LOWBAY INDUSTRIAL LIGHTING

Basics of Quality Lighting
Economics of Energy Effective Lighting
General Industrial Workspace Lighting
Industrial Cleanrooms
Task Lighting for Manufacturing
Industrial Laboratories
Lighting Fixture Specifications
Lighting Controls for Industrial Buildings

LOWBAY INDUSTRIAL LIGHTING knowhow

INTRODUCTION

Activities in industrial workplaces are becoming increasingly complex. During a typical day, workers often shift from written material on desks, to mid range computer screens or digital displays at a distance. Lighting and control systems must support all of these activities. Workers perform best when the work environment is carefully planned to meet their needs. Taking full advantage of available daylight is a cost-effective way to meet lighting needs and contribute to employee sense of well being. Daylight issues are discussed in the *Warehouse Skylighting knowhow*™ publication.

Industrial spaces designed by our firm carefully balance issues of quality lighting, daylight integration, and long-term economy of operation.

Gerry Power IALD
Lighting Designer

This guide gives specific information for energy-effective lighting in small industrial spaces that require medium to high light levels. Lowbay industrial workspaces have medium to low ceiling heights of less than 25 feet, with fixtures suspended up to 3 feet lower. Principles discussed in this guide apply as well to larger facilities with the same criteria. High ceiling industrial spaces requiring moderate light levels such as warehouses, are covered in the *Highbay Industrial Lighting knowhow*™ publication.

Photo courtesy of Kling-Lindquist

Demanding tasks in industrial spaces require well planned lighting systems and balanced brightness, as shown in this laboratory.

The **Quality Chart** below shows important criteria for various industrial tasks. In the following pages, lighting equipment is compared, control strategies identified and sample layouts are shown weighing economic and quality issues.

Penny Wise and Pound Foolish

If poorly designed lighting distracts a worker for just 1% of the time, the loss in productivity can equal $5 per sq. ft.*

* Assumes a worker of moderate salary and benefits occupying under 100 sq. ft. = an annual personnel cost of $500 per sq. ft.

QUALITY ISSUES FOR INDUSTRIAL LIGHTING

	Component Production	Assembly	Control Panel/ Computers	Inspection	Machining	Precision Crafting
Fixture location related to workers	●	●	●	●	●	●
Light on walls and ceilings	●	●	○	●	●	●
Control of direct and reflected glare	●	●	●	●	●	●
Light patterns, uniformity vs. shadows	○	○	◐	◐	●	●
Control of source flicker and strobe effect	◐	○	○	●	◐	◐
Daylight integration and control	◐	◐	◐	◐	◐	◐
Modeling of objects and faces	●	○	○	●	●	●
Color rendering and color temperature	○	○	◐	●	○	●
Appearance of space and fixtures	○	○	○	○	○	○

● Very Important ◐ Important ○ Somewhat Important

* Adapted from the ***Lighting Design Guide. IESNA Lighting Handbook***, 9th Edition

basics of quality lighting

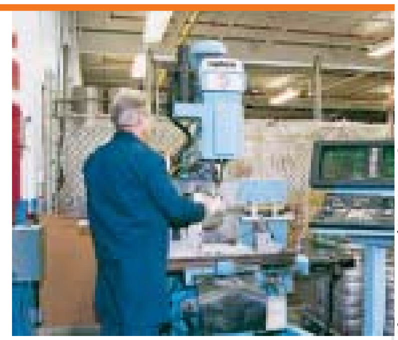


Photo courtesy of Kurt Versen Co.

Face computer screens away from bright light sources and windows.

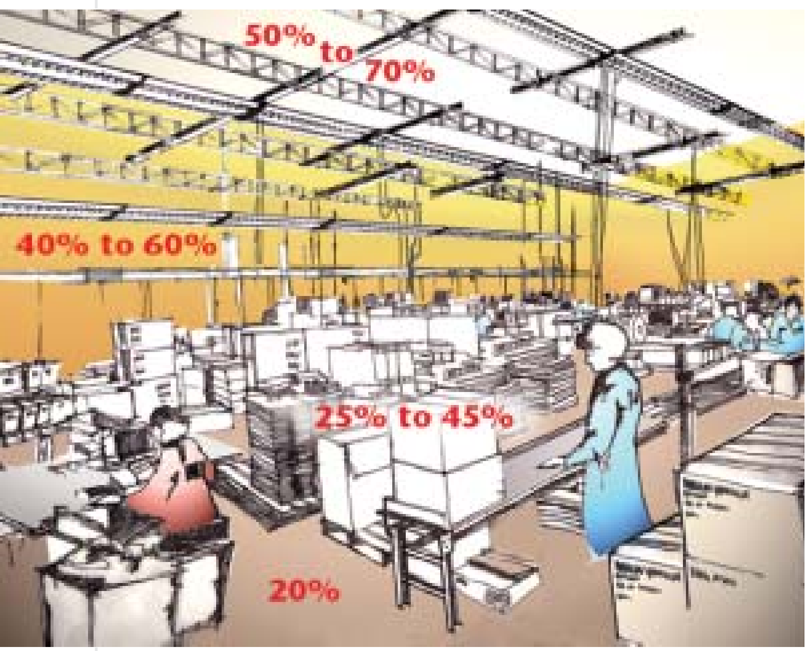
INDUSTRIAL QUALITY ISSUES

Often the first consideration in providing an electric lighting system is to determine the QUANTITY of light that is necessary for the activity in the space. The illuminance values (footcandles) can be calculated fairly precisely if all space parameters are known. Footcandle levels recommended by the Illuminating Engineering Society of North America (IESNA), for lowbay industrial facilities are listed on page 6.

Providing a QUALITY lighted environment is a more complex task. A work place that is comfortable and pleasant will have a significant positive effect on worker productivity. Employees are a company's single largest investment so it pays to provide a good working atmosphere. Following are important QUALITY factors to consider.

REFLECTANCE AND CONTRAST

Manufacturers of paint and other surface materials, publish reflectance values for their products. Specifying the best possible reflective surfaces not only produces a better appearing space, but also a more efficient system. Light that is reflected, not absorbed by dark colors, is usable light. It is important to maintain the reflectance values and relationship as shown in the illustration below.



Dark colors absorb light and light colors reflect. To achieve comfortable brightness ratios encourage the building owner to select reflectance values for equipment and room surfaces based on the values shown above.

Based on *Recommended Practice for Lighting Industrial Facilities*, ANSI/IESNA RP-7-01.

GLARE CONTROL

When brightness ratios exceed maximum recommended values, disturbing or disabling glare can result. To minimize glare-producing conditions, consider the following:

- Achieve required light levels using more lower wattage fixtures to reduce individual lamp brightness.
- Locate control panels and computer screens facing away from windows or bright light fixtures. If the location of these elements is fixed, adjust the lighting fixture locations and shade the windows.
- Raise bright fixtures, including T-5 and metal halide, above the workers' usual viewpoint. Lower fixtures with bright lamp sources must be shielded.
- Direct some light toward the ceiling to balance space brightness ratios and reduce contrast between the ceiling and the fixtures.

METRICS FOR QUALITY LIGHTING

Look for catalogue published values indicating how comfortable or glare-free the lighting fixtures will be in a given space. Visual Comfort Probability (VCP) is based on U.S. research and applies only to direct lensed fixtures. Unified Glare Rating (UGR), a European method, is more comprehensive. The comfort zone for VCP is 70 and above. A UGR value above 19 is considered unacceptable. For more information on glare control refer to *Recommended Practice for Lighting Industrial Facilities*, IESNA publication ANSI/IESNA RP-7-01.

FLICKER EFFECT

The light output of fluorescent and HID sources varies or "flickers" in a manner that is noticeable to many people. This effect is reduced with high frequency electronic ballasts as frequency is increased from 60-Hz to above 20,000-Hz. Flicker effect with HID is less apparent with coated lamps. This topic is discussed in the *Highbay Industrial knowhow*™ publication, and in detail in the *IESNA Lighting Handbook* 9th Edition.

LAMP COLOR MATTERS

Outdated fluorescent and HID lamps – such as cool white and mercury vapor, are inferior in color rendering. All light sources recommended in the lighting layouts on pages 4, 5 and 6 and the Lighting Fixture Schedule on page 7, are high color rendering. If the recommended lamps are used consistently, colors will be seen accurately, an important consideration in many industrial tasks and particularly critical for proper identification of safety colors used in many industries as an indication of danger.

Paint Color Affects Your Costs

If surfaces are painted with highly reflective (light) colors, instead of dark colors, the lighting system will be more efficient. A higher percentage of the light will be effectively reflected back into the room and be usable.

Photo courtesy of Holophane

ECONOMICS OF SYSTEM CHOICES

Least Expensive – Not Always Most Cost Effective

A easy way to look at the cost of owning and operating a lighting system over time is through a Simple Payback analysis:

Simple Payback = Incremental investment / Incremental annual cash flow *

* Adapted from ANSI/IESNA RP-7-01

Compare the three layouts shown on page 4 – **Industrial Workplace General Lighting**. The costs of owning and operating the different systems over a 10-year period, based on 2000 hours per year, at today's costs are detailed in the blue chart below.

While the BASE CASE Layout 1 Type A is the least expensive initial cost, it costs the most to operate over time because of the following reasons:

To achieve 50 FC Maintained:

- Type A (BASE CASE) requires 1.18 watts per sq. ft.
- Type B is more efficient at 1.04 watts per sq. ft.
- Type E is BETTER YET at 1.01 watts per sq. ft.

To maintain 60% of the initial light level over 10 years:

- Type A must be group re-lamped 3 times.
- Type B must be group re-lamped 1.75 times.
- Type E requires just one relamping because of superior lumen maintenance.

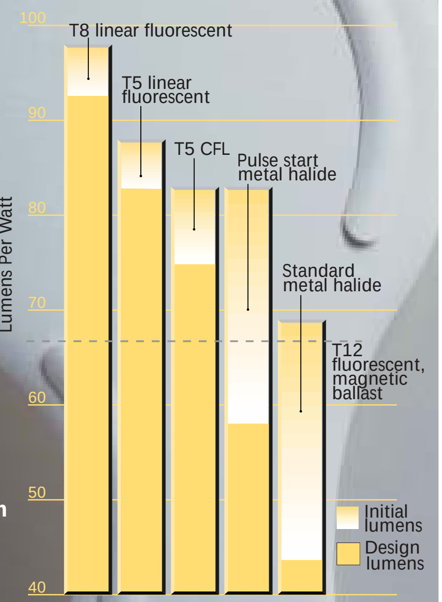
(See lamp comparison chart below.)

This Simple Analysis is just a start in comparing costs over time. Other important factors will affect potential savings such as the cost of money over time, and the impact of associated systems. For example, reducing lighting loads (heat) will almost always lead to HVAC savings. The costs associated with environmental issues such as hazardous waste disposal of lighting system components may be reduced as the components of newer equipment become more sustainable.

NEW LIGHT SOURCES

In this guide, standard high intensity discharge (HID) metal halide (MH) is compared to newer pulse-start MH. T-8 fluorescent lamps are compared to MH choices, T-5 high output and long compact fluorescent (CFL – also called, BIAX , DULUX or PL-L Long) lamps. Each of these lamp/ballast types are used in the example layouts. Other HID sources such as high pressure sodium or mercury vapor have not been recommended because of inherently poor color rendition.

Lamp/Ballast Efficacies



When our office budgets lighting for our client's project, we consider first costs of course, but also the economic impact of long-term operation and maintenance.

Glenn Urbana, Architect

DAYLIGHT IN THE WORKPLACE

Daylight is considered the best color-rendering source because our judgment of color is related to natural light. Daylight also has a positive effect on workers' sense of well being. Take care to manage heat gain from sunlight and provide supplemental electric lighting near windows to reduce contrast between the windows and adjacent surfaces. For further information on daylighting in industrial settings, see the *Warehouse Skylighting knowhow*™ publication.

Layout & Fixture Type	Installed Cost/ sq. ft.	Change	Annual Energy Cost @ .10/KWH	Annual Maintenance Cost/sq. ft.	Total Operating Cost/sq. ft.	Annual Savings /sq. ft.	Simple Payback in Years
1 - A (BASE)	$ 0.75	N/A	$ 0.25	$ 0.08	$ 0.32		
1 - B	$ 0.87	$ 0.12	$ 0.21	$ 0.05	$ 0.26	$ 0.06	2.07
3 - E	$ 1.20	$ 0.45	$ 0.20	$ 0.04	$ 0.24	$ 0.08	5.62

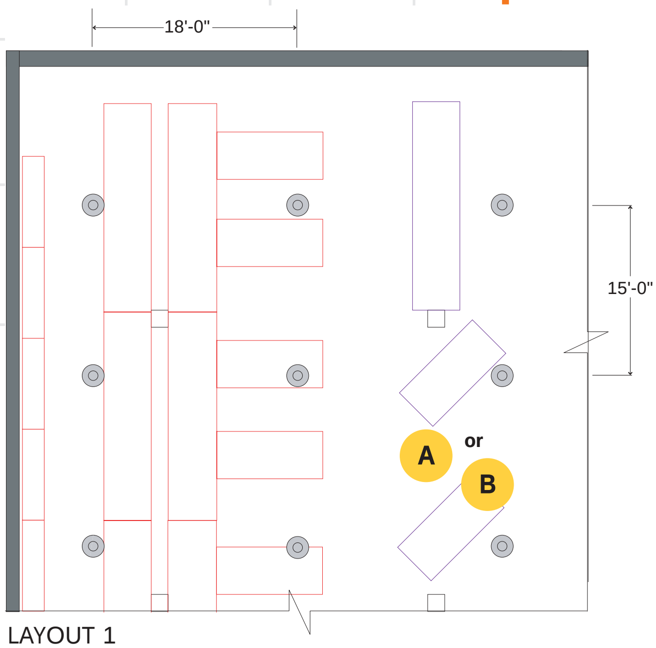
SOURCE EFFICACY IS NOT THE WHOLE STORY

LAMP COMPARISON

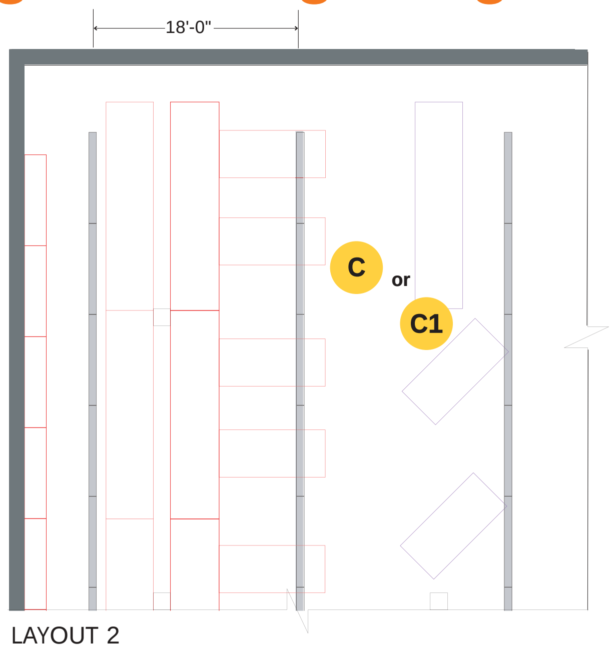
Lamp Type	Rated Input Watts	Rated Life (Hours)	Initial Lumens	Initial Lumens/ Watt	Lumens @ 40% of rated life	% of Initial (Design Lumens)	Design Lumens/ Watt	In Fixture Types
Metal Halide — Standard	250	10,000	20,500	82	13,500	66%	54	A
Metal Halide — Pulse Start	250	15,000	23,800	95	16,600	67%	64	B, G
Fluorescent T-8 Standard	32	20,000	2,900	95	2,750	95%	92	C, F, J, L
Fluorescent T-5 High Output	54	20,000	5,000	93	4,740	95%	88	C-1, K
Compact Fluorescent (long)	50	14,000	4,300	86	3,870	90%	77	E, H
Induction Lamp	165	100,000	12,000	73	9,600	80%	58	Not used

The chart above compares light output stability for lamps shown or discussed in this Guide. Close comparison shows that while Metal Halide initially delivers more lumens per watt, over time, Fluorescent may be a better choice. Consider long life Induction lamps where maintenance is difficult. The Rated Input Watts are for lamps alone. For fixture watts including ballast loss, see Lighting Fixture Schedule, pg. 7.

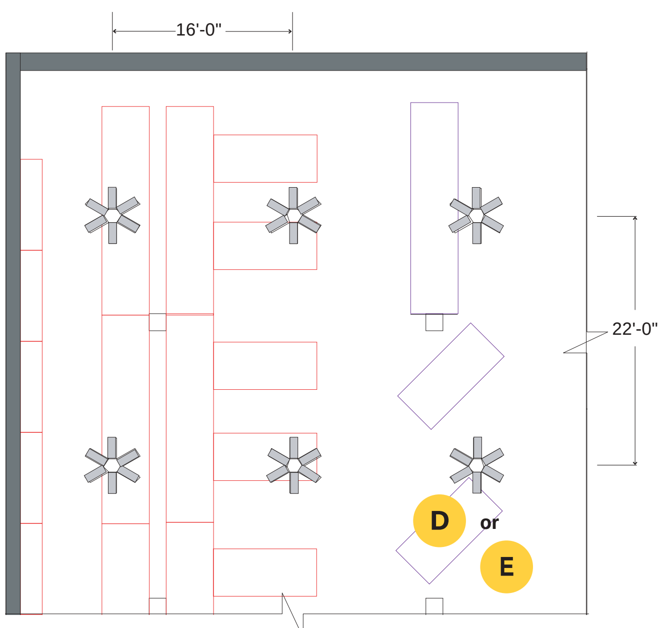
industrial workplace general lighting



LAYOUT 1
Type A - STANDARD PRACTICE
Type B - BETTER

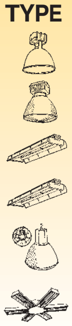


LAYOUT 2
Type C and C-1 - BETTER



LAYOUT 3
Type D - BETTER   Type E - BETTER YET

FIXTURES



TYPE

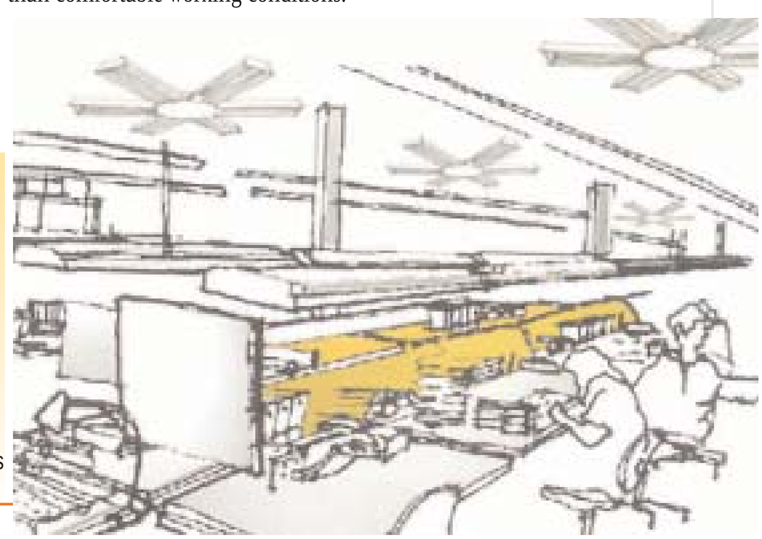
- **A:** 250W Metal Halide Open Metal Reflector
- **B:** 250W Pulse-Start Metal Halide Prismatic Reflector
- **C:** 4' 2-lamp T-8 Fluorescent Pendant Reflector
- **C-1:** 4' 2-lamp T-5 Fluorescent Pendant Reflector
- **D:** 9-lamp 36W Compact Fluorescent Open Reflector
- **E:** 6-lamp 50W Compact Fluorescent Radiating Reflectors

Rationale

Type E (illustrated below and in layout 3) is rated BETTER YET because it is superior in comfort and quality. It allows more ceiling brightness than the more enclosed Type D. Multiple lamp fixtures D and E are advantageous because if a lamp fails some light is still available from the remaining lamps. Type A is a single lamp fixture. New Induction Lamp fixtures were analyzed as an important consideration for superior uniformity and lamp life, but not included here because of higher initial cost compared to other fixtures shown. (The cost premium currently would be 175% over Type A because more fixtures are required).

TASK LIGHTING MAKES SENSE

For detailed or close work, supplemental task lighting, close to the work surface makes sense, to optimize energy use, and to give workers personal control to adjust their lighting to meet specific requirements. Relying on the general ambient lighting system to provide adequate light for demanding tasks will result in higher energy costs and less than comfortable working conditions.



Task lighting is good for business, effective energy use and better worker control.

Photo courtesy of IBM Corp.

INDUSTRIAL CLEANROOMS

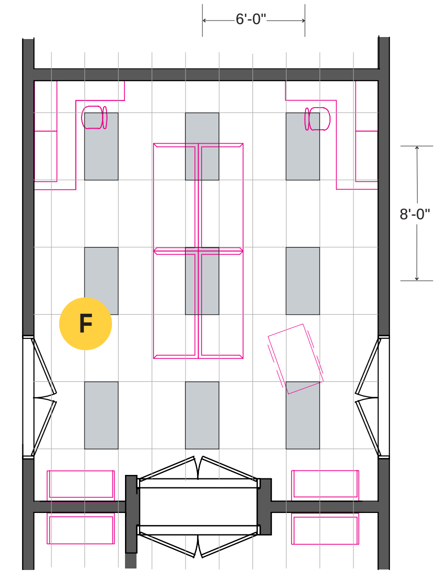
Specialized industrial processing areas must meet federal standards for air quality, as well as the need to protect electronics or biological research materials. Luminaires are fully recessed and gasketed so as not to interfere with the flow of clean air in the room. High light levels and good color rendering are essential. Furnishings are often fully moveable so general illumination must be uniform through out the space.

POWER LIMITS FOR INDUSTRIAL SPACES*

Whole Building Method	Watts/ Sq. Ft.
Manufacturing Facility	**2.2**
Workshop	**1.7**

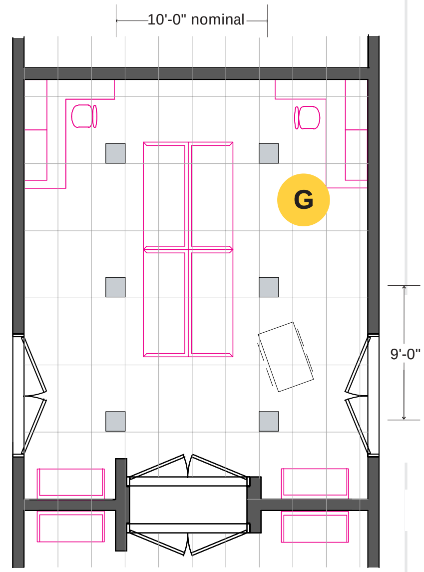
Space Method	Watts/ Sq. Ft.
General Lighting Lowbay	**2.1**
Critical/Detailed Tasks	**6.2**
Active Storage/Fine Material	**1.6**
Transition/Corridors	**0.7**
Equipment Room	**0.8**
Workshop	**2.5**
Laboratory	**1.8**
Control Room	**0.5**

* From ANSI/ASHRAE/IESNA Standard 90.1-2001



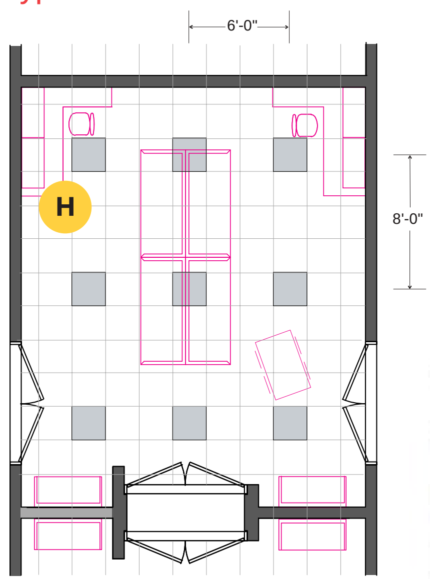
LAYOUT 4 2'x4' ceiling grid

Type F – STANDARD PRACTICE



LAYOUT 5 2'x4' ceiling grid

Type G – BETTER



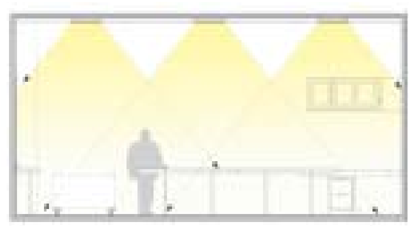
LAYOUT 6 2'x2' ceiling grid

Type H – BETTER YET

FIXTURES

TYPE

- **F:** T-8 Recessed Lensed 2x4
- **G:** Metal Halide Recessed Lensed 1x1
- **H:** Compact Fluorescent 2x2



Rationale

Layout 6, using 40 watt long CFL is rated BETTER YET for superior color and lumen maintenance compared to Layout 5, Metal Halide. It is also more cost effective than the BASE CASE, Layout 4 - T8 fluorescent.

COMPARISON CHART:	General Work - 50 FC required						Clean Work - 80 FC Required		
	Layout 1		Layout 2		Layout 3		Layout 4	Layout 5	Layout 6
Fixtures	Type A	Type B	Type C	Type C-1	Type D	Type E	Type F	Type G	Type H
Uniformity	★	★★★	★★	★★	★★★★	★★★	★★	★★★	★★
Comfort & Quality	★★	★★★	★★★	★★	★★★	★★★★	★	★★	★★★
Maintained footcandles	54	57	54	56	49	56	77	84	84
Power Density (watts/sq ft)*	1.18	1.04	0.94	0.97	1.03	1.01	1.67	2.5	1.93
First Cost Increase (materials & labor)	Base Case	16%	64%	85%	79%	60%	Base Case	-25%	-15%
OVERALL VALUE	★	★★★	★★★	★★	★★★	★★★★	★★	★★	★★★

Comparisons are based on research of current lighting practice in the New England and New York regions, and illustrated in Layout 1 based on 250W standard Metal Halide open reflector fixtures and in Layout 4 on recessed T-8 fluorescent fixtures. * All lamp/ballast input values from *The Advanced Lighting Guidelines - 2001* Chap. 6 or "Default Wattage Tables" by Lighting Design Lab, Northwest Energy Efficiency Alliance.

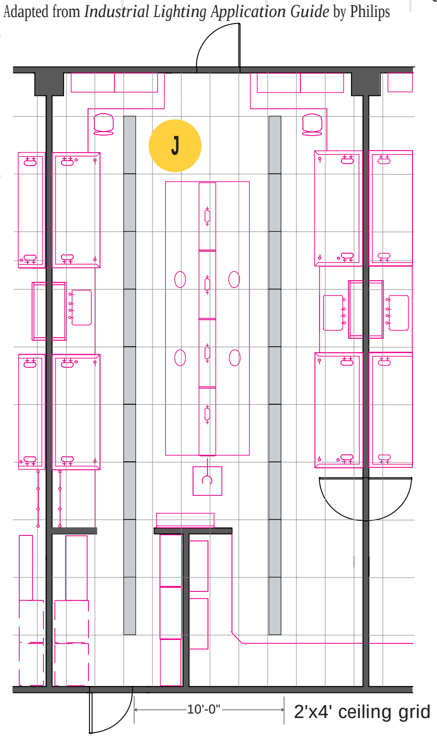
industrial laboratories

Industrial laboratories may include many different tasks from critical research to routine preparation. High incidence of reflective materials such as glass and metal containers, instruments and computer screens make the need for glare free lighting crucial. Work may include hazardous material and must be well-lighted.

Adapted from *Industrial Lighting Application Guide* by Philips

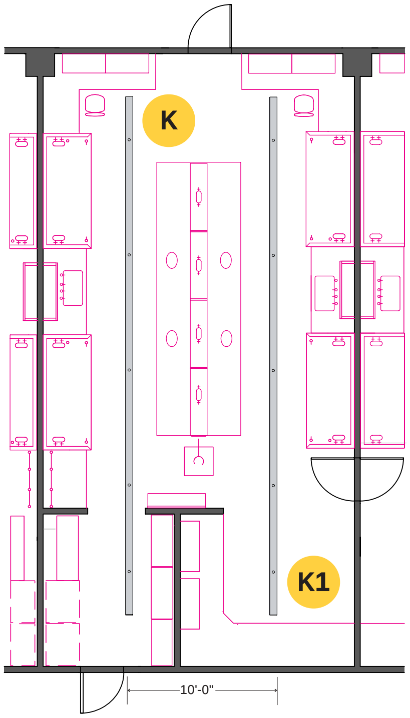
When we design industrial laboratories, glarefree uniform lighting and sustainability are equal priorities.

Mark Loeffler, IALD, LC
The Retek Group



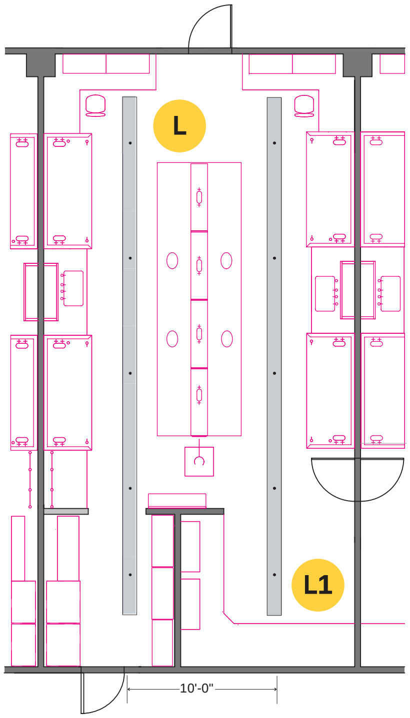
LAYOUT 7 Recessed Direct

Type J – STANDARD PRACTICE



LAYOUT 8 Pendant Indirect

Type K – BETTER



LAYOUT 9 Pendant Direct/Indirect

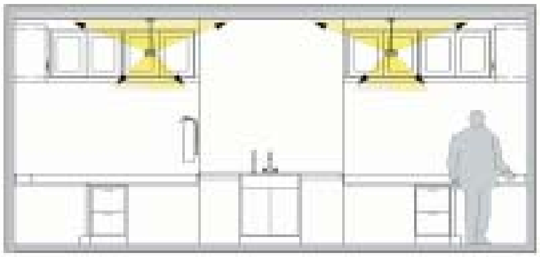
Type L – BETTER YET

When using pendant fixtures in continuous runs, 8 ft. modules are cost effective. In layouts 8 and 9, (8) 8 ft. fixtures are used with (2) 4 ft. fixtures to complete the lengths needed for these examples. See Lighting Fixture Schedule, page 7 opposite for Fixture descriptions and pictures.

RECOMMENDED QUANTITY OF LIGHT FOR INDUSTRIAL SPACES
(FOOTCANDLES)

	Task Complexity	Task Complexity
Material Processing	Medium: 30 FC	Fine: 50 FC
Component Assembly	Medium: 50 FC	Fine: 100 FC
Cleanroom	Medium: 50-70 FC	Difficult: 75-100 FC
Laboratories	General: 50-70 FC	Color Matching: 100 FC
Control Panel/VDT Observation: 30 FC vertical		

From *The IESNA Lighting Handbook*, 9th Edition.



Direct/indirect fluorescent lighting provides a comfortable and energy effective atmosphere for most laboratories. This type of system minimizes reflected glare and gives some direct lighting for modeling of objects that the lab worker is studying.

COMPARISON CHART: Industrial Laboratories - 60FC required

	Layout 7 **Type J**	Layout 8 **Type K**	Layout 9 **Type L**
Uniformity	★★	★★★	★★★
Comfort & Quality	★★	★★	★★★
Maintained Horizontal Footcandles	66	47	63
Power Density (watts per sq. ft.)*	1.18	1.12	1.09
Ceiling Height Range	9'0"-10'	9'6"-10'	9'6"-10'6"
First Cost Increase (material & labor)	Base	72%	141%
OVERALL VALUE	★	★★	★★★

Comparisons are based on research of current lighting practice in the New England and New York regions, and illustrated in Layout 7 based on recessed T-8 fluorescent. * All lamp/ballast input values from *The Advanced Lighting Guidelines - 2001* Chap. 6 or "Default Wattage Tables" by Lighting Design Lab, Northwest Energy Efficiency Alliance.

Photo courtesy of The Retek Group

lighting fixture schedule

INDUSTRIAL LIGHTING FIXTURES

These specifications include fixtures that ensure a balance of performance, effective energy use and easy maintenance at a cost-effective price. Luminaire Efficacy Rating (LER) has been established for common fixtures of this type. Look for catalog information that meets or exceeds the minimum LER values listed here, to assure lighting quality using energy effective equipment.

High Intensity Discharge Fixtures are often categorized as High Bay or Low Bay. In this Guide, Low Bay fixtures are shown, designed to provide a wide spread of light for lower ceiling conditions. The spread is typically 65 to 100 degrees, generally greater than a 1.0 spacing to mounting height ratio.

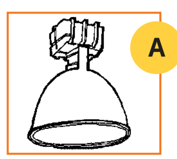
Linear Fluorescent Fixtures are designed to minimize accumulation of dirt by providing for convection. Because of required airflow, lenses or diffusers are uncommon. In work environments where greater protection from airborne particles is needed, dust-tight covers are used. In damp locations, diffusers with vapor-tight gasketing are necessary. In lower ceiling heights, T-5 lamped fixtures should be shielded because of potential glare from high brightness.

Compact Fluorescent Fixtures have recently been developed using multiple large compact fluorescent lamps. They are similar to HID Fixtures in size and have the advantage of tailored light output because of choices of lamp output and quantity.

Induction Lamp Fixtures use a new high frequency electronics driven phosphor-based light source. At more than 60,000 hours life, this source is a good consideration where lamp maintenance is difficult. Available in 55, 85 and 165 watts, it is a viable alternative to HID industrial lighting due to long life and superior lumen maintenance.

A. Metal Halide, Lowbay Open Reflector

LAMP: (1) 250W Metal Halide
Fixture watts: 295
DESCRIPTION: Pendant mounted open metal reflector housing. Field adjustable light pattern for medium to wide light distribution for various ceiling heights. (highbay to lowbay) LER - 50

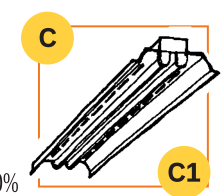


B. Metal Halide, Prismatic Glass Reflector

LAMP: (1) Pulse-start 250W Metal Halide
Fixture watts: 288
DESCRIPTION: Pendant mounted open prismatic glass refractor housing with approximately 25% +/- uplight component. Field adjustable light pattern for medium to wide light distribution for various ceiling heights. (highbay to lowbay) LER - 40

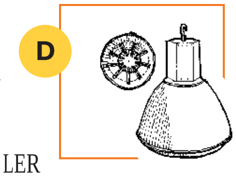
C. T-8 Fluorescent Pendant Industrial Reflector

LAMPS: Type C, (2) 32W T8, 835 color
Fixture watts: 62
Type C-1, (2) 28W T5, 835 color
Fixture watts: 64
DESCRIPTION: Pendant mounted fluorescent fixture, wired for continuous runs per row. White baked enamel reflector finish. Slotted for 20% uplight. LER - 68 for T8 lamps, T5 lamps not rated.



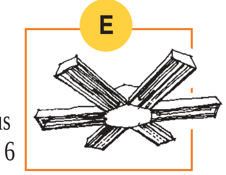
D. Compact Fluorescent Pendant Reflector

LAMPS: (9) FT36W/2G11
Fixture watts: 305
DESCRIPTION: Pendant mounted large compact fluorescent open reflector fixture with direct distribution reflector and center lamp cluster. Available with 4, 5, 6, 8 or 9 lamps. Not rated for LER



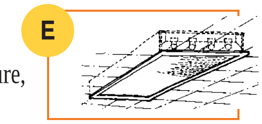
E. Compact Fluorescent Pendant, Radiating Reflectors

LAMPS: (6) 50W Long CFL, 835 color
Fixture watts: 318
DESCRIPTION: Pendant mounted large compact fluorescent fixture with radiating reflector components, direct distribution. Available in various lamp configurations from 3 "arms" – 3 lamps to 6 "arms" – 12 lamps. Not rated for LER



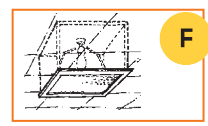
F. T-8 Recessed Lensed 2 x 4, Cleanroom Fixture

LAMPS: (3) 32W T8, 835 color
Fixture watts: 93
DESCRIPTION: Recessed 2 x 4 fluorescent fixture, electronic ballast, hermetically sealed to meet National Sanitation Foundation Listing (NSF). Not rated for LER



G. Metal Halide Recessed Lensed 1 x 1, Cleanroom Fixture

LAMP: (1) Pulse-start 175W Metal Halide
Fixture watts: 208
DESCRIPTION: Recessed 1 x 1 sealed to meet NSF Listing. Not rated for LER

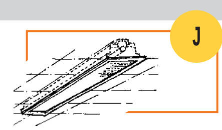


H. Compact Fluorescent 2 x 2, Cleanroom Fixture

LAMPS: (3) 40W Long CFL, 835 color
Fixture watts: 107
DESCRIPTION: Recessed 2 x 2 compact fluorescent fixture, sealed to meet NSF Listing.
Not rated for LER

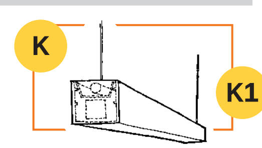
J. T-8 Fluorescent Recessed Lensed 1 x 4

LAMPS: (2) 32W T-8, 835 color
Fixture watts: 62
DESCRIPTION: 1 x 4 recessed lensed fluorescent.
LER - 60



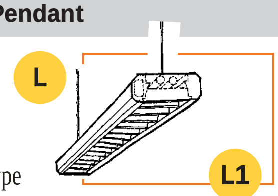
K. T-5 Fluorescent Pendant Indirect Fixture

LAMPS: 54W T5 HO, 835 color
Type K: 8 ft. (2) lamps, Fixture watts: 118
Type K-1: 4 ft. (1) lamp, Fixture watts: 58
DESCRIPTION: Pendant mounted indirect fluorescent fixture. One lamp in profile. Type K – shared 2-lamp ballast. Not rated for LER.



L. T-8 Fluorescent Direct/Indirect Pendant

LAMPS: 32W T8, 835 color
Type L: 8 ft. (4) lamps, Fixture watts: 114
Type L-1: 4 ft. (2) lamps, Fixture watts: 62
DESCRIPTION: Pendant mounted indirect fluorescent fixture. Two lamps in profile. Type L – shared 4 lamp ballast. Not rated for LER.



lighting controls

When an area is not in use, reduced light levels save energy and operating expense. Several ways of applying controls in industrial building are:

- Occupancy sensors
- Manual or building system activated timer switches
- High/low switched ballasts
- Building time clock or automated control systems
- Daylight photosensor switching or dimming

High/Low switching of fixtures with an occupancy sensor or a manual switch is cost effective in **medium use** areas. While frequent switching may reduce fluorescent lamp life hours, calendar life will be considerably longer. New "Programmed Rapid Start" ballasts significantly improve the life of frequently switched lamps.

Daylight sensing controls are an effective and comfortable way to optimize energy use in rooms where abundant daylight is available for at least 25% of the time. Design controls for lights in a zone parallel to the windows within an area depth of 2 to 2.5 times the window height.

Automatic Shutoff: A time-clock control or computer-activated system can be programmed to assure that non-essential lighting, including task lights, is off during unoccupied hours. Automatic shutoff is a requirement of ANSI/ASHRAE/IESNA Standard 90.1 2001.

CONTROL TIPS

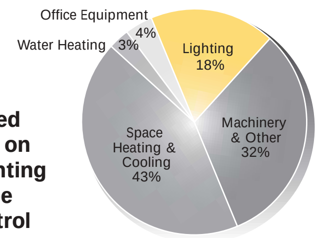
- Occupancy sensors should not be connected to the lighting in main circulation aisles.
- Use Dual Technology sensors in manufacturing and clean rooms to avoid "false offs".
- In large rooms with multiple work zones, small separate lighting zones will give the most energy savings because often not all areas are occupied at the same time.
- Do not locate manual switches in areas with HID lighting unless the fixtures are instant restart.

For further information on Control Strategies see Chapter 8, *Advanced Lighting Guidelines 2001*, by New Buildings Institute, Inc.

Lighting – A Major Electric Cost

A simple way to save significant operational cost is to plan control strategies to turn lights off or down when they are not needed.

The percentage of total energy used for industrial lighting varies based on the magnitude of other loads. Lighting energy use is significant and can be effectively optimized through control strategies.



COST SAVING THROUGH STRATEGIC CONTROLS

Calculating savings for advanced lighting controls will require specific knowledge about the building or space operating schedule. For example, assume an operation schedule of 2000 hours per year, and an electric cost of $.10 per KWH for the Laboratory Layout 9, using Type L on page 6.

The cost of lighting per square ft. is:

$$\frac{\text{Power density X hours per year X KWH rate}}{1000}$$

or $\frac{1.09 \text{ X } 2000 \text{ hr. X } \$.10}{1000}$ = **$.22 per sq. ft. per yr.**

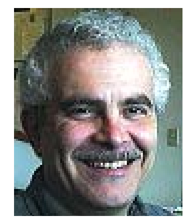
The annual lighting cost for this Laboratory example is $206 (total sq. ft. (946) x $.22). If the lights are turned off due to control use 35% of the time, then the annual savings = $72.00.

HVAC EFFECTS

Heating and air-conditioning costs are affected by the lighting load. If lighting energy is reduced, the net HVAC effect always adds to the lighting savings.

Adding the effects of HVAC savings at a multiplier of 1.15, typical for New York City,* the total savings including HVAC effects is: $72 x 1.15 = $83. Colder climates in the Northeast would use a somewhat lower factor of 1.11.

*adapted from *Lighting Controls Patterns for Design* – EPRI/ESEERCO 1996



Today, lighting controls are entering a new era, where they will be considered not just for saving lighting energy but as a real amenity for the people for whom buildings are built.

F. Rubinstein,
Staff Scientist LBNL

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