PDHonline Course E114 (2 PDH)

Commercial Interior Lighting Design

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Commercial Interior Lighting Design

Thomas Mason, P.E.

Course Content

A commercial interior lighting design is made up of the following components:

- Area, object or task being illuminated.
- Available lighting fixture mounting location.
- Lighting fixture.
- Lamp or light source.
- Control device.
- Power distribution.

Each will be discussed separately.

Area, object or task being illuminated: There are three distinct criteria for lighting, government-mandated minimums, recognized guides for similar areas, objects and tasks, and utility, as defined by the user.

Government regulations for lighting come from OSHA and the local and State Building Codes. US DOE is just beginning to try to minimize lighting. OSHA mandates "adequate lighting at the workplace and references the IESNA Table." The IESNA Table (discussed shortly) is NOT mandated, but offered as a guide for OSHA enforcers. The State Building Codes mandate compliance with all of NFPA 70, the National Electric Code and parts of NFPA 101, the Life Safety Code.

This discussion will continue, but the final answers are that 30-fc (foot candles) is good workplace lighting, 5-fc is adequate general lighting for clear walkways and 1-fc is the minimum for paths of egress, all the way out of the building, to the public way. Old eyes and precision tasks require 100-150-fc.

In 1989, ASHRAE, the national air conditioning society, published a guide for energy conservation. There were several pages on minimizing lighting. US DOE (Department of Energy) undertook efforts to get individual States to incorporate ASHRAE 90.1 into the State Building Codes. ASHRAE 90.1 was revised in 1999 and is now on a 3-year revision cycle. It has been adopted by most states (See Related Links, at the conclusion of this course). The ASHRAE standard is severe to the point of being impossible and is not enforced.

It is extremely rare for government enforcement to control the lighting design. Plans Reviewers, however, often ask for extra battery-powered emergency egress lights. The basic question of night lights or no night lights has not been addressed by any organized government action and remains discretionary. Lighting levels and fixture counts are determined by other criteria.

The *national standard* for lighting levels is the IESNA Table, in the IESNA Handbook ($425, www.IESNA.org). It is summarized in larger light fixture catalogs, textbooks and handbooks. A summary is included in the Attachment to this course.

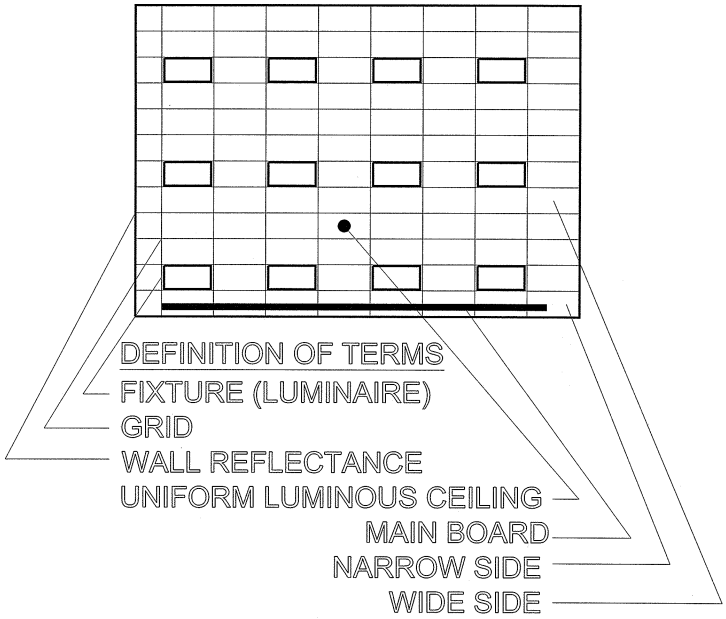
A minor distinction should be made here. The IESNA Table is entitled, "Recommended Lighting Levels". It is frequently enforced as MINIMUM lighting levels by antagonists. It is more often enforced as MAXIMUM lighting levels by project accountants and value engineering teams. In fact, lighting from the same fixture, in the same mounting location, over the same task, will vary +/- 20% as the lamps age and dirt builds up. Meaningful light level calculations include a lamp maintenance factor, assumed wall reflectance and explicitly stated relamping interval .

User criteria start to recognize the variations within a task grouping and between users. High visual precision always requires higher light levels. As stated previously, 30-fc is good lighting for walking around a store, office or plant. To see the features of merchandise, though, the merchant needs to place "sparkle" on the goods, usually through spotlights. To use a computer terminal in an office, most persons prefer a lower overall light level and adjustable task lighting (remember that the primary light source for viewing is the screen brightness control). In a plant, "pinch points" must be extremely will lighted, usually with high reflectance yellow paint.

Be aware that the eye's ability to focus is related to light level. In photography, it is termed "depth of field". A wide-open lens has shallow depth of field. Objects closer or farther than the focal point will be fuzzy. With a stopped-down lens, the sharp range may be from 5-ft to infinity. The human eye has similar optical physics, but is confounded by the additional fact that the lens hardens as persons age and becomes incapable of adjusting. A fixed eye, with a fixed pair of glasses, can focus on labels at a greater range of distances under high light level. A pocket light is often better than a pocket magnifying lens.

Available lighting fixture mounting location: .The basic discussion begins with a large open space, as a classroom or open office, with a 2x4 ceiling grid at 10-ft above finished floor. Lighting for this case can be lay-in 2x4 fluorescents, recessed downlight "cans' and pendant fixtures.

2x4 fluorescents can be placed in rows or mounted as individual fixtures. The following graphic illustrates available patterns and resulting light levels from a 3-lamp (32-w) fixture with two circuits. The two circuits permit 1-tube, 2-tube or 3-tube operation. This installation is the current recommendation from IESNA, US DOE and State educational funding agencies.

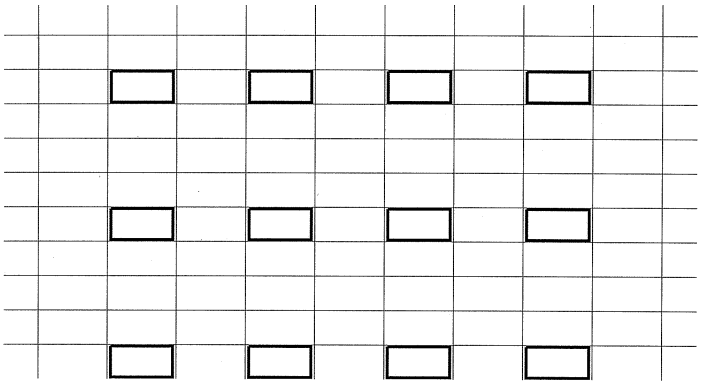


Measurement of lighting levels is carefully defined by several IESNA standards. For most purposes, a light meter held at 30-in above the floor, somewhat away from the body (to avoid shadows) produces meaningful results. Predicted lighting levels are produced by computer software using laboratory measurements of fixture lighting output, entered reflectance values for the walls and room geometry, then performs computations. Extensive academic literature addresses the assumptions, underlying computational principles and accuracy of results. Field measurements indicate that predicted values for the center of the room (uniform luminous ceiling) are good. Field measurements at the walls usually produce higher values than predicted.

The "main board" is shown because State education funding agencies require that the long axis of the lighting fixtures be parallel to the main board. Glare on the vertical surface of the board is beyond the scope of this course. The "narrow side" and "wide side" refer to an asymmetric fixture pattern within the drop ceiling T-bar grid. The grid itself is usually provided by the Architect, but can be selected by others. There are four conflicting grid location criteria - symmetry, minimum waste of ceiling tiles, continuing pattern from entry and view from street. The economic criterion produces full symmetry with large pieces of tile at the wall boundary. This also conceals imperfections in wall construction.

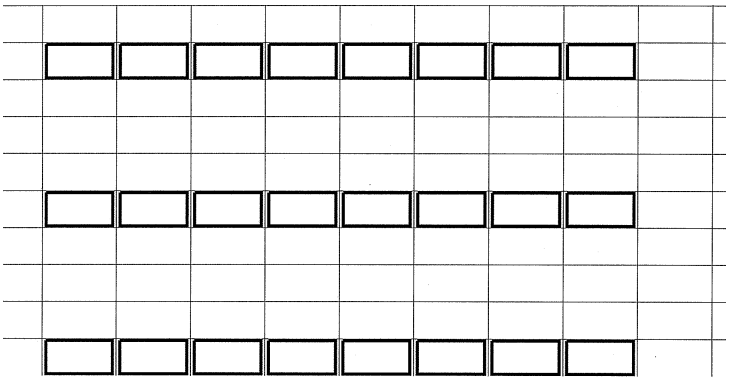
Fixture positioning will be addressed in a later section.

The following graphic presents computer simulation results from a major fixture manufacturer. Most distributors and manufacturer's representatives offer simulation services, some offer the software; third-party firms offer software and simple spreadsheet calculations are available.



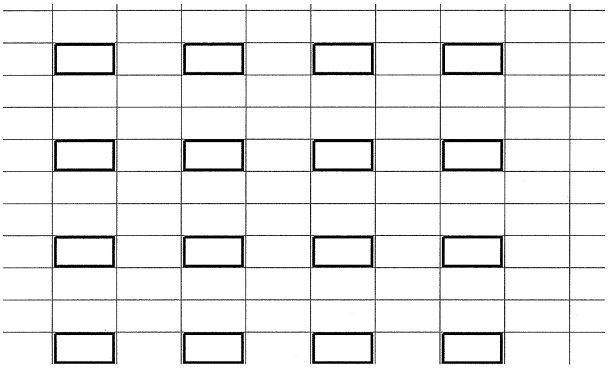
BASE CASE, 8-FT x 8-FT, C-C
3-32W TUBES --> 60fc AVE
2-32W TUBES --> 40fc AVE
1-32W TUBE --> 20fc AVE
(LITHONIA SIMULATION)
$100/fixture + installation

Note from this computer simulation that for a uniform fixture pattern of substantial size, produced light level is directly proportional to lamp count. For this ratio to be valid, edge effects must be ignored, fixtures must be close enough to avoid significant variation and the fixtures must have good optics in 1-, 2- and 3-tube operation. The Base Case is the standard grid for schools and popular for open offices that lack task lighting.



STRIP CASE, 8-FT, C-C SPACING
3-32W TUBES --> 120fc AVE
2-32W TUBES --> 80fc AVE
1-32W TUBE --> 40fc AVE
(RATIO CALCULATIONS)

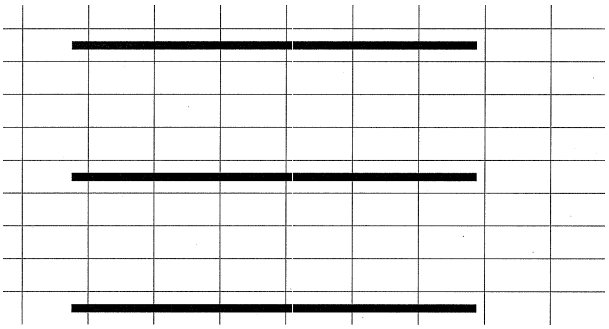
The Strip Case in included to demonstrate ratio calculations for another uniform luminous ceiling. The ratio method was used exclusively 50-years ago, under the name, "Watts per Square Foot Method". This method is still standard for area and building lighting power calculations.



OLD STANDARD
4-FT SPACING x 4-FT SPACING
3-32W TUBES --> 80fc AVE
2-32W TUBES --> 53fc AVE
1-32W TUBE --> 27fc AVE
(RATIO CALCULATIONS)

Until EPACT, the 2-tube 40w fixture was universal. The Old Standard Case produced 60fc with these fixtures. 40w lamps and ballasts are no longer available. A one-for-one replacement with 2-tube 32w lamp fixtures produces 53fc, below the IESNA recommendation. 3-tube 32w fixtures produce levels substantially above the IESNA recommendation and no energy savings. Ergo, symmetry was redefined from equal separation to equal center-to-center spacing.

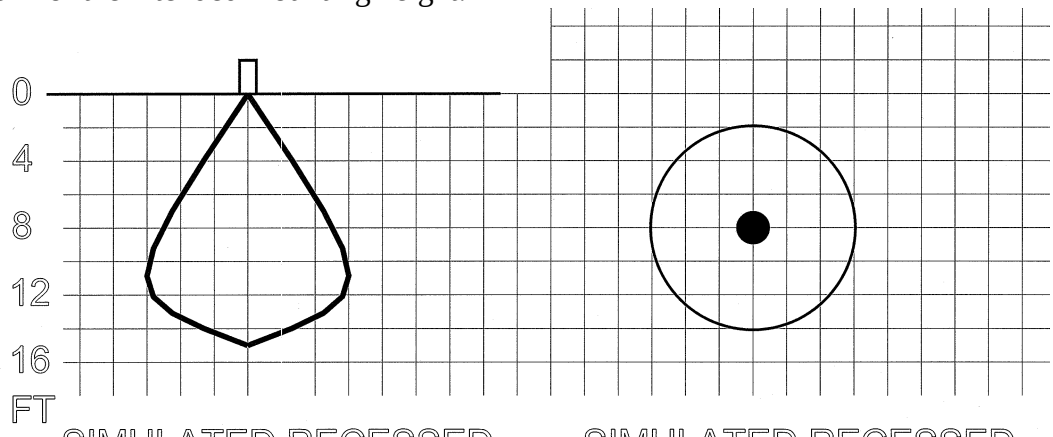
In order to extend the discussion from an open office with a 10-ft grid ceiling, the same principles must be applied. Surface-mounted wrap-around 2-lamp 4-ft fluorescent fixtures work on plaster ceilings, with spacings unrestricted. Surface or pendant-mount industrial strip lights are flexible in installation and provide roughly 2x the light levels of lensed lay-ins. Current production lensed lay-ins are the product of many years of research and optical design. The result is very good lighting uniformity and low glare. Surprisingly, the length of 1-fc throw of a 2x4 lensed lay-in with an emergency battery pack is 30-ft, equal to the throw of the best 12V 12w halogen emergency egress lighting wall pack.



SEMI-INDIRECT PENDANT STRIP
8-FT, C-C SPACING
2-32 TUBES --> 15fc AVE
(WIDE RANGE OF RESULTS AVAILABLE)
$50/ft + installation

Pendant fixtures are popular with Architects and very appropriate when task lighting is provided. The lighting recommendation for corridors is 15fc, with 5fc acceptable for clear walkways. This level is easily achieved by low efficiency indirect fixtures. The 30-50-100fc level for the working area can be provided by office cubicle furniture containing fluorescent fixtures, portable directional halogen lamps and company-issued miner's helmets. A special problem is conference tables and large work tables to spread out construction drawings and such. Central room lighting of 50-100fc is necessary. Avoid chandeliers.

Recessed downlights work well for corridor and low-intensity general lighting. Some generic comments will be offered, but the best information is available from the catalog photometrics. Both vertical and horizontal distributions are given and resulting light levels can easily be picked off for the intended mounting height.



SIMULATED RECESSED DOWNLIGHT
30FC PHOTOMETRICS
- VERTICAL
$100/fixture + installation

SIMULATED RECESSED DOWNLIGHT
30FC PHOTOMETRICS
- HORIZONTAL

The uniformity of the light distribution from a downlight is usually bad, due to the severe limitations on the available optical design. A reflector incandescent (similar to a PAR floodlight) is directional and there are a few compact fluorescent lamps with integral reflectors. More often, however, a high efficiency metal halide lamp with remote ballast is used along with a reflector which is part of the fixture. As with the 2x4 lay-ins, the local distributor is eager to run simulations and recommend specific fixtures and lamps. A usable approximation can be made by picking off the desired light level from the photometrics (30fc in the example) and using fixture spacing at that diameter (12-ft in the example). Intensity dropoff is very rapid for downlights. Again, distributors and manufacturer's representatives are eager to perform light level simulations and recommend fixture spacing. They need to know desired fc and mounting height.

Edge effects become critical for large spaces, especially as the walls are often the focus for use of specialized areas.

Lighting fixture: The functional aspects of fixture selection are light level produced, mounting and energy usage. Each of these is much more closely related to the lamp selection than the fixture selection. The only exception, now rare, is air handling lay-in troffers. There was a popular theory that by taking HVAC return air through the fixture, the heat losses could be captured before entering the occupied space. Special fixtures were ducted as well as wired. Installation cost and trades coordination have made such installations uneconomic. The remaining concerns are aesthetic. The solution is to seek an attractive model installation and then peruse lighting catalogs. Most vendors specialize in a particular style, so it is an error to study the catalogs before recognizing the range available. Architects are extremely valuable in negotiating with owners on area use, style preferences and practical mounting limitations. Engineers more frequently encounter Change Orders when the Owner sees what the installation looks like.

Lamp or light source: Lamp selection is associated with three primary criteria, color, intensity and electric power. Secondary criteria are operating cycle and dimability. Each will be discussed in turn.

Lamp	B	Color	Intensity	60 fc Power	Cycle	Dimmability	Comment
LPS low pressure sodium HID	Y	Monochromatic orange	High		3-min start; 5-min cooldown	Not commercial	Very rare because of color, ext.
HPS high pressure sodium HID	Y	Orange	Low to High	1.7 w/sq-ft	3-min start; 5-min cooldown	Not commercial	Very popular exterior lighting
MV	Y	Cold	High		3-min start;	Not	Becoming

mercury vapor HID					5-min cooldown	commercial	rare, ext
MH metal halide HID	Y	Cool to warm	Low to High	2.0 w/sq-ft	3-min start; 5-min cooldown	Special ballast and controls	Very popular, interior and exterior
4-ft fluorescent	Y	Cool to warm	Low	Lensed 3.3 w/sq-ft Bare 2.1 w/sq-ft	Near instantaneous	Special ballast and controls	Almost universal in commercial applications
Compact fluorescent	Y	Cool to warm	Low	2.5 w/sq-ft	Near instantaneous	Special ballast and controls	Becoming very popular
Halogen incandescent	N	Warm	High	8 w/sq-ft	Ramp up, ramp down	Simple controls	Special applications, as merchandising
incandescent	N	Warm	Low	12.5 w/sq-ft	Ramp up, ramp down	Simple controls	Short life, low efficiency, lowest cost
ASHRAE 90.1 mandate				1.5 w/sq-ft			

Where B = Ballast required (external current limiting high voltage transformer)
Power = from 2002 MEANS Electrical Estimating Guide

Low pressure sodium, high pressure sodium, mercury vapor and metal halide are used in exterior lighting, discussed in another course in this series.

Metal halide is becoming the lighting source of choice for interior use. It is energy efficient, available with good color rendition and optical designs are becoming available that are aesthetic and functional. 70w MH downlights are a very good design, producing surprisingly high light levels.

4-ft fluorescent tubes are almost universal in application, from service garages, to offices to high-end department stores. It is a well understood, mature technology. The recent EPACT mandates forced adoption of available technology. The current ASHRAE 90.1 mandates are attempting to force innovation beyond current technology., maybe lasers and light pipes.

Compact fluorescents are a relatively new technology, but very attractive in features and economy. Units with integral ballasts, for direct replacement of incandescents are available for $2.50 each. 55w integral ballast units deliver the light level of a 250w incandescent lamp. The following table was prepared to see if efficiency changes over the range of available compact fluorescent sizes. (It doesn't.) Lumens are light output, whereas foot candles are fixture output reaching the user plane. The conversion factor is the quality of the optics. Unfortunately, few optical systems have yet been designed for compact fluorescent lamps.

Compact Fluorescent

Watts	Lumens	L / W
11	650	59
15	950	63
20	1200	60
24	1400	58
30	1850	62
45	2700	60
55	3300	60

Long Life Premium Incandescent

Watts	Lumens	L / W
15	80	5
25	185	7
40	325	8
60	555	9
75	750	10
100	1025	10
150	1770	12
200	2335	12
300	3595	12

source: Tek Supply, 11/15/02

A *halogen* incandescents are an optimized incandescent. They run extremely hot. The light source is almost a point, making optical control easy and attractive. 300w halogen torchier floor lamps have cause many residential fires. 100w MR-16 lamps on track fixtures provide superior merchandising sparkle, even in low ceiling selling spaces.

Incandescent lamps are the pariah of lighting design. The only justification for continued use is low replacement cost in a high vandalism/theft application. Compact fluorescents work better and cost less on a life-cycle basis in any application where they survive.

Control device: There are a daunting range of control devices available and required for modern commercial lighting. A small enclosed office would be expected to have a light switch at the entrance. But, if there are two ceiling fixtures, ASHRAE 90.1 mandates two-level switching, occupancy detector for automatic turn off or a dimmer. As discussed previously, ASHRAE 90.1 is law in most States, but not enforced.

Two-level switching works well with 3-tube 2x4 fluorescent fixtures. Vendors say that *occupancy detectors* work when the new PIR/ultrasonic units are specified. *Dimmers* work well with halogen incandescents. Special fluorescent and HID dimmers are available that work with special fluorescent and HID ballasts. Vendors claim normal lamp life and no extra noise.

Computerized lighting control has been available for 30 years and appears to be mandated by ASHRAE 90.1. [The requirement is for whole-building lighting curtailment with local override capability.] The conflict is that commercial facilities do not receive maintenance. The custodian is tasked with keeping the place running without spending money or bringing in contractors. He gets by through disabling automatic controls and wasting energy (for which he is not responsible). Computerized lighting controls will require replacement of expensive, proprietary, possibly unavailable parts and reprogramming. ASHRAE and IESNA are funded by vendors and endorse computerized controls for commercial reasons. US DOE and EPA and State Building Commissions are government bureaucracies.

Two systems of computerized lighting control must be mentioned - economical networked low-voltage relay systems and super-humdinger Building Automation and "smart" panelboards. Several small firms offer a range of small lighting power relay/control units which mount above the ceiling in a classroom or office. Existing line-voltage switches are reused to trigger the relays. Existing operation continues without notice by users. The networked relays, however, accept end-of-day shutoff commands and housekeeping turnon commands from a central timeclock or small computer. Cost is less than $500/circuit, complete.

High-end *Building Automation* systems may be installed as part of the HVAC controls to hide the cost from the lighting construction budget. "Smart" panelboards are now offered by several major electric distribution vendors. These incorporate remote operation of individual circuit breakers and an integrated microprocessor to handle commands and report status. Cost increment for the "smart" panelboards is substantial, but may be appropriate for institutional or new office construction.

Power distribution:

Facility power starts at the utility service. The main switch must be big enough to handle all building lighting, HVAC and any significant office or process loads. NFPA 70, the National Electrical Code, says to use 3.5 w/sq-ft for lighting and 2.5 w/sq-ft for HVAC. These numbers are conservative, but certainly adequate.

The most economical power distribution system for commercial lighting is 480/3 feeders from the main panel to local lighting panels. Per the voltage drop table in the Appendix, no 277/1 lighting fixture should be more than 300 wire-ft from the panel. That is, considering the necessary up-run from the panel and orthogonal runs down corridors, the actual wire distance from the panel should be no more than 300-ft. Greater distances can be accommodated at the cost of oversize wiring to avoid voltage drop. 300-ft, by coincidence, is the maximum data run for Local Area Networks, from a technology closet to the desktop.

An alternate distribution method is 480/3 to an electrical closet, a 480-208 lighting transformer and 120/1 lighting fixtures. No 120/1 fixture can be more than 130-ft from the panel without upsizing the conductors.

The third method is 208/3 feeder to the 208/3 lighting panel and 120/1 lighting fixtures. Again, no 120/1 fixture can be more than 130-ft from the panel without upsizing the conductors.

After power is available at the area lighting panel, circuits must be assigned to groups of fixtures. The largest panel permitted by the NEC is 42 circuits. The standard lighting branch circuit is 2-#12, #12G-3/4"C on a 20/1 circuit breaker with a 16A (80%) maximum load. This permits 4432 VA on a 277 V circuit or 1920 VA on a 120 V circuit. A 3- 32w fixture with 10% ballast losses requires 106 VA. The result is a maximum of 40 3-tube fixtures on a 277 V circuit or 18 3-tube fixtures on a 120 V circuit. The numbers used in these calculations should be followed, with changes only for the fixtures selected. A 120 V circuit is not 115 V or 110 V. A 460 V motor has load calculated at 480 V. A 20 A circuit breaker is permitted only 16 A.

The allocation of fixtures laid out on the plan drawing to the lighting panel is largely discretionary, within the maximum fixtures per circuit. The only firm guide is to NOT place lighting and receptacles in the same room on the same circuit. A receptacle fault should not interrupt lighting.

The fixture allocation to lighting panel circuits is done on a form called a "Panel Schedule". The Plans Examiner usually glances at the Panel Schedule before approving the Building Permit. He looks for the size of the main circuit breaker compared to the total load, checks the voltage matches the supply circuit and often checks the short circuit withstand rating. (42,000 A withstand at 480 V and 22,000 A withstand at 208 V are conservative unless the panel is located within 50-ft of the service switchboard.) The form is not prescribed, but those numbers should be available for review. The following example Panel Schedule is the most elaborate encountered in 30-years of consulting practice. It might be better termed "Panel Worksheet and Schedule". It provides space to upsize outgoing circuit conductors for voltage drop or large circuit breakers. It indicated the incoming wire size, has spaces for common options and a legend of common branch circuit notes. Automated Panel Schedules are available for MicroSoft Excel and integrated electrical design packages.

Panel		Feed-Thru Lugs		Neutral Bus		Equip Gnd Bus		Insulated/Isolated Gnd Bus		Volts			Phase		Wire	
Location						Mounting				Main Amps				Main Bkr Amps		Pos
Ckt No	Use	VA	Wire Size	Poles /Notes	Amps	Ph A	Ph B	Ph C	Amps	Poles /Notes	Wire Size	VA	Use			Ckt No
1																2
3																4
5																6
7																8
9																10
11																12
13																14
15																16
17																18
19																20
21																22
23																24
25																26
27																28
29																30
31																32
33																34
35																36
37																38
39																40
41																42
Panel Feeder Size									Max ph. Amps				Ave Ph Amps			
Available SC Amps RMS Sym						Total VA			Demand VA							

Notes: * = HID Switch Rated SE = Service Entrance rated
# = HACR Rated ST = Shunt Trip
GF = Ground Fault L = Lockable X = Reuse Existing Conduit and Wires

The lighting fixture is usually shown on the building plan with an arbitrary symbol indicating the fixture type and an arrow indicating the power circuit homerun to the lighting panel. The panel circuit is shown on the homerun arrow.

Appendices

Lighting Levels of Importance, not in OSFC Table

Room Type	**IES fc**
Minimum walkway (NFPA 101)	1.0
Bar or intimate dining	3.0
Restaurant	20
Cleanup	30

Partial Summary of IESNA Recommended Lighting Levels, with Ohio Schools Facilities Commission Design Manual (funding agency) comments

SCHOOL LIGHTING LEVELS - 1996		
ROOM TYPE CLASSIFICATION	**1993 IES**	**RECOMMENDED MINIMUM FOOTCANDLES***
ADMINISTRATIVE		
Offices/Receptionist	50-100	60-70
Storage Rooms	5-30	15-25
Restrooms	20	25-35
Conference/Resource Rooms	-	60
Health Clinic	-	60
Teacher Prep/Workroom	-	60
CLASSROOMS-GENERAL	-	60
Art Rooms/Kiln	70	60
Modular Technology Labs	-	60
CADD Labs	50-70	60
Industrial Tech/Production Labs	-	60
Computer Labs	50-100	70
Graphics Labs	-	60
Life Skills Labs	150	50
Laundry Rooms	-	30
Music Rooms	50	60-70
Large Group Instruction Rooms	-	60
MEDIA CENTER	-	50-60
Active Areas	50	50-60
Inactive Areas	30	40
ATHLETIC AREAS		
Gymnasium - Elementary School	50	50
Gymnasium - Middle School	-	60
Gymnasium - High School	75	75
Multi-use P.E. Rooms	-	60
Locker Rooms	10-20	30
AUDITERIAS		
Assembly	20	20
Stage/Work Lights	30	20
Make-up/Dressing Rooms	-	60
Theatrical Control Room	-	50
Equip room with dimmable incandescent lighting offering 10 footcandles of illumination.		
STUDENT DINING (***Used*** for testing)	10-100	60
Cooking	-	75-80
Food Preparation	-	75-80
Serving Line	-	75-80

SCHOOL LIGHTING LEVELS - 1996		
ROOM TYPE CLASSIFICATION	**1993 IES**	**RECOMMENDED MINIMUM FOOTCANDLES***
Ware Washing	-	75-80
CUSTODIAL CLOSETS	-	20-30
ELECTRICAL ROOMS	-	20-30
MECHANICAL ROOMS	-	30
PARKING AREA	-	.5
DRIVEWAYS	-	1
CIRCULATION AREAS		
Building Entries	5	5
Corridors	10-20	30
Corridors with Lockers	20	20-35
Stairways	20	20-30
*Maintenance factor 70%		

Very informal Analysis of ASHRAE 90.1(01) electrical mandates.

8.2.1.1 Feeder conductors shall be sized for a maximum voltage drop of 2% at design load.

8.2.1.2 Branch circuit conductors shall be sized for a maximum voltage drop of 3% at design load.

COMMENT: The old rule, 3% branch, 5% feeder + branch, was in NEC 210-19, FPN 4, not enforceable. The ASHRAE 90-1(01) is enforceable, but adds the words “design load” to provide a little wiggle room, especially on receptacles and lighting. See chart, below.

		(TECH RCPT)		(GEN RCPT)				(PERIM LTG)		(ROOM LTG)	
AWG	OHM /1000-FT 3%DROP	1-PH, 120V DED NEUT A-FT	FT16A	3-PH, 208V 1-PH, 120V BAL NEUT A-FT	FT16A	3-PH, 240V NO NEUT A-FT	FT16A	1-PH, 277V DED NEUT A-FT	FT16A	3-PH, 480V 1-PH, 277V BAL NEUT A-FT	FT16A
12	1.7	998	60	2080	130	2200	140	2404	150	4800	300
10	1.1	1580	100	3280	205	3469	220	3806	240	7569	470
8	0.7	2450	150	5110	320	5405	340	5901	370	11792	740
6	0.45	3800	240	7850	490	8303	520	9153	570	18115	1130

CAT5E 280FT 9/25/02

8.2.2.1 Record drawings shall be provided to the building owner, including (b.) floor plans indicating location and area served for all distribution.

COMMENT: I did these dwgs for a previous employer. It is a plan with alternate cross hatches for panels serving each area. Not difficult. Yes, time consuming.

8.2.2.2 Operation and Maintenance Manual shall include (c.) names and addresses of at lease one qualified service agency and (d.) complete narrative of how each system is intended to operate.

COMMENT: We can try to include this in the EC's tasks, but HVAC already provides a Sequence of Operation to the MC.

9.2.1.1 Mandatory automatic lighting shutoff lighting in all spaces, by zone no more than 70 x 70 from a timeclock or occupant sensor.

COMMENT: No more nightlights. Don't know how to handle EXIT signs or egress lights. Sounds like lighting panel contactors (not good) or "smart panel boards" or computerized control systems. A later section requires manual overrides, which tilts the decision towards computerized systems.

9.2.1.2.b. Control device shall be capable of overriding the shutoff control for no more than four hours and (c.) be readily accessible and located so the occupant can see the controlled lighting.

COMMENT: Custodian maintenance headache-to-nightmare.

9.2.1.3 All exterior lighting not exempted shall be controlled by a photosensor or astonomical time switch.

COMMENT: This is daytime turn-off.

Table 9.3.1.1 (partial)
Whole Building Lighting Power Densities

Building Area Type	**W / sq-ft**	derived fc	Comment
Gym	**1.7**	51	450w MH, vs OSFC 75
Library	**1.5**	27	T32 lay-in, vs OSFC 50-60
Office	**1.3**	23	T32 lay-in, vs OSFC 60-70
School / University	**1.5**	27	T32 lay-in, vs OSFC 60
			Where OSFC = Ohio Schools Facilities Commission Design Manual, 2002 (funding agency)

COMMENT: This requirement appears to offer a significant challenge.

Table 9.3.1.2
Space-By-Space Lighting Power Densities

Building Specifric Type	**W / sq-ft**	derived fc	Comment
Stairs	**.9**	16	T32 lay-in, vs OSFC 30
Corridor	**.7**	13	T32 lay-in, vs OSFC 30
Classroom	**1.6**	29	T32 lay-in, vs OSFC 60
Office - Open	**1.3**	23	T32 lay-in, vs OSFC 60-70
Office - Enclosed	**1.5**	27	T32 lay-in, vs OSFC 60-70

COMMENT: This requirement appears to offer a significant challenge.

Table 9.3.2
Lighting Power Limits for Building Exteriors

		derived fc	Comment
Building entrance with canopy	**3 W/sq-ft**	54	CF lensed downlight or canopy fixture
Building entrance without canopy	**33 W/ft doorway**	2	99W, 36-in door, Use 70W HPS or MH, OSFC 5 fc
Building exit	**20 W/ft doorway**	1 fc	60W, 36-in door, Use 50W or 70W HPS or MH, OSFC 5 fc

COMMENT: This requirement appears to offer a significant challenge. HRAE 90-1.]