The Architect's Guide to Energy Conserving Products and Systems

A Publication of the
AIA/ACSA Council on Architectural Research

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CONTENTS

INTRODUCTION

Welcome to the inaugural edition of the ***Architect's Guide to Energy Conserving Products and Systems. The*** purpose of this new, annual publication is to provide accurate, up-to-date information on building products with superior energy performance - a "one-stop" directory targeted specifically and exclusively at practicing architects in the United States and Canada.

The architectural profession is currently more interested in, and receptive to, information on energy conserving design and construction than they have been in almost a decade. Unfortunately, this information is not being provided to them in a systematic and sustained fashion. As a result, many of the energy conserving fenestration and lighting products and systems on the market today are simply not specified by the profession. Although an architect may have seen or read about a particular product, he or she may not have a readily accessible **means to** obtain more information. Alternatively, a particular product of potential interest to architects may only be advertised in engineering or "energy-related" publications. Whatever the reason, a wide range of energy conserving fenestration and lighting technologies currently go unnoticed, or at least under-noticed, by practicing architects.

The joint Council on Architectural Research of the American Institute of Architects and the Association of Collegiate Schools of Architecture intends to fill this "information gap" by publishing and disseminating the ***Architect's Guide to Energy Conserving Products and Systems.***

ORGANIZATION

The premier issue of the ***Guide*** is organized into 4 chapters covering 4 general product types: Glazing and Windows, Electronic Ballasts, Lamps, and Controls. These products all substantially impact the energy performance of buildings, and the Guide has chosen to restrict its scope to these 4 categories for its inaugural edition. In future years the Guide will expand to include the full range of building products and systems.

Each chapter has been divided into specific product subcategories to facilitate organization and presentation of the material. The product categories and subcategories that are included in the 1993-1994 issue of the ***Guide*** are:

1. Glazing and Windows
- 1.1 Commercial glazing
- 1.2 Commercial window units
- 1.3 Commercial glazing using plastic products
- 1.4 Residential windows

2. Electronic Ballasts
- 2.1 Electronic ballasts for T12 and T8 fluorescent lamps
- 2.2 Electronic ballasts for U-tube and twin tube fluorescent lamps
- 2.3 Electronic dimming ballasts
- 2.4 Electronic ballasts for compact fluorescent lamps
- 2.5 Specialty ballasts

3. Lamps
- 3.1 T12 and T8 straight tube fluorescent lamps
- 3.2 T12, T8 and T5 U-tube and twin tube fluorescent lamps
- 3.3 Compact fluorescent lamps

4. Controls
- 4.1 Occupant sensors

INTRODUCTORY TEXT

Each chapter is organized into two main subsections: a short introduction which explains the types of products included in the chapter and a series of catalogue-style pages providing information on specific products from individual manufacturers.

The introductory section provides definitions and background information on the specific products included in the chapter. In particular, the text describes the performance criteria used to screen and select the products described on the manufacturer's ad pages. These criteria were developed by a panel of technical experts to ensure selection of products and systems with superior energy performance characteristics. The resulting requirements are high but achievable within the current marketplace. Only products and systems which meet or exceed these minimum performance requirements have been included in the Guide.

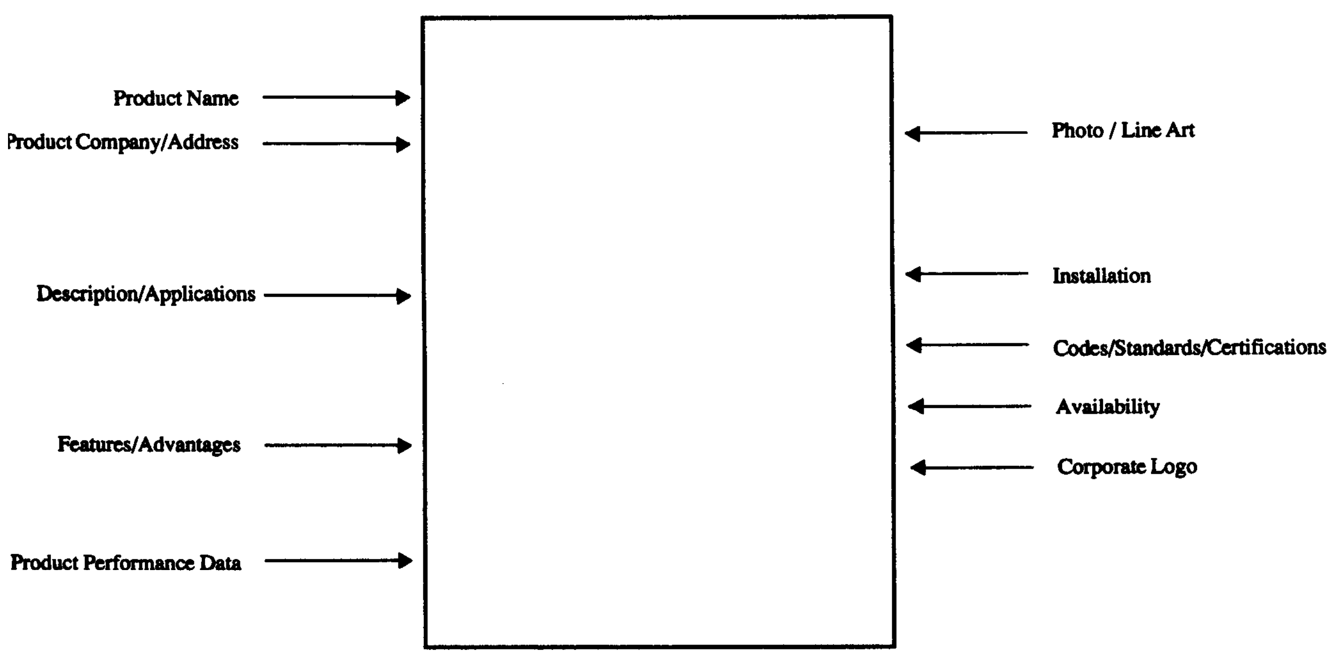
Readers should familiarize themselves with the information in the introductory section before proceeding to the manufacturer's ad pages. This will help clarify some of the data presented on the ad pages and will give the reader a better understanding of what makes a particular product energy efficient.

MANUFACTURER'S AD PAGES

Each manufacturer's ad page contains information on products in a specific Guide subcategory. Up to five products can be included on any individual page and each of the products listed meets or exceeds the performance requirements established by the expert advisory panel.

Information is presented catalogue-style, with the majority of the page devoted to descriptive text and graphics provided by the manufacturer. At the bottom of the page is a table contaming specific product performance data. The data in this table is required for every product listed in the Guide and includes information on all the required performance criteria for that particular product. The table has individual entries for each product listed (up to five) and allows for quick comparisons between similar product types.

Pictured below is a sample page layout. Each manufacturer's ad page in the Guide follows the same basic format.



GLAZING AND WINDOWS

This section of the *Guide* covers energy efficient glazing and windows for commercial andresidential buildings. Because the *Guide* is designed as a "one-stop" resource for architects, only products and systems **with superior energy performance characteristics** have been identified. To ensure that the *Guide* meets this objective, a panel of energy experts established minimum performance requirements for each of the 4 product categories included under the "Glazing and Windows" heading. ***Only products that meet these minimum required performance levels and specifications have been included in the Guide.***

BACKGROUND

The following "Glazing and Windows" product categories are included in the ***Guide***:

1.1) Commercial Glazing
1.2) Commercial Window Units
1.3) Commercial Glazing Using Plastic Products
1.4) Residential Windows

When referencing this section of the ***Guide*** readers must remember that the energy performance of glazing and window systems is complex and interactive. Glazing systems lose heat to the cold outside air in winter and gain heat from the hot outside air in summer, just like opaque walls and roofs. Additionally, glazing systems admit solar radiation, some of which is visible (daylight.) The radiation is turned into heat within the glazing unit, warming the panes, and the inside of the building. Sometimes the solar heat admittedthrough glazing is desirable and sometimes not. Regardless of desirability, this added characteristic of glazing makes it much more complex to analyze and specify from an energy standpoint.

This is especially true in commercial and institutional architecture where the energy required for lighting and cooling usually far exceeds that required for heating. (Such buildings are said to be "cooling dominated" or "internal load dominated") Further, lighting and cooling requirements are interactive. Therefore, it is important that glazing and window products be evaluated using techniques that consider their effect on both lighting and HVAC systems. This is essential where daylight design strategies are employed.

To account for and optimize these interactions involves more than simply specifying high quality products. It demands sensitive design of the entire building envelope. An inefficient window used in a highly efficient design can outperform an "energy conserving*' window in the wrong application.

The ***Guide assumes*** its readers need information on the most efficient products available for use in the proper applications.

PRODUCT PERFORMANCE REQUIREMENTS

The ***Guide*** applies four interrelated criteria to ensure that the products listed exhibit superior energy performance. These four criteria - which take into account the interactive nature of glazing systems - are: Winter Night U-value, Visible Transmittance, Shading Coefficient, and Coolness Index. The table opposite summarizes required minimum and maximum values for these performance criteria. Additional descriptive information on each product category or subcategory is also provided. The following discussions describe each section of the table in more detail.

Product Performance Requirements: Glazing and Windows

		1	2	3	4	5	6
PRODUCT CATEGORY		**Number of Panes**	**Type of Coating**	**U-Value Winter Night**	**Visible Light Transmittance in (%)**	**Shading Coefficient**	**Coolness Index % (Day. Trans./ Shad. Coeff.)**
(1.1 & 1.2) Commercial Glazing and Commercial Window Units	Commercial Glass (predominant heating zone)	2	Low-e	<=0.35	>=20%*	No Requirement	>=95
			Reflective	<=0.52			>=100
	Commercial Glass (predominant cooling zone with significant heating)	2	Low-e	<=0.40	>=20%*	No Requirement	>=100
			Reflective	<=0.52			
	Commercial Glass (predominant cooling zone with significant heating)	2	None	<=0.52	>=20%*	No Requirement	>=100
	Commercial Glass (predominant cooling zone with limited heating)	1	No Requirement	<=0.80	>=20%*	No Requirement	>=100
	Commercial Glass (cooling zone)	1	No Requirement	No Requirement	>=20%*	No Requirement	>=100
(1.3) Commercial Glazing Using Plastic Products	Commercial Plastic (heating or cooling zone)	2	None	<=0.52	>=20%*	No Requirement	>=100
(1.4) Residential Windows	Residential (predominant heating zone)	2	Low-e	<=0.40	No Requirement	No Requirement	>=80
			None	<=0.58			
	Residential (predominant cooling zone with significant heating)	2	Low-e	<=0.45	No Requirement	<=0.75**	>=80
			None	<=0.58			
	Residential (predominant cooling zone with limited heating)	1	No Requirement	<=0.85	No Requirement	<=0.75**	>=80
	Residential (cooling zone)	1	No Requirement	No Requirement	No Requirement	<=0.65**	>=80

Note: Commercial Glass refers to all flat glass glazing and window products. including laminated glass. Commercial Plastic refers to exclusively plastic glazing products.

- Glass with visible light transmittance <30% should only be considered for daylighting applications in southern climates.

•• These shading coefficient levels are not necessarily applicable for passive solar applications.

1,2 - Number of Panes, Type of Coating

The first two columns of the chart help describe each product subcategory, listing the "Number of Panes" and "Type of Coating" (if any) for each glazing or window type included in the Guide. (Please note that the "Commercial Glass (1.1)" and "Commercial Window Units (1.2)" categories are combined.)

The remaining four columns indicate the performance levels required for each of the criteria used to screen and select products. ***Only products which meet or exceed these levels have been included in the Guide.***

3. "U-value - Winter Night"

The "U-value" of a construction component (e.g., wall, window, roof) measures how much heat is transferred across one square foot of that component during one hour when there is a 1°Fahrenheit temperature difference between the inside and outside air temperatures. In general, a higher U-value means higher heat loss, and U-value requirements in the U.S. are designed to reduce this loss. Because of this emphasis on heat loss reduction, "'Winter Night" values are used when specifying glazing and windows, and the *Guide* follows this convention.

Current methods for reducing heat loss across glazing include: increasing the number of panes, inserting films between panes, increasing the space between panes or films, substituting gases like Argon for air in the interpane space, and applying low-e coatings to glass panes or to films. By using combinations of these technologies, manufacturers are now able to offer glazed surfaces with R-values in excess of 6.

However, the heat transfer dynamics of windows and glazing/frame systems are considerably more complex than the heat transfer characteristics of single, homogeneous building materials like insulation. A double glazed window is made up of several materials and components including glass, frame and glazing spacers. The frame itself can be of a single material like wood, vinyl or metal. It can also he composed of multiple materials. An example is a thermally improved metal window with a frame comprised of metal and a plastic thermal break. These materials, their shape and the way they are connected to one another all have an effect on the thermal performance of the total window "assembly." Further, convection, the natural movement of air between panes of glass in a convective loop, adds additional complexity to the heat flow characteristics of window and glazing/frame systems.

For many years manufacturers used different methods for evaluating and advertising the thermal performance, or U-value, of window units. Some determined *center-of-glass* values while others tested or calculated for *total unit values* that accounted for the effects of glazing spacers and frames. This made it difficult for architects to compare window products from different manufacturers.

This lack of consistency was a result of disagreements about appropriate and practical methods for evaluating windows due to the complex nature of their thermodynamics. For example, the U-value of glazing is higher near the edge of the window than at center-of-glass. This means that, for the same glazing type, windows with a higher ratio between perimeter and glass area have higher U-values. A manufacturer might therefore have to assign a different U-value for virtually every window shape.

For a long time such obstacles prevented a unified approach to reporting U-values. However, with the advance of calculation methods, and thanks to industry associations like the National Fenestration Rating Council, a tremendous effort has been made to standardize methods for testing/calculating, rating, labeling and advertising thermal performance characteristics (especially U-value) of window products. The procedures require that the effects of framing and glazing spacers be considered. This is particularly important as higher performance glass products am developed and specified. As the U-value of the glass itself is lowered, the performance of glazing spacers and frames becomes more significant.

Guide U-value requirementsfor *windows* (residential and commercial) refer to the *"total unit,"* including all frame effects.

U-value requirements *for commercial glazing* products (glass and plastic) refer to the glazing only, without any spacer or frame effects. This is because, in commercial applications, fenestration is often assembled from separately purchased materials. Since glazing is marketed and purchased by itself, it is also rated separately. The U-value of the glazing must then be used by an architect or engineer in conjunction with the U-value of the mullions to derive the overall U-value of the assembly. Alternately, the fenestration fabricator can test the glazing/mullion assembly for its overall U-value. Since such tests are expensive, the architect still needs to select the glazing first and this can only be done by knowing the glazing U-value.

The maximum allowable values listed in the chart were developed by the *Guide's* panel of technical experts to represent high performance achievable in glazing and window systems currently on the market. Each listed value was also developed in relation to the other required performance criteria (i.e. visible light transmittance, shading coefficient and coolness index) for that particular product type.

Difference8 in the prescribed U-values - whether for total units or for glass alone - are primarily related to variations in climate and building load. We have recognized, for example, that glass with low-e coatings is usually selected where heating loads predominate, while glass with a reflective coating is usually selected where cooling loads are more significant In the former case a lower (better) U-value is desirable and has been prescribed. In the latter, a higher U-value has been allowed.

Products included *in the Guide* meet or exceed the U-value requirements listed.

4. Visible light Transmittance

Visible light or daylight transmittance is the percentage of light, in *the visible* portion of the spectrum, that is transmitted through a glass assembly. The higher the visible light transmittance the greater the amount of light admitted through the glazing. The *Guide* prescribes minimum levels of visible transmittance for commercial glazing to ensure adequate light and view are maintained.

It should be noted that while we have included glazing products with visible light transmittances as low as 2096, we recommend that glass with a transmittance less than 30% only be used in southerly climates where solar gain (cooling requirements) may outweigh daylighting requitements. In all other cases the glass products considered should have a visible light transmittance of 30% or more.

We did not prescribe a minimum visible light transmittance for residential windows. Usually daylighting is not a primary concern and typical visible light transmittance values for glass used in residential windows are perfectly adequate to provide appropriate light and view.

5. Shading Coefficient

Shading coefficient is defined as the ratio between the *solar heat* transmitted through a given glazing assembly and the solar heat transmitted through a single pane of clear, 1/8" thick sheet glass under certain standard temperature and windconditions. The lower the shading coefficient the smaller the transmittance of solar radiation or heat from exterior to interior.

In the past, products with low shading coefficients, like reflectively coated glass, also had low visible light transmittance values. While these products reduced solar heat gain and cooling loads, they also appeared "darker" when looking from the inside to the outside and could potentially place a greater demand on lighting.

Now glazing systems with the same shading coefficient may have markedly *different* visible light transmission values. An ideal glazing for internal load dominated commercial andinstitutional buildings (the majority) would transmit high levels of visible light but wouldtransmit lower levels of solar radiation. To achieve this objective, the visible light transmittance value should be maximized and the shading coefficient minimized. (Passive solar designs are an exception to this.)

The *Guide* has no prescribed Shading Coefficient levels for commercial glazings. However, it does prescribe minimum Coolness Index values (see below) which include Shading Coefficient and Visible Light Transmittance values.

For residential windows, in most climates, the U-value of the window is the most important energy characteristic. However, in southern climates a low shading coefficient, which reduces solar radiation transmittance (heat gain), is desirable. Therefore, *the Guide prescribes* maximum values for shading coefficient and minimum values for coolness index for residential windows in cooling zones. (please note that these shading coefficient values are not necessarily recommended for windows used in passive solar applications.)

Glass Type (1/4")	(A) Visible Transmittance	(B) Shading Coefficient	(C) Coolness Index (A/B)
Clear, uncoated	78 - 80	0.80 - 0.82	98
Low-e, clear	71 - 75	0.61 - 0.76	96 - 114
Reflective, clear	7 - 27	0.14 - 0.27	27-70
Tinted	44 - 68	0.51 - 0.59	75 - 158
Low-e, tinted	36 - 68	0.43 - 0.59	75 - 158

6. Coolness Index

To facilitate comparisons between glazing products, a single term, the *Coolness* Index, is employed. The Coolness Index is simply the ratio between the visible light transmittance and the shading coefficient of a glazing system. An ideal glazing product for most commercial and institutional projects would have a *high* coolness index, maximizing the visible light and minimizing the solarradiation transmitted. The Coolness Index is relatively less important for residential windows.

Two techniques are currently employed to improve (increase) the coolness index of glazing systems. One is to employ low-e coatings. The other is to use tinted glass. Many tints in the blue/green range improve the coolness index of glazing systems. Only a few tints in the rose, bronze and grey families have the same beneficial effect and most can have a negative impact, decreasing visible light transmittance more than the shading coefficient.

The table above exemplifies the effects of low-e coatings, reflective coatings and tinting on the daylight transmittance, shading coefficient and coolness index for a typical, double pane, ¼" thick, clear glazing system with a ½" air space between panes. Similar systems are widely used in commercial and institutional applications. The table presents ranges of daylight transmittance, shading coefficient and coolness index for commercially available products.

It is evident from the data in the table that reflective coatings are not appropriate for glazing used in daylighting strategies. While reflective glass has an excellent shading coefficient it also blocks out a large portion of the visible light. "Clear, uncoated" and" low-e, clear" glazing transmit high levels of visible light. However, they also transmit relatively high levels of solar heat. Such glazing may require shading devices to improve its overall thermal performance in certain applications. Finally, "tinted" and "1ow-e tinted" glazing offer a combination of high visible light transmission, above 30%, and a high coolness index, many above 100. Such products should be of primary consideration when selecting glazing for daylight applications.

The *Guide* prescribes minimum Coolness Index values for all product subcategories on the chart. These are the key values for measuring and comparing energy efficiency levels.

All products in the *Guide* meet or exceed these minimum Coolness Index levels.

MANUFACTURER'S AD PAGES

Each manufacturer's ad page provides descriptive information on up to5 individual products which the manufacturer has chosen to list under a specific category. As part of this information, the manufacturer is required to include a Product Data Form which provides specific technical information on the individual products listed on that page. The Form displays information for each of the four required performance categories: Winter Night U-Value, Visible Light Transmittance, Shading Coefficient and Coolness Index. These values must meet or exceed the required minimum and maximum (see earlier discussion) and can be used to compare one product to another.

In addition to the required performance data, each Product Data Form contains technical information intended to better describe the product to a potential specifier or user. This information is not exhaustive and should be supplemented by manufacturer's data The Product Data Form is intended to provide basic descriptive information on each product and to facilitate quick comparisons between products in the same category.

Product Data Form: Glazing and Windows

PRODUCT NAME	Number of Panes	Exterior Appear-ance	Clear or Tinted/ Location*	Suspended Film (Y or N)	Type/ Location of Coating**	U-Value		Visible Light			Solar Energy		Shading Co-efficient	Coolness Index % (Day. Trans./ Shad.Coeff.)	Relative Heat Gain
						Winter Night	Summer Day	Transmittance In (%)	Reflectance Out (%)	Reflectance In (%)	Transmittance In (%)	Reflectance Out (%)			

Note Commercial Glass refers to all flat glass glazing and window products, including laminated glass.
Commercial Plastic refers to exclusively plastic glazing products.

* Glass with visible light transmittance <30% should only be considered for daylighting applications in southern climates.
** These shading coefficient levels are not necessarily applicable for passive solar applications.

SAMPLE PRODUCT NAME: (GLAZING AND WINDOWS)

Sample Corporate Address
185 Tatum zzril
Milford Plains, NJ 00012
Phone: 200-800-3000

Sample Graphic

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Description/Applications

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Features/Advantages

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Codes/Standards/Certifications

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Installation

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Availability

Duis Autem Vel Sum
1122 Manor Ave.,
Feuga, MI 43000
North: 312-787-5813

Corporate Logo

PRODUCT NAME	# of Panes	Exterior Appearance	Clear or Tinted/ Location	Suspended Film (Y or N)	Type/ of Coating	U-Value Winter Night	U-Value Summer Day	Visible Light Transmittance In(%)	Visible Light Reflectance Out(%)	Visible Light Reflectance In (%)	Solar Energy Transmittance Out (%)	Solar Energy Reflectance Out (%)	Shading Co-efficient	Coolness Index % (Day. Trans./ Shad. Coeff.)	Relative Heat Gain
Glazing	2	Clear	C	N	N	0.48	0.45	80	15	15	65	11	0.8	97	173
Glazing b	2	Clear	C	N	E2	0.33	0.38	70	16	16	57	13	0.8	93	160
Glazing c	2	Tinted	T1	N	E2	0.33	0.38	60	15	15	33	8	0.5	125	104
Glazing d	1	Tinted	T1	N	E2	0.57	0.55	70	6	6	35	4	0.6	115	133
Glazing e	1	Tinted	T1	N	E2	0.57	0.55	70	7	7	3%	5	0.6	118	140

ELECTRONIC BALLASTS

This section of the *Guide* covers energy efficient electronic ballasts for fluorescent lamps. Because *the Guide* is designed as a "one-stop" resource for architects, only products and systems with superior energy performance characteristics have been identified. To ensure that the *Guide* meets this objective, a panel of energy experts established minimum performance requirements for each of the 5 product categories included under the "Electronic Ballasts" heading. *Only products that meet these minimum required performance levels and specifications have been included in the Guide.*

BACKGROUND

All fluorescent lamps require a *ballast* for operation. Ballasts serve two essential functions. They provide a high initial voltage to start the lamp and they regulate current to the lamp so that the lamp can realize its rated lumen output and lamp life. Because lamp manufacturers specify electrical input characteristics that ballast manufacturers must meet, each ballast is designed to operate a specific lamp type.

There are two distinct ballast technologies used today: magnetic andelectronic. Magnetic ballasts are the older technology. Although advances have been made in recent years to reduce the energy use of magnetic ballasts, in general their performance is inferior to electronic ballasts. An electronic ballast takes incoming power at 60 Hz, and converts it to high frequency current, allowing efficient conversion of input power to the power required by the lamp. Electronic ballasts also operate quieter than magnetic ballasts, and reduce the incidence of fluorescent lamp flicker. The *Guide* focuses exclusively on electronic ballasts.

Electronic ballasts are available in a wide range of configurations. These include:

Rapid Start Ballasts - preheat a lamp's electrodes prior to and during operation. Rapid start ballasts tend to use more energy as a result of this heating function. However, rapid start produces smooth starting and long lamp life.

Instant Start Ballasts - do not heat a lamp's electrodes. Rather, the ballasts provi& a relatively high voltage for starting the lamp. While these ballasts tend to use less energy it is usually at the expense of lamp life.

Two-Level Ballasts - with a switching &vice allow them to be used at full or half light output. Two-level ballasts may be used in conjunction with occupancy sensors, lumen maintenance and daylight controls.

Dimming Ballasts - Ballasts with the capability of allowing the light output of the lamp to be continuously controlled from 100% down to approximately 10%. Dimming ballasts are designed to be used in conjunction with manual dimmers, as well as automatic lumen maintenance and daylight controls.

Low (Partial) and High Output Ballasts - Low output ballasts have a ballast factor (see following discussion) less than 0.85. High output ballasts have a ballast factor greater than 1.0. These ballasts are used in special applications by lighting designers to tune light levels to specific site requirements and reduce energy requirements. Low output ballasts should be used to operate lamps in rapid start mode only.

PRODUCT PERFORMANCE REQUIREMENTS

Performance values for electronic ballasts only apply to specific lamp/ballast combinations. The *Guide* covers electronic ballasts designed to drive 5 types of fluorescent lamps:

2.1) Electronic Ballasts for Straight Tube T12 and T8 Fluorescent Lamps
2.2) Electronic Ballasts for U-tube and Twin Tube Fluorescent Lamps
2.3) Electronic Dimming Ballasts
2.4) Electronic Ballasts for Compact Fluorescent Lamps
2.5) Specialty Ballasts.

These represent products with the greatest potential for energy conservation.

The table below summarizes the required minimum performance levels for each of the "Electronic Ballast" product categories included in the *Guide*, focusing on efficacy (light output relative to energy input), quietness of operation, lamp flicker and the effects of ballasts on line current (an issue of great concern to utility companies). Each section of the table is described in the following discussions.

1. Compatible lamp Quantity/Type

Values are provided for specific lamp/ballast combinations, and the first column indicates the type and quantity of lamps under consideration in each specific row.

Product Performance Requirements: Electronic Ballasts

PRODUCT CATEGORY		1 Compatible Quantity/ Type	2 Ballast Factor	3 Ballast Efficacy Factor (BEF)	4 Sound Rating	5 Total Harmonic Distortion	6 Flicker Index (%)	7 Power Factor	8 Current Crest Factor	9 Lamp Ballast Efficacy (l/w)
(2.1) Electronic Ballasts for T12 and T8 Fluorescent Lamps	Electronic	(2)-F40T12	>=0.85	>=1.24	A	<=20%	<=5%	>=0.90	<=1.7	>=79.0
	Electronic	(2)-F34T12	>=0.85	>=1.46	A	<=20%	<=5%	>=0.90	<=1.7	>=81.5
	Electronic	(2)-F32T8	>=85	>=1.47	A	<=20%	<=5%	>=0.90	01.7	>=86.4
(2.2) Electronic Ballasts for U-tube and Twin Tube Fluorescent Lamps	Electronic	(2)-16" & 24" U & Twin Tube	>=0.85	>=1.24	A	<=20%	<=5%	>=0.90	<=1.7	>=79.0
	Electronic	(1)-16 & 24" U & Twin Tube	>=0.85	>=1.24	A	<=20%	<=5%	>=0.90	<=1.7	>=79.0
(2.3) Electronic Dimming Ballasts	Electronic Dimming	(2)-F40T12	>=0.85 @ 100% >=0.15 @ 20%	N/A	A	<=20%	<=5%	>=0.90	<=1.7	>=80.0
	Electronic Dimming	(2)-F32T8	>=0.85 @ 100% >=0.15 @ 20%	N/A	A	<=20%	<=5%	>=0.90	<=1.7	>=83.0
(2.4) Electronic Ballasts for Compact-Fluorescent Lamps	Electronic or HPF Reactor	Compact Fluorescent* Preheat	>=0.85	N/A	A	<=33%	<=5%	>=0.90	<=1.7	>=60.0
	Electronic or HPF Reactor (super low heat-rise)	Compact Fluorescent* Rapid Start	>=0.85	N/A	A	<=33%	<=5%	>=0.90	<=1.7	>=60.0
	Electronic or HPF Reactor	Compact Fluorescent* Rapid/Instant Start	>=0.85	N/A	A	<=33%	<=5%	>=0.90	<=1.7	>=60.0
(2.5) Specialty Ballasts	Low (Partial) Output	(2)-F32T8	<0.85	N/A	A	<=20%	<=5%	>=0.90	<=1.7	>=83.0
	High Output	(2)-F32T8	>1.00	N/A	A	<=20%	<=5%	>=0.90	<=1.7	>=83.0

* Lamps that do not contain integral starters.

2. Ballast Factor

Ballast Factor is the ratio of a lamp's light output when operated with the subject ballast compared to the rated output when operated with a reference ballast. Ballast factor is *not* a measure of energy efficacy but rather a factor used to adjust the nominal output of a lamp to the actual lumen output of a specific lamp/ballast combination. The *Guide* requires relatively high Ballast Factor levels to ensure that full-light products are specified.

3. Ballast Efficacy Factor

Ballast efficacy factor is an efficiency measure derived by multiplying the ballast factor by 100 and dividing by the measured input power in watts.

$$\text{Ballast Efficacy Factor} = \frac{\text{Ballast Factor (\%)}}{\text{Input watts to Lamp/Ballast}}$$

Ballast efficacy factor is used as a performance criteria in federal and state regulations. However, it is only useful for comparing different ballasts operating the same quantity and type of lamp. It should *not* be used as an absolute measure of energy efficiency.

The *Guide* has established minimum Ballast Efficacy Factors for T12, T8, U-tube and Twin-tube lamp/ballast combinations to ensure high levels of system efficacy for these specific combinations. Such factors are not applicable to Dimming, Compact Fluorescent and Specialty Ballasts.

4. Sound Rating

Audible noise is measured by a factor called *sound rating.* Sound rating is a relative measure of a ballast's sound output, rated "A" through "D". with "A" being quietest. All electronic ballasts should be "A" rated.

$$\text{Lamp Ballast Efficacy} = \frac{\text{Rated Lamp Lumens x No. of Lamps x Ballast Factor}}{\text{Input Power to Ballast}}$$

or

$$= \frac{\text{Ballast Efficacy Factor x Rated Lamp Lumens x No. of Lamps}}{100}$$

5. Total Harmonic Distortion

Total harmonic distortion is a factor, expressed as a *percentage,* that shows the effect of a ballast's 'harmonics" on line current (amperage). Fluorescent ballasts, both magnetic and electronic, affect current rather than input voltage and, in the process, generate current harmonics. Total harmonic distortion is a measure of the amplitude of these harmonics. Significant levels of harmonic distortion can adversely affect the performance of certain types of electrical equipment. Many electronic ballasts can achieve total harmonic distortion levels of 205% or less (33% or less for compact fluorescent ballasts), and these are the maximum values prescribed in the *Guide.* Additional research is being conducted to evaluate the real impact of current harmonics. Until this research is completed, conservative harmonic distortion levels specified by the *Guide* or by utility companies should be followed.

6. Flicker Index

Fluorescent lamps "flicker" as a result of the frequency of the operating current. The measure of lamp flicker is the *flicker index.* Magnetic ballasts operate at the frequency of the line current (60Hz). Flicker produced by magnetic ballasts may cause eye strain and headaches. Electronic ballasts convert line current and operate fluorescent lamps at much higher frequencies. virtually eliminating the problems associated with lamp flicker. Electronic ballasts should have a flicker index of 5% or less. Flicker does *not* refer to the start-up flicker that occurs with certain fluorescent lamp/ballast systems.

7. Power Factor

Power factor is a ratio of power (watts) to the root mean square volt-amps of the ballast. Put simply, it is a measure of the amount of current and voltage a utility must supply compared to the power that a customer actually uses.

The power factor can be used to determine how efficiently total input power is being utilized It is of particular concern to utilities who may penalize customers whose electric load has a low power factor.

Electronic ballasts should have a power factor of 0.90 or more and this is the minimum value required by the *Guide.*

8. Current Crest Factor

Current crestfactor is a ratio of peak lamp current to the root mean square lamp current. Ballasts with a high current crest factor will reduce lamp life. The *Guide* requires current crest factors of 1.7 or less.

$$\text{Power Factor} = \frac{\text{Power (watts)}}{\text{RMS Current (amps) X RMS Voltage (volts)}}$$

9. Lamp/Ballast Efficacy

Lamp/Ballast (system) Efficacy is the ratio of lamp light output to ballast input watts. The efficacy of a ballast changes with the type of lamp it operates and lamp efficacy changes with the type of ballast driving it, The lamp/ballast efficacy provides the *only* means for directly comparing different lamp/ballast systems.

The minimum Lamp/Ballast Efficacy values prescribed in the chart are specific for each ballast/lamp category included in the *Guide.*

MANUFACTURER'S AD PAGES

Each manufacturer's ad page provides descriptive information on up to 5 individual products which the manufacturer has chosen to list under a specific product category. As part of this information, the manufacturer is required to include a Product Data Form which provides specific technical information on the individual products listed on that page. The Form displays information for each of the eight required performance categories: Ballast Factor, Ballast Efficacy Factor, Sound Rating, Total Harmonic Distortion, Flicker Index, Power Factor, Current Crest Factor and Lamp/Ballast Efficacy. These values can be compared against the required minimum and maximum (see earlier discussion) and can be used to compare one product to another.

In addition to the required performance data, each Product Data Form contains technical information intended to better describe the product to a potential specifier or user. This information is not exhaustive and should be supplemented by manufacturer's data. It is intended to provide basic descriptive information on each product and to facilitate quick comparisons between products in the same category.

Product Data Form: Electronic Ballasts

PRODUCT NAME	Compatible Lamp Quantity/ Type	Nominal Lamp Watts (Ea)	Input Watts	Ballast Factor	Ballast Efficacy Factor (BEF)	Rapid Start or Instant Start	Sound Rating	Total Harmonic Distortion (%)	Flicker Index (%)	Power Factor	Current Crest Factor	Lamp/ Ballast Efficacy (l/w)

Ballasts are to be compatible with 120 & 277 voltages.
Ballasts and related hardware shall withstand line transients as defined in IEEE publication 587, category A.
Ballasts shall be Class P thermal protected.
Ballasts for indoor use shall start lamps at a starting temperature of 50 degrees Fahrenheit.
Ballasts for outdoor applications shall be Type I outdoor rated.
Ballasts shall be warranted for 3 years and have a replacement labor allowance of $10.00.
Electronic dimming ballasts shall dim smoothly and continuously from 100% to 20% or less of full light output.
Ballasts shall not contain polychlorinated biphenyls (PCBs.)
Power factor correction is an acceptable option for reactor ballasts.

SAMPLE PRODUCT NAME: (ELECTRONIC BALLASTS)

Sample Corporate Address
185 Tatum zzril
Milford Plains, NJ 00012
Phone: 200-800-3000

Sample Graphic

Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet.

Description/Applications

The Lorem Ipsum work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post- modernity have subjected to critique, with precisely that.

Features/Advantages

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Codes/Standards/Certifications

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Installation

Prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique.

Availability

Duis Autem Vel Sum
1122 Manor Ave.,
Feuga, MI 43000
North: 312-787-5813

Corporate Logo

PRODUCT NAME	Compatible Lamp Quantity/Type	Nominal Lamp Watts (Ea)	Input Watts	Ballast Factor	Ballast Efficacy Factor (BEF)	Rapid Start or Instant Start	Sound Rating	Total Harmonic Distortion (%)	Flicker Index (%)	Power Factor	Current Crest Factor	Lamp/ Ballast Efficacy (l/w)
Ballast a	(2)-F40T12	200	75	0.91	1.24	R	A	19	4	1.0	1.6	81
Ballast b	(2)-F40T12	200	75	0.92	1.25	R	A	18	4	1.0	1.6	81
Ballast c	(2)-F40T12	200	75	0.93	1.31	R	A	19	4	1.0	1.5	82
Ballast d	(2)-F40T12	200	75	0.91	1.24	I	A	18	3	.94	1.6	82
Ballast e	(2)-F40T12	200	75	0.92	1.24	I	A	17	4	1.0	1.4	81

FLUORESCENT LAMPS

This section of the *Guide* covers energy efficient fluorescent lamps. Because the *Guide* is designed as a "one-stop" resource for architects, only products and systems with superior **energy performance characteristics** have been identified. To ensure that the *Guide* meets this objective, a panel of energy experts established minimum performance requirements for each of the 3 product categories included under the "Fluorescent Lamps" heading. ***Only products that meet these minimum required performance levels and specifications have been included in the Guide.***

BACKGROUND

One third to one half of all electricity consumed in modem commercial buildings is used for lighting. A typical new office building uses about 4 kWh/ft^2 per year for lighting and another 0.7 kWh/ft^2 per year for air conditioning to remove the excess heat produced by that lighting. Lighting represents the most significant area for energy conservation in modem commercial and institutional design.

In recent years significant improvements have been made in the energy efficiency and color rendition of fluorescent lamps. With these improvements have come new products, like compact fluorescent lamps, allowing energy efficient fluorescent lighting to be used in place of incandescent lighting in certain applications.

In order to achieve energy efficient design it is necessary to develop an understanding of the technologies and individual products that make up modem lighting installations. Essentially, fluorescent lighting is made up of four components; lamps, ballasts, luminaires and controls. This issue of *the Guide* deals with all components except luminaires. At the time of publication members of the lighting industry were developing methods for evaluating and rating luminaires. When these standards are finalized, luminaires will be added to the products covered by a subsequent edition of *the Guide.*

Fluorescent lamps are made up of glass tubes, straight or bent, covered with phosphor. The tubes are filled with a gas and sealed with a drop of liquid mercury. At the ends of the tube are electrodes, usually made of a strand of tungsten filament. A ballast is required to regulate the electric current passing through the lamp. (Ballasts are described in an earlier section.)

Two recent technical advances are responsible for improvements in the energy efficiency of fluorescent lamps (exclusive of changes in ballast technology which was coveted earlier). The first is the use of rare earth phosphors in place of traditional halophosphors. Rare earth phosphors can increase a lamp's light output by as much as 8%. The second is the growing popularity of smaller diameter lamps like T8 (1" diameter) in place of traditional T12(1½" diameter). A two lamp F32T8 system using an energy-saving magnetic ballast has an efficacy (efficiency) of 78 lumens/watt compared to 68 lumens/watt for a two lamp F40T12. Using an instant start electronic ballast can boost the system's efficacy to as much as 90 lumens/watt.

Compact fluorescent lamps, another recent innovation. are comprised of a small fluorescent lamp, a lamp holder and, in integral systems, a built-in ballast. Compact fluorescent lamps are designed to replace incandescent lamps, and use approximately 1/3 the energy for equivalent light output, lasting roughly 10 times as long. They also have excellent color rendering properties. Presently, compact fluorescent lamps are available in a wide variety of configurations and wattages.

PRODUCT PERFORMANCE REQUIREMENTS

The table below summarizes the required minimum performance levels for each of the "'Fluorescent Lamps" product catego-***ries*** included **in the *Guide:***

3.1) T12 and T8 Straight Tube Fluorescent Lamps
3.2) T12, T8 and T5 U-Tube and Twin Tube Fluorescent Lamps
3.3) Compact Fluorescent Lamps

It is important to understand that the energy performance of fluorescent lamps is closely linked to and interacts with the ballast driving the lamp(s). When designing the lighting system, lamps and ballasts must be carefully selected to match the performancecharacteristics of each other. Failure to do so could result in lighting malfunction and/or unrealized performance goals. (Please refer to the "Electronic Ballast" section of the *Guide* for further information.)

This edition of the *Guide* focuses on three fluorescent lamp types; straight tube (conventional), U-tube/twin tube and compact fluorescent. The specific lamp types selected are those with the best potential energy performance. That is, the most light output for the least energy input.

Performance criteria focus on energy (lumen output vs. watt input), color quality, light output over time (lumen depreciation) and lamp life. *Products must meet or exceed these criteria to be included in the Guide.*

Each section of the summary table is described in mom detail in the following discussions.

1,2,3 - Nominal Wattage, Initial Lamp lumens, Nominal length

The first three columns provide basic descriptive information on each product subcategory: nominal wattage, initial lamp

Product Performance Requirements: Fluorescent Lamps

PRODUCT CATEGORY		1 Nominal Wattage	2 Initial Lamp Lumens	3 Nominal Length	4 Color Rendering Index	5 Lamp Lumen Depreciation (%)		6 Rated Lamp Life (Hours)**		7 Lamp Mortality (@ 70% Life)
						40% Rated Life	70% Rated Life	Rapid Start	Instant Start	
(3.1) T12 and T8 Straight Tube Fluorescent Lamps	T12-48"	34W	2800	48"	>=69	>=88%	>=82%	20.000	N/A	<=10%
	T12-48"	4OW	3200	48"	>=69	>=88%	>=82.5%	20,000	N/A	<=10%
	T8-48"	32W	2850	48"	>=75	>=90%	>=84%	20,000	15.000	<=l0%
(3.2) T12, T8 and TS U-lube and Twin Tube Fluorescent Lamps	Tl2 U-tube	4OW	3050	,24"	>=69	>=87%	>=81%	12.000	N/A	<=l0%
	T8 U-tube	24W	2050	24"	>=69	>=87%	>=81%	20,000	15,000	<=10%
	T8 U-tube	31W	2800	24	>=75	>=90%	>=84%	20.000	15.000	<=l0%
	T5 twin-tube	39W	2850	16"	>=69	>=90%	>=84%	12.000	9.000	<=12%
	T5 twin-tube	4OW	3150	22	>=69	>=88%	>=82.5%	20.000	15.000	<=12%
	T5 twin-tube	55w	4800	22"	>=69	>=88%	>=82.5%	20,000	15,000	<=12%
(3.3) Compact Fluorescent Lamps	Compact Fluorescent* T4 & T5 twin-tube	All wattages	Varies	N/A	>=79	>=90%	>=81%	10,000	7,500	<=l2%
	Compact Fluorescent* T4 & T5 quad-tube	All Wattages	Varies	N/A	>=79	>=90%	>=81%	10.000	7,500	<=12%

* Includes integral or modular, screwbase lamp/ballast assemblies and lamps intended for dedicated CF luminaires.
** Ratings based on 3 hour per start operation.

lumen output at the rated wattage, and nominal length.

Because most fluorescent lamps generate less light on a commercial ballast than on the laboratory reference ballast used to establish the lumen ratings in the manufacturer's tables, the rated lumen output values must be adjusted using a *ballast factor* to determine the actual lamp output. *Guide* values for *wattage* (energy input per lamp) and *initial lamp lumens* (light output per lamp) are therefore nominal, not actual. In-situ performance values will vary depending on the particular ballast and system configuration utilized. (See *Guide* section on Electronic Ballasts.) The use of nominal values conforms to standard industry practice for selecting and specifying lamps.

The remaining six columns of the chart indicate the performance levels which each product type must meet or exceed to be included in the *Guide.* The meaning and derivation of these performance requirements am described in more detail in the following paragraphs.

4. Color Rendering Index

Color rendering index is defined as a measure of the degree of color shift objects undergo when illuminated by the subject light source as compared to the color of those same objects when illuminated by a reference light source of comparable color temperature. A color rendering index of 100 represents the reference condition. The greater (closer to 100) the color rendering index, the closer the subject lamp comes to matching colors illuminated by a reference lamp of the same color temperature.

The prescribed values listed in the performance requirements chart represent high, but achievable, color rendering indexes for the lamps in question. These values will assure that color quality is not sacrificed while achieving energy efficacy.

$$\text{Lamp Lumen Depreciation} = \frac{\text{Lamp Lumen Output (at 40\% or 70\% of rated lamp life)}}{\text{Initial Lamp Lumen Output}}$$

5. Lamp lumen Depreciation

Lamp lumen depreciation is the ratio of the initial lamp lumen output to the lamp lumen output measured after a percentage of the rated lamp life. Simply stated it is a measure of a lamp's reduced light output over time. Lamp lumen depreciation values are given at 40% and 70% of the rated lamp life.

The chart prescribes minimum values of lamp lumen depreciation (at 40% and 70% of rated life) for each lamp. Products which meet or exceed these levels will maintain satisfactory levels of light output over the life of the lamp, thereby ensuring that both energy savings and lighting quality are maintained.

6. Rated lamp life

Rated lamp life values are given for both rapid start and instant start lamps based on 3-hour per start operation. Rapid start lamps have ballasts that preheat the electrodes prior to starting and during operation. While this feature uses somewhat mom energy, it produces a lamp with a smooth start and long lamp life. These are the only lamps suitable for dimming applications. Instant start lamps do not require the ballast to preheat the electrodes. These lamps tend to use less energy, often at the expense of lamp life.

The chart prescribes high but achievable minimum rated lamp life values for each of the product types listed.

7. Lamp Mortality

Lamp mortality is defined as the percentage of lamps that are burned out at 70% of the rated lamp life. The chart prescribes maximum Lamp Mortality percentages for each lamp type to ensure that lamps included in the *Guide* are high quality and durable as well as energy efficient.

MANUFACTURER'S AD PAGES

Each manufacturer's ad page provides descriptive information on up to 5 individual products which the manufacturer has chosen to list under a specific product category. As part of this information, the manufacturer is required to include a Product Data Form which provides specific technical information on the individual products listed on that page. The Form displays information for each of the four required performance categories for Fluorescent Lamps: Color Rendering Index, Lamp Lumen Depreciation, Rated Lamp Life, and Lamp Mortality. These values must meet or exceed the required minima and maxima established by the *Guide* (see discussion above) and can be used to compare one product to another.

In addition to the required performance data, each Product Data Form contains technical information (eg. "Base Type" and "Color Temperature") intended to better describe the product to a potential specifier or user. This information is not exhaustive and should be supplemented by manufacturer's data. It is intended to provide basic descriptive information on each lamp and to facilitate quick comparisons between lamps in the same category.

Product Data Form: Fluorescent lamps

PRODUCT NAME	Nominal Wattage	Initial Lamp Lumens	Nominal Length	Base Type	Color Temperature (K)**	Color Rendering Index	Lamp Lumen Depreciation (%)		Rated Lamp Life (Hours)*		Lamp Mortality (@ 70% Life)
							40% Rated Life	70% Rated Life	Rapid Start	Instant Start	

* Ratings based on 3 hour per start operation.

** Color Temperature (CT) is defined as: The measure of a lamp's "warmth" or "coolness" in appearance.
A "Cl"' below 3000K (yellow-red) is considered "warm" (warm white @ 3000K). A "CT" above 4000K (bluish) is considered "cool" (coolwhite @ 4100K).

SAMPLE PRODUCT NAME: (FLUORESCENT LAMPS)

Sample Corporate Address
185 Tatum zzriI
Milford Plains, NJ 00012
Phone: 200-800-3000

Sample Graphic

Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod incidunt ut loareet.

Description/Applications

The Lorem Ipsum and later works, the architectural project may be understood as the transformation of a form of construction ready-made by these projects are, as Mies said, and later works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, architectural project may be understood as the transformation of construction.

Features/Advantages

And later works, the architectural project may be understood as the transformation of a form of construction ready-made by these projects are, as Mies said, and later works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces

Codes/Standards/Certifications

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Installation

Work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, prescriptive rationality that theorists of post-modernity have subjected to critique.

Availability

Duis Autem Vel Sum
1122 Manor Ave.,
Feuga, MI 43000
North: 312-787-5813

Corporate Logo

PRODUCT NAME	Nominal Wattage	Initial Lamp Lumens	Nominal Length	Base Type	Color Temperature (K)	Color Rendering Index	Lamp Lumen Depreciation (%)		Rated Lamp Life (Hours)		Lamp Mortality (@ 70% Life)
							40% Rated Life	70% Rated Life	Rapid Start	Instant Start	
Compact Fluorescent a	50	4800	24"	Single-Pin	3000	80	95	85	10.000	7,500	10
Compact Fluorescent b	50	4800	24"	Single-Pin	3000	80	95	85	10.000	7,500	10
Compact Fluorescent c	50	4800	24"	Single-Pin	3000	80	95	85	10,000	7,500	10
Compact Fluorescent d	50	4800	24"	Bi-Pin	3000	80	95	85	10,000	7,500	10
Compact Fluorescent e	50	4800	24"	Bi-Pin	3000	80	95	85	10,000	7,500	10

LIGHTING CONTROLS (OCCUPANCY SENSORS)

This section of the *Guide* covers one type of lighting control product: occupancy sensors. It is anticipated that additional control types, specifically lumen maintenance and daylight controls, will be added to future editions of the *Guide.* Because controls, when properly used and maintained, inherently exhibit superior energy performance, the *Guide* does not establish minimum performance requirements for occupancy sensors with respect to energy conservation. Rather, the *Guide* prescribes certain general performance specifications to ensure that only high quality sensors are selected. *Only products that meet or exceed these minimum performance specifications have been included in the Guide.*

BACKGROUND

Occupancy sensors are devices that detect motion and automatically turn off light fixtures when motion is not detected for a pm-set period of time. Occupancy sensors are most effective in spaces where occupancy is intermittent, such as individual offices, conference areas, hallways or bathrooms. They are not effective in spaces with nearly constant occupancy during predictable periods of the day, like lobbies, reception areas or open office spaces.

Typically an occupancy sensor consists of four components: a motion detector, electronic control unit, relay and power supply. The *motion detector* senses motion and sends a signal to the control unit. The *control unit* processes the input signal to either keep closed or open the relay that sends power to the lights.

There are two basic types of occupancy sensors: ceiling-mounted and wallbox. As the names imply, a ceiling-mounted unit locates the detector on the ceiling, in the center of the room, and the wallbox unit locates the detector on a wall at switch height. In ceiling-mounted sensors the motion detector is typically housed in one unit and the relay and power supply are housed in another. In wall-mounted sensors, system components are usually all housed in a single package designed to fit in a typical switch box.

Wallbox sensors are designed for smaller spaces like individual offices. The detectors are designed to cover a smaller area and the relay is designed to operate a single light circuit with a relatively small connected lighting load. Ceiling mounted sensors are used in larger spaces with relatively large lighting loads. They can also be used, in conjunction with appropriate relay systems, to control multiple lighting circuits.

Two technologies are used for the motion detecting component of sensors: passive infrared and ultrasonic. *Passive infrared* units are designed to react to the infrared heat energy emitted by people. The coverage pattern of passive infrared sensors is fan shaped with gaps between cones of "vision." These coverage gaps widen and the sensitivity of this type of detector decreases as the distance from the detector head increases. *Ultrasonic sensors are* designed to detect changes in the frequency of reflected ultrasonic waves emitted by the unit. Ultrasonic sensors can be more expensive but provide a greater coverage area, eliminating blind spots or gaps. On the other hand, this increased sensitivity makes these units more susceptible to false readings from non-occupant movement, like breezes and air movement from HVAC systems.

Today, occupant sensors are available that combine both passive infrared and ultrasonic technologies in a single unit. Manufacturers of these units claim improved operation and reduced number of false readings. However, such improvements come at an increased cost.

PRODUCT PERFORMANCE SPECIFICATIONS

In order to be included in the *Guide,* occupancy sensors must meet or exceed certain basic performance specifications. These specifications relate to mode of operation, features to be included, installation and safety issues. The requited specifications are summarized below.

The following will provide additional information about some of the terms that appear in the specifications.

Sensitivity refers to the degree to which a sensor can detect motion in space. A *sensitivity adjustment* control should be provided, allowing a trained installer to fine-tune the occupancy sensor in order to minimize the number of false readings. It should be noted that reducing sensitivity also reduces coverage area, the area (square footage) effectively monitored by the detector.

Coverage pattern is the geometric shape that an occupancy sensor "sees". This shape is especially critical with passive infrared sensors, which should come equipped with *field-adjustable* masks to set the pattern of detection to match the room configuration. Failure to do so may result in "blind spots" where the sensor is not able to see certain areas in the space to be monitored.

Time delay is the amount of time required, where no motion is detected, before the relay turns off the light circuit. Relays must be equipped with a ***delay adjustment*** control to permit setting of the time delay. The time delay should be set to prevent frequent cycling of the light circuit (when occupants leave and reenter a space relatively quickly) which is both disturbing to occupants anddetrimental to lamp life. Specific occupancy patterns dictate appropriate time delay settings.

Manual-on/automatic-off refers to the mode in which the sensor operates. In manual-on/automatic-off mode the occupant is required to manually turn on the

CEILING-MOUNTED OCCUPANT SENSORS

Unit to be U.L. listed for (120)(277) VAC operation.
Acceptable detectors: Passive infrared (PIR), ultrasonic (US) and combination infrared/ultrasonic (PIR/US).
Detector head to include LED positive detection indicator.
Detector head to include relay adjustment from 30 seconds to 30 minutes.
Detector head to include sensitivity adjustment.
Detector head to have setup bypass switch.
Manual-on activation to be performed by wall switch.
Input rating (120)(277) VAC. Contacts rated (6)(20) amps.
Low-voltage wiring between devices to be multi-conductor, plenum rated.
Sensors and control units to be supplied with teflon leads to comply with NE and UL codes for plenum ceilings.
Sensors located in daylighted spaces arc required to be turned on manually (manual-on function). A wall switch (momentary contact or other type) shall be included to control the manual-on function. The device shall switch off lights automatically (auto-off function). A manual-off function may be included but shall not override the auto-off function as the default mode.
In the event of device failure, circuit shall be designed to fail with lights on.
Ultrasonic devices to comply with Section 119(d) of California's *Energy Efficiency Standards for Residential and Nonresidential Buildings* and FDA reporting requirements under 21 Code of Federal Regulations, Section 1002.10,1990.
Infrared detector must contain field-adjustable mask to set pattern of detection to match room configuration.

WALLBOX OCCUPANT SENSORS

Power supply, relay and sensor/controller unit to be U.L. listed for (120)(277)(240) VAC operation.
Acceptable detectors: Passive infrared (PIR), ultrasonic (US) and combination passive infrared/ultrasonic (PIR/US).
Device to include LED positive detection indicator or equal.
Device to include &lay adjustment under cover switch from 30 seconds to 15 minutes.
Manual-on activation to be performed by switch on cover.
Ultrasonic devices to include sensitivity adjustment.
Sensors located in daylighted spaces arc required to be turned on manually (manual-on function). A wall switch (momentary contact or other type) shall be included to control the manual-on function. The device shall switch off lights automatically (auto-off function). A manual-off function may be included but shall not override the auto-off function as the &fault mode.
In the event of device failure, circuit shall be designed to fail with lights on.
Ultrasonic devices to comply with Section 119(d) of California's *Energy Efficiency Standards for Residential and Nonresidential Buildings* and FDA reporting requirements under 21 Code of Federal Regulations, Section 1002.10,1990.

light circuit with a wall switch. The sensor automatically switches off the light circuit if no movement is detected after a pm-set period of time. A manual-off setting may be included in spaces where daylight is available, or to accommodate functions like video or slide presentation that require lights to remain off at times when a space is occupied. However, automatic-off should be the primary operating mode.

MANUFACTURER'S AD PAGES

Each manufacturer's ad page provides descriptive information for up to five individual sensor products the manufacturer has chosen to list under the "occupancy sensor" category. As part of this information, the manufacturer is required to include a Product Data Form which provides specific technical information on the individual products listed on that page.

The Form covers some of the required specifications information, together with additional technical data to better describe the product to a potential specifier or user. The information is not exhaustive and should be supplemented by manufacturer's literature. It is intended to provide basic descriptive information on each sensor and to facilitate quick comparisons between sensors in the same product category.

Product Data Form: Occupancy Sensors

PRODUCT NAME	Type*	Location of Detector**	Coverage Area (sq. ft.)	Maximum Load (watts)		Operating Mode(s) ***	Time Delay Range (sec./min.)	Audible Alarm (Y or N)	Masking Labels (Y or N)
				@ 120V	@ 277V				

* Passive Wired (PIR), ultrasonic (US) or combination (PIR/US).
** Ceiling-mounted (CM) or wallbox (WB).
*** Always off mode (OFF), always on mode (ON) and/or automatic mode (AUTO).

SAMPLE PRODUCT NAME: (CONTROLS)

Sample Corporate Address
185 Tatum zzril
Milford Plains, NJ 00012
Phone: 200-800-3000

Sample Graphic

Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet.

Description/Applications

The Lorem Ipsum and later works, the architectural project may be understood as the transformation of a form of construction ready-made by these projects am, as Mies said, and later works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, architectural project may be understood as the transformation of construction.

Features/Advantages

And later works, the architectural project may be understood as the transformation of a form of construction ready-made by these projects are. as Mies said, and later works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces

Codes/Standards/Certifications

Later works, the architectural project may be understood as the transformation of a form of construction ready-made by these projects are, as Mies said, and later works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, the architectural project may be understood as the transformation of a form of construction ready-made by the forces works, the architectural project may be understood as the transformation of a form.

Installation

Work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, I work was complicit with precisely that prescriptive rationality that theorists of post-modernity have subjected to critique, prescriptive rationality that theorists of post-modernity have subjected to critique.

Availability

Duis Autem Vel Sum
1122 Manor Ave.,
Feuga, MI 43000
North: 312-787-5813

Corporate Logo

PRODUCT NAME	Type	Location of Detector	Coverage Area (sq. ft.)	Maximum Load (watts) @ 120V	@277V	Operating Mode(s)	Time Delay Range (sec./min.)	Audible Alarm (T or N)	Labels (Y or N)
Control a	PIR	CM	50	2400	4155	ON	20 sec./min.	Y	Y
Control b	PIR	CM	50	2400	4155	ON	20 sec./min.	Y	Y
Control c	PIR	CM	50	2400	4155	ON	20 sec./min.	Y	Y
Control d	PIR/US	WB	50	2400	4155	AUTO	20 sec./min.	Y	Y
Control e	PIR/US	WB	50	2400	4155	AUTO	20 sec./min.	Y	Y