LE 5

Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaires

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NEMA Standards Publication LE 5-2001

Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaires

Published by

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FOREWORD

This standards publication was developed to assist the federal government, state governments, electrical utility companies, and manufacturers of lighting fixtures in performing a standardized test method for determining the luminaire efficacy rating of fluorescent lighting fixtures incorporating various shielding media and various types of applicable lamps and ballasts.

This standards publication was prompted by the need of the lighting fixture manufacturing industry to have a uniform method of determining energy efficiency of their products using various components.

It is not the intent of this standards publication to inhibit luminaire design or to impose arbitrary tolerances on any luminaire manufacturer.

Even though the recommendations for regulations in Appendix A take into consideration in part lighting quality through incorporation of visual comfort probability, the International Association of Lighting Designers and the Illuminating Engineering Society of North America desire to include in the future an additional numerical value for lighting quality to accompany the luminaire efficacy rating value. This numerical expression for lighting quality has not yet been fully developed.

The Luminaire Section accomplished the preparation of this standards publication in close cooperation with the Lamp and Ballast Sections of the NEMA Lighting Systems Division. Input from users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the Luminaire Section of NEMA by contacting:

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This standards publication was developed by the Luminaire Section. Section approval of the standard does not necessarily imply that all section members voted for its approval or participated in its development. At the time it was approved, the group/section was composed of the following members:

American Electric Lighting
Cooper Lighting Group
EGS Electrical Group
GE Lighting Systems
Genlyte Thomas Group
Hubbell, Incorporated
Holophane Corporation
Indy Lighting Incorporated
Juno Lighting, Incorporated
Lighting Corporation of America
Lithonia Lighting Group
Red Dot Division, L.E. Mason
Simkar Corporation
Steel Craft Industries
The Jones Metal Products Company

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PURPOSE

The purpose of this standards publication is to:

a. Provide governmental agencies with a practical and uniform method for calculating a metric for regulating the "energy efficiency" of fluorescent luminaires.

b. Provide electrical utility companies with a method to establish minimum luminaire efficacy ratings for use with energy savings rebate programs.

c. Provide a LER methodology for fluorescent luminaires that is applicable to all lamp/ballast systems, thus providing a tool for promoting energy efficient luminaires to the lighting engineering and design community.

d. Create a workable and realistic number of fluorescent luminaire types for regulating "energy efficiency."

e. Organize the types of luminaires into categories that will reasonably represent the design function, physical and dimensional attributes, and the photometric characteristics of the various types of high volume luminaires.

f. Preserve for the lighting fixture manufacturers and the lighting industry the right to use laboratory facilities, testing methods, and completed test data that currently exist and are in accordance with approved industry standards.

g. Establish a luminaire efficacy rating (LER) based on rated lumens per watt, in lieu of a standard based solely on either coefficients of utilization or luminaire efficiency. The word rated is used so as not to require the use of absolute photometry and to be able to use published rated lumen values. LER is calculated using actual test values of both ballast factor and total input watts to establish the rated efficacy of the luminaire (LER is given in rated lumens per watt).

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Section 1
GENERAL

1.1 SCOPE

This standards publication provides a procedure for the determination of the luminaire efficacy rating of commercial and industrial fluorescent luminaires under laboratory test conditions.

This standard describes five types of fluorescent, high-volume luminaires. Each luminaire type is classified into subcategories that, in combination, represent better than 80% of the fluorescent luminaire market in the United States.

This standard does not apply to compact fluorescent down-lights, low volume or specialty luminaires, i.e. security luminaires.

1.2 REFERENCED PUBLICATIONS

The following publications are adopted in whole or in part as indicated by reference in this standards publication.

American National Standards Institute (ANSI)
11 West 42nd Street, 13th Floor
New York, NY 10036

ANSI C82.2-1984 (R 1989)	*Methods of Measurement of Fluorescent Lamp Ballasts*
ANSI C82.3-1983 (R 1989)	*Specifications for Fluorescent Lamp Reference Ballasts*
ANSI C78.1-1991	*Dimensional and Electrical Characteristics of Rapid Start Type Fluorescent Lamps*
ANSI C78.3-1991	*Fluorescent Lamps—Instant-start and Cold Cathode Types—Dimensional and Electrical Characteristics*
ANSI C78.375-1991	*Fluorescent Lamps—Guide for Electrical Measurements*
ANSI/IEEE 100-1992	*IEEE Standard Dictionary of Electrical and Electronics Terms*

Illuminating Engineering Society of North America (IESNA)
120 Wall Street, FL. 17
New York, NY 10005-4001

IESNA	*Lighting Handbook - 8th Edition*
IESNA LM 41-1985	*Approved Method for Photometric Testing of Indoor Fluorescent Luminaires*

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1.3 DEFINITIONS

ballast: An auxiliary device used with an electrical discharge lamp(s) to obtain the necessary circuit conditions (voltage, current, and wave form) for the proper starting and operation of a particular fluorescent lamp(s) from a particular line voltage and frequency.

ballast factor (BF): The percentage of light output produced when a fluorescent lamp(s) is energized from a commercially available ballast as compared to the light output produced when energized from a reference ballast. Ballast factor tests are run in accordance with ANSI C82.2

fixture: The structural parts of a luminaire, including parts designed to distribute the light and to position and/or protect the lamp(s), to mount and support the ballast(s), and to provide a wire way or means of connecting the lamp(s) and ballast(s) to the power supply. A fixture includes the ballast(s), but does not include lamp(s).

floating door: A door frame which appears visually separated from the fixture housing by a regressed area on all four sides/ends. The regressed area is normally painted black. Thus, the door frame appears to float.

fluorescent lamp: A low pressure mercury electric-discharge lamp in which a fluorescing coating (phosphor) transforms a portion of the ultraviolet energy generated by the arc discharge into visible light.

luminaire: A complete lighting unit consisting of a lamp or lamps and ballast(s) together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps through the ballast(s) to the power supply.

luminaire efficacy rating (LER): A mathematical method of determining the rated efficacy of a luminaire.

reference ballast: A ballast specially constructed to have certain prescribed electrical characteristics for use in testing electrical discharge lamps and other ballasts in accordance with ANSI C82.3.

shielding angle (of a luminaire): The angle between a horizontal line through the light center and the line of sight at which the bare source first becomes visible.

spacing criterion—luminaire (SC): A classification parameter for indoor luminaires relating to the distribution of the direct illuminance component produced on the work plane. The SC of a luminaire is an estimated maximum ratio of spacing to mounting height above the work plane for a regular array of that luminaire such that the work plane illuminance will be acceptably uniform.

square cell louver: A louver having a cell size approximately equal both lengthwise and crosswise.

typical fluorescent rated lamp lumens: The rated average lumen output for a typical lamp, taken from the manufacturer's catalog. These values are substantiated by tests performed in laboratories accredited by the National Voluntary Laboratory Accreditation Program.

visual comfort probability (VCP): The rating of a lighting system expressed as a percentage of people who, when viewing from a specified location and in a specified direction, will be expected to find it acceptable in terms of discomfort glare.

NOTE—In this procedure, the room size for VCP is 60' x 60' x 8.5' viewed both parallel and perpendicular to lamps.

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Section 2
SELECTION OF COMPONENTS

2.1 TEST SPECIMEN—LIGHTING FIXTURE

The fixture selected for test shall be clean and representative of the manufacturer's current and regular production.

2.2. TEST SPECIMEN(S)—FLUORESCENT BALLAST(S)

Ballast(s) chosen for the test shall be typical of current production and shall be tested and certified as having a ballast factor that is within plus or minus 0.025 of established ballast factors, or the manufacturer's established ballast factor, for the particular ballast/lamp when tested in accordance with ANSI C82.2.

2.3 TEST SPECIMEN(S)—FLUORESCENT LAMP(S)

Lamps of stable output should be used. They should be constant in light output for constant line voltage and repeated operation.

Lamps selected for tests should be typical of current production and should be selected for uniform luminance and color from end-to-end and around the axis.

Lamps shall conform to the requirements for reference lamps in accordance with ANSI C78.1 and C78.3. Where American National Standards do not exist for a given lamp type, values published by the lamp manufacturers shall apply. Lamps shall be burned for at least 100 hours in order to ensure stable electrical characteristics.

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Section 3
TESTING FACILITIES AND EQUIPMENT

3.1 FACILITIES

Because of the importance of obtaining accurate and repeatable measurements, a National Voluntary Laboratory Accreditation Program accredited photometric laboratory is recommended for testing.

The photometric laboratory shall have facilities for performing tests in accordance with all applicable sections of the IESNA LM-41.

3.2 GENERAL CRITERIA

Due to the sensitivity of fluorescent lamp light output to air flows, all testing should be conducted in a simulated "draft free" environment. Since air movement is necessary to avoid thermal stratification, care should be taken to minimize any draft or air-flow within the immediate vicinity of the test lamps or luminaire, or both.

Temperature should be controlled to 25° C (75° F) within a tolerance of a plus or minus 1°C (1.8°F).

Lamp circuit pin connections should remain the same throughout the tests both for the calibration and for the luminaire test.

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Section 4
PROCEDURE

4.1 LUMINAIRE EFFICACY RATING—FLUORESCENT LUMINAIRES

The luminaire efficacy rating (LER) shall be specified as a minimum value as shown in 5.4 for each luminaire type and classification shown in 5.2.

4.2 LUMINAIRE TYPE AND CLASSIFICATIONS

a. 2' x 4' Recessed
2-lamp, 3-lamp, 4-lamp
Lensed
Spacing Criterion >1.1
VCP < 70, ≥ 70

2’ x 2’ Recessed
2 “U-lamp,” 2 or 3 “CFL-lamp”
Lensed
Spacing Criterion > 1.1
VCP < 70, ≥ 70

b. 2'x4' Recessed
2-lamp, 3-lamp, 4-lamp
Louvered
Spacing Criterion >1.1
VCP ≥ 80
Shielding Angle <22º, 22-29º, ≥30º

2’x2’ Recessed
2 “U-lamp,” 2 or 3 “CFL-lamp”
Louvered
Spacing Criterion >1.1
VCP ≥ 80
Shielding Angle <22º ,22-29º, ≥30º

c. Plastic Wraparound
2-lamp, 4-lamp
Width <9", 9-12", >12"

d. Strip Lights
1-lamp—4 ft, 1-lamp—8 ft, 2-lamp—4ft, 2-lamp—8ft

e. Industrial
2-lamp—4ft, 2-lamp—8ft

4.3 EXCEPTIONS

Exceptions to minimum luminaire efficacy rating:

a. Air handling luminaires with "floating door" construction may have LER values 6% lower than (multiply values by 0.94) shown in appropriate minimum LER table.

b. Luminaires with average luminance in the lengthwise, crosswise, and 45º plane that do not exceed 250 footlamberts at 55º from the vertical may have an LER value of 4% less than shown in appropriate minimum LER table. This exception is in addition to that shown in Exception a.

c. If the spacing criterion is ≤ 1.1, add 6% to each number (multiply each number by 1.06) in the appropriate minimum LER table.

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4.4 LUMINAIRE EFFICACY RATING—FLUORESCENT LUMINAIRES—REGULATORY REQUIREMENTS

The luminaire efficacy rating (LER) shall be specified as a minimum value, a value which cannot be lowered by changing the type of applicable lamp after original installation.

The minimum base system is defined as follows:

Nominal 4' T12 lamp luminaire
Lamp = F40 T12 34 Watt—Halophosphor
Ballast = Premium Magnetic (E), T12

All other currently available lamp/ballast systems (excluding specialty products) are more efficient and have a higher LER value (including nominal 8ft luminaires using 8ft T8 or T12 lamps).

LER values published on manufacturer's literature will be based on a specific lamp and ballast performance in a particular luminaire. Lamp and ballast performance may vary depending on the component manufacturer, type of product, thermal conditions within the luminaire, and other factors. These variations impact the overall LER value and individuals using LER data should make note of the lamp and/or ballast used in the determination of the published LER when comparing products.

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Section 5
CALCULATIONS

5.1 LUMINAIRE EFFICACY RATING—FLUORESCENT LUMINAIRES

The luminaire efficacy rating (LER) shall be calculated for a given luminaire by the following formula:

LER = (EFF x TLL x BF) / Watts Input

Where:

LER = Luminaire Efficacy Rating, expressed in rated lumens per watt. This value shall be shown as a whole number, rounding up (≥ 0.5) or down (< 0.5) as required.

EFF* = Luminaire Efficiency, expressed as a two-place decimal rounding up (≥ 0.005) or down (< 0.005) as required. (Three place decimals may be used if desired.)

TLL = Total Lamp Lumens. Total number of lamps in the test luminaire multiplied by the typical rated fluorescent lamp lumens of the test lamps in accordance with Table 5-1.

BF = Ballast factor of test ballast or the average ballast factor of test ballasts used in the photometric test.* This value is to be shown as a two-place decimal, rounding up (≥ 0.005) or down (< 0.005) as required.

WATTS INPUT = Total wattage of the luminaire as measured during the photometric test.* This value is to be shown as a whole number, rounding up (≥ 0.5) or down (< 0.05) as required.

* The photometric test for luminaire efficiency shall be in accordance with IESNA LM-41.

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Table 5-1
TYPICAL RATED FLUORESCENT LAMP LUMENS*

Description	Watts	Phosphor	CRI	Avg. Rated Lumens
F40T12	34	Halophosphor (Cool White)	62	2650
F40T12 U6	34	Halophosphor (Cool White)	62	2600
F40T12 U3	34	Halophosphor (Cool White)	62	2200
F40T12	40	Rare Earth (741)	70-79	3200
F40T12 U6	40	Rare Earth (741)	70-79	3050
F40T12 U3	40	Rare Earth (741)	70-79	2900
F40W/2G11	40	Rare Earth (741)	80-82	3150
F40T10	42	Rare Earth	80-89	3700
F32T8	32	Rare Earth (741)	70-79	2800
F32T8 U6	32	Rare Earth (741)	70-79	2750
F32T8 U1-5/8	32	Rare Earth (741)	70-79	2725
F96T12	75	Rare Earth (741)	70-79	6420
F96T12	60	Halophosphor (Cool White)	62	5300
F96T8	59	Rare Earth (741)	70-79	5700

* Typical rated average lamp lumens at 100 hours as established by the NEMA Lamp Section. Tested in accordance with IES LM9 and ANSI C78.375 in laboratories recommended as being accredited by the National Voluntary Laboratory Accreditation Program. Specific manufacturer's values may differ from those listed above.

5.2 CALCULATION OF BALLAST FACTOR

Ballast factor (BF) should be calculated in the following comparative method:

$$BF_T = BF_B \times (CF_T / CF_B)$$

Where:

BF_T = Ballast factor of the ballast being tested (unknown ballast factor)

BF_B = Ballast factor of base test ballast for lamp type being tested (known ballast factor)

CF_T = Calibration Flux with ballast being tested

CF_B = Calibration flux using same lamps as being used in test for which ballast factor is being calculated (same as used for CF_T) and operated on base ballast(s) used for BF_B.

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Section 6
LIGHTING ENERGY COST

6.1 COMPARATIVE YEARLY ENERGY COST OF LIGHT

The yearly lighting energy cost for comparative purposes in this procedure is to be based on 1000 lumens and the following:

a. 3000 average burning hours per year
b. $0.08/kwh average electrical energy rate

Thus the constant (K) for the comparative yearly lighting energy cost per watt = $0.24.

6.2 CALCULATION

Comparative yearly lighting energy cost = (K / LER) x 1000

Where:

K = $0.24 (3000 average burning hours per year x $0.08/kwh average electrical energy cost)

LER = The LER value for the given luminaire under consideration.

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Section 7
RECOMMENDED REPORTING CATEGORIES AND FORMAT

7.1 CATEGORY DESCRIPTION

7.1.1 LER values and comparative yearly lighting energy cost values should be shown in promotional literature and catalogs in conjunction with other pertinent information as shown below.

a. Catalog number (showing number of lamps)
b. Luminaire category
c. Lamp type and rated lumen value
d. Ballast type
e. Luminaire lumen output (EFF x TLL x BF), or the values for efficiency, total lamp lumens, and ballast factor may be shown individually
f. Luminaire watts input
g. LER
h. Comparative yearly lighting energy cost per 1000 lumens (see Section 6.)
i. Luminaire efficiency

7.1.2 A two-letter designation for the luminaire category should be included with the LER value whenever it is given. The first letter of the designation should be F for fluorescent luminaires. The second letter should be one of the following letters, representing categories as set forth in the tables in Appendix A:

- L—lensed (Table A-1)
- P—parabolic louvered (Table A-2)
- W—wraparound (Table A-3)
- S—strip (Table A-4)
- I—industrial (Table A-5)

7.2 RECOMMENDED REPORTING FORMAT (EXAMPLE ONLY)

See Table 7-1 below for an example of a recommended reporting format.

Table 7-1
REPORTING FORMAT

1	2	3	4	5	6	7	8	9
Luminaire Catalog #	Luminaire Category	Luminaire Efficiency	Lamp Type and Lamp Lumens	Ballast Type and Ballast Factor	Luminaire Lumen Output*	Luminaire Watts Input	LER	Energy Cost**
G440A12	FL	89%	F40T12 34W 2650 Lu	Premium Magnetic Ⓔ 0.94	6654 Lu	138	48	$5.00

* Calculated as (EFF x TLL x BF). See Section 5.1.
** Comparative yearly lighting energy cost per 1000 lumens.

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Appendix A
THE RATIONALE AND RECOMMENDED REGULATIONS FOR FLUORESCENT LUMINAIRES

A.1 LUMINAIRE CHARACTERISTICS

In reviewing fluorescent luminaires, judging a luminaire by efficiency alone is a poor measure of merit. The most efficient luminaire is basically a "bare lamp." Likewise, judging a luminaire by its coefficient of utilization (CU) is inappropriate. A luminaire's coefficient of utilization is not only a function of its efficiency, but its application as well. The CU is dependent in part on the geometry of the room in which it is installed and the reflectivity of the room surfaces.

Luminaires must be classified into various categories and rated within these categories. The following are some examples:

Type:
Recessed
Surface mounted
Suspended
Strip lights
Plastic wraparounds
Industrials

Physical Dimensions:
Width
Depth
Length

Physical dimensions are important because a luminaire that is recessed mounted within a ceiling must mate with the ceiling construction for width and length, and its depth must correlate with the available plenum depth.

The inexpensive wraparound unit may be shallow and narrow, so as to be inconspicuous in the space and to minimize cost. (Even the least efficient wraparound is much more efficient than the incandescent unit it replaces.)

Photometric Characteristics:[*]
Spacing criterion—spacing to mounting height
Visual comfort probability
Shielding angle
Maximum average luminance
Side luminance
Coefficient of utilization
Efficiency

[*] For definitions, refer to the IESNA *Lighting Handbook*.

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Electrical Characteristics:
Number of lamps
Type and wattage of lamps
Number and type of ballast
Power factor
Watts input—total for luminaire

A.2 FLUORESCENT MARKET—PERCENTAGE BY TYPES SHIPPED

The National Electrical Manufacturers Association reports that for 1998 four major types of fluorescent fixtures constituted 86% of the fluorescent commercial, institutional, and industrial markets.

Type	Description	Percent
1	Recessed (air and non-air-handling)	51
2	Strip Lights	16
3	Plastic Wraparounds	9
4	Industrial	10
5	All Others	14
	TOTAL	100

The Type 1 recessed lighting fixture is comprised of many sizes from 1' x 1' to 4' x 4', but the predominate size is 2' x 4', which represents almost 75% of the market.

Size	Percent
2’ x 4’	74
2’ x 2’	16
1’ x 4’	8
Others	2
TOTAL	100

The approximate breakdown by lamp quantity for the 2' x 4' recessed luminaire is:

Lamps	Percent
4	46
3	35
2	18
Other	1
TOTAL	100

The Type 2 (strip light) consists primarily of 4' and 8' lengths, using the 4', rapid start 40 watt lamp or the 8' slim line or high output, rapid start fluorescent lamp. Approximately 27% are one lamp, and 73% are two lamp units.

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The Type 3 (plastic wraparound) fixture is primarily a 4' luminaire employing the 4' rapid-start lamp. The approximate lamp and fixture width breakdown is as follows:

Number of Lamps	Fixture Width	Percent
1	3-18 in	4
2	8-18 in	72
3	13-18 in	1
4	13-18 in	23
	TOTAL	100

The Type 4 (industrial) luminaire is primarily 4' and 8' in length, using the 4' rapid-start 40-watt lamp or the 8', slim line or high output, rapid-start lamp. The two-lamp version comprises approximately 89% of the product.

A.3 LUMINAIRE TYPES AND CLASSIFICATIONS

In analyzing the fluorescent lighting market, the Luminaire Section has determined that the following types of luminaires, subdivided into the appropriate classifications, would be representative of the market:

a. 2' x 4' Recessed,
Lensed
Spacing Criterion > 1.1
2-lamp, 3-lamp, and 4-lamp
VCP < 70, ≥ 70

2’ x 2’ Recessed,
Lensed
Spacing Criterion > 1.1
2 “U-lamp,” 2 or 3 FT40W Lamp
VCP < 70, ≥ 70

b. 2' x 4' Recessed,
Louvered
Spacing Criteria > 1.1
2-lamp, 3-lamp, and 4-lamp
VCP ≥ 80
Shielding angle < 22º, 22-29º, ≥ 30º

2’ x 2’ Recessed,
Louvered
Spacing Criteria > 1.1
2 “U-lamp,” 2 or 3 FT40W Lamp
VCP ≥ 80
Shielding angle < 22º, 22-29º, ≥ 30º

c. Plastic Wraparound
2-lamp and 4-lamp
Width < 9", 9-12", > 12"

d. Strip Lights
1-lamp (4’ and 8’) and 2-lamp (4’ and 8’)

e. Industrial
2-lamp only (4’ and 8’)

A.4 HEAT TRANSFER LUMINAIRES

The F40T12 34-watt or F40T12 32-watt fluorescent lamp is not recommended for use in heat transfer luminaires. Test data should be secured for heat transfer luminaires for each lamp/ballast system selected.

A.5 RECOMMENDED REGULATIONS—FLUORESCENT LUMINAIRES ONLY

The minimum required luminaire efficacy rating (LER) for fluorescent luminaires (nominal 4' T12 luminaries) shall be in accordance with Tables A-1 through A-5.

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A.6 PHOTOMETRIC TESTS

The photometric test for luminaire efficiency shall be in accordance with IESNA LM-41.

Photometric tests on fluorescent luminaires that were run with the F40T12 40-watt lamp and were completed prior to 1993 may be utilized for the calculation of LER values by substituting appropriate F40T12 34-watt lamp lumen values from Table 5-1 and appropriate ballast factors and watt input values as required from Tables A-6 through A-11.

Table A-1
MINIMUM LER—LENSED RECESSED FLUORESCENT LUMINAIRES
WITH SPACING CRITERION > 1.1

2' x 4'
(Nominal 4' T12 Lamp Luminaire)

VCP	< 70	≥ 70
4-lamp	43	41
3-lamp	43	42
2-lamp	47	46

2' x 2'
(Nominal 2' U-shaped T12 and 2' FT40W Lamp Luminaire)

VCP	< 70	≥ 70
2 U-lamp	40	34
2 FT40W Lamp	53	46
3 U-lamp	30	26
3 FT40W Lamp	43	36

Note—Exceptions are as follows:

1. Air handling luminaires with "floating door" construction may have LER values 6% lower than (multiply values by 0.94) shown in Tables A-1 and A-2.

2. Luminaires with average luminance in the lengthwise, crosswise, and 45º plane that do not exceed 850 cd/m^2 at 55º from the vertical may have an LER value of 4% less than (multiply values by 0.96) shown in Tables A-1 and A-2. This exception is in addition to that shown in Note 1.

3. If the spacing criterion is ≤ 1.1, add 6% to each number (multiply each number by 1.06) in the table.

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Table A-2
MINIMUM LER—LOUVERED RECESSED FLUORESCENT LUMINAIRES
WITH VCP ≥ 80 AND
SPACING CRITERION > 1.1

2' x 4'
(Nominal 4' T12 Lamp Luminaire)

Shielding Angle	< 22°	22-29°	≥ 30°	Square Cell Louvre ≥ 30°
4-lamp	46	41	37	37
3-lamp	47	46	41	38
2-lamp	53	50	47	39

2' x 2'
(Nominal 2' U-shaped T12 and 2' FT40W Lamp Luminaire)

Shielding Angle	< 22°	22-29°	≥ 30°	Square Cell Louvre ≥ 30°
2 U-lamp	39	38	34	30
2 FT40W Lamp	48	49	43	40
3 U-lamp	36	28	26	23
3 FT40W Lamp	45	47	41	37

Note—Exceptions are as follows:

1. Air handling luminaires with "floating door" construction may have LER values 6% less than (multiply values by 0.94) shown in Tables A-1 and A-2.

2. Luminaires with average luminance in the lengthwise, crosswise, and 45º plane that do not exceed 850 cd/m^2 at 55º from the vertical may have an LER value of 4% less than (multiply values by 0.96) shown in Tables A-1 and A-2. This exception is in addition to that shown in Note 1.

3. If the spacing criterion is ≤ 1.1, add 6% to each number (multiply each number by 1.06) in the table.

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Table A-3
MINIMUM LER—PLASTIC WRAPAROUND LUMINAIRES
(Nominal 4' T12 Lamp Luminaire)

Width	< 9”	9-12”	> 12”
4-lamp	—-	—-	46
2-lamp	46	47	48

Table A-4
MINIMUM LER—BARE LAMP STRIP LUMINAIRES
(Nominal 4' T12 Lamp Luminaire)

Number of Lamps	Lamp Length	LER
2	4’	56
2	8’	52
1	4’	50
1	8’	41

Table A-5
MINIMUM LER—BARE LAMP INDUSTRIAL LUMINAIRES
(Nominal 4' T12 Lamp Luminaire)

Number of Lamps	Lamp Length	LER
2	4’	53
2	8’	51

All other commercial fluorescent luminaires are considered low volume and are excluded.

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Table A-6
TYPICAL RATED AVERAGE BALLAST FACTORS*

(Nominal 4' Fluorescent)

Ballast Type Description	Lamp Type F40T12	F40T12 ES	F40T10	F32T8
1 Lamp Premium Magnetic (E)	.94	.87	.95	.94
1 Lamp Premium Magnetic T8	N/A	N/A	N/A	.94
1 Lamp Heater Cutout	.83	.81	.85	.86
1 Lamp Electronic	.88	.88	.85	.88
2 Lamp Premium Magnetic (E)	.94	.87	.95	.94
2 Lamp Premium Magnetic T8	N/A	N/A	N/A	.94
2 Lamp Heater Cutout	.83	.81	.85	.86
2 Lamp Electronic	.88	.88	.85	.88
3 Lamp Magnetic	N/A	.87	N/A	N/A
3 Lamp Magnetic T8	N/A	N/A	N/A	N/A
3 Lamp Heater Cutout	N/A	N/A	N/A	.86
3 Lamp Electronic	.88	.88	.85	.88
4 Lamp Electronic	.88	.88	.85	.88

(Nominal 2' Fluorescent)

Ballast Type Description	Lamp Type FT40W/2G11	F40T12 U6	F40T12 U3	F32T8 U6
2 Lamp Premium Magnetic (E)	.95	.87	.88	.94
2 Lamp Electronic	.88	.88	N/A	.88
3 Lamp Premium Magnetic (E)	.95	N/A	N/A	N/A
3 Lamp Electronic	.88	N/A	.83	.88

(Nominal 8' Fluorescent)

Ballast Type Description	Lamp Type F96T12	F96T8
1 Lamp Premium Magnetic (E)	.87	N/A
1 Lamp Premium Mangetic T8	N/A	.90
1 Lamp Electronic	.98	.88
2 Lamp Premium Magnetic (E)	.87	N/A
2 Lamp Premium Magnetic T8	N/A	.90
2 Lamp Electronic	.88	.88

NOTES
1. N/A = not applicable.

2. Variations in electronic ballast design may result in variances from values shown above. Ballast factors should be calculated in accordance with Section 5.2.

* Industry standard, typical rated average ballast factors as established by the NEMA Ballast Section. Tested in accordance to ANSI C82.2. Specific manufacturer's values may differ from those listed above.

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Table A-7
TYPICAL RATED INPUT WATTS*—FLUORESCENT, RECESSED—LENSED

Quantity	Lamps Description	Lamp Watts	Ballast Description	Input Watts
2' x 4' Luminaires				
4	F40T12	40	Premium Magnetic (E)	162
4	F40T12	40	Heater Cutout	137
4	F40T12 ES	34	Premium Magnetic (E)	138
4	F40T12 ES	34	Heater Cutout	112
4	F40T12 ES	34	Electronic	N/R
4	F32T8	32	Premium Magnetic T8	133
4	F32T8	32	Electronic	110
3	F40T12	40	Premium Magnetic (E)	128
3	F40T12	40	Heater Cutout	113
3	F40T12 ES	34	Premium Magnetic (E)	113
3	F40T12 ES	34	Heater Cutout	93
3	F40T12 ES	34	Electronic	N/R
3	F32T8	32	Premium Magnetic T8	103
3	F32T8	32	Electronic	88
2	F40T12	40	Premium Magnetic (E)	84
2	F40T12	40	Heater Cutout	70
2	F40T12 ES	34	Premium Magnetic (E)	70
2	F40T12 ES	34	Heater Cutout	56
2	F40T12 ES	34	Electronic	N/R
2	F32T8	32	Premium Magnetic T8	70
2	F32T8	32	Electronic	60
2' x 2' Luminaire				
2	F40T12U ES	34	Premium Magnetic (E)	70
2	F40T12U ES	34	Electronic	58
2	F32T8U	32	Premium Magnetic T8	70
2	F32T8U	32	Electronic	60
2	FT40W/2G11	40	Premium Magnetic	77
2	FT40W/2G11	40	Electronic	76
3	F40T12U ES	34	Premium Magnetic (E)	109
3	F40T12U ES	34	Electronic	81
3	F32T8U	32	Premium Magnetic T8	98
3	F32T8U	32	Electronic	79
3	FT40W/2G11	40	Premium Magnetic	131
3	FT40W/2G11	40	Electronic	108

NOTE—N/R = not recommended.

* Input Watts are representative for typical luminaire systems based on laboratory test data. Specific values may vary depending on the lamp and/or ballast components and the luminaire construction, which affects the thermal conditions of the system performance.

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Table A-8
TYPICAL RATED INPUT WATTS* —FLUORESCENT, RECESSED—LOUVRED

Quantity	Lamps Description	Lamp Watts	Ballast Description	Input Watts
2' x 4' Luminaires				
4	F40T12	40	Premium Magnetic Ⓔ	165
4	F40T12	40	Heater Cutout	140
4	F40T12 ES	34	Premium Magnetic Ⓔ	140
4	F40T12 ES	34	Heater Cutout	112
4	F40T12 ES	34	Electronic	N/R
4	F32T8	32	Premium Magnetic T8	140
4	F32T8	32	Electronic	111
3	F40T12	40	Premium Magnetic Ⓔ	132
3	F40T12	40	Heater Cutout	115
3	F40T12 ES	34	Premium Magnetic E	113
3	F40T12 ES	34	Heater Cutout	93
3	F40T12 ES	34	Electronic	N/R
3	F32T8	32	Premium Magnetic T8	105
3	F32T8	32	Electronic	89
2	F40T12	40	Premium Magnetic Ⓔ	85
2	F40T12	40	Heater Cutout	70
2	F40T12 ES	34	Premium Magnetic Ⓔ	70
2	F40T12 ES	34	Heater Cutout	56
2	F40T12 ES	34	Electronic	N/R
2	F32T8	32	Premium Magnetic T8	70
2	F32T8	32	Electronic	61
2' x 2' Luminaire				
2	F40T12U ES	34	Premium Magnetic Ⓔ	70
2	F40T12U ES	34	Electronic	61
2	F32T8U	32	Premium Magnetic T8	70
2	F32T8U	32	Electronic	61
2	FT40W/2G11	40	Premium Magnetic	80
2	FT40W/2G11	40	Electronic	76
3	F40T12U ES	34	Premium Magnetic Ⓔ	113
3	F40T12U ES	34	Electronic	82
3	F32T8U	32	Premium Magnetic T8	98
3	F32T8U	32	Electronic	79
3	FT40W/2G11	40	Premium Magnetic	120
3	FT40W/2G11	40	Electronic	108

NOTE—N/R = not recommended.

* Input Watts are representative for typical luminaire systems based on laboratory test data. Specific values may vary depending on the lamp and/or ballast components and the luminaire construction, which affects the thermal conditions of the system performance.

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Table A-9
TYPICAL RATED INPUT WATTS* —FLUORESCENT PLASTIC WRAPAROUND

Quantity	Lamps Description	Lamp Watts	Ballast Description	Input Watts
2	F40T12	40	Premium Magnetic (E)	81
2	F40T12	40	Heater Cutoff	69
2	F40T12 ES	34	Premium Magnetic (E)	72
2	F40T12 ES	34	Heater Cutout	54
2	F40T12 ES	34	Electronic	N/R
2	F32T8	32	Premium Magnetic T8	70
2	F32T8	32	Electronic	57
4	F40T12	40	Premium Magnetic (E)	164
4	F40T12	40	Heater Cutoff	140
4	F40T12 ES	34	Premium Magnetic (E)	144
4	F40T12 ES	34	Heater Cutout	116
4	F40T12 ES	34	Electronic	N/R
4	F32T8	32	Premium Magnetic T8	142
4	F32T8	32	Electronic	110

NOTE—N/R = not recommended.

* Input Watts are representative for typical luminaire systems based on laboratory test data. Specific values may vary depending on the lamp and/or ballast components and the luminaire construction, which affects the thermal conditions of the system performance.

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Table A-10
TYPICAL RATED INPUT WATTS* —FLUORESCENT STRIP LIGHTS

Quantity	Lamps Description	Lamp Watts	Ballast Description	Input Watts
1	F40T12	40	Premium Magnetic Ⓔ	49
1	F40T12	40	Heater Cutoff	44
1	F40T12 ES	34	Premium Magnetic Ⓔ	42
1	F40T12 ES	34	Heater Cutout	36
1	F40T12 ES	34	Electronic	N/R
1	F32T8	32	Premium Magnetic T8	36
1	F32T8	32	Electronic	30
2	F40T12	40	Premium Magnetic Ⓔ	87
2	F40T12	40	Heater Cutoff	71
2	F40T12 ES	34	Premium Magnetic Ⓔ	71
2	F40T12 ES	34	Heater Cutout	57
2	F40T12 ES	34	Electronic	N/R
2	F32T8	32	Premium Magnetic T8	71
2	F32T8	32	Electronic	55
1	F96T12	75	Magnetic	99
1	F96T8	59	Magnetic T8	65
1	F96T8	59	Electronic	57
2	F96T12	75	Premium Magnetic	156
2	F96T8	59	Magnetic T8	135
2	F96T8	59	Electronic	110

NOTE—N/R = not recommended.

* Input Watts are representative for typical luminaire systems based on laboratory test data. Specific values may vary depending on the lamp and/or ballast components and the luminaire construction, which affects the thermal conditions of the system performance.

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Table A-11
TYPICAL RATED INPUT WATTS*—FLUORESCENT INDUSTRIALS

Quantity	Lamps Description	Lamp Watts	Ballast Description	Input Watts
2	F40T12	40	Premium Magnetic (E)	87
2	F40T12	40	Heater Cutoff	71
2	F40T12 ES	34	Premium Magnetic (E)	71
2	F40T12 ES	34	Heater Cutout	57
2	F40T12 ES	34	Electronic	N/R
2	F32T8	32	Premium Magnetic T8	71
2	F32T8	32	Electronic	60
2	F96T12	75	Premium Magnetic	156
2	F96T12	75	Electronic	N/R
2	F96T8	59	Magnetic T8	135
2	F96T8	59	Electronic	110

NOTE—N/R = not recommended.

* Input Watts are representative for typical luminaire systems based on laboratory test data. Specific values may vary depending on the lamp and/or ballast components and the luminaire construction, which affects the thermal conditions of the system performance.

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