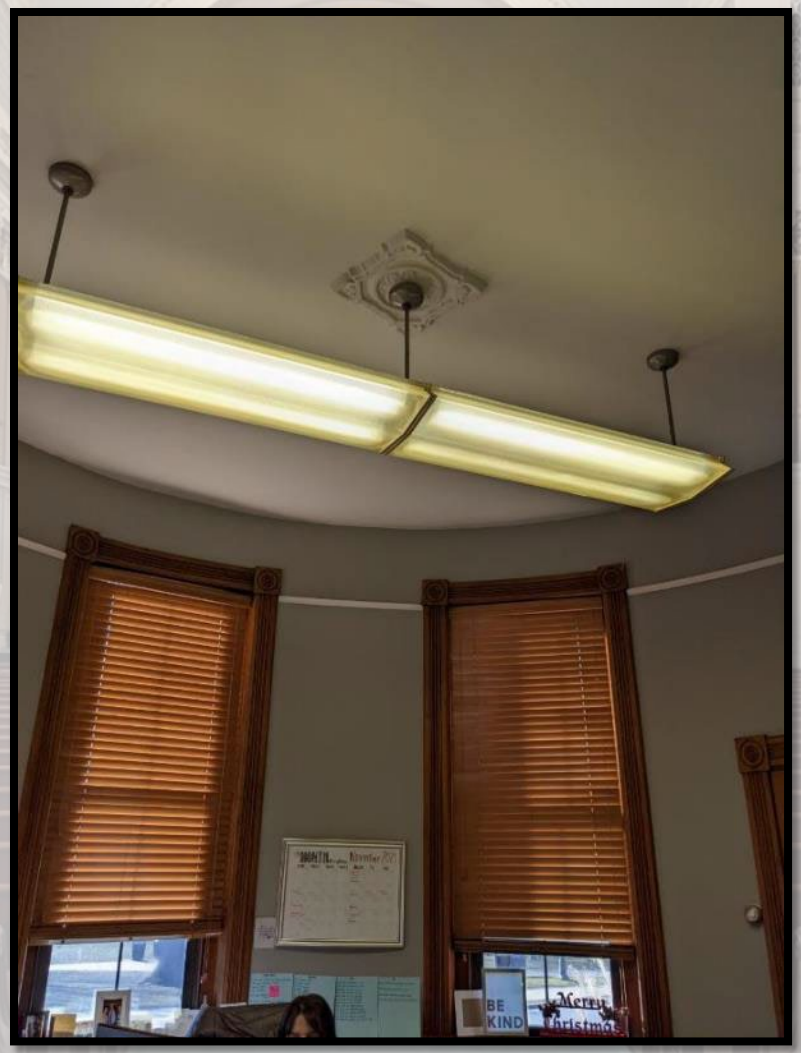


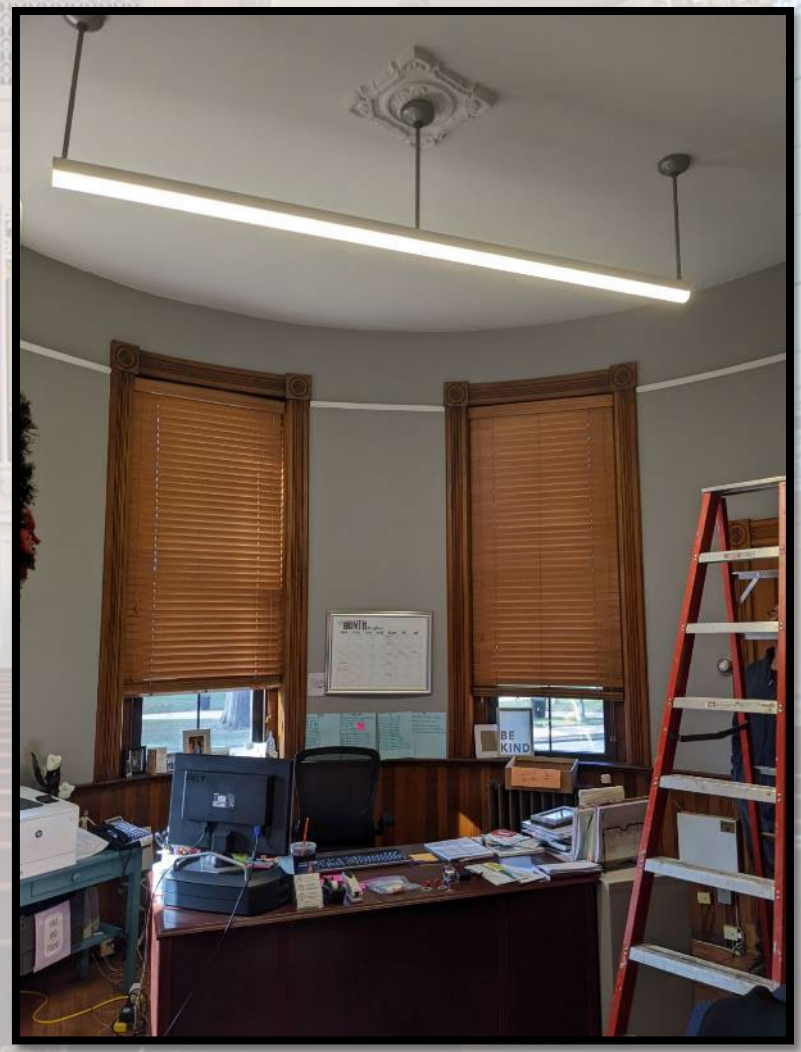
Discussion photos



(left) Hallway with magnetic-ballasted PL fixtures
(center, right) Hallway and bathroom with new 2-bulb fixtures (FEIT Enhanced 100w)

Discussion photos

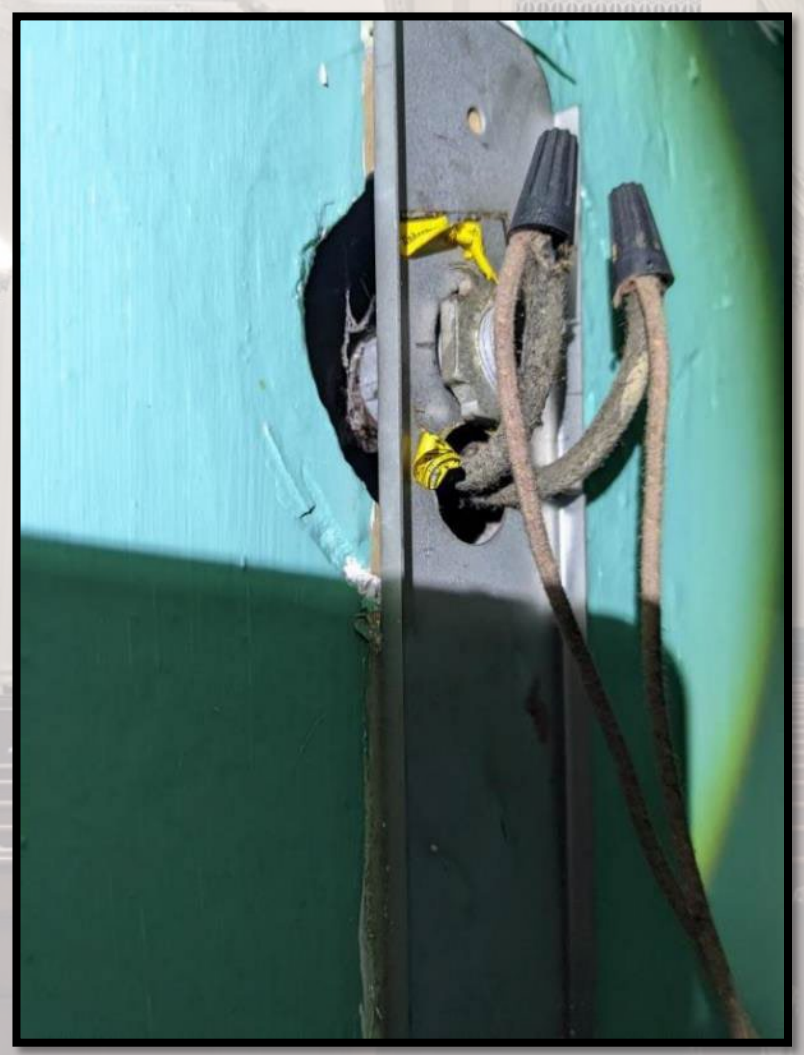




8ft T12 fixture (rear), reballasted & LED tubes (front)

Old and new Office fixtures

Discussion photos



1902 original wall gas fixture

New high lumen “garage” bulbs

Q & A time…..

Any questions or advice:

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