# ANSI/NEMA FL 1

# FLASHLIGHT BASIC PERFORMANCE STANDARD


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**ANSI Approval Date: August 18, 2009**

# ANSI/NEMA FL 1-2009

*Flashlight Basic Performance Standard*

*Published by*

**National Electrical Manufacturers Association**
1300 North 17th Street, Suite 1752
Rosslyn, Virginia 22209

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# Contents

## Foreword

In the preparation of this Standards Publication, input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted by contacting the:

FSC Secretary
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752
Rosslyn, Virginia 22209

This Standards Publication was developed by the Flashlight Standards Committee. At the time it was approved, the Committee was composed of the following members:

| | | |
|---|---|---|
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| Princeton Tec | Bordentown, NJ | 08505 |
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# SCOPE

This Standards Publication covers basic performance of hand-held/portable flashlights, spotlights, and headlamps providing directional lighting.

# Section 1
# GENERAL

## 1.1 REFERENCE STANDARDS

In this publication, reference is made to standards listed below. Copies are available from the indicated sources:

ANSI/IEC 60529 *Degrees of Protection Provided by Enclosures (IP Code)*
**National Electrical Manufacturers Association**
1300 North 17th Street, Suite 1752
Rosslyn, Virginia 22209
www.nema.org

ANSI/IEEE 268 *Standard for Use of the International System of Units (SI) --The Modern Metric System*
**IEEE**
3 Park Avenue, 17th Floor
New York, NY 10016-5997 USA
www.ieee.org

## 1.2 DEFINITIONS

### 1.2.1 Beam Distance

Beam distance is defined as the distance from the device at which the light beam is 0.25 lux (0.25 lux is approximately the equivalent of the light emitted from the full moon “on a clear night in an open field”).

### 1.2.2 Peak Beam Intensity

Peak Beam Intensity is the maximum luminous intensity typically along the central axis of a cone of light. The value is reported in candela and does not change with distance.

### 1.2.3 Run Time

Run Time is defined as the duration of time from the initial light output value—defined as 30 seconds after the point the device is first turned on—using fresh batteries, until the light output reaches 10% of the initial value.

### 1.2.4 Light Output

Light Output is the total luminous flux. It is the total quantity of emitted overall light energy as measured by integrating the entire angular output of the portable light source. Light output in this standard is expressed in units of lumens.

### 1.2.5 Impact Resistance

Impact resistance is the degree to which a device resists damage from dropping on a solid surface.

### 1.2.6 Enclosure Protection Against Water Penetration Ratings

Based on the ANSI/IEC 60529 standard, the following enclosure ratings for the devices covered by this standard have been defined:

Water Resistant—IPX4—Water splashed against the device from any direction shall have no harmful effects.

Water Proof—IPX7—Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water under standardized conditions of pressure and time.

Submersible—IPX8—Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions which shall be stated by the manufacturer, but which are more severe than for IPX7.

### 1.2.7 Hand-Held/Portable

A hand-held/portable device is small enough to be operated when held in one or both hands (like flashlights, headlamps, spotlights, and bicycle lights) and light enough to be easily carried from place to place.

### 1.2.8 Spectroradiometer

A spectroradiometer is an instrument capable of dividing light into its constituent wavelengths. For the intent of this standard, a spectroradiometer is used for measuring the total spectral flux and luminous flux of the device under test in the visible spectral range (380 to 790nm).

### 1.2.9 Light Measuring Device

A light measuring device is a commercially available device that is used to measure the amount of light striking a surface from a given source. Typically, this device is calibrated during manufacture to ensure a certain level of accuracy for the user. Also known as “light meters,” “photometers,” and in some cases can be systems based on CCD cameras or other technologies. The device should be calibrated to the CIE eye response curve.

### 1.2.10 Surface Light Intensity

Surface Light Intensity is defined in this standard as surface illuminance and is measured in units of lux.

### 1.2.11 Integrating Sphere

For the intent of this standard, an integrating sphere is a measurement device with an entrance port that can accept all the directional light output of the device under test, or can totally enclose the device itself. The walls of the sphere should be highly diffuse with high reflectivity (>80%) and the spectroradiometer should be shielded from direct view of the device under test by a baffle system.

## 1.3 SAMPLE SIZE AND ORDER OF TESTING

### 1.3.1 Performance Testing

Performance testing includes beam distance, peak beam intensity, light output, and run time. These are defined in individual test requirements:

a. Beam Distance: sample size is 3.

b. Peak Beam Intensity: sample size is 3.

c. Light Output: sample size is 3.

d. Run Time (Battery Life): sample size is 3

Performance tests may be conducted concurrently.

### 1.3.2 Reliability Testing

Reliability Testing includes impact resistance testing followed by Enclosure Protection Against Water Penetration testing. These are defined in individual test requirements:

a. Impact Resistance: sample size is 5.

   Impact Resistance tests are performed prior to all other Reliability testing, if applicable.

b. Enclosure Protection Against Water Penetration: sample size is 5.

c. If an Impact Resistance and an Enclosure Protection Against Water Penetration claim are both made, the same test sample units shall be used for both tests. The samples shall be tested for Enclosure Penetration only after the Impact Resistance testing is complete.

### 1.4 UNITS OF MEASURE

All values shall be given in SI (metric) units.

# Section 2
# TEST METHODS

## 2.1 GENERAL

### 2.1.1 Lab Conditions

Lab conditions shall be a controlled temperature of 22 ± 3 °C and a relative humidity of 50% nominal, 80% maximum.

Ambient light conditions shall be the minimum of the following two options: 1 lux or no more than 10% of the lowest value measured during any test.

Designated (light) measuring equipment shall be annually calibrated by an accredited commercial third party service showing traceability to NIST standards. Records shall be kept of the calibration history.

### 2.1.2 Sampling Selection

All samples must be representative of final production products. If multiple light output grades are used in the product, the test specimens must use the lowest light output grade offered.

## 2.2 BEAM DISTANCE

**Note—The same test data set shall be used for both beam distance and peak beam intensity.**

### 2.2.1 Purpose

To provide a procedure to determine the maximum distance at which the device is capable of producing 0.25 lux of light within 30 s to 2 min of operation.

### 2.2.2 Power Source

All tests are conducted with fresh batteries or fully charged batteries/energy storage devices.

12V DC devices that are only tethered shall be powered with 13.8V DC using a power supply.

Batteries used for testing and claim substantiation shall be of the same type and/or brand as those offered for sale with the product.

If the product is sold without batteries and a beam distance claim is made, a specific battery type and chemistry shall be recommended with the package. The batteries recommended by the manufacturer are to be used for testing.

### 2.2.3 Conditions

Tests will be conducted at lab conditions—see clause 2.1.1.

Ambient light conditions shall be the minimum of the following two options: 1 lux or no more than 10% of the lowest value measured during any test.

If the device offers multiple output levels, the beam distance will be measured at the maximum level or as otherwise identified.

If the device has variable focusing or adjustable beam angle, the beam distance will be measured at the focus level or beam angle that produces the maximum beam distance or as otherwise identified.

### 2.2.4 Apparatus

A timing device, a distance measuring device, and a light measuring device that measures in units of lux shall be used. Minimum aperture area shall be 100 mm².

### 2.2.5 Procedures

Place the light measuring device at a test distance of either 2 or 10 or 30 meters from the front of the surface of the lens of the device to be tested. The test distance chosen shall be at least 10 times the largest dimension of the device's lens or output height or width.

Use the light measuring device to identify and record the highest indicated value.

Measurements shall be taken 30 s to 2 min of turning on the device.

### 2.2.6 Final calculations

Use the Inverse Square Law to calculate the beam distance to 0.25 lux as follows:

$$\text{Surface light intensity} \times (\text{distance})^2 = \text{peak beam intensity}$$

$$\sqrt{(\text{peak beam intensity} / 0.25)} = \text{Max Beam Distance}$$

where:
Surface light intensity is in lux (lx)
Distance and Max Beam Distance are in meters (m)
Peak beam intensity is in candela (cd)

The reported value shall be the highest calculated beam distance of the values measured in clause 2.2.5.

The published figure shall be the average of the results of the three devices tested. Round to whole numbers following standard rounding rules.

## 2.3 PEAK BEAM INTENSITY

**Note—The same test data set shall be used for both beam distance and peak beam intensity.**

### 2.3.1 Purpose

To provide a procedure to determine the peak beam intensity, reported in units of candela, of the device's beam pattern within 30 s to 2 min of operation.

### 2.3.2 Power Source

All tests are conducted with fresh batteries or fully charged batteries/energy storage devices.

12V DC devices that are only tethered shall be powered with 13.8V DC using a power supply.

Batteries used for testing and claim substantiation shall be of the same type and/or brand as those offered for sale with the product.

If the product is sold without batteries and a peak beam intensity claim is made, a specific battery type and chemistry shall be recommended with the package. The batteries recommended by the manufacturer are to be used for testing.

### 2.3.3 Conditions

Tests will be conducted at lab conditions—see clause 2.1.1.

Testing should be performed in a dark environment where the ambient conditions are determined to be less than 1 lux in the entire test area prior to the test.

If the device offers multiple output levels, the peak beam intensity will be measured at the maximum level or as otherwise identified.

If the device has variable focusing or adjustable beam angle, the peak beam intensity will be measured at the focus level or beam angle that produces the maximum beam intensity or as otherwise identified.

### 2.3.4 Apparatus

A timing device, a distance measuring device, and a light measuring device that measures in units of lux shall be used. Minimum aperture area shall be 100 mm².

### 2.3.5 Procedures

Place the light measuring device at a test distance of either 2 or 10 or 30 meters from the front of the surface of the lens of the device to be tested. The test distance chosen shall be at least 10 times the largest dimension of the device's lens or output height or width.

Use the light measuring device to identify and record the highest indicated value.

Measurements shall be taken 30 s to 2 min of turning on the device.

### 2.3.6 Final calculations

$$\text{Surface light intensity} \times (\text{distance})^2 = \text{Peak beam intensity}$$

where:
Surface light intensity is in lux (lx)
Distance is in meters (m)
Peak beam intensity is in candela (cd)

The reported value shall be the highest calculated peak beam intensity of the values measured at test distances in clause 2.3.5.

The published figure shall be the average of the results of the three devices tested. Round to whole numbers following standard rounding rules.

## 2.4 RUN TIME

### 2.4.1 Purpose

To provide a procedure to determine the amount of time elapsed (under continuous operation) at which the device's light output reaches a level when users will commonly replace the batteries.

### 2.4.2 Power Source

All tests are conducted with fresh batteries or fully charged batteries/energy storage devices.

Batteries used for testing and claim substantiation shall be of the same type and/or brand as those offered for sale with the product.

If the product is sold without batteries and a run time claim is made, a specific battery type and chemistry shall be recommended with the package. The batteries recommended by the manufacturer are to be used for testing.

### 2.4.3 Conditions

Tests will be conducted at lab conditions—see clause 2.1.1.

Testing should be performed in a dark environment where the ambient conditions are determined to be less than 1 lux in the entire test area prior to taking an actual measurement with a light measuring device.

If the device offers multiple output levels, the run time will be measured at the maximum level or as otherwise identified.

The device shall be securely mounted for testing after the batteries have been inserted.

### 2.4.4 Apparatus

A timing device and a light measuring device shall be used.

### 2.4.5 Initial and End Point

The initial reading is taken at 30 s of continuous operation. When using a light measuring device, ensure that the distance from the front surface of the device to the sensor is identical for initial and end point measurements.

The light is operated continuously without any off time. (NOTE—If the device has an auto shut off mechanism, the operator must restart the light within 15 s for the test to be valid.)

Periodic light measurements and corresponding time values are recorded, and the end point is reached when the output value reaches 10% of the initial value for each sample.

Record run time for each sample.

### 2.4.6 Final Calculation

Run Time is the average run time of the 3 samples. A run time less than one hour is reported in minutes; more than 1 hour but less than 10 hours is reported in hours and minutes, rounded to the nearest 15 min. For 10 hours or more, report the run time only in hours. Standard rounding rules apply.

## 2.5 LIGHT OUTPUT

### 2.5.1 Purpose

To provide a procedure for the measurement of the total luminous flux (lumens) emitted by the device.

### 2.5.2 Power Supply

All tests are conducted with fresh batteries or fully charged batteries/energy storage devices.

12V DC devices that are only tethered shall be powered with 13.8V DC using a power supply.

Batteries used for testing and claim substantiation shall be of the same type and/or brand as those offered for sale with the product.

If the product is sold without batteries and a light output claim is made, a specific battery type and chemistry shall be recommended with the package. The batteries recommended by the manufacturer are to be used for testing.

### 2.5.3 Conditions

Tests will be conducted at lab conditions—see clause 2.1.1.

If the device offers multiple output levels, the light output will be measured at the maximum level or as otherwise identified.

If the device has variable focusing or adjustable beam angle, the light output will be measured at the focus level or beam angle that produces the maximum light output or as otherwise identified.

### 2.5.4 Apparatus

An integrating sphere system with a spectroradiometer for spectral mismatch corrections and computing software to measure total light output shall be used.

The minimum sphere diameter shall be equal to or greater than 3 times the maximum diameter of the port on the sphere where light enters it.

### 2.5.5 Test Equipment Sampling Calibration

For each individual model, the test equipment shall be properly calibrated per the test equipment manufacturer's instructions. The calibration procedure must include a lamp traceable to an NIST standard.

### 2.5.6 Procedures

Devices are to be securely mounted against an external port adapter or placed inside the sphere. Exposure shall be set to produce test equipment manufacturer's recommended detector saturation level.

For each unique product color sample absorption correction must be completed.

Measurements shall be taken at 30 s to 2 min of continuous operation after turning on the device.

### 2.5.7 Final Calculation

Light Output is the average lumen value of the 3 samples. Round to whole numbers following standard rounding rules.

## 2.6 IMPACT RESISTANCE

### 2.6.1 Purpose

To ensure structural integrity of hand-held/portable lighting devices under specified impact conditions. The test procedure provides specifications and methods that will ensure products meet a minimum standard of reliability as a result of impact testing.

### 2.6.2 Conditions

The test will be conducted at lab conditions—see clause 2.1.1.

### 2.6.3 Apparatus

The apparatus shall consist of:

- An impact surface consisting of a minimum 4 cm nominal thickness of cured concrete. Impact area must be a minimum of 1 m x 1 m.
- A measuring device to confirm the drop test height.

### 2.6.4 Drop Test

Products are dropped with all intended additions: batteries, elastic, tethers, hand straps, etc.

Drop height for product samples shall be 1 m minimum. Higher drop heights can be used for testing and product claims; however, any product claiming a drop height different than 1 m must meet all passing requirements listed below.

Each sample is dropped 6 times using impact orientations that approximate a cube. Each sample must be released on each orientation of the approximated cube. Samples must be marked prior to the drop test in a manner that can assure that all 6 drop orientations are tested.

Samples shall be in the “off” position with batteries in place.

The test sample is held in the desired orientation with its lowest part at the correct height. Drop the sample onto the impact surface. No additional impetus shall be given to the sample other than the acceleration due to gravity. The sample shall be allowed to come to rest after each drop.

The test sample is examined after each drop.

#### 2.6.5 Passing Criteria

Dropped samples must not exhibit any cracks or breaks visible with normal vision.

The product must remain fully functional. Some reassembly is allowed provided that it is done without any tool or replacement components.

Cosmetic defects such as scuffs, scratches, rubs, or abrasions will not be considered reasons for failure.

#### 2.6.6 Impact Resistance Rating

Test samples must pass a drop test from a minimum of 1 m in order for the impact resistance claim to be made.

Ratings in excess of 1 m shall be reported with values rounded down to the nearest whole meter.

All five test samples must pass the rated height.

### 2.7 ENCLOSURE PROTECTION AGAINST WATER PENETRATION RATING

#### 2.7.1 Purpose

To ensure protection from damage under specific conditions of exposure to water. The procedure includes specifications and methods that will ensure the device meets minimum standards of reliability as a result of exposure to water under certain specific conditions.

#### 2.7.2 Conditions

All tests will be conducted in lab conditions—see clause 2.1.1.

Samples shall be in the “off” position with batteries in place.

#### 2.7.3 Apparatus

#### 2.7.3.1 Water Resistant

An apparatus is used to spray water from all directions at specified water pressure, direction, and duration as described in ANSI/IEC 60529, Section 14.2.4 for IPX4 evaluation.

#### 2.7.3.2 Water Proof

A 1 m deep reservoir sufficient to cover the entire device with water or a water vessel that is pressurized equivalent to 1 m depth as described in ANSI/IEC 60529, Section 14.2.7 for IPX7 evaluation.

#### 2.7.3.3 Submersible

A reservoir at the claimed depth sufficient to cover the entire device with water or a water vessel that is pressurized equivalent to the claim depth as described in ANSI/IEC 60529, Section 14.2.8 for IPX8 evaluation.

### 2.7.4 Test Procedure

#### 2.7.4.1 Water Resistant

As described in ANSI/IEC 60529, Section 14.2.4 for IPX4.

#### 2.7.4.2 Water Proof

As described in ANSI/IEC 60529, Section 14.2.7 for IPX7.

#### 2.7.4.3 Submersible

As described in ANSI/IEC 60529, Section 14.2.8 for IPX8. The duration shall be 4 hours at manufacturer specified depth.

### 2.7.5 Passing Criteria

#### 2.7.5.1 Water Resistant

All test samples shall function normally immediately after the test and 30 min after the test. Water ingress is allowed as long as the above conditions are met.

#### 2.7.5.2 Water Proof and Submersible

All test samples shall function normally immediately after the test and 30 min after the test.

The sample passes the water proof and submersible test if there is no ingress of water in any functional area that contains unprotected electrical components (contacts, batteries, PCB, wires) or light sources.

Protection shall provide exclusion of water from the components above.

### 2.7.6 Enclosure Protection Against Water Penetration Rating

The submersible rating shall be expressed in meters and rounded down to the nearest whole meter. All five samples must pass the rated depth.

# Section 3
# MARKING

## 3.1 PROPER USE OF ICONS AND STYLING GUIDELINES

The ANSI/NEMA FL 1 Standard icons are voluntary to use on packaging, and any combination from a single icon to the complete grouping of icons can be used.

The smallest size icon that will be acceptable on packaging is 9.0 mm x 9.0 mm for an individual icon.

There is no maximum size requirement for the icons.

All icons on the same surface or side of a package or document must be the same size.

The icons must only have a total of two contrasting colors. If more than one icon is used, all icons on the same surface or side of a package or document must use the same color scheme.

If an individual icon is used or the icons are separated on the packaging, then the format for the icon will require the solid “FL 1 Standard” border to be on top (see examples below).



## 3.2 CLAIM CONSISTENCY

If an ANSI/NEMA FL 1 Standard claim is made for a performance criterion, all other claims pertaining to performance covered in this document must follow its requirements.

The icons must represent the maximum setting / function of the lighting device unless otherwise identified. All icons on the same surface or side of package or document must represent a common setting / function of the lighting device unless it is displayed in a table format as described in section 3.4. Icons representing multiple settings / functions cannot be mixed on the package or document without the table format.

## 3.3 ICON APPEARANCE

For purposes of retail packaging, consumer literature, or any other communication directed at the consumer, the markings given below shall apply:

### 3.3.1 Beam Distance

Numerical indication in the icon shall be as per clause 2.2.6.

### 3.3.2 Peak Beam Intensity


Numerical indication in the icon shall be as per clause 2.3.6.

### 3.3.3 Run Time




The first icon is for a run time of less than one hour; the second is for run times longer than 1 hour but less than 10 hours and the third one is for a run time of 10 hours or more. Numerical indication in the icon shall be as per clause 2.4.6.

### 3.3.4 Light Output

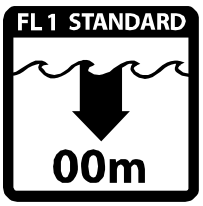

Numerical indication in the icon shall be as per clause 2.5.7.

### 3.3.5 Impact Resistant


Numerical indication in the icon shall be as per clause 2.6.6.

### 3.3.6 Water Resistant

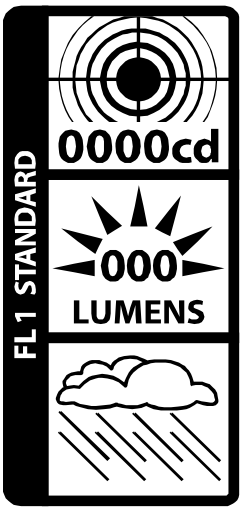
### 3.3.7 Waterproof AND Submersible



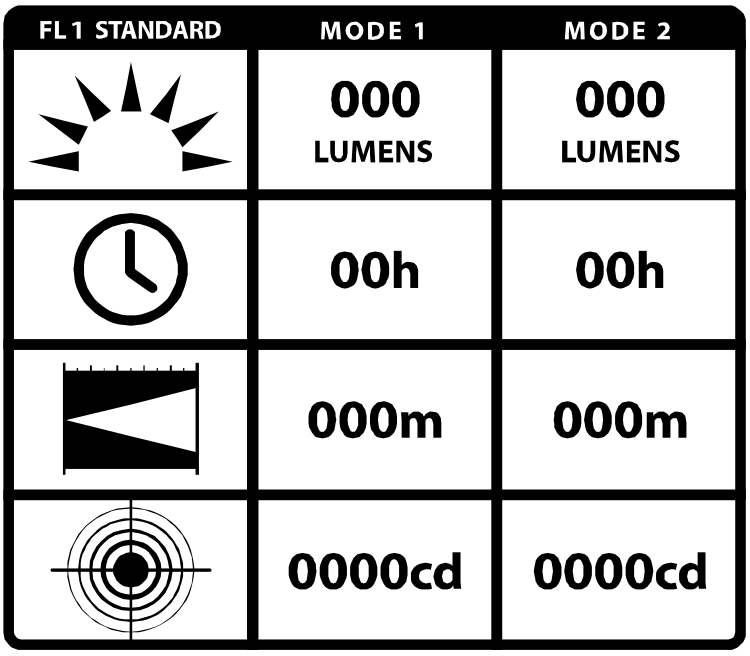

Numerical indication in the icon shall be 1m for waterproof and as per clause 2.7.6 for submersible.

### 3.4 USE OF MULTIPLE ICONS

If icons are linked together, then the solid “FL 1 Standard” border is extended to cover all icons; and this border can be on top or on the left side of the icons. The linked icons must represent a common setting / function of the lighting device (see examples below).


If the manufacturer determines to provide information for multiple settings / functions of the lighting device, then the required format will be in a table. The required table format is shown below.




The manufacturer will replace “Mode 1” and “Mode 2” in the top row of the chart with the proper identifier as determined by the manufacturer.

There are four performance criteria that could change with multiple settings / functions of the lighting device: Light Output, Run Time, Beam Distance, and Peak Beam Intensity. The manufacturer can determine which of the performance criteria to display in the table. Any row of the performance criteria shown in the table not being displayed can be eliminated from the table as needed.

If more than two modes need to be displayed, additional columns can be added as required. The top row of each column must remain the identifier of the light setting / function.

There is no size requirement for this table as long as the proportions remain consistent to the format shown above, and the information is easily legible when displayed on the packaging.

## Downloading the ANSI/NEMA FL 1 Standard Icons

Electronic Copy of Standard: To download the Adobe Illustrator file containing the ANSI/NEMA FL 1 Standard icons, double-click on the thumbtack-shaped picture below.

Hardcopy of Standard: A CD containing the file is included with purchase.

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**PLEASE NOTE:**

-ICONS AND CHARTS ARE TO SCALE
please SCALE Icons Proportionally
-TYPE is Myriad BOLD
-DO NOT adjust kerning

BEAM DISTANCE


LIGHT OUTPUT


IMPACT RESISTANCE


RUNTIME




WATER RESISTANT


WATERPROOF & SUBMERSIBLE


PEAK BEAM INTENSITY


Please use TITLE block and these BOXES
to build ANSI FL 1 Table.

REFER TO EXAMPLE FOR PROPER SPACING ETC.
SCALE PROPORTIONALLY.
PLEASE CENTER TYPE WITHIN THE TITLE BLOCK
WITH EACH COLUMN.

| FL 1 STANDARD | MODE 1 | MODE 2 |
|---|---|---|
| | | |
| | | |

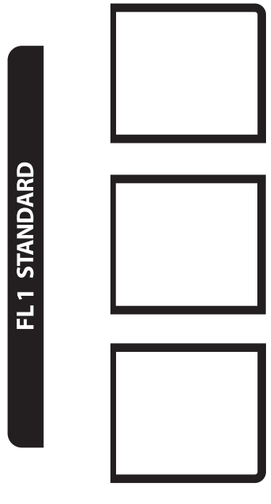
EXAMPLE

| FL 1 STANDARD | MODE 1 | MODE 2 |
|---|---|---|
| | 000 LUMENS | 000 LUMENS |
| | 00h | 00h |
| | 000m | 000m |
| | 0000cd | 0000cd |

Please use TITLE block and these BOXES
to build Vertical LINKED ICONS ANSI FL 1 Chart.

REFER TO EXAMPLE FOR PROPER SPACING ETC.
SCALE PROPORTIONALLY.
PLEASE CENTER TYPE WITHIN THE TITLE BLOCK.

EXAMPLE


EXAMPLE


Please use TITLE block and these BOXES
to build Horizontal LINKED ICONS ANSI FL 1 Chart.

REFER TO EXAMPLE FOR PROPER SPACING ETC.
SCALE PROPORTIONALLY.
PLEASE CENTER TYPE WITHIN THE TITLE BLOCK.

| FL 1 STANDARD | | |
|---|---|---|
| | | |