

**Rebates and Retrofits
The Stimulus Put to Work**

Graybar
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Part One

**BUSINESS OPPORTUNITIES OF
LIGHTING EFFICIENCY**

Opportunities

- Save energy cost
 - Demand
 - Consumption
- Gather incentives from electric utility
- Take advantage of 2005 EPACT tax deduction
- Take advantage of yet-undefined stimulus financial incentives

Services

- **Retrofit** Changing components in existing lighting systems to increase efficiency
- **Relighting** Replacing existing lighting systems to increase efficiency
- **Rate Checking** Make sure customer is paying the right amount

Retrofit Basics

- Discover old/inefficient technology
- Use cost effective methods to replace with new technology
- Use savings to offset costs.

Relighting Basics

- Discover old/inefficient technology that has a negative impact on the building's value
- Use cost effective methods to replace with new lighting systems
- Use savings to capitalize "building improvements"

The Process

- Feasibility Survey
- Preliminary Audit
- Preliminary Project Prospectus
- Investment Grade Audit
- Detailed Project Prospectus
- Engineering
- Installation
- Commissioning
- Measurement and Verification

Feasibility Study

- Visit site
- Note project scope (do they have plans??)
- Note likely opportunities
- Decide whether this is worth pursuing
- Budget to do this work: \$0.005/sf
 - 10,000 sf building = \$50
 - 100,000 sf building = \$500

Preliminary Audit

- Obtain customer’s electric bills for the last year
- Make sure they are on the right rate
- Perform a more thorough site visit
 - More carefully note project scope
 - More carefully note quantity and density of cost effective changes
 - Spot checks on existing technology
- Budget for this work: \$0.02/sf
 - 10,000 sf building = \$200
 - 100,000 sf building = \$2,000

Preliminary Project Prospectus

- For each opportunity, develop a lighting design
- Using approximate costs and experience
- Use the proper rates
- Be sure to take into account project conditions
 - Night work?
 - Extra preparation?
- Be sure to include all markups and profits
- Prepare in an approved format
- DO NOT SPECIFY WHAT YOUR TECHICAL SOLUTION unless approved.
- Budget for this work: \$.02/sf

Investment Grade Audit

- Very carefully survey and count applicable project elements
- More frequent spot checks of existing technology
- Measure patterns of occupancy and use to determine hours and other patterns
- Obtain or make scaled plans with accurate dimensions
- Budget for this work: \$.05/sf

Detailed Project Prospectus

- For each opportunity, develop a detailed lighting design in plan
- Using exact costs and electrical estimating experience
- Use exact rates for labor, material, markup
- Be sure to take into account project conditions and provide a cost for all including
 - Night work
 - Extra preparation
 - Disposal
 - Clean up
 - Etc.
- Be sure to include all markups and profits
- Prepare in an approved format
- DO NOT SPECIFY WHAT YOUR TECHICAL SOLUTION unless approved.
- Budget for this work: \$0.05/sf

Final Engineering

- Detailed and complete drawings
- Detailed and complete specifications
- Exact materials lists and quotations
- Complete list of general and special conditions of the project
- Final written proposal with all costs, conditions and legal provisions
- Budget for this work: \$.05/sf

Installation and Commissioning

- Follow up as contractor performs project
- Job site visits
- Check to make sure project is installed correctly and all settings are correct
- Budget for this work: \$.02-.05 /sf

Measurement and Verification

- Install and check metering
- An added value and added costs
- Approximate budget \$.25/sf

Project Development Costs

| | |
|-------------------------------------|---|
| Feasibility Survey | \$.005/sf |
| Preliminary Audit | \$.02 |
| Preliminary Project Prospectus | \$.02 |
| Investment Grade Audit | \$.05 |
| Detailed Project Prospectus | \$.05 |
| Engineering | \$.05 |
| Installation | \$.02-.05 + Cost |
| Commissioning | Included |
| <u>Measurement and Verification</u> | <u>Up to \$.25</u> |
| Total | \$.215-.245 /sf PLUS COST and M&V |

The Project as Seen by the Owner

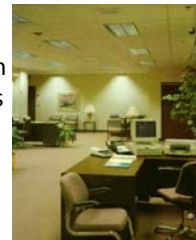
How much do I pay?
How much do I save?

Example:

- First cost \$5.00
- Payback per year: \$1.00
- Payback period: 5 years

Project Example

- 120,000 sf building
- 100,000 sf of office area with 2x4 3-lamp parabolic troffers on 8' x 8' centers (approx.)
- Limited number of wall switches
- Single light level switching



Components: Look Closely

| | |
|--|--|
| <p>Original 1980's</p> <ul style="list-style-type: none"> • (3) F34T12 lamps • (1) 1-lamp ballast and (1) 2-lamp ballast standard magnetic • Design level 50-60 footcandles • Power 126 watts | <p>1990's Retrofit</p> <ul style="list-style-type: none"> • (3) F32T8 lamps • (1) 3-lamp electronic ballast • Design level 50-60 footcandles • Power 90 watts |
|--|--|

Common Changes

| | |
|---|---|
| <p>Simple Lamp and Ballast</p> <ul style="list-style-type: none"> • Remove lamps and ballasts • Install (3) new Super T8 lamps and (1) new Super T8 Low ballast factor ballast • Installed cost of retrofit \$45 • New lighting power 72 watts • Light level essentially equal and parabolic "gloomy" | <p>Simple Relighting</p> <ul style="list-style-type: none"> • Remove fixture "guts" • Install new RT5R with T5 lamps and normal ballast factor ballast • Installed cost of retrofit \$100 • New lighting power 62 watts • Light level slightly lower but space is more cheerful |
|---|---|

A Basic Project Financial

1562 fixtures \$0.10/kWh 3500 hours Annual Energy Cost \$68,884

| | |
|--|--|
| <p>Original T12</p> <ul style="list-style-type: none"> • Development cost \$21,500 • Cost <ul style="list-style-type: none"> - Retrofit \$70,920 - Relight \$159,200 • Annual Energy Savings <ul style="list-style-type: none"> - Retrofit: \$29,521 - Relight: \$34,988 • Payback (before profits and incentives) <ul style="list-style-type: none"> - Retrofit: 3.1 years - Relight: 5.2 years | <p>Retrofitted T8</p> <ul style="list-style-type: none"> • Development cost \$21,500 • Cost <ul style="list-style-type: none"> - Retrofit \$70,920 - Relight \$159,200 • Annual Energy Savings <ul style="list-style-type: none"> - Retrofit: \$9,840 - Relight: \$15,307 • Payback (before profits and incentives) <ul style="list-style-type: none"> - Retrofit: 9.3 years - Relight: 11.8 years |
|--|--|

A Basic Project Financial

1562 fixtures \$0.10/kWh 3500 hours Annual Energy Cost \$68,884

| | |
|--|---|
| <p>Original T12</p> <ul style="list-style-type: none"> • Payback (before profits and incentives) <ul style="list-style-type: none"> - Retrofit: 3.1 years - Relight: 5.2 years • HVAC savings: up to 1/3 more • TEP Rebate <ul style="list-style-type: none"> - Retrofit: 1.5 years - Relight: 2.6 years • Other Options <ul style="list-style-type: none"> - Use 2 level ballast, add \$50,000 - Get \$60,000 tax deduction | <p>Retrofitted T8</p> <ul style="list-style-type: none"> • Payback (before profits and incentives) <ul style="list-style-type: none"> - Retrofit: 9.3 years - Relight: 11.8 years • HVAC Savings • TEP Rebate • ??? |
|--|---|

Summary

- Projects require a lot of basic spreadsheet work
- Care to include all possible income and expenses are essential in accuracy and profitability

Part Two

BASIC APPROACHES

Well Known and High Value Targets

- Large square footages
- Long operating hours
- High lighting levels
- T12 fluorescent lamps
- Mercury Vapor lamps
- Overlighted spaces
- National / Regional Chains
- Institutions

General Considerations

1. Do Your Homework

- Check with TEP
- Determine the possible incentives and subsidies available to the project
- An incentive agreement must be signed before purchase orders are placed
- Design Assistance may be paid in addition

General Considerations

2. Set lighting levels properly

IES Categories

- A 3 fc Public Spaces
- B 5 fc Simple Orientation and Short Visits
- C 10 fc Working Spaces with Simple Tasks
- D 30 fc Tasks of high contrast and large size
- E 50 fc Tasks of low contrast or small size
- F 100 fc Tasks of low contrast and small size

A light meter is recommended to determine existing levels

- Delamping can be used if existing levels are excessive or will be excessive after cleaning and relamping
- If light levels are low, delamping is not recommended

General Considerations

3. Evaluate possible task-and-ambient lighting

| | | |
|---------------------|--------|---------|
| Task light level | 100fc | 250 sf |
| Ambient light level | 30fc | 750 sf |
| Average light level | 47.5fc | 1000 sf |

General Considerations

4. Establish an Appropriate Budget

| | | |
|------------------------------------|-----|----------------------|
| Ordinary lighting-manual switching | | \$ 3.00/sf |
| High efficacy lamps | 10% | \$.30/sf |
| High efficiency ballasts | 10% | \$.30/sf |
| Dimming ballasts | | \$ 1.00/sf |
| Motion sensing controls | | \$.50/sf |
| Automatic daylighting controls | | \$.50/sf |
| Total costs | | \$4.10-\$5.30 |

General Considerations

5. Evaluate only efficient options

These are efficient

- Low RCR
- Light finishes
- Symmetric lighting
- Direct lighting
- Efficacious light sources
- Efficient luminaires

General Considerations

6. Do careful calculations

- Set sensible minimum and maximum criteria
- Try different layouts
- Run point by point calculations

General Considerations

7. Determine control zones

- Minimum code required
- High use/low use
- Daylighted

General Considerations

8. Apply controls

- Use common sense
- Challenge the amount of energy saved
- Avoid complex and hard-to-commission systems

General Considerations

9. Compare your results to the energy code

- The Energy Code is restrictive
- A good design today is 5-10% under

General Considerations

10. Restraint-Restraint-Restraint

- The best projects use the minimum to do the job
- More is not always better

Special Considerations for Retrofitting

Age of Existing System

- Over 20 years = generally favor relighting
- 10-20 years = consider relighting
- 0-10 years = concentrate on retrofits

Special Considerations for Retrofitting

Core Technology

- Mercury vapor or incandescent suggest relighting or major retrofits
- Standard metal halide can be replaced sometimes
- T12 fluorescent suggests the option of retrofitting
- T8 can be retrofitted under ideal conditions

Examples

Best Buy

- Stores 20,000 sf to 45,000 sf 12 sales hours/day
- Big Box 18' to 20' high
- Existing 400 watt metal halide lighting systems on 16' x 16' centers
 - 460 luminaire watts
 - Magnetic ballast

Opportunities at Best Buy

- Annual hours 6,000
- Assume 20% average HVAC burden
- Lighting is >50% of the electric bill

Design

OPTION 1: Fluorescent High Bay

- Uses (6) F54T5HO lamps and (2) electronic instant start non-dimming ballast
- 360 watts
- Cost per fixture \$300



Design

OPTION 2: New Generation Metal Halide High Bay

- Uses a 350 watt ceramic metal halide lamps electronic start dimming ballast
- CRI = 92 CCT = 4000K
- 370 watts
- Cost per fixture \$300
- Recycle reflector – change ballast box only



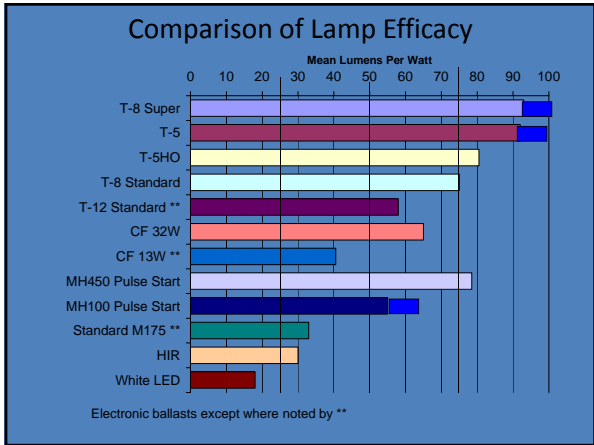
Discussion

- Which is better?



Part Three
LIGHTING TECHNOLOGY

- ### Select Proper Electric Light Sources
- Efficacy (lumens per watt)
 - Determines the efficiency of converting electricity to light.
 - The higher the efficacy the better.
 - Color Temperature
 - We tend to prefer "white" light sources between 3000K ("warm") and 4100K ("cool"). We might consider 5000K (cold) for studios.
 - Color Rendering Index
 - Measures light source quality.
 - Sources with CRI < 70 are noticeably distorted. CRI<60 unacceptable.
 - Whenever possible choose light sources with CRI > 80.
 - Lamp Life
 - Choose lamps with maximum life possible to minimize maintenance.
 - System Costs
 - Choose systems that employ low cost lamps and ballasts.



What Do You Call a 32 watt T-8 Lamp?

| Sylvania Designation | Initial Lumens | CRI | Industry Names | Utah Power |
|----------------------|----------------|-----|---------------------------|------------|
| FO32/7xx | 2800 | 75 | Standard | Standard |
| FO32/7xx/XP | 2850 | 75 | Standard | Standard |
| FO32/8xx | 2900 | 82 | Premium | Standard |
| FO32/8xx/XP | 3000 | 85 | Premium | Standard |
| FO32/8xx/XPS | 3100 | 85 | Super or High Performance | Premium ★ |

What Do You Call a 32 watt T-8 Lamp?


| Phillips Designation | Initial Lumens | CRI | Industry Names | Utah Power |
|----------------------|----------------|-----|---------------------------|------------|
| F32T8/TL7xx | 2800 | 78 | Standard | Standard |
| F32T8/7xx/PLUS | 2800 | 78 | Standard | Standard |
| F32T8/TL8xx | 2950 | 86 | Premium | Standard |
| F32T8/8xx/PLUS | 2950 | 86 | Premium | Standard |
| F32T8/ADV8xx | 3100 | 86 | Super or High Performance | Premium ★ |

What Do You Call a 32 watt T-8 Lamp?

| GE Designation | Initial Lumens | CRI | Industry Names | Utah Power |
|----------------|----------------|-----|---------------------------|------------|
| F32T8/SPxx | 2800 | 78 | Standard | Standard |
| F32T8/SPxx/XL | 2850 | 78 | Standard | Standard |
| F32T8/SPx | 2950 | 86 | Premium | Standard |
| F32T8/SPxx/XL | 2950 | 86 | Premium | Standard |
| F32T8/SPx/HL | 3100 | 82 | Super or High Performance | Premium ★ |

The King of the Hill: the T-8 SYSTEM

- Called "super" or "premium" or "high performance"
- Standard 32 watt T-8 lamps with high initial lumens, high lumen maintenance, and long life construction
 - GE "HL" series
 - Sylvania "XPS" series
 - Phillips "Advantage" series
- New High Efficiency Electronic Ballasts
 - Standard 2-lamp T8 ballast is 59 watts – super ballast is 53 watts
- Optional instant start ballasts give 99 mean lumens per watt and should be used where lights are turned on and left on
- Optional program start ballasts give 92 mean lumens per watt and provide extended lamp life, especially when frequently switched.



For Primary Lighting Systems: Linear Fluorescent Lamps

- T-8 "Premium" Lamps
 - 101 MLPW vs. 75 MLPW for ordinary T-8.
 - 85+ CRI.
 - 30,000 hour lamp life on program start electronic ballasts.
- T-5 Standard and Premium Lamps
 - 99 MLPW.
 - 83+CRI.
 - 20,000 hours + life.
- T-5 HO
 - 82 MLPW.
 - 83+CRI.
 - 20,000 hours life.



T8 Core Lamp Technologies

BASIC OPTIONS INCLUDE

- Standard lamp (20,000 hours)
- Premium Long Life lamp (+50 lumens, +4,000 hours)
- Low mercury TCLP compliant lamp
- Premium Long Life Low Mercury lamp

T8 Core Lamp Technologies

PHOSPHOR OPTIONS INCLUDE

- Standard 75 CRI (7xx) 2800 lumens
- New 78-82 CRI (7xx) 2850 lumens
- Standard 82-85 CRI (8xx) 2950-3000 lumens
- High lumen 86 CRI (8xx) 3100-3200 lumens

★

T8 Core Lamp Technologies

BARRIER COAT OPTIONS INCLUDE

- Standard 7xx 90% lumen maintenance at 8000 hours
- Premium 7xx 95% lumen maintenance at 9600 hours
- Standard 8xx 92% lumen maintenance at 8000 hours
- Premium 8xx 95% lumen maintenance at 9600 hours

T8 Core Ballast Technologies

Input power for 2 F32T8 lamps at 0.88 BF

- Magnetic (70 watts)
- Standard Electronic Instant Start (59 watts)
- Efficient Electronic Instant Start (53 watts)
- Standard Electronic Program Start (60 watts)
- Efficient Electronic Program Start (56 watts)

T8 Core Ballast Technologies

Input power for 2 F32T8 lamps, efficient electronic instant start ballast

- Normal light output, 0.88 BF (53 watts)
- High light output, 1.15 (72 watts)
- Low light output, 0.78 (48 watts)
- For comparison, a rapid start dimming ballast, 0.05 to 0.88 (64 watts)

T8 Core Ballast Technologies

Input Voltage

- Fixed (120, 277, 347, etc) about 1-2% more efficient
- Universal (100-300), easier to stock

Power Quality

- <20% THD
- <10% THD

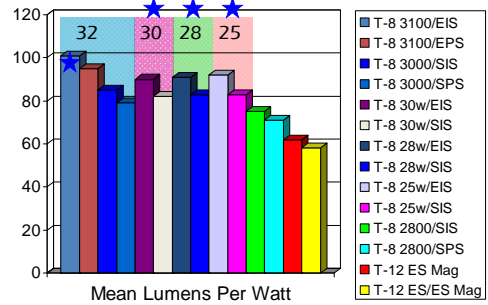
The T8 is a System

- Choices of Lamp
 - Basic Type (generic, premium, "super")
 - Quality (lumen maintenance and life)
 - Color temperature
 - Mercury content
- Range of lamp watts
 - 32 standard
 - 30, 28, 25
- Standard, efficient or dimming electronic ballast
- Normal, high or low ballast factor ballast



Range of 2 lamp system (non dimming)
 Worst 3930 L 52w
 Best 6986 L 72w
 Less lamp power, same maintained output

Lamp/Ballast Systems



Lamp/Ballast Compatibility

| Lamp Type | 32 watt lamp ★ | 30 watt lamp ★ | 28 watt lamp ★ |
|-----------------------|----------------|----------------|----------------|
| Instant Start Ballast | YES | YES | YES |
| Rapid Start Ballast | YES | NO | NO |
| Program Start Ballast | YES | NO | NO |
| Dimming Ballast | YES | NO | NO |

Applications



Direct Lighting (40-60 MEAN fc)

Typical Layout: 3 lamp troffers on 8' x 10' centers

- (3) Standard T8, standard IS normal BF ballast provides 58 fc at 1.12 w/sf
- (3) "super" T8, efficient IS ballast low BF ballast provides 62 fc @ 0.90 w/sf
- (3) F30T8 and a standard IS normal BF ballast provides 62 fc @ 1.05 w/sf
- (3) F28T5 and an efficient IS low BF ballast provides 53fc @ 0.85 w/sf
- (3) F25T8 and an efficient IS low BF ballast provides 51fc @ 0.81 w/sf

Conclusions

- Low wattage T8 systems are not as efficacious as standard F32T8 systems
- Low wattage T8 systems are not fully compatible with all types of ballasts
- Use of efficient electronic ballasts is a more durable way to ensure long term savings
- Nonetheless, low wattage T-8 lamps can save energy most easily

T-5 vs. T-8

The T-5 System

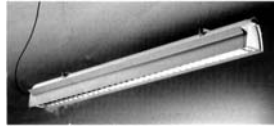
- Choice of both standard and high output lamps
- 5/8" diameter
- Smaller, more efficient luminaires
- More costly and harder to get lamps

The T-8 System

- Yes there are HO lamps but not really
- 1" diameter
- Low cost readily available
- Variable ballast factor

Direct Small Aperture

Theoretically requires 40% of the dimensions of a T-12 luminaire to achieve the same efficiency



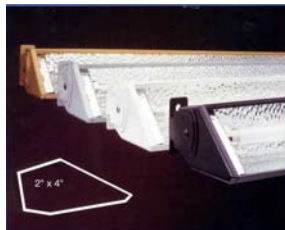
T5 High Bay Replacement

- High efficiency
- Multiple level or dimmed
- Instant start and restrike
- Potentially attractive



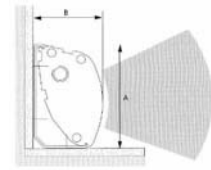
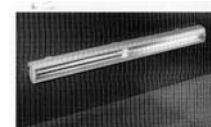
Asymmetric Wallwash

- Requires only 20% of the volume of a T-12 luminaire
- Makes linear luminaire cross-section similar to a quartz luminaire



Asymmetric Aimable

- Reduced material weight and bulk by 75%+
- Permits small and effective products
- Reduced weight and dimensions make the product more applicable



Integral Electronic ballast
 3 1/2" x 2 1/2" x 15mm

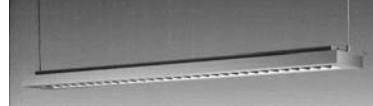
Asymmetric Cove

- Reduced overall dimensions now 2" x 6" include ballast
- Small profile can include adjustability



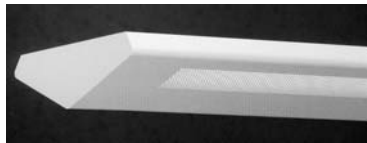
Direct/Indirect

- Smaller profile, less material, lighter weight
- Potential for high efficiency
- Conventional and advanced designs



Indirect

- Smaller profile
- Potentially optimum use of the T-5 HO lamp
- Minimum downlight %



Comparing T-8 and T-5HO

| System | 2-T8 | 1-T5HO |
|--------------------------------------|------|------------|
| • Maintained average illumination fc | 49 | 46 |
| • Power density (w/sf) | .83 | .86 |
| • Average ceiling illumination fc | 100 | 85 |
| • Ceiling max/min ratio | 11.5 | 5.8 |

Summary: Lamps and Ballasts

- T-8 beats T-5 in terms of cost, luminous efficacy, range of options, availability, ease of management, dimming options, etc. etc.
- T-5 beats T-8 in size and competes in luminous efficacy
- T-5HO beats both in "wallop" (lumens per unit volume)
- T-5 Systems end up having higher light in real life

The down side of T-5

- Lamp costs
- Ballast costs
- Warm up time
- Lamp availability
- Client resistance to change

The up side of T-5

- Lamp costs will come down
- Ballast costs will come down
- We will get used to warm up time
- Lamp availability will improve
- Clients will appreciate the change some day....

Summary: T-5 choices

- The T-5 luminaire is smaller.
- T-5 luminaires offer aesthetic opportunities of size and style while remaining affordable
- T-5 luminaires offer better "fit".

Summary: T-8 choices

- The T-8 luminaire is bigger.
- T-8 luminaires are still best for general purpose uses.
- Ceiling height should dictate T-5 versus T-8 decisions in many spaces.
- T-8 luminaires offer better cost competition.

Secondary and Special Lighting Systems

- Compact fluorescent lamps
 - 10,000 hour lamp life.
 - 50-65 MLPW varies with wattage.
 - High CRI >80.
 - Color temperature 3000K, 3500K, 4100K, and others.
 - NOW - use 57 watt and 70 watt compact fluorescent INSTEAD of low wattage metal halide!
- Pulse start metal halide lamps
 - 50-79 MLPW varies with wattage.
 - 7,500 to 20,000 hour lamp life.
 - Standard lamps CRI 65-70.
 - Ceramic high color lamps CRI>80.
 - Long warm up and restrike times.
 - PREFER THE CERAMIC METAL HALIDE LAMPS FOR SUPERIOR COLOR



Light Sources for Limited Use

- Halogen IR lamps
 - Excellent CRI ~100.
 - Color temperature warm 2850-3000K.
 - Highly directional.
 - Inexpensively dimmable.
 - Life 3000-4000 hours.
 - Efficacy 20-30 MLPW.



Why Not High Pressure Sodium or Low Pressure Sodium Lamps?

- High pressure sodium lamps produce a pinkish yellow light.
 - CRI <20.
 - Color temperature <2200K.
 - Provides poor visibility for indoor tasks, including problems with focusing on small work
 - Provides decreased peripheral vision and response time in outdoor lighting.
- Low pressure sodium lamps produce monochromatic yellow light.
 - CRI = 0.
 - Worse than high pressure sodium in all respects.



Light Source Applications

| | General (Indoor) | Special & Utility (Indoors) | Display & Mood (Indoors) | Outdoor Lighting |
|----------------------|------------------|-----------------------------|--------------------------|------------------|
| Linear Fluorescent | ++ | + | | |
| Compact Fluorescent | | ++ | + | + |
| Metal Halide | | + | + | ++ |
| HIR Tungsten Halogen | | | + | |

- ### Know Your Ballasts
- Use electronic ballasts exclusively for fluorescent and compact fluorescent lamps.
 - For T-8 lamps, investigate “low light output” and “high light output” ballasts to fine tune fixture watts to the minimum needed for a space.
 - Dimming ballast prices are still high – carefully evaluate the need for dimming.
 - Low temperature ballasts permit compact fluorescent lamp starting and operation at <math><0^{\circ}</math> F.
 - Use electronic ballasts for metal halide lamps up to 150 watts (and maybe higher).

Choose Suspended Luminaires for Efficiency and Comfort

- ### Standard Recessed Lighting
- Common luminaires in conjunction with t-bar grid ceilings in low ceiling applications.
 - Moderate efficiency
 - Choice of basic types
 - Common and inexpensive
-

- ### New Generation Recessed Lighting
- Based on T5 – NOT T5HO – lamps
 - Extremely high efficiency
 - Enclosed T5 lamp for thermal management
 - Very thin – some are only as thick as the ceiling grid
-

- ### Occasional Luminaires
- Use recessed downlights both in t-bar grid ceilings and hard lid ceilings.
 - Compact fluorescent downlights for most interior and many exterior applications.
 - Metal halide downlights in high bay applications and outdoors.
 - Halogen downlights and accent lights in special “social” spaces and A/V environments.
 - Compact fluorescent and HID wallwashers
 - Durable wall sconces
 - Incandescent in theaters and AV spaces
 - Compact fluorescent in corridors, offices, other low abuse settings
 - HID in pools and some large spaces
-

Decorative and Stylish Luminaires


- Add a touch of style
- Use in low abuse “special” locations
 - Major entries and lobbies
 - Commons areas
 - Cafeterias
 - Libraries
- All of these are compact fluorescent



Surface-mounted High Abuse Luminaires

Choose T-8, T-5, HID or compact fluorescent luminaires for a number of occasional and utility applications such as:

- Stairwells.
- Exterior doors.
- Locker and toilet rooms.
- Showers.



Specialty Luminaires for Gyms and other Big Spaces



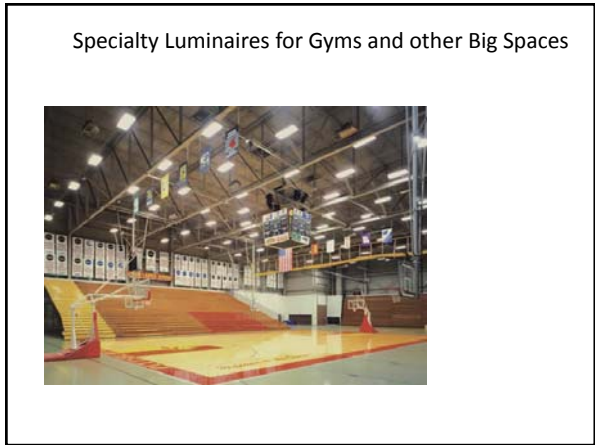
RECENT BREAKTHROUGHS IN METAL HALIDE MAKE FLUORESCENT AND CERAMIC METAL HALIDE WITH ELECTRONIC BALLAST MAKE BOTH ESSENTIALLY EQUAL IN POWER EFFICIENCY

HIGH BAY FLUORESCENT


- Excellent color rendering
- Immediate starting and restarting
- Full range dimming (costly)

HIGH BAY CMH HIGH BAY (PS-ELECTRONIC)

- Superior color rendering
- Lower cost with dimming
- Partial range dimming
- Standard warm-up and restrike problems



Exit Signs



- Unless otherwise required by code use LED exit signs.
- Red or green depending on local authorities.
- Use very low power making them especially easy to equip with their own backup battery.
- Remember, LED exit signs don't have a downlight egress light - you will need to provide that.
- .

Discussion