

ANSI C78.01650-2003

American National Standard

for electric lamps—

Pulse Start Metal-Halide Lamps
175-Watt, M152
250-Watt, M153
320-Watt, M154
400-Watt, M155

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American National Standard

Approved: October 20, 2003 Secretariat: ANSLG-- National Electrical Manufacturers Association

For Electric Lamps -

Pulse Start Metal-Halide Lamps
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Foreword (This foreword is not part of ANSI C78.1650-2003.)

Suggestions for improvement of this standard should be submitted to the Secretariat C78, American National Standard Lighting Group, 1300 North 17th Street, Suite 1847, Rosslyn VA 22209.

This standard was processed and approved by Accredited Standards Committee on Electric Lamps, C78, and its Working Group, C78 WG4 for High-Intensity Discharge Lamps. Committee approval of the standard does not necessarily imply that all committee members voted for that approval.

This document is a compilation of the new higher wattage pulse-start metal-halide lamp standards. Historically, individual metal-halide lamp standards have been designated and published as the ANSI C78.1300 series. This compilation includes the 175W/M152, 250W/M153, 320W/M154, and 400W/M155 lamps.

Information concerning the approval of this standard is based on the documents listed in the table below:

Edition	**CDV**	**RV**
First Edition	78(4)_4090 78(4)_4092 78(4)_4094 78(4)_4097	78(4)_4091 78(4)_4093 78(4)_4095 78(4)_4097

David Mullen, Chairman, ASC C78
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American National Standard

for Electric Lamps-

175-watt, M152 single-ended pulse-start metal-halide lamps

1 Lamp designation and description

Metal-halide lamp designations are assigned in accordance with ANSI C78.380.

Designation	Bulb	Base
M152/E-KA	BT28 (BT90) or ED28 (ED90)	E39 Mogul Screw
M152/E-ZL	BD17 (BD54) or ED17 (ED54)	E26/24 Medium Screw

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI C78.380-2002, *Electric Lamps - High-Intensity-Discharge Lamps - Method of Designation*

ANSI C78.387-1995, *Electric Lamps - Metal-Halide Lamps - Methods of Measuring Characteristics*

ANSI C79.1-2002, *Nomenclature for Glass Bulbs Intended for Use with Electric Lamps*

ANSI C81.61-1990, *Electric Lamp Bases*

ANSI C81.63-1991, *Electric Lamp Base and Lampholder Gauges*

ANSI C82.4-2002, *Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple Supply Type)*

ANSI C82.5-1990, *Reference Ballasts for High-Intensity-Discharge Lamps*

ANSI C82.6-1985 and ANSI C82.6a-1988, *Ballasts for High-Intensity- Discharge Lamps - Methods of Measurement*

ANSI C82.9-1996, *Definitions for High-Intensity-Discharge and Low Pressure Sodium Lamps, Ballasts, and Transformers*

UL1598 –2000, *Luminaires*

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3 Physical characteristics

3.1 Bulb designations

Bulb designations are defined in ANSI C79.1. Due to the long term use of the conventional method of bulb designations, their use will continue herein with the equivalent metric bulb designations shown in parentheses (i.e. BT28 [BT90]) in contrast with the use of metric primary dimensions elsewhere in this standard.

3.2 Base specifications

Screw-shell-type bases are specified in ANSI C81.61. Compliance shall be checked by the relevant gauges in ANSI C81.63.

3.3 General characteristics

	M152/E-KA	*M152/E-ZL*
Bulb	BT28 (BT75) ED28 (ED75)	B17 (B54) E17 (E54)
Base	E39	E26/24
Nominal diameter [1]	90.0 (3.50)	54 (2.13)
Maximum overall length (MOL) [1]	211 (8.31)	138 (5.43)
Light center length (LCL) [1]	127 ± 5 (5 ± 0.2)	86 ± 3 (3.39 ± 0.12)
Effective arc length [1]	25 ± 5 (0.98 ± 0.2)	25 ± 5 (0.98 ± 0.16)
Maximum electrode tip deviation [2]	3	3
Maximum permissible bulb temperature [3]	400 (752)	400 (752)
Maximum permissible base temperature [3]	210 (410)	210 (410)

[1] Dimensions are in mm, with equivalent inches within parentheses
[2] Maximum electrode tip deviation is from base axis (apex at base eyelet), measured in degrees
[3] Temperatures are in ºC, with equivalent ºF within parentheses

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4 Maximum outline drawings

Figure 1 [or Figures] defines the maximum outline dimensional limits, including eccentricity, of the lamp(s). The figure(s) do not define the actual bulb configuration. All dimensions are in millimeters.

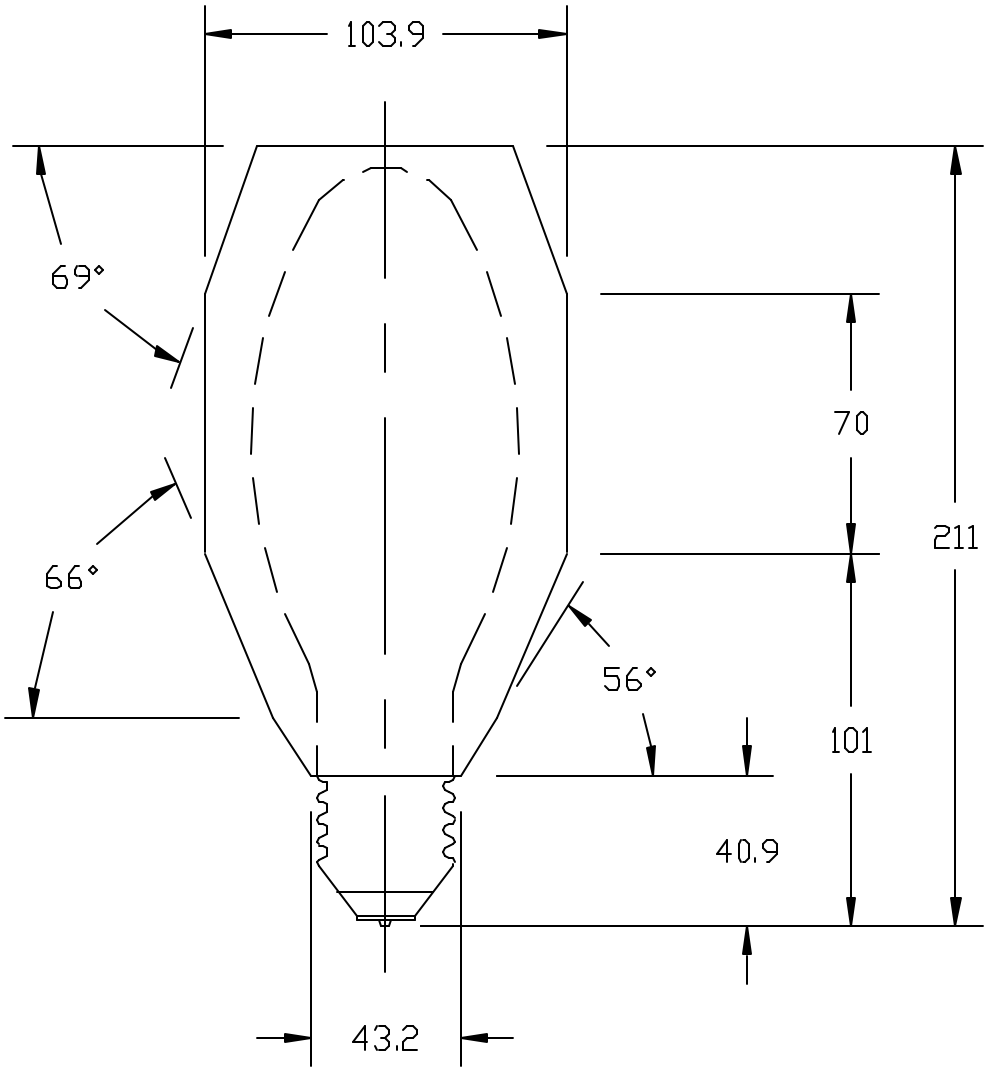


Figure 1
Maximum Outline Drawing(s)
Bulb: BT28 (BT90), ED28 (ED90)
Base: E39 mogul screw

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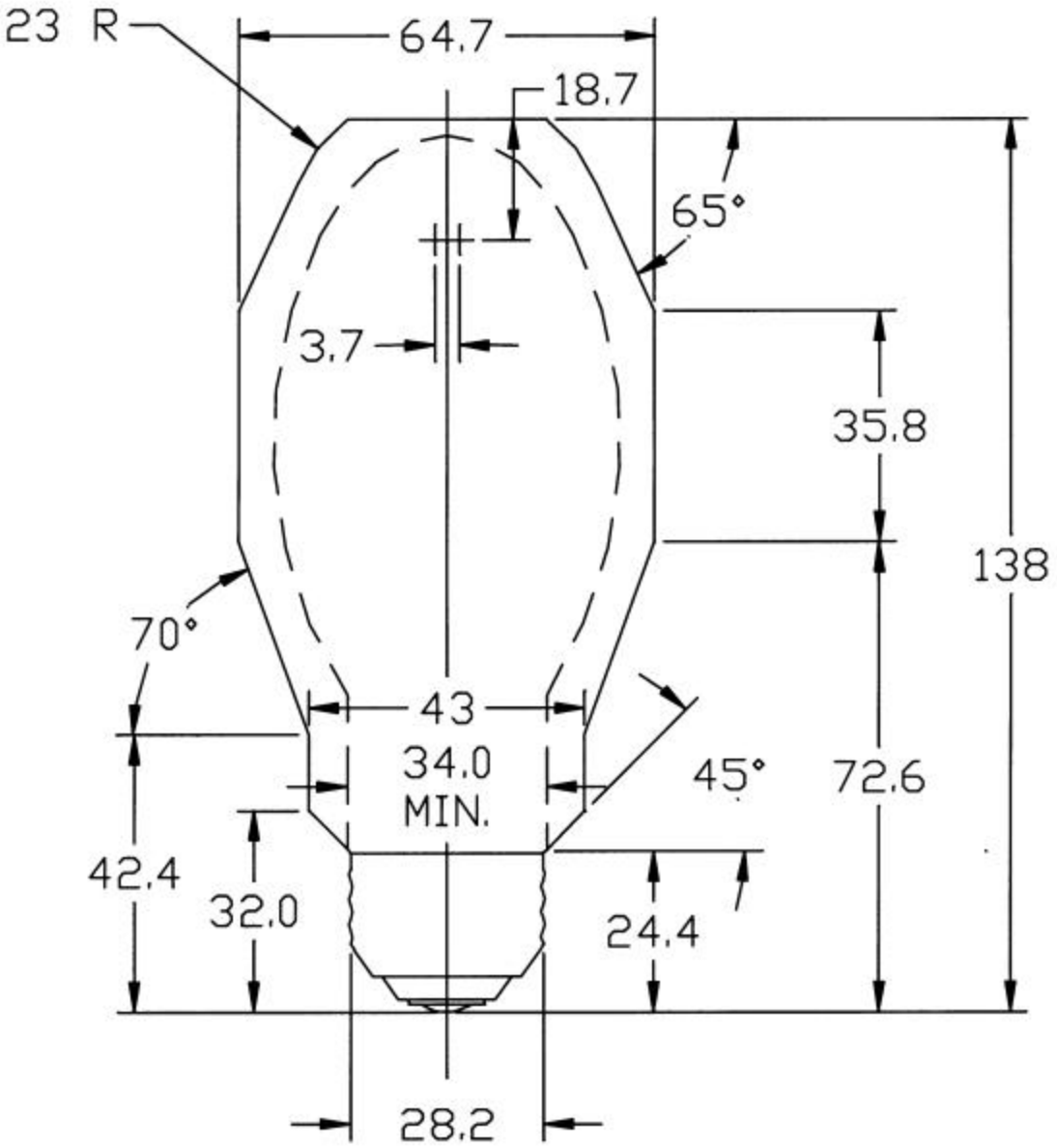


Figure 2
Maximum Outline Drawing(s)
Bulb: BD17(BD54), ED17(ED54) for Enclosed Fixtures
Base: E26 Medium Screw

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5 Electrical characteristics

See ANSI C78.387 for measurement procedures.

Lamps shall be measured in the vertical, base-up, position unless otherwise designated by the lamp manufacturer.

5.1 Lamp operating characteristics at 100 hours operation

	Min	*Nom*	*Max*
Voltage at lamp terminals (V, rms)	117	132	147
Lamp current (A, rms)	-	1.5	-
Lamp wattage (W)	-	175	-

The preceding lamp operating characteristics are based on operation in an ambient temperature of 25°C ± 5°C (77°F± 9°F) on a reference ballast as defined in Section 7.

5.2 Lamp reignition voltage spike (Vrs)

The reignition voltage spike during warm-up for any lamp shall not exceed 150 volts peak throughout life when operated on a linear reactor ballast having the following characteristics:

Supply voltage (volts, rms)	340
Ballast short circuit current (amperes, rms)	1.9
Impedance (ohms)	179
Power factor	0.075 ± 0.005
Linearity	Requirements identical to reference ballasts (see ANSI C82.5)

5.3 Lamp reignition voltage (Vr)

The maximum value through life measured on a reference ballast defined in section 7 is 270 volts.

6 Lamp starting voltage and warm-up requirements

See ANSI C78.387 for measurement procedures.

Lamps shall be measured in the vertical, base-up, position unless otherwise designated by the lamp manufacturer.

6.1 Lamp starting voltage requirements as a function of time and temperature

6.1.1 Lamp starting voltage requirements for lamps not requiring auxiliary starting circuits

Not applicable.

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6.1.2 Lamp starting voltage requirements for lamps requiring auxiliary starting circuits

Lamps shall start within the time specified at the ambient temperature indicated when the following sine-wave open-circuit test voltages and a starting pulse at the minimum pulse characteristics of 8.3 are applied. The characteristics are measured at the terminals of the lampholder. The pulse is applied to the center terminal of the lamp base with the shell grounded.

	Minimum OCV		Probability of starting
Temperature	RMS Volts	Peak Volts	within 120 seconds
10°C ± 1°C (50°F ± 2°F)	254	359	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	359	90% of 100-hour lamps

6.2 Lamp warm-up requirement

A bare lamp operating in still air at an ambient temperature of 25°C ± 5°C (77°F ± 9°F) and at the minimum specified starting current shall reach 95% of the specified minimum lamp operating voltage in not more than 10 minutes.

7 Reference ballast characteristics

See ANSI C82.5 for the general specifications for reference ballasts.

Supply voltage	220 volts*
Reference current	1.5 amperes
Impedance	102 ohms
Power factor	0.075 ± 0.005
Frequency	60 Hz

* A momentary higher open-circuit voltage and an auxiliary starting circuit as specified in section 8 may be necessary to start the lamp.

8 Data for ballast design

The ballast requirements shall be met throughout the full range of ballast rated supply voltages. They apply to ballasts integral to the luminaire as well as remotely connected ballasts or ignitors. Capacitive loading across the lampholder terminals may be necessary to simulate characteristics of remotely connected ballast.

The ballast terms used in this section are defined in ANSI C82.9 and the Methods of Measurements in ANSI C82.6. For additional limits on ballast performance, see ANSI C82.4.

8.1 Requirements for lag ballasts

8.1.1 Lag ballasts without auxiliary starting circuits

Not applicable.

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8.1.2 Lag ballasts with auxiliary starting circuits

Lag ballasts shall supply the following minimum open-circuit voltage to reliably start and sustain the arc discharge at the ambient temperatures shown below.

Temperature	Minimum OCV[1] RMS Volts	Minimum OCV[1] Peak Volts	Probability of starting within 120 seconds
10°C ± 1°C (50°F ± 2°F)	254	345[1]	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	345[1]	90% for 100-hour lamps

[1] OCV (open circuit voltage) is measured with the ignitor removed from the circuit at minimum line conditions.

See 8.3 for starting pulse requirements.

8.2 Requirements for peak lead ballast

8.2.1 Peak lead ballasts without auxiliary starting circuits

Not applicable.

8.2.2 Peak lead ballasts with auxiliary starting circuits

Peak lead ballasts shall supply the following minimum open-circuit voltage requirements to reliably start and sustain the arc discharge of the lamp at the ambient temperatures shown below.

Temperature	Minimum OCV [1] RMS Volts	Minimum OCV [1] Peak Volts	Probability of starting within 120 seconds
10°C ± 1°C (50°F ± 2°F)	254	483	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	483	90% for 100-hour lamps

[1] OCV (open circuit voltage) is measured with the ignitor removed from the circuit at minimum line conditions.

See 8.3 for starting pulse requirements.

8.2.3 Current waveshape characteristics

The following current waveshape characteristics, as determined by ballast design, are required to sustain a lamp throughout its warm-up period. See ANSI C82.6 for measurement procedures.

Maximum off-time (OT), ms	2.3
Maximum peak current, A	3.8
Maximum overshoot, mA	45 [1]

[1] Overshoot is measured with a stiff line per ANSI 82.6.

1 This value is lower than the product of 1.414 and Vrms to accommodate magnetic regulated ballasts.

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8.2.4 Minimum sustaining voltage (Vss)

Sustaining Voltage (Vss) Minimum: 270 V
The ballast shall meet this value at minimum rated input voltage for reliable lamp operation during warm-up and through life.

8.3 Ignitor (starter) requirements

The starting pulse (defined in C82.9) shall be applied to the center terminal of the lamp base with the wiring between ballast and lampholder (or its equivalent capacitance) connected. See the manufacturer's literature for the appropriate value of equivalent capacitance. The pulse, measured at the lampholder terminals across a dummy lamp load of 20pF, shall have the following characteristics:

(a) Minimum pulse height, kV	3.0
(b) Maximum pulse height, kV	4.0
(c) Minimum pulse width, µs @ kV	1.3 @ 2.7
(d) Minimum pulse repetition rate per half cycle	1
(e) Pulse position(s) for lag circuit ballasts	64°-110°, 244°-290°
(f) Pulse position(s) for lead circuit ballasts	during the period when the OCV exceeds 90% peak.
Any special starter requirements in addition to the above:	None

8.4 Starting current requirements

Amperes,(rms)	Lag Ballasts	Peak-Lead Ballasts
Minimum	1.5	1.5
Maximum	2.3	2.3

Starting current is measured 5 to 15 seconds after the lamp has started.

8.5 Current crest factor

The lamp current crest factor, at any rated supply voltage, during warm-up and operation of a reference lamp shall not exceed 1.8.

8.6 Maximum voltage across lamp terminals

8.6.1 Non-Pulse-Start circuits

Not applicable.

8.6.2 Pulse-Start circuits

A ballast shall not provide to the lamp terminals a voltage in excess of the following values:

RMS	Peak	Pulse
528	1100	4000

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8.7 Lamp operating wattage

The operating wattage of a bare lamp is measured in its designated operating position on a ballast throughout its range of rated supply voltages in a still air ambient of 25°C ± 5°C (77°F ± 9°F). The following wattage limits apply:

	Minimum (watts)	Maximum (watts)
Wattage limits, 100-hour lamps	140	210 *

To meet these limits, a ballast at 100% rated input voltage shall operate a reference lamp within ± 5% of the wattage delivered to the same lamp in the same position by a reference ballast. Also the ballast, throughout the input voltage range for which it was intended, shall operate a reference lamp within ± 15% of the wattage delivered to that reference lamp by a reference ballast at its rated voltage.

The wattage design center of a ballast intended for this lamp shall be 175 watts.

***CAUTION:** Specific wattage limits are based on normal tolerance distributions of lamp voltage, ballast adjustment, and line voltage. If these tolerances are extreme and in the same direction, the specified wattage limits could be exceeded.

For additional limits of ballast performance, see ANSI C82.4.

8.8 Minimum lamp operating wattage

Operation of metal halide lamps below the wattage limits of this standard will lower lamp efficacy and may result in color shift, arc instability, flicker and reduced lamp life. The lamp manufacturer shall be consulted before operating metal halide lamps at reduced wattage or with dimming circuits.

9 Information for luminaire design

CAUTION: To insure correct thermal operation, UV protection and non-passive failure protection, the luminaire shall be designed in accordance with lamp manufacturers' recommendations for use and application.

Metal-halide lamps are constructed of a glass bulb with an internal arc tube. These arc tubes operate under high pressure (typically 5 atmospheres) and temperature (typically 900°C or greater). The arc tube may unexpectedly rupture due to internal causes or external factors. When this occurs, the glass bulb surrounding the arc tube may break and extremely hot particles from the arc tube and glass fragments from the glass bulb may be discharged into the fixture enclosure and possibly the surrounding environment, thereby creating a risk of personal injury or other hazard.

Also see UL 1598 for requirements on the construction of luminaires.

9.1 Voltage rise, luminaire effect limit

The lamp voltage of reference lamps, operating on a sinusoidal power supply of 60 Hz with the specified reference ballast at its rated input voltage, shall not change more than 5 volts when going from stabilized operation in open air to stabilized operation in a luminaire.

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American National Standard

for Electric Lamps-

250-watt, M153 single-ended, pulse-start, metal-halide lamps

1 Lamp designation and description

Metal-halide lamp designations are assigned in accordance with ANSI C78.380.

Designation	Bulb	Base
M153/E - KA	BT28 (BT90) or ED28 (ED90)	E39 Mogul screw
M153/O - QC	BT28 (BT90) or ED28 (ED90)	EX39 Mogul Exclusionary

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

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ANSI C79.1-2002, *Nomenclature for Glass Bulbs Intended for Use with Electric Lamps*

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ANSI C82.6-1985 and ANSI C82.6a-1988, *Ballasts for High-Intensity- Discharge Lamps - Methods of Measurement*

ANSI C82.9-1996, *Definitions for High-Intensity-Discharge and Low Pressure Sodium Lamps, Ballasts, and Transformers*

UL1598 –2000, *Luminaires*

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3 Physical characteristics

3.1 Bulb designations

Bulb designations are defined in ANSI C79.1. Due to the long term use of the conventional method of bulb designations, their use will continue herein with the equivalent metric bulb designations shown in parentheses (i.e. BT28 [BT90]) in contrast with the use of metric primary dimensions elsewhere in this standard.

3.2 Base specifications

Screw-shell-type bases are specified in ANSI C81.61. Compliance shall be checked by the relevant gauges in ANSI C81.63.

3.3 General Characteristics

	M153/E-KA M153/O-QC
Bulb	BT28 (BT75) ED28 (ED75)
Base	E39 for /E EX39 for /O
Nominal diameter [1]	90.0 (3.50)
Maximum overall length (MOL) [1]	211 (8.31)
Light center length (LCL) [1]	127 ± 5 (5 ± 0.2)
Effective arc length [1]	33.5 ± 5 (1.31 ± 0.2)
Maximum electrode tip deviation [2]	3
Maximum permissible bulb temperature [3]	400 (752)
Maximum permissible base temperature [3]	210 (410)

[1] Dimensions are in mm, with equivalent inches within parentheses
[2] Maximum electrode tip deviation is from base axis (apex at base eyelet), measured in degrees
[3] Temperatures are in ºC, with equivalent ºF within parentheses

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4 Maximum outline drawings

Figure 1 [or Figures] defines the maximum outline dimensional limits, including eccentricity, of the lamp(s). The figure(s) do not define the actual bulb configuration. All dimensions are in millimeters.

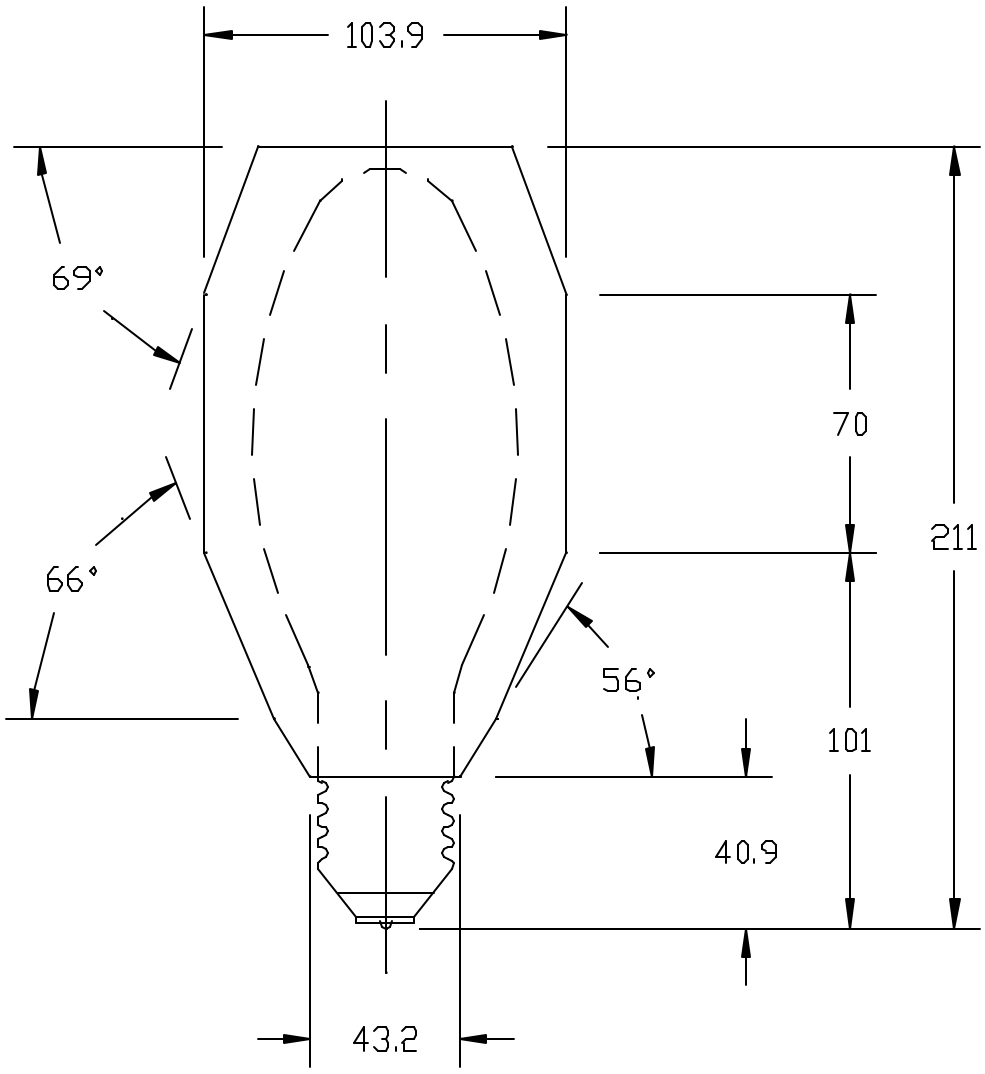


Figure 1
Maximum Outline Drawing(s)
Bulb: BT28 (BT90), ED28 (ED90)
Base: E39 mogul, EX39 mogul exclusionary

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5 Electrical characteristics

See ANSI C78.387 for measurement procedures.

Lamps shall be measured in the vertical, base-up, position unless otherwise designated by the lamp manufacturer.

5.1 Lamp operating characteristics at 100 hours operation

	Min	Nom	Max
Voltage at lamp terminals (V, rms)	118	133	148
Lamp current (A, rms)	-	2.1	-
Lamp wattage (W)	-	250	-

The preceding lamp operating characteristics are based on operation in an ambient temperature of 25°C ± 5°C (77°F± 9°F) on a reference ballast as defined in Section 7.

5.2 Lamp reignition voltage spike (Vrs)

The reignition voltage spike during warm-up for any lamp shall not exceed 150 volts peak throughout life when operated on a linear reactor ballast having the following characteristics:

Supply voltage (volts, rms)	340
Ballast short circuit current (amperes, rms)	2.5
Impedance (ohms)	136
Power factor	0.075 ± 0.005
Linearity	Requirements identical to reference ballasts (see ANSI C82.5)

5.3 Lamp reignition voltage (Vr)

The maximum value through life measured on a reference ballast defined in section 7 is 270 volts.

6 Lamp starting voltage and warm-up requirements

See ANSI C78.387 for measurement procedures.

Lamps shall be measured in the vertical, base-up, position unless otherwise designated by the lamp manufacturer.

6.1 Lamp starting voltage requirements as a function of time and temperature

6.1.1 Lamp starting voltage requirements for lamps not requiring auxiliary starting circuits

Not Applicable

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6.1.2 Lamp starting voltage requirements for lamps requiring auxiliary starting circuits

Lamps shall start within the time specified at the ambient temperature indicated when the following sine-wave open-circuit test voltages and a starting pulse at the minimum pulse characteristics of 8.3 are applied. The characteristics are measured at the terminals of the lampholder. The pulse is applied to the center terminal of the lamp base with the shell grounded.

	Minimum OCV		Probability of starting within
Temperature	RMS Volts	Peak Volts	120 seconds
10°C ± 1°C (50°F ± 2°F)	254	359	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	359	90% of 100-hour lamps

6.2 Lamp warm-up requirement

A bare lamp operating in still air at an ambient temperature of 25°C ± 5°C (77°F ± 9°F) and at the minimum specified starting current shall reach 95% of the specified minimum lamp operating voltage in not more than 10 minutes.

7 Reference ballast characteristics

See ANSI C82.5 for the general specifications for reference ballasts.

Supply voltage .....220 volts*
Reference current.....2.1 amperes
Impedance .....74 ohms
Power factor.....0.075 ± 0.005
Frequency .....60 Hz

* A momentary higher open-circuit voltage and an auxiliary starting circuit as specified in section 8 may be necessary to start the lamp.

8 Data for ballast design

The ballast requirements shall be met throughout the full range of ballast rated supply voltages. They apply to ballasts integral to the luminaire as well as remotely connected ballasts or ignitors. Capacitive loading across the lampholder terminals may be necessary to simulate characteristics of remotely connected ballast.

The ballast terms used in this section are defined in ANSI C82.9 and the Methods of Measurements in ANSI C82-6. For additional limits on ballast performance, see ANSI C82.4.

8.1 Requirements for lag ballasts

8.1.1 Lag ballasts without auxiliary starting circuits

Not Applicable

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8.1.2 Lag ballasts with auxiliary starting circuits

A lag ballast shall supply the following minimum open-circuit voltage to reliably start and sustain the arc discharge at the ambient temperatures shown below.

Temperature	Minimum OCV[1] RMS Volts	Minimum OCV[1] Peak Volts	Probability of starting within 120 seconds
10°C ± 1°C (50°F ± 2°F)	254	345[1]	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	345[1]	90% of 100-hour lamps

[1] OCV (open circuit voltage) is measured with the ignitor removed from the circuit at minimum line conditions.

See 8.3 for starting pulse requirements.

8.2 Requirements for peak lead ballast

8.2.1 Peak lead ballasts without auxiliary starting circuits

Not Applicable

8.2.2 Peak Lead ballasts with auxiliary starting circuits

A peak lead ballast shall supply the following minimum open-circuit voltage requirements to reliably start and sustain the arc discharge of the lamp at the ambient temperatures shown below.

Temperature	Minimum OCV[1] RMS Volts	Minimum OCV[1] Peak Volts	Probability of starting within 120 seconds
10°C ± 1°C (50°F ± 2°F)	254	483	98% for 0- hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	483	90% for 100 -hour lamps

[1] OCV (open circuit voltage) is measured with the ignitor removed from the circuit at minimum line conditions.

See 8.3 for starting pulse requirements.

8.2.3 Current waveshape characteristics

The following current waveshape characteristics, as determined by ballast design, are required to sustain a lamp throughout its warm-up period. See ANSI C82.6 for measurement procedures.

Maximum off-time (OT), ms	2.3
Maximum peak current, A	5.0
Maximum overshoot, mA	75 [1]

[1] Overshoot is measured with a stiff line per ANSI 82.6.

[1] This value is lower than the product of 1.414 and Vrms to accommodate magnetic regulated ballasts.

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8.2.4 Minimum sustaining voltage (Vss)

Sustaining voltage (Vss) minimum: 270 V

The ballast shall meet this value at minimum rated input voltage for reliable lamp operation during warm-up and through life.

8.3 Ignitor (starter) requirements

The starting pulse (defined in C82.9) shall be applied to the center terminal of the lamp base with the wiring between ballast and lampholder (or its equivalent capacitance) connected. See the manufacturer's literature for the appropriate value of equivalent capacitance. The pulse, measured at the lampholder terminals across a dummy lamp load of 20pF, shall have the following characteristics:

(a) Minimum pulse height, kV 3.0
(b) Maximum pulse height, kV 4.0
(c) Minimum pulse width, µs @ kV ..... 1.3 @ 2.7
(d) Minimum pulse repetition rate per half cycle 1
(e) Pulse position(s) for lag circuit ballasts ..... 64°-110°, 244°-290°
(f) Pulse position(s) for lead circuit ballasts ..... During the period when the OCV exceeds 90% peak.

Any special starter requirements in addition to the above: .. None

8.4 Starting current requirements

Amperes, rms	Lag Ballasts	Peak-Lead Ballasts
Minimum	2.1	2.1
Maximum	3.2	3.2

Starting current is measured 5 to 15 seconds after the lamp has started.

8.5 Current crest factor

The lamp current crest factor, at any rated supply voltage, during warm-up and operation of a reference lamp shall not exceed 1.8.

8.6 Maximum voltage across lamp terminals

8.6.1 Non-pulse-start circuits

Not Applicable.

8.6.2 Pulse-start circuits

A ballast shall not provide to the lamp terminals a voltage in excess of the following values:

RMS	Peak	Pulse
528	1100	4000

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8.7 Lamp operating wattage

The operating wattage of a bare lamp is measured in its designated operating position on a ballast throughout its range of rated supply voltages in a still air ambient of 25°C ± 5°C (77°F ± 9°F). The following wattage limits apply:

	Minimum (watts)	Maximum (watts)
Wattage limits, 100-hour lamps	200	300 *

To meet these limits, a ballast at 100% rated input voltage shall operate a reference lamp within ± 5% of the wattage delivered to the same lamp in the same position by a reference ballast. Also the ballast, throughout the input voltage range for which it was intended, shall operate a reference lamp within ± 15% of the wattage delivered to that reference lamp by a reference ballast at its rated voltage.

The wattage design center of a ballast intended for this lamp shall be 250 watts.

***CAUTION:** Specific wattage limits are based on normal tolerance distributions of lamp voltage, ballast adjustment, and line voltage. If these tolerances are extreme and in the same direction, the specified wattage limits could be exceeded.

For additional limits of ballast performance, see ANSI C82.4.

8.8 Minimum lamp operating wattage

Operation of metal halide lamps below the wattage limits of this standard will lower lamp efficacy and may result in color shift, arc instability, flicker and reduced lamp life. The lamp manufacturer shall be consulted before operating metal halide lamps at reduced wattage or with dimming circuits.

9 Information for luminaire design

CAUTION: To insure correct thermal operation, UV protection and non-passive failure protection, the luminaire shall be designed in accordance with lamp manufacturers' recommendations for use and application.

Metal-halide lamps are constructed of a glass bulb with an internal arc tube. These arc tubes operate under high pressure (typically 5 atmospheres) and temperature (typically 900°C or greater). The arc tube may unexpectedly rupture due to internal causes or external factors. When this occurs, the glass bulb surrounding the arc tube may break and extremely hot particles from the arc tube and glass fragments from the glass bulb may be discharged into the fixture enclosure and possibly the surrounding environment, thereby creating a risk of personal injury or other hazard.

Also see UL 1598 for requirements on the construction of luminaires.

9.1 Voltage rise, luminaire effect limit

The lamp voltage of reference lamps, operating on a sinusoidal power supply of 60 Hz with the specified reference ballast at its rated input voltage, shall not change more than 5 volts when going from stabilized operation in open air to stabilized operation in a luminaire.

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American National Standard

for Electric Lamps -

320-watt, M154 single-ended pulse start metal-halide lamps

1 Lamp Designation and Description

Metal-halide lamp designations are assigned in accordance with ANSI C78.380.

Designation	Bulb	Base
M154/E - KA	BT28 (BT90) or ED28 (ED90)	E39 Mogul Screw
M154/O - QC	BT28 (BT90) or ED28 (ED90)	EX39 Mogul Exclusionary
M154/E - ZC	BT37 (BT118) or ED37 (ED118)	E39 Mogul Screw
M154/O – TC	BT37 (BT118) or ED37 (ED118)	EX39 Mogul Exclusionary

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI C78.380-2002, *Electric Lamps - High-Intensity-Discharge Lamps - Method of Designation*

ANSI C78.387-1995, *Electric Lamps - Metal-Halide Lamps - Methods of Measuring Characteristics*

ANSI C79.1-2002, *Nomenclature for Glass Bulbs Intended for Use with Electric Lamps*

ANSI C81.61-1990, *Electric Lamp Bases*

ANSI C81.63-1991, *Electric Lamp Base and Lampholder Gauges*

ANSI C82.4-2002, *Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple Supply Type)*

ANSI C82.5-1990, *Reference Ballasts for High-Intensity-Discharge Lamps*

ANSI C82.6-1985 and ANSI C82.6a-1988, *Ballasts for High-Intensity- Discharge Lamps - Methods of Measurement*

ANSI C82.9-1996, *Definitions for High-Intensity-Discharge and Low Pressure Sodium Lamps, Ballasts, and Transformers*

UL1598 –2000, *Luminaires*

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3 Physical Characteristics

3.1 Bulb Designations

Bulb designations are defined in ANSI C79.1. Due to the long term use of the conventional method of bulb designations, their use will continue herein with the equivalent metric bulb designations shown in parentheses (i.e. BT28 [BT90]) in contrast with the use of metric primary dimensions elsewhere in this standard.

3.2 Base Specifications

Screw-shell-type bases are specified in ANSI C81.61. Compliance shall be checked by the relevant gauges in ANSI C81.63.

3.3 General Characteristics

	M154/O-QC M154/E-KA	M154/O-TC M154/E-ZC
Bulb	BT28 (BT75) ED28 (ED75)	BT37 (BT118) ED37 (ED118)
Base	E39 for /E EX39 for /O	E39 for /E EX39 for /O
Nominal diameter [1]	90.0 (3.50)	118 (4.6)
Maximum overall length (MOL) [1]	211 (8.31)	292 (11.5)
Light center length (LCL) [1]	127 ± 5 (5 ± 0.2)	178 ± 6 (7 ± 0.24)
Effective arc length [1]	31 ± 7 (1.22 ± 0.28)	31 ± 7 (1.22 ± 0.28)
Maximum electrode tip deviation [2]	3	3
Maximum permissible bulb temperature [3]	400 (752)	400 (752)
Maximum permissible base temperature [3]	210 (410)	210 (410)

[1] Dimensions are in mm, with equivalent inches within parentheses
[2] Maximum electrode tip deviation is from base axis (apex at base eyelet), measured in degrees
[3] Temperatures are in ºC, with equivalent ºF within parentheses

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4 Maximum Outline Drawings

Figure 1 [or Figures 1(a) and (b)] defines the maximum outline dimensional limits, including eccentricity, of the lamp(s). The figure(s) do not define the actual bulb configuration. All dimensions are in millimeters.

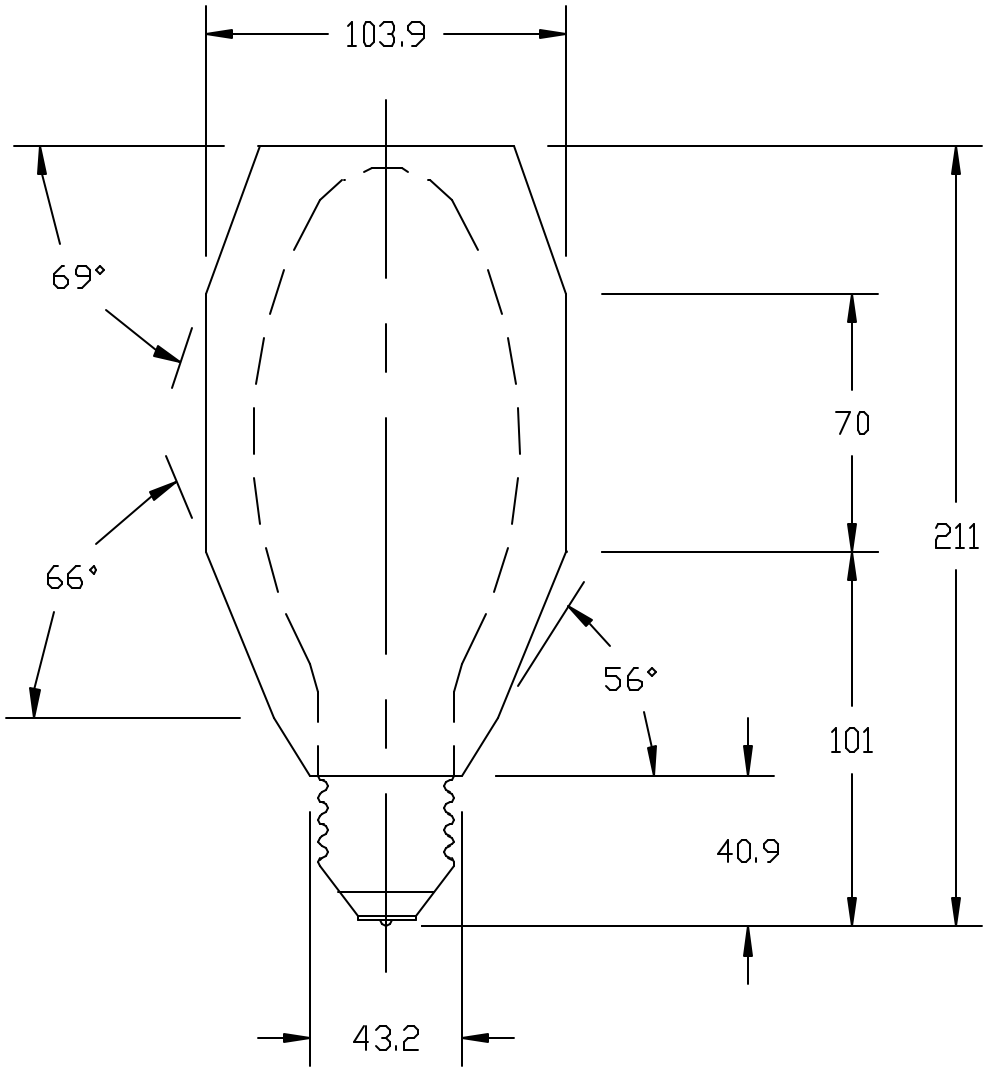


Figure 1a
Maximum Outline Drawing(s)
Bulb: BT28 (BT90), ED28 (ED90)
Base: E39 mogul screw, EX39 mogul exclusionary

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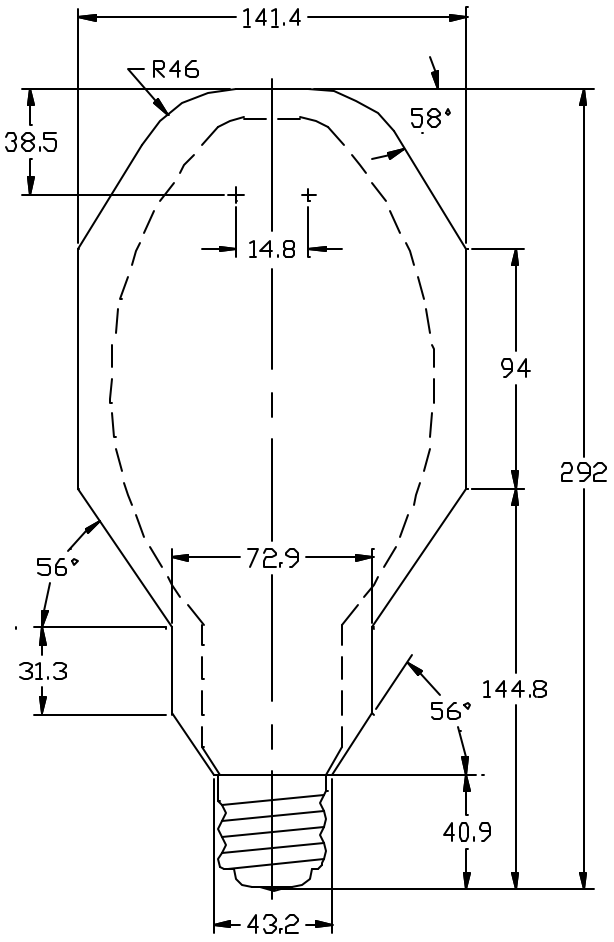


Figure 1b
Maximum Outline Drawing(s)
Bulb: BT37 (BT118), ED37 (ED118)
Base: E39 mogul screw, EX39 mogul exclusionary

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5 Electrical characteristics

See ANSI C78.387 for measurement procedures.

Lamps shall be measured in the vertical, base-up, position unless otherwise designated by the lamp manufacturer.

5.1 Lamp operating characteristics at 100 hours operation

	Min	Nom	Max
Voltage at lamp terminals (V, rms)	120	135	150
Lamp current (A, rms)	-	2.63	-
Lamp wattage (W)	-	320	-

The preceding lamp operating characteristics are based on operation in an ambient temperature of 25°C ± 5°C (77°F± 9°F) on a reference ballast as defined in Section 7.

5.2 Lamp reignition voltage spike (Vrs)

The reignition voltage spike during warm-up for any lamp shall not exceed 150 volts peak throughout life when operated on a linear reactor ballast having the following characteristics:

Supply voltage (volts, rms)	350
Ballast short circuit current (amperes, rms)	3.89
Impedance (ohms)	90
Power factor	0.075 ± 0.005
Linearity	Requirements identical to reference ballasts (see ANSI C82.5)

5.3 Lamp reignition voltage (Vr)

The maximum value through life measured on a reference ballast defined in section 7 is 270 volts.

6 Lamp starting voltage and warm-up requirements

See ANSI C78.387 for measurement procedures.

Lamps shall be measured in the vertical, base-up, position unless otherwise designated by the lamp manufacturer.

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6.1 Lamp starting voltage requirements as a function of time and temperature

6.1.1 Lamp starting voltage requirements for lamps not requiring auxiliary starting circuits

Not applicable

6.1.2 Lamp starting voltage requirements for lamps requiring auxiliary starting circuits

Lamps shall start within the time specified at the ambient temperature indicated when the following sine-wave open-circuit test voltages and a starting pulse at the minimum pulse characteristics of 8.3 are applied. The characteristics are measured at the terminals of the lamp holder. The pulse is applied to the center terminal of the lamp base with the shell grounded.

	Minimum OCV		Probability of starting within
Temperature	RMS Volts	Peak Volts	120 seconds
10°C ± 1°C (50°F ± 2°F)	254	359	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	359	90% of 100-hour lamps

6.2 Lamp warm-up requirement

A bare lamp operating in still air at an ambient temperature of 25°C ± 5°C (77°F ± 9°F) and at the minimum specified starting current shall reach 95% of the specified minimum lamp operating voltage in not more than 10 minutes.

7 Reference ballast characteristics

See ANSI C82.5 for the general specifications for reference ballasts.

Supply voltage .....220 volts*
Reference current.....2.63 amperes
Impedance .....55 ohms
Power factor.....0.075 ± 0.005
Frequency .....60 Hz

* A momentary higher open-circuit voltage and an auxiliary starting circuit as specified in section 8 may be necessary to start the lamp.

8 Data for Ballast Design

The ballast requirements shall be met throughout the full range of ballast rated supply voltages. They apply to ballasts integral to the luminaire as well as remotely connected ballasts or ignitors. Capacitive loading across the lampholder terminals may be necessary to simulate characteristics of remotely connected ballast.

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The ballast terms used in this section are defined in ANSI C82.9 and the Methods of Measurements in ANSI C82-6. For additional limits on ballast performance, see ANSI C82.4.

For additional limits on ballast performance, see ANSI C82.4.

8.1 Requirements for lag ballasts

8.1.1 Lag ballasts without auxiliary starting circuits

Not Applicable

8.1.2 Lag ballasts with auxiliary starting circuits

A lag ballast shall supply the following minimum open-circuit voltage to reliably start and sustain the arc discharge at the ambient temperatures shown below.

	Minimum OCV[1]		Probability of starting within 120
Temperature	RMS Volts	Peak Volts	seconds
10°C ± 1°C (50°F ± 2°F)	254	345[1]	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	345[1]	90% of 100-hour lamps

[1] OCV (open circuit voltage) is measured with the ignitor removed from the circuit at minimum line conditions.

See 8.3 for starting pulse requirements.

8.2 Requirements for peak lead ballast

8.2.1 Peak lead ballasts without auxiliary starting circuits

Not Applicable

8.2.2 Peak Lead Ballasts with Auxiliary Starting Circuits

A peak lead ballast shall supply the following minimum open-circuit voltage requirements to reliably start and sustain the arc discharge of the lamp at the ambient temperatures shown below.

	Minimum OCV[1]		Probability of starting within
Temperature	RMS Volts	Peak Volts	time specified
10°C ± 1°C (50°F ± 2°F)	254	483	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	483	90% of 100-hour lamps

[1] OCV (open circuit voltage) is measured with the ignitor removed from the circuit at minimum line conditions.

See 8.3 for starting pulse requirements.

[1] This value is lower than the product of 1.414 and Vrms to accommodate magnetic regulated ballasts.

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8.2.3 Current waveshape characteristics

The following current waveshape characteristics, as determined by ballast design, are required to sustain a lamp throughout its warm-up period. See ANSI C82.6 for measurement procedures.

Maximum off-time (OT), ms	2.3
Maximum peak current, A	5.7
Maximum overshoot, mA	80 [1]

[1] Overshoot is measured with a maximum source impedance of 0.3 ohms.

8.2.4 Minimum sustaining voltage (Vss)

Sustaining Voltage (Vss) Minimum: 270 V

The ballast shall meet this value at minimum rated input voltage for reliable lamp operation during warm-up and through life.

8.3 Ignitor (starter) requirements

The starting pulse (Defined in C82.9) shall be applied to the center terminal of the lamp base with the wiring between ballast and lampholder (or its equivalent capacitance) connected. See the manufacturer's literature for the appropriate value of equivalent capacitance. The pulse, measured at the lampholder terminals across a dummy lamp load of 20pF, shall have the following characteristics:

(a) Minimum pulse height, kV.....3.0
(b) Maximum pulse height, kV.....4.0
(c) Minimum pulse width, µs @ kV.....1.3 @ 2.7
(d) Minimum pulse repetition rate per half cycle 1
(e) Pulse position(s) for lag circuit ballasts.....64°-110°, 244°-290°
(f) Pulse position(s) for lead circuit ballasts.....During the period when the OCV exceeds 90% peak.

Any special starter requirements in addition to the above: .....None

8.4 Starting current requirements

Amperes, (rms)	Lag Ballasts	Peak-Lead Ballasts
Minimum	2.63	2.63
Maximum	4.0	4.0

Starting current is measured 5 to 15 seconds after the lamp has started.

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8.5 Current crest factor

The lamp current crest factor, at any rated supply voltage, during warm-up and operation of a reference lamp shall not exceed 1.8.

8.6 Maximum voltage across lamp terminals

8.6.1 Non-pulse-start circuits

Not Applicable.

8.6.2 Pulse-start circuits

A ballast shall not provide to the lamp terminals a voltage in excess of the following values:

RMS	Peak	Pulse
528	1100	4000

8.7 Lamp Operating Wattage

The operating wattage of a bare lamp is measured in its designated operating position on a ballast throughout its range of rated supply voltages in a still air ambient of 25°C ± 5°C (77°F ± 9°F). The following wattage limits apply:

	Minimum (watts)	Maximum (watts)
Wattage limits, 100-hour lamps	256	384 *

To meet these limits, a ballast at 100% rated input voltage shall operate a reference lamp within ± 5% of the wattage delivered to the same lamp in the same position by a reference ballast. Also the ballast, throughout the input voltage range for which it was intended, shall operate a reference lamp within ± 15% of the wattage delivered to that reference lamp by a reference ballast at its rated voltage.

The wattage design center of a ballast intended for this lamp shall be 320 watts.

***CAUTION:** Specific wattage limits are based on normal tolerance distributions of lamp voltage, ballast adjustment, and line voltage. If these tolerances are extreme and in the same direction, the specified wattage limits could be exceeded.

For additional limits of ballast performance, see ANSI C82.4.

8.8 Minimum lamp operating wattage

Operation of metal halide lamps below the wattage limits of this standard will lower lamp efficacy and may result in color shift, arc instability, flicker and reduced lamp life. The lamp manufacturer shall be consulted before operating metal halide lamps at reduced wattage or with dimming circuits.

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9 Information for Luminaire Design

CAUTION: To insure correct thermal operation, UV protection and non-passive failure protection, the luminaire shall be designed in accordance with lamp manufacturers' recommendations for use and application.

Metal-halide lamps are constructed of a glass bulb with an internal arc tube. These arc tubes operate under high pressure (typically 5 atmospheres) and temperature (typically 900°C or greater). The arc tube may unexpectedly rupture due to internal causes or external factors. When this occurs, the glass bulb surrounding the arc tube may break and extremely hot particles from the arc tube and glass fragments from the glass bulb may be discharged into the fixture enclosure and possibly the surrounding environment, thereby creating a risk of personal injury or other hazard.

Also see UL1598 for requirements on the construction of luminaires.

9.1 Voltage rise, luminaire effect limit

The lamp voltage of reference lamps, operating on a sinusoidal power supply of 60 Hz with the specified reference ballast at its rated input voltage, shall not change more than 5 volts when going from stabilized operation in open air to stabilized operation in a luminaire.

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American National Standard

for Eectric Lamps -

400-watt, M155 single-ended pulse-start metal-halide lamps

1 Lamp designation and description

Metal-halide lamp designations are assigned in accordance with ANSI C78.380.

M155/E - KA	BT28 (BT90) or ED28 (ED90)	E39 Mogul Screw
M155/O - QC	BT28 (BT90) or ED28 (ED90)	EX39 Mogul Exclusionary
M155/S - ZC	BT37 (BT118) or ED37 (ED118)	E39 Mogul Screw
M155/E - ZC	BT37 (BT118) or ED37 (ED118)	E39 Mogul Screw
M155/O - TC	BT37 (BT118) or ED37 (ED118)	EX39 Mogul Exclusionary

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

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ANSI C78.387-1995, *Electric Lamps - Metal-Halide Lamps - Methods of Measuring Characteristics*

ANSI C79.1-2002, *Nomenclature for Glass Bulbs Intended for Use with Electric Lamps*

ANSI C81.61-1990, *Electric Lamp Bases*

ANSI C81.63-1991, *Electric Lamp Base and Lampholder Gauges*

ANSI C82.4-2002, *Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple Supply Type)*

ANSI C82.5-1990, *Reference Ballasts for High-Intensity-Discharge Lamps*

ANSI C82.6-1985 and ANSI C82.6a-1988, *Ballasts for High-Intensity- Discharge Lamps - Methods of Measurement*

ANSI C82.9-1996, *Definitions for High-Intensity-Discharge and Low Pressure Sodium Lamps, Ballasts, and Transformers*

UL1598 –2000, *Luminaires*

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3 Physical characteristics

3.1 Bulb designations

Bulb designations are defined in ANSI C79.1. Due to the long term use of the conventional method of bulb designations, their use will continue herein with the equivalent metric bulb designations shown in parentheses (i.e. BT28 [BT90]) in contrast with the use of metric primary dimensions elsewhere in this standard.

3.2 Base specifications

Screw-shell-type bases are specified in ANSI C81.61. Compliance shall be checked by the relevant gauges in ANSI C81.63.

3.3 General characteristics

	M155/O-QC M155/E-KA	M155/O-TC M155/S-ZC M155/E-ZC
Bulb	BT28 (BT75) ED28 (ED75)	BT37 (BT118) ED37 (ED118)
Base	E39 for /E EX39 for /O	E39 for /E and /S EX39 for /O
Nominal diameter [1]	90.0 (3.50)	118 (4.6)
Maximum overall length (MOL) [1]	211 (8.31)	292 (11.5)
Light center length (LCL) [1]	127 ± 5 (5 ± 0.2)	178 ± 6 (7 ± 0.24)
Effective arc length [1]	39 ± 7 (1.54 ± 0.24)	39 ± 7 (1.54 ± 0.24)
Maximum electrode tip deviation [2]	3	3
Maximum permissible bulb temperature [3]	400 (752)	400 (752)
Maximum permissible base temperature [3][4]	210 (410)	210 (410)

[1] Dimensions are in mm, with equivalent inches within parentheses

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[2] Maximum electrode tip deviation is from base axis (apex at base eyelet), measured in degrees
[3] Temperatures are in ºC, with equivalent ºF within parentheses
[4] Some manufacturers rate base temperature at values up to 250C.

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4 Maximum outline drawings

Figure 1 [or Figures 1(a) and (b)] defines the maximum outline dimensional limits, including eccentricity, of the lamp(s). The figure(s) do not define the actual bulb configuration. All dimensions are in millimeters.

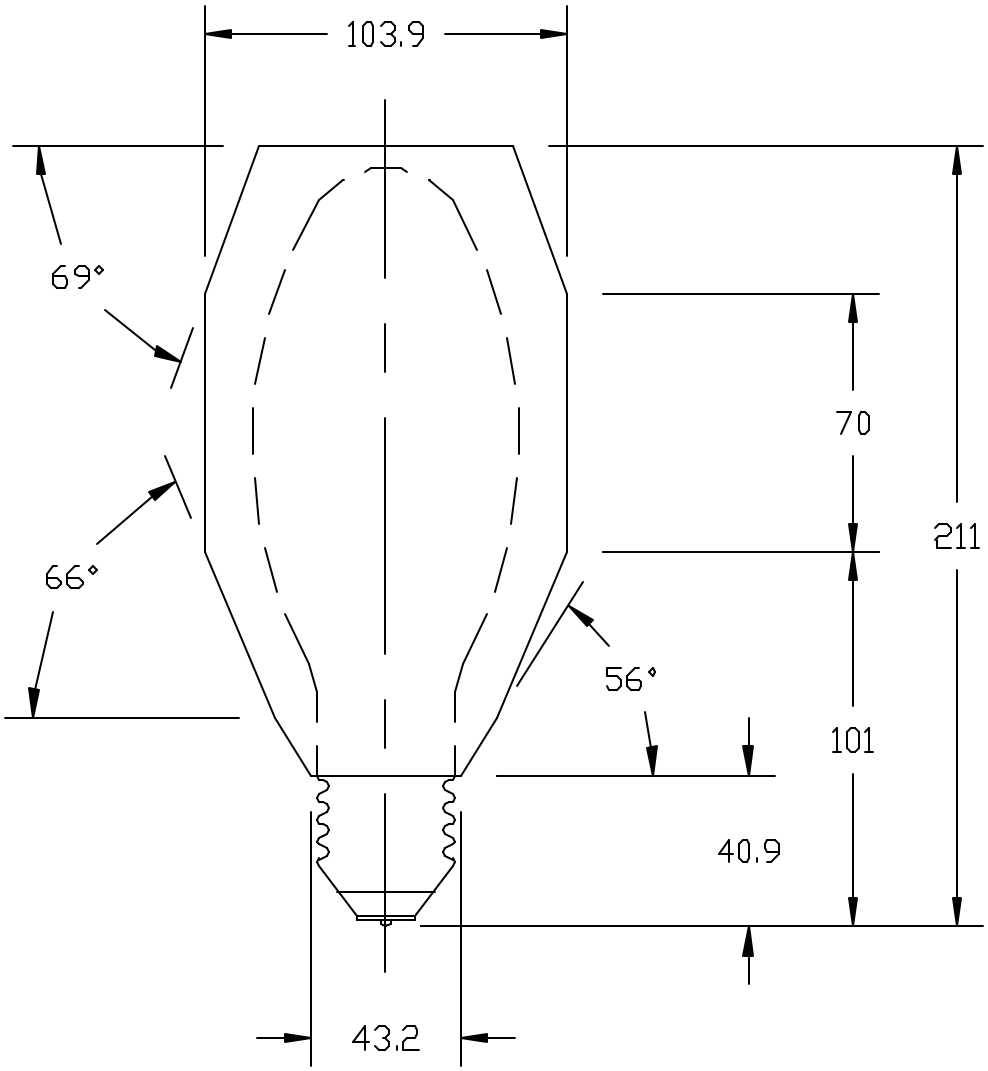


Figure 1a
Maximum Outline Drawing
Bulb: BT28 (BT90), ED28 (ED90)
Base: E39 mogul, EX39 mogul exclusionary

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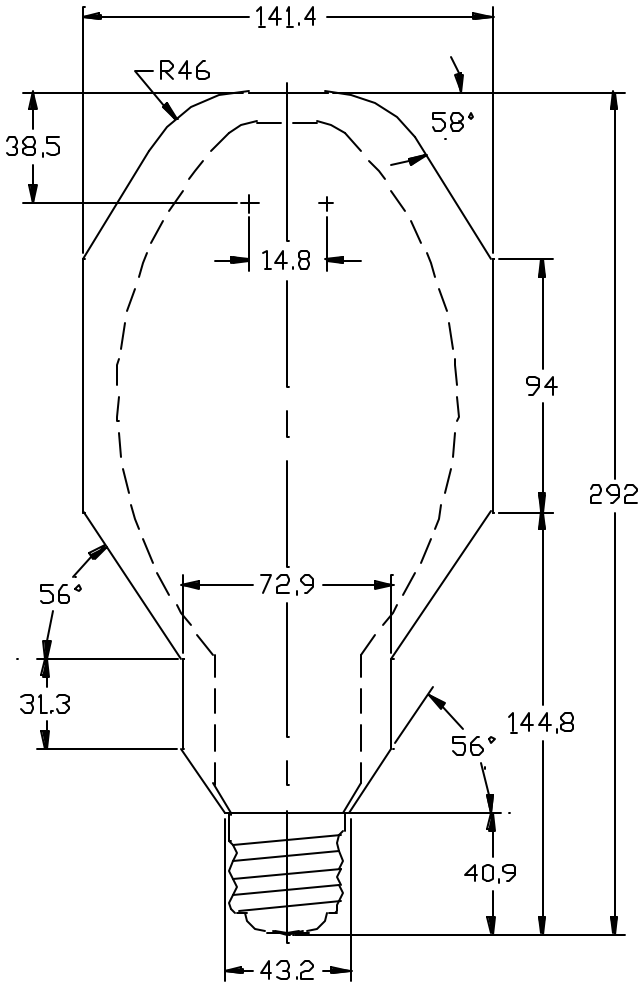


Figure 1b
Maximum Outline Drawing
Bulb: BT37 (BT118), ED37 (ED118)
Base: E39 mogul, EX39 mogul exclusionary

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5 Electrical characteristics

See ANSI C78.387 for measurement procedures.

Lamps shall be measured in the vertical, base-up, position unless otherwise designated by the lamp manufacturer.

5.1 Lamp operating characteristics at 100 hours operation

	Min	Nom	Max
Voltage at lamp terminals (V, rms)	120	135	150
Lamp current (A, rms)	-	3.25	-
Lamp wattage (W)	-	400	-

The preceding lamp operating characteristics are based on operation in an ambient temperature of 25°C ± 5°C (77°F± 9°F) on a reference ballast as defined in Section 7.

5.2 Lamp reignition voltage spike (Vrs)

The reignition voltage spike during warm-up for any lamp shall not exceed 150 volts peak throughout life when operated on a linear reactor ballast having the following characteristics:

Supply voltage (volts, rms)	350
Ballast short circuit current (amperes, rms)	4.00
Impedance (ohms)	87.5
Power factor	0.075 ± 0.005
Linearity	Requirements identical to reference ballasts (see ANSI C82.5)

5.3 Lmp reignition voltage (Vr)

The maximum value through life measured on a reference ballast defined in section 7 is 270 volts.

6 Lamp starting voltage and warm-up requirements

See ANSI C78.387 for measurement procedures.

Lamps shall be measured in the vertical, base-up, position unless otherwise designated by the lamp manufacturer.

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6.1 Lamp starting voltage requirements as a function of time and temperature

6.1.1 Lamp starting voltage requirements for lamps not requiring auxiliary starting circuits

Not aplicable

6.1.2 Lamp starting voltage requirements for lamps requiring auxiliary starting circuits

Lamps shall start within the time specified at the ambient temperature indicated when the following sine-wave open-circuit test voltages and a starting pulse at the minimum pulse characteristics of 8.3 are applied. The characteristics are measured at the terminals of the lamp holder. The pulse is applied to the center terminal of the lamp base with the shell grounded.

	Minimum OCV		Probability of starting within 120
Temperature	RMS Volts	Peak Volts	seconds
10°C ± 1°C (50°F ± 2°F)	254	359	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	359	90% of 100-hour lamps

6.2 Lamp warm-up requirement

A bare lamp operating in still air at an ambient temperature of 25°C ± 5°C (77°F ± 9°F) and at the minimum specified starting current shall reach 95% of the specified minimum lamp operating voltage in not more than 10 minutes.

7 Reference ballast characteristics

See ANSI C82.5 for the general specifications for reference ballasts.

Supply voltage	220 volts*
Reference current	3.25 amperes
Impedance	45 ohms
Power factor	0.075 ± 0.005
Frequency	60 Hz

* A momentary higher open-circuit voltage and an auxiliary starting circuit as specified in section 8 may be necessary to start the lamp.

8 Data for ballast design

The ballast requirements shall be met throughout the full range of ballast rated supply voltages. They apply to ballasts integral to the luminaire as well as remotely connected ballasts or ignitors. Capacitive loading across the lamp holder terminals may be necessary to simulate characteristics of remotely connected ballast.

The ballast terms used in this section are defined in ANSI C82.9 and the Methods of Measurements in ANSI C82-6. For additional limits on ballast performance, see ANSI C82.4.

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8.1 Requirements for lag ballasts

8.1.1 Lag ballasts without auxiliary starting circuits

Not applicable

Lag Ballasts with Auxiliary Starting Circuits

A lag ballast shall supply the following minimum open-circuit voltage to reliably start and sustain the arc discharge at the ambient temperatures shown below.

	Minimum OCV[1]		Probability of starting within
Temperature	RMS Volts	Peak Volts	120 seconds
10°C ± 1°C (50°F ± 2°F)	254	345[1]	98% for 0-hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	345[1]	90% of 100-hour lamps

[1] OCV (open circuit voltage) is measured with the ignitor removed from the circuit at minimum line conditions.

See 8.3 for starting pulse requirements.

8.2 Requirements for peak lead ballast

8.2.1 Peak lead ballasts without auxiliary starting circuits

Not applicable

8.2.2 Peak lead ballasts with auxiliary starting circuits

A peak lead ballast shall supply the following minimum open-circuit voltage requirements to reliably start and sustain the arc discharge of the lamp at the ambient temperatures shown below.

	Minimum OCV [1]		Probability of starting
Temperature	Rms Volts,	Peak Volts	within 120 seconds
10°C ± 1°C (50°F ± 2°F)	254	483	98% for 0- hour lamps
-30°C ± 1°C (-22°F ± 2°F)	254	483	90% for 100 -hour lamps

[1] OCV (open circuit voltage) is measured with the ignitor removed from the circuit at minimum line conditions.

See 8.3 for starting pulse requirements.

1 This value is lower than the product of 1.414 and Vrms to accommodate magnetic regulated ballasts.

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8.2.3 Current waveshape characteristics

The following current waveshape characteristics, as determined by ballast design, are required to sustain a lamp throughout its warm-up period. See ANSI C82.6 for measurement procedures.

Maximum off-time (OT), ms	2.3
Maximum peak current, A	9.0
Maximum overshoot, mA	100 [1]

[1] Overshoot is measured with a stiff line per ANSI 82.6.

8.2.4 Minimum sustaining voltage (Vss)

Sustaining Voltage (Vss) Minimum: 270 V

The ballast shall meet this value at minimum rated input voltage for reliable lamp operation during warm-up and through life.

8.3 Ignitor (starter) requirements

The starting pulse (Defined in C82.9) shall be applied to the center terminal of the lamp base with the wiring between ballast and lampholder (or its equivalent capacitance) connected. See the manufacturer's literature for the appropriate value of equivalent capacitance. The pulse, measured at the lampholder terminals across a dummy lamp load of 20pF, shall have the following characteristics:

(a) Minimum pulse height, kV.....3.0

(b) Maximum pulse height, kV.....4.0

(c) Minimum pulse width, µs @ kV .....1.3 @ 2.7

(d) Minimum pulse repetition rate per half cycle 1

(e) Pulse position(s) for lag circuit ballasts.....64°-110°, 244°-290°

(f) Pulse position(s) for lead circuit ballasts.....during the period when the OCV exceeds 90% peak.

Any special starter requirements in addition to the above:....None

8.4 Starting current requirements

Amperes, rms	Lag Ballasts	Peak-Lead Ballasts
Minimum	3.2	3.2
Maximum	5.0	5.0

Starting current is measured 5 to 15 seconds after the lamp has started.

8.5 Current crest factor

The lamp current crest factor, at any rated supply voltage, during warm-up and operation of a reference lamp shall not exceed 1.8.

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8.6 Maximum voltage across lamp terminals

8.6.1 Non-pulse-start circuits

Not applicable.

8.6.2 Pulse-start circuits

A ballast shall not provide to the lamp terminals a voltage in excess of the following values:

RMS	Peak	Pulse
528	1100	4000

8.7 Lamp operating wattage

The operating wattage of a bare lamp is measured in its designated operating position on a ballast throughout its range of rated supply voltages in a still air ambient of 25°C ± 5°C (77°F ± 9°F). The following wattage limits apply:

	Minimum (watts)	Maximum (watts)
Wattage limits, 100-hour lamps	320	480 *

To meet these limits, a ballast at 100% rated input voltage shall operate a reference lamp within ± 5% of the wattage delivered to the same lamp in the same position by a reference ballast. Also the ballast, throughout the input voltage range for which it was intended, shall operate a reference lamp within ± 15% of the wattage delivered to that reference lamp by a reference ballast at its rated voltage.

The wattage design center of a ballast intended for this lamp shall be 400 watts.

***CAUTION:** Specific wattage limits are based on normal tolerance distributions of lamp voltage, ballast adjustment, and line voltage. If these tolerances are extreme and in the same direction, the specified wattage limits could be exceeded.

For additional limits of ballast performance, see ANSI C82.4.

8.8 Minimum lamp operating wattage

Operation of metal halide lamps below the wattage limits of this standard will lower lamp efficacy and may result in color shift, arc instability, flicker and reduced lamp life. The lamp manufacturer shall be consulted before operating metal halide lamps at reduced wattage or with dimming circuits.

9 Information for luminaire design

CAUTION: To insure correct thermal operation, UV protection and non-passive failure protection, the luminaire shall be designed in accordance with lamp manufacturers' recommendations for use and application.

Metal-halide lamps are constructed of a glass bulb with an internal arc tube. These arc tubes operate under high pressure (typically 5 atmospheres) and temperature (typically 900°C or greater). The arc tube may unexpectedly rupture due to internal causes or external factors. When this occurs, the glass bulb surrounding the arc tube may break and extremely hot particles from the arc tube and glass fragments from the glass bulb may be

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discharged into the fixture enclosure and possibly the surrounding environment, thereby creating a risk of personal injury or other hazard.

Also see UL 1598 for requirements on the construction of luminaires.

9.1 Voltage rise, luminaire effect limit

The lamp voltage of reference lamps, operating on a sinusoidal power supply of 60 Hz with the specified reference ballast at its rated input voltage, shall not change more than 5 volts when going from stabilized operation in open air to stabilized operation in a luminaire.

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