

**NOTICE OF
ADOPTION**

ADOPTION NOTICE 1
23 December 1991 for
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May 17, 1985*

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American National Standard

for ballasts for fluorescent lamps –
specifications
(replacement for table 6)

Approved July 15, 1991

Secretariat: National Electrical Manufacturers Association

This table replaces table 6 in ANSI C82.1-1985, and revises ANSI C82.1a-1990

**Table 6 – Tolerances of minimum lamp light
output for rapid start circuits**

Lamp type	Minimum light output tolerances (percent)
<i>Linear lamps</i>	
4, 6, 8WT5	-10
14WT8	-10
15WT8	-10
14, 15, 20WT12	-10
17, 25, 32, 40WT8	-7.5
30, 40WT12	-7.5
*34WT12	-15
0.800A and 1.0A T12	-5
1.5A T12 and PG17	-5
<i>Circular lamps</i>	
20WT9	-10
22, 32, 40WT9	-10
32WT10	-10
40WT10	-10
<i>U-Shaped lamps</i>	
16, 24, 31WT8	-7.5
40WT12	-7.5
*A ballast that is rated for use with both a 40-watt and a 34-watt lamp and meets the 40-watt lamp requirements need not be tested on a 34-watt lamp.	

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American National Standard

for ballasts for fluorescent lamps –
specifications –
(replacement for table 7)

Approved July 15, 1991

Secretariat: National Electrical Manufacturers Association

Page 1 of 2 pages

This table replaces table 7A in ANSI C82.1b-1990. (Table 7B is not revised.)

Table 7A – Cathode voltage limits for rapid start lamps

Lamp type	Dummy load * (ohms)	Voltage across dummy load (volts)		Voltage during operations (volts)	
		min	max	min	max
<i>Linear lamps</i>					
17, 25, 32, 40WT8	11.0 ± 0.1	3.4	4.5	2.5	4.4
30, 34, 40WT12	9.6 ± 0.1	3.4	4.5	2.5	4.0
40WT10	9.6 ± 0.1	3.4	4.5	2.5	4.0
0.800A and 1.0A T12	3.2 ± 0.05	3.4	4.5	3.0	4.0†
1.5A T12 and PG17	3.2 ± 0.05	3.4	4.5	3.3	4.3
<i>Circular Lamps</i>					
20WT9	9.6 ± 0.1	3.4	4.5	2.5	4.0
22, 32, 40WT9	9.6 ± 0.1	3.4	4.5	2.5	4.0
32, 40WT10	9.6 ± 0.1	3.4	4.5	2.5	4.0
<i>U-Shaped Lamps</i>					
16, 24, 31WT8	11.0 ± 0.1	3.4	4.5	2.5	4.4
40WT12	9.6 ± 0.1	3.4	4.5	2.5	4.0

* Where one ballast winding operates two cathodes in parallel, the dummy load resistor should be half the value given.

† Maximum voltage is 4.3V if the filament resistance exceeds 150% of the stated objective. See ANSI C82.2-1984 for method of measurement.

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Table 7B – Cathode voltage limits for rapid start operation of preheat lamps

Lamp type	Dummy load* (ohms)	Voltage across Dummy load (volts)			Voltage during operations (volts)		
		Min @90% input voltage	Max at rated input voltage	Max @110% input voltage	Min @90% input voltage	Max at rated input voltage	Max @110% input voltage
4, 6, 8WT5	70.0 ± 0.1	6.5	8.4	9.2	5.4	8.0	8.8
14, 15WT8	26.0 ± 0.25	6.8	9.0 [†]	10.0 [†]	4.0	8.5	9.5
14, 15, 20WT12	29.0 ± 0.3	6.8	9.0 [†]	10.0 [†]	4.0	8.5	9.5
*Where one ballast winding operates two cathodes in parallel, the dummy load resistor should be half the value given.							
†This voltage may be exceeded provided that at 110% primary the current through a 14-ohm resistor does not exceed 0.750 amperes.							

American National Standard

for ballasts for fluorescent lamps –
specifications
(replacement for table in 5.2.2)

Approved January 22, 1990

Secretariat: National Electrical Manufacturers Association

Replace the table that appears in 5.2.2 of ANSI C82.1-1985 with the following:

Type of Fluorescent Lamp	Maximum Distance (in)	Maximum Distance (mm)
T5 Diameter Linear Lamps	1/4	6
Other Linear Lamps		
– If rated 500 mA or less	1/2	13
– If rated greater than 500 mA	1	25
T4 and T5 "Single-Ended" Lamps	*	*
T8 and T12 U-Shaped Lamps	1/2	13
Circular Lamps	1/2	13

* To be determined

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American National Standard

for ballasts for fluorescent lamps –
specifications

ANSI C82.1-1985



american national standards institute, inc.
1430 broadway, new york, new york 10018

American National Standard

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C82.1-1985
Revision of
ANSI C82.1-1977

American National Standard for Ballasts for Fluorescent Lamps – Specifications

Secretariat

National Electrical Manufacturers Association

Approved May 17, 1985

American National Standards Institute, Inc

Foreword (This Foreword is not part of American National Standard C82.1-1985.)

The satisfactory performance of fluorescent lamps is contingent to a considerable extent upon the characteristics of the ballasts with which they are used. This American National Standard for Ballasts for Fluorescent Lamps — Specifications, ANSI C82.1-1985, describes the ballast characteristics that have been found necessary for the proper operation of fluorescent lamps. This standard is based on American National Standard C82.1-1972 and its supplement C82.1a-1973.

The first edition of the standard was originally published in 1950 as a proposed standard for trial use and criticism. A revised edition was similarly published in 1953. In 1956 the proposed standard was revised and approved as an American National Standard. Two revisions were approved and published in 1958. The standard was again revised in 1960, 1968, 1972, and 1977. The 1977 revision clarified marking requirements and ballast heating requirements. It also reflected changes in minimum output tolerance limits of 30-watt and 40-watt RS lamps and changes in maximum rapid start cathode voltage limits. This 1985 revision includes the ballast required for the 32-watt, T-8 lamp.

Dimensions in this standard are given in inches; millimeter conversions are given in parentheses and have been rounded.

Suggestions for improvement of this standard will be welcome. They should be sent to the Secretary of Committee C82, National Electrical Manufacturers Association, 2101 L Street, NW, Washington, DC 20037.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Lamp Ballasts, C82. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C82 Committee had the following members:

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Fred P. Smith, Secretary

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American National Standard for Ballasts for Fluorescent Lamps — Specifications

1. Scope

This standard is intended to cover ballasts which have rated open-circuit voltages of 2000 volts¹ or less and are intended to operate at a frequency of 50 Hz or 60 Hz. This comprises ballasts for hot-cathode fluorescent lamps, either switch-start (preheat-start), rapid-start (continuously heated cathodes), or instant-start, and also ballasts for cold-cathode fluorescent lamps, used primarily for lighting purposes, which come within this voltage range. The ballast and lamp combinations covered by this specification normally are intended for use in room ambient temperatures of 10°C to 40.6°C. At ambient temperatures outside this range, certain special operating characteristics may be required.

2. Referenced American National Standards

This standard is intended to be used in conjunction with the following American National Standards. When these standards are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply:

ANSI/NFPA 70-1984, National Electrical Code

ANSI C78 series, Dimensional and Electrical Characteristics of Fluorescent Lamps

ANSI C82.2-1984, Fluorescent Lamp Ballasts — Methods of Measurement

ANSI C82.3-1983, Reference Ballasts for Fluorescent Lamps

ANSI/UL 935-1978, Fluorescent-Lamp Ballasts — Safety Standard

¹ See ANSI/NFPA 70-1984 for requirements for various voltage classifications.

3. Definitions

ballasts. Devices which, by means of inductance, capacitance, or resistance, singly or in combination, limit the lamp current of fluorescent lamps to the required value for proper operation, and also, where necessary, provide the required starting voltage and current and, in the case of ballasts for rapid-start lamps, provide for low-voltage cathode heating. For the purpose of this specification, ballasts consisting of resistance only are not considered. In many instances, radio-interference-suppression capacitors, capacitors for power factor correction, and capacitor-discharge resistors may form a part of such ballasts.

cold-cathode lamp. An electric discharge lamp in which the electrodes, operating at less than incandescent temperatures, furnish an electron current by field emission, and in which the cathode drop is relatively high (75 volts to 150 volts). The current density at the cathodes is relatively low, and cathodes become impractically large for currents greater than a few hundred milliamperes.

hot-cathode lamp. An electric discharge lamp in which the electrodes operate at incandescent temperatures and the cathode drop is relatively low (10 volts to 20 volts). The current density at the cathodes is relatively high, and lamps may be designed to carry any desired current up to several amperes. The energy to maintain the cathodes at incandescence may come either from the arc (arc heating), from circuit elements, or from both.

instant-start systems. Those systems in which an electric discharge lamp is started by the application to the lamp of a voltage sufficiently high to eject electrons from the electrodes by field emission, initiate electron flow through the lamp, ionize the gases, and start a discharge through the lamp without previous heating of the electrodes.

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rapid-start systems. Those systems in which hot-cathode electric discharge lamps are operated under the following conditions: (1) the lamps are started with the cathodes heated to a temperature sufficient for adequate electron emission and without establishing local ionization across the cathodes; (2) such heating is accomplished either by means of low-voltage heater windings in the ballast itself or by separate low-voltage transformers; (3) sufficient voltage is applied across the lamp and between the lamp and the starting aid (usually the fixture itself) to initiate the discharge when the cathodes reach a temperature high enough for adequate emission; and (4) cathode heating voltage is maintained even after the lamp is in full operation.

NOTE: Two types of rapid-start systems have evolved: (1) those for lamps with nominal 3.6-volt cathodes (low resistance) and (2) those for lamps with nominal 8.0-volt cathodes (high resistance). In some cases the same lamp can be suitable for operation in either rapid-start or switch-start (preheat-start) systems.

reference ballasts. Series-reactor-type ballasts, which are designed, manufactured, and maintained for the purpose of providing comparison standards for use in testing ballasts or lamps. They are also used in selecting the *reference lamps* that are needed in the work of testing ballasts. Reference ballasts are characterized by constant impedance over a wide range of operating current and also by constant characteristics that are relatively uninfluenced by time, temperature, magnetic surroundings, etc. The general specifications for reference ballasts are given in ANSI C82.3-1985. The values of reference current, impedance, and line voltage for the reference ballasts to be used with each size and rating of lamp are given in American National Standards for Dimensional and Electrical Characteristics of Fluorescent Lamps, ANSI C78 Series.

reference lamps. Seasoned lamps which, under stable operating conditions and in conjunction with the specified reference ballast, operate at values of lamp voltage, lamp wattage (for rapid-start lamps arc wattage is to be used and not total wattage), and lamp current, each within 2-1/2% of the values given in the appropriate lamp standard (see American National Standard Dimensional and Electrical Characteristics of Fluorescent Lamps, ANSI C78 Series). Reference lamps of the rapid-start type are operated in circuits in which their cathodes are continuously heated by appropriate low-voltage power sources.

switch-start (preheat-start) systems. Systems in which hot-cathode electric discharge lamps are started with the cathodes preheated through the use of a starting switch, either manual or automatic in its operation. The starting switch, when closed, connects the two cathodes, in series, in the ballast circuit so that cur-

rent flows to heat the cathodes to emission temperature. When the switch is opened, a voltage surge is produced which initiates the discharge. Only the arc current flows through the cathodes after the lamp is in operation.

4. Ballast Marking

4.1 Marking. Ballasts shall be marked to indicate the supply voltage and frequency, the input current, the manufacturer, the ballast type designation, and the number, type, and wattage or current of fluorescent lamps the ballast will operate.

4.1.1 Power Factor. Ballasts operating with an average power factor of 90% or above shall be labeled as high-power factor type. Ballasts of the corrected type and operating at a power factor of less than 90% shall indicate the average operating power factor. Ballasts of the uncorrected type need not be marked for power factor.

4.1.2 Open-Circuit Voltage. The value of the open-circuit voltage, when over 300 volts, shall be marked.

4.1.3 Required Grounding. All ballasts providing voltages in excess of 150 volts shall be marked to indicate that the ballast case must be grounded.

4.1.4 Supplementary Marking. Except for single-lamp series-reactor type ballasts, supplementary marking shall be included to indicate the correct point of connection for various leads. Any necessary restrictions or conditions concerning operation of a ballast shall be so indicated as part of the supplementary marking.

4.2 Color Coding of Ballast Leads

4.2.1 Line Leads. The following color codings are for the line leads of ballasts:

(1) On ballasts with only one line lead, such as the series-reactor type, the lead shall be *black*.

(2) On ballasts with two line leads, when one lead connects to a neutral wire, that lead shall be *white* or *natural gray* and the other shall be *black*.

(3) On ballasts with two line leads which connect to ungrounded lines, both leads shall be *black*.

4.2.2 Lamp Leads. The following color codings are for the lamp leads of ballasts:

(1) On a single-lamp series-reactor type ballast, the lamp lead shall be *black*.

(2) On a single-lamp or multilamp ballast (except series-reactor type) where lamps are operated independently and lamp currents are essentially in phase with each other, the lamp leads shall be *blue*.

(3) On a multilamp ballast, where a lead-lag type circuit is used, the leading-lamp lead shall be *red*, and the lagging-lamp lead shall be *blue*.

Table 1
Color Coding for Multilamp Ballast Leads

3-Lamp	4-Lamp*	5-Lamp*	6-Lamp*
Red	Red	Red	Red
Yellow	Yellow	Yellow	Yellow
Blue/White 50/50	Blue/White 50/50	Blue/White 50/50	Orange
Blue	Brown	Brown	Blue/White 50/50
	Blue	Orange	Orange/Black 50/50
		Blue	Brown
			Blue

*C78 specifications for more than three lamps in series are not available at present.

(4) On a ballast with a compensator winding, compensator leads shall be *yellow-blue* tracer or *yellow*.²

(5) On a two-lamp instant-start ballast of the series-sequence type, lamp leads shall be *red* and *blue*, respectively. Circuit arrangements shall be such that *red* and *white* leads are connected to respective ends of one lamp and *black* and *blue* leads to the other lamp. If the circuit arrangement is such that both lamps do not connect back to the line leads, this paragraph shall be followed insofar as possible.

(6) On a single-lamp ballast of the continuously heated cathode type (rapid-start), the leads to that lamp cathode operated at the maximum voltage with reference to either of the line leads shall be *red*. The leads connected to the other lamp cathode shall be *blue*.

(7) On a multilamp ballast of the series-sequence continuously heated cathode type (rapid-start), the leads to that cathode operated at the maximum voltage with reference to either of the line leads shall be *red*. The leads to the cathode at the other extreme of voltage relative to the *red* cathode shall be *blue*. For two-lamp ballasts, the leads to the pair of common cathodes shall be either *yellow-blue* tracer or *yellow*.²

When more than two lamps are involved, the leads to each cathode or pair of cathodes, beginning at the high voltage (or *red*) end, shall have colors used in the order shown in Table 1.

4.2.3 Other Ballast Types. Ballasts not covered by 4.2.1 and 4.2.2 shall comply with these requirements insofar as possible.

5. Ballast Performance

5.1 General. Measurements necessary to determine ballast performance shall be made in accordance with ANSI C82.2-1984.

² Choice is given depending upon the type of wire utilized by the manufacturer and its ability to be distinguished from white.

5.2 Starting Conditions

5.2.1 Starting. For satisfactory lamp starting, a ballast, when operated at any voltage between 90% and 110% of its rated primary voltage and at rated frequency, shall provide the starting characteristics specified in the ANSI C78 Series.

When ballasts are designed to operate lamps in parallel circuits, the relevant requirements shall be met for each separate lamp, both with and without lamps operating or preheating in other circuits.

5.2.2 Fixture and Circuit Grounding. Rapid-start lamps, and switch-start (preheat-start) lamps when operated in circuits of the rapid-start type, require a starting aid consisting of a metal strip (usually a conventional part of the fixture), the surface of which shall be at least 1 inch (25 mm) wide. This surface shall extend essentially the full length of the lamp and *shall be connected to ground*. The distance from the starting aid to the bulb wall, as measured in a direction normal to the surface of the starting aid, shall not be greater than the following:

Type of Fluorescent Lamp	Maximum Distance (in)	Maximum Distance (mm)
Lamps rated at		
0.500 amperes or less	1/2	13
All others	1	25

Ballast circuits and connections (including ground connections) shall be such that the potential difference between the starting aid and one of the cathodes of each lamp will be greater than the minimum specified in the ANSI C78 Series.

(If operation on ungrounded power supplies is contemplated, the necessary starting-aid potential should be maintained regardless of accidental grounds on either side of the line. In some types of circuits this may require the use of a two-winding transformer.)

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Table 2
Required Starting Current for
Instant-Start Ballasts

Lamp Size	Lamp Operating Current (mA)	Test Resistor* (ohms)	Minimum Starting Current (mA)
42-inch T-6	120	3000	75
	200	3000	90
	300	3000	100
64-inch T-6 and 72-inch T-8	120	4000	75
	200	4000	90
	300	4000	100
96-inch T-8	120	5000	75
	200	5000	90
	300	5000	100
40 W T-12 IS	425	2750	100
48-inch T-12	425	2750	100
72-inch T-12	425	3400	100
96-inch T-12	425	4000	100
40 W T-17 IS	425	2750	100

*The values given in this column include the resistance of the ammeter and should be held within $\pm 2\%$.

Table 3
Required Starting Current for Two-Lamp
Series-Sequence Type Ballasts for
96-Inch T-12 Instant-Start Lamps

Resistor Value (ohms)		Minimum Current through the 4000-Ohm Resistor (mA)
No. 1 Lamp Position (Red-White Leads)	No. 2 Lamp Position (Blue-Black Leads)	
4000	9000	90
1200	4000	100

Table 4
Required Starting Current for Two-Lamp
Series-Sequence Type Ballasts for
48-Inch T-12, 40-Watt T-12, or
40-Watt T-17 Instant-Start Lamps

Resistor Value (ohms)		Minimum Current through the 2750-Ohm Resistor (mA)
No. 1 Lamp Position (Red-White Leads)	No. 2 Lamp Position (Blue-Black Leads)	
2750	750	90
750	2750	100

5.2.3 Required Starting Current. Instant-start types of ballasts shall meet the requirements for starting current as listed in 5.2.3.1 through 5.2.3.3.

If the normal wiring of the ballast being tested is such that the primary circuit of the ballast is normally closed by the insertion of lamps into the lampholders, the primary circuit shall be completed by some other means when these tests are being made.

5.2.3.1 Single-Lamp Ballasts. With the specified test resistor (see Table 2) connected to the ballast in place of the lamp, the rms current through the resistor, at any supply voltage between 90% and 110% of rated voltage, shall not be less than that shown in Table 2.

5.2.3.2 Multilamp Ballasts. Multilamp ballasts, other than those types covered in 5.2.3.3, shall meet the following requirements, which apply to *each lamp position*: With the specified test resistor (see Table 2) connected to the ballast in place of one of the lamps, and with all other positions connected to reference lamps, the rms current through the resistor, at any supply voltage between 90% and 110% of rated voltage, shall not be less than the value shown in Table 2.

In addition, if one or more of the lamp positions is such that it can start and operate a lamp (not necessarily at rated current) *without* lamps in the other positions, the resistor current in this position shall also meet the specifications given in Table 2 *without* lamps in the other circuits.

5.2.3.3 Other Multilamp Ballasts. Two-lamp series-sequence type ballasts for the operation of any of the types of lamps shown in Tables 3 and 4 shall be tested with two resistors as specified in Tables 3 and 4. These resistors shall be connected in the ballast circuit as specified in the tables, and the current through the specified measurement resistor, at any supply voltage between 90% and 110% of rated voltage, shall not be less than that shown in the appropriate table.

5.3 Ballast Output. Ballasts shall deliver power and current to the lamps in compliance with 5.3.1 and 5.3.2.

5.3.1 Switch-Start and Instant-Start Ballasts. Ballasts of these types shall deliver power and current to a reference lamp, as measured in percent of the power and current delivered to the same lamp by a reference ballast, within the limits given in Table 5. Both the reference ballast and the ballast under test shall be operated at their rated voltage and frequency.

Power and current measurements of the ballast under test shall be made when it is connected to a full complement of reference lamps.

5.3.2 Rapid-Start Ballasts. Rapid-start ballasts shall provide the operating characteristics given in 5.3.2.1 and 5.3.2.2 when connected to a full complement of normally-operating lamps.

Table 5
Power and Current Requirements
for Switch-Start and Instant-Start Ballasts

Ballast Types	Percent of Values Delivered by Reference Ballast	
	Power	Current
Switch-start	Not < 92-1/2	Not > 115
Instant-start	Not < 92-1/2	Not > 120

Table 6
Tolerances of Minimum Lamp Light Output

Lamp Type	Minimum Light Output Tolerances (Percent)
30 W T-12 RS	-7.5
32 W T-8 RS	-7.5
40 W T-12 RS	-7.5
0.800 A and 1.0 A T-12 RS	-5
1.5 A RS	-5
22 W 8-inch circular	-10
32 W 12-inch circular	-10
40 W 16-inch circular	-10
14 W T-12	-10
15 W T-8	-10
15 W T-12	-10
20 W T-12	-10

5.3.2.1 Lamp Light Output. With rated voltage applied to the primary of the ballast, the light output delivered by a reference lamp shall be equal to the light output delivered by the same reference lamp when operated on its reference ballast at its rated primary voltage, subject to the tolerances in Table 6.

The maximum light output shall be limited by the maximum permissible lamp current as specified in 5.3.2.2.

5.3.2.2 Lamp Current. With rated voltage applied to the primary of the ballast, the lamp current in a reference lamp shall not exceed 115% of the current delivered to the same lamp by a reference ballast at its rated primary voltage.

5.4 Cathode Preheating Current. Ballasts designed for the operation of switch-start lamps shall provide preheating current within the limits required by the ANSI C78 Series.

When ballasts are designed to operate more than one lamp, each circuit shall meet this requirement, both with and without lamps operating or preheating in the other circuits.

5.5 Regulation

5.5.1 Ballasts for Rapid-Start Lamps. Ballasts for rapid-start lamps shall, at 90% and 110% of rated line voltage, operate a reference lamp at a level of light output not less than 75% or greater than 125%, respectively, of the light output of the same lamp when it is operated with the same ballast at *rated* primary voltage.

5.5.2 Ballasts for Switch-Start Lamps and Instant-Start Lamps. Ballasts for switch-start lamps and instant-start lamps shall, at 90% and 110% of rated line voltage, deliver to a reference lamp not less than 85% or more than 115%, respectively, of the power delivered by a reference ballast to the same lamp at corresponding voltages.

5.6 Operating-Current Waveshape

5.6.1 Normal Operating Conditions. With rated voltage applied to the primary of the ballast, the current waveshape supplied to a warmed-up reference lamp shall have a crest factor (ratio of peak current to rms current) that does not exceed the following values:

<u>Ballast Type</u>	<u>Crest Factor</u>
Switch-start	1.70
Rapid-start	1.70
Instant-start	1.85

Successive half cycles of current shall show substantially the same shape when observed on a cathode-ray oscilloscope.

5.6.2 Special Operating Conditions. If multilamp ballasts for instant-start lamps are so designed that the failure of one lamp permits the other lamps to continue in operation, the current waveshape under these conditions shall meet the same requirements as given in 5.6.1 for normal operation.

5.7 Supplementary Cathode Heating

5.7.1 Switch-Start Ballasts. Switch-start ballasts shall not furnish a current greater than 110% of the arc stream current to any cathode terminal of a lamp in normal operation.

5.7.2 Rapid-Start Ballasts. Rapid-start ballasts shall provide supplementary cathode heating as follows:

(1) When two cathodes are supplied from a common winding, they shall be connected in multiple.

(2) The cathode heating voltage shall be measured using a dummy load resistor. All cathode windings must be loaded during this measurement. With the rated voltage applied to the primary of the ballast, the cathode heating windings shall deliver voltages to the dummy resistors within the limits shown in Table 7.

(3) When reference lamps are in normal operation at rated primary voltage, the voltage across any cathode shall be within the limits tabulated in Table 7.

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Table 7
Cathode Voltage Limits

Lamp Type	Dummy Load* (ohms)	Voltage Across Dummy Load (volts)		Voltage during Operations (volts)	
		Min	Max	Min	Min
22 W T-9 8-inch circular	9.6 ± 0.1	3.4	4.5	2.5	4.0
32 W T-8 RS	11.0 ± 0.1	3.4	4.5	2.5	4.4
32 W T-10 or T-9 12-inch circular	9.6 ± 0.1	3.4	4.5	2.5	4.0
40 W T-10 or T-9 16-inch circular	9.6 ± 0.1	3.4	4.5	2.5	4.0
30 W T-12 RS	9.6 ± 0.1	3.4	4.5	2.5	4.0
40 W T-12 RS	9.6 ± 0.1	3.4	4.5	2.5	4.0
0.800 A T-12 RS	3.2 ± 0.05	3.4	4.5	3.0	4.0
1.0 A T-12 RS	3.2 ± 0.05	3.4	4.5	3.0	4.0
1.5 A RS	3.2 ± 0.05	3.4	4.5	3.3	4.3
14, 15, and 20 W T-12 at 90% primary	29.0 ± 0.3	6.8	—	4.0	—
at rated primary		7.5	9.0†	4.0	8.5
at 110% primary		—	10.0†	—	9.5
14 and 15 W T-8 at 90% primary	26.0 ± 0.25	6.8	—	4.0	—
at rated primary		7.5	9.0†	4.0	8.5
at 110% primary		—	10.0†	—	9.5

*Where one ballast winding operates two cathodes in parallel, the dummy load resistor should be half the value given.

†This voltage may be exceeded provided that at 110% primary the current through a 14-ohm resistor does not exceed 0.750 amperes.

5.8 Voltage across Starter Terminals. Ballasts for switch-start lamps, when operated at any voltage between 90% and 110% of their rated primary voltage and at rated frequency, shall meet the requirements of 5.8.1 and 5.8.2.

5.8.1 Voltage — with Reference Lamps. When operating reference lamps the ballasts shall not furnish at the starter terminals a voltage in excess of the value listed in Table 8. This limit applies both when the lamps are first lighted and after they have warmed up.

5.8.2 Voltage — with Deactivated Lamps. When connected to nonreference lamps having one or both cathodes deactivated, the ballast shall not furnish at the starter terminals a voltage in excess of the value listed in Table 8.

5.9 Radio-Interference Suppression. Fluorescent lamps may be a source of electromagnetic radiation at radio frequencies. Several means are available for suppressing the interference caused by such radiation. The starters for use with switch-start lamps shall contain capacitors which assist in this suppression.

Table 8
Maximum RMS Volts
across Starter Terminals

Lamp Rating (watts)	Normal Lamp	Deactivated Lamp
4, 6, 8, 14, 15, 20	70	*
30, 40	128	265
32, 90	95	*

*To be determined.

Switch-start ballasts which contain a compensating winding shall include a capacitor of 0.0048 μ F (minimum) connected across such winding. Instant-start ballasts, with the exception of ballasts for operating slim-line lamps at 120 mA, shall contain 0.008- μ F (minimum) capacitors (low-inductance) for this purpose, either connected across each lamp or across the line, or both. Further suppression of conducted radio interference may be

obtained through the use of the delta-capacitor or the inductor-capacitor type of filter at the line connection of the ballast.

5.10 Ballast Heating. When ballasts are operated in an ambient air temperature of $40^{\circ}\text{C} \pm 5^{\circ}\text{C}$, at rated line voltage and frequency in an enclosure, as specified in ANSI C82.2-1984 and when they are operating lamps that meet reference lamp specifications under heat-run conditions, the maximum permissible temperature rise of any coil or power capacitor shall be as follows:

<i>Ballast Windings</i>		<i>Capacitor</i>	
<i>Normal</i>	<i>Abnormal</i> ³	<i>Normal</i>	<i>Abnormal</i> ³
65°C	95°C ⁴	30°C	40°C

No impregnating compound or any other material except those in the form of nonfluidic pressure extrusion shall be emitted during this heating test.

5.11 Dielectric Test

5.11.1 Series-Reactor or Autotransformer Type Ballast. A ballast of the series-reactor or of the autotransformer type, while hot from the abnormal heating test, shall be capable of withstanding for 1 minute, without breakdown, the application of a test potential as follows: The test potential shall be applied between all live-metal parts and all dead-metal parts that are likely to become grounded. The value of the test potential shall be: twice the rated primary voltage, twice the secondary voltage, or twice the secondary voltage to ground, whichever may be the highest, plus 1000 volts.

5.11.2 Two-Winding Transformer Type Ballast. A ballast of the two-winding transformer type, while hot from the abnormal heating test, shall be capable of withstanding for 1 minute, without breakdown, the application of test potentials as follows:

(1) Twice the rated input voltage plus 1000 volts between live-metal parts of the primary and secondary windings, and between the primary winding and dead-metal parts that are likely to become grounded.

(2) Twice the rated secondary voltage plus 1000 volts between live-metal parts of the primary and secondary windings, and between live-metal parts of the secondary winding and dead-metal parts that are likely to become grounded.

5.12 Leakage Current. The maximum ac leakage current of a ballast, at the highest rated primary voltage,

³ Abnormal heating condition is defined as that obtained with one lamp out or on preheat, whichever produces maximum temperature in any coil in the ballast assembly.

⁴ For simple reactance ballasts rated at 125 volts or less, without a capacitor, this limit shall be 110°C in a 40°C ambient.

under all conditions of open circuit or operation shall not exceed the following:

<i>Maximum Measured ac Voltage (volts)</i>	<i>Leakage Current RMS (mA)</i>
150 or less	0.5
Greater than 150	0.75

5.13 Shock Hazard. In order to reduce shock hazard during insertion, rapid-start ballasts shall conform to one of the following:

(1) They shall have an rms voltage between any output lead and ground that does not, at rated ballast supply voltage, exceed the value shown in the following table:

<i>Lamp Type</i>	<i>Maximum Voltage Any Output Lead to Ground (volts)</i>
40W T-12 RS	180 rms 325 peak

(2) They shall be so designed that the available current to ground from any output lead shall not exceed 5 mA at rated ballast supply voltage when measured through a resistance of 500 ohms (including the milliammeter resistance).

(3) They shall be limited to use with circuit-interrupting lamp holders.

(4) They shall be limited to use with lamp bases and holders with inaccessible live parts.

NOTE: Limitations given in (3) and (4) shall be indicated in the ballast marking.

6. Design Center Voltages⁵

The following voltages are the design center input voltages for fluorescent lamp ballasts:

120
208
240
277
480

7. Application Requirements

7.1 Limits for Contact Resistance. Even relatively small resistance in series with the cathode of the rapid-start lamp, because of the low heater-circuit voltage, may seriously interfere with the lamp starting or oper-

⁵ See ANSI/NFPA 70-1984 for maximum voltage-to-ground limitations and grounding requirements.

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ation. The added resistance in any cathode circuit shall not exceed at any time the following values:

<i>Lamp Type (mA)</i>	<i>Maximum Added Resistance Any Cathode Circuit (ohms)</i>
500 or less	0.5
800 (high output)	0.2
1500	0.2

7.2 Operating Temperature Limits. The service installation must be designed so that the temperature at the hottest spot on the ballast case shall not exceed 90°C under actual operating conditions.

7.3 Supply Voltage Limits

7.3.1 Average Voltage. The average voltage of the supply system should not depart more than - 7.5% or more than + 5% from the primary voltage rating shown on the ballast label.

7.3.2 Voltage Excursions. For satisfactory ballast

operation, the supply voltage excursions must not exceed $\pm 10\%$ of the ballast primary rating.

7.4 Equipment Grounding. Exposed non-current-carrying metal parts of fluorescent lamp ballasts (such as the ballast case) shall be grounded if the open-circuit voltage of the ballast exceeds 150 volts.

7.5 Audible Sound Level. Noise is an inherent characteristic of electromagnetic devices and cannot be completely eliminated.

Care should be exercised in the selection of the ballast location and the method of mounting because ballast noise can be amplified by reflections from surrounding objects and by resonance of the mechanical mounting and electrical connections. This unintentional amplification can make the ballast appear to produce considerably more noise than that generated by the ballast. The ballast or luminaire manufacturer, or both, should be consulted for specific recommendations for a quiet installation.

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