Unofficial Translation

In the event of any doubt or misunderstanding arising from this translation, the standard in Thai will be held to be authoritative

TIS 23-2521(1978)
Thai Industrial Standard
for
Ballast for Fluorescent Lamps

1. Scope

1.1 This standard prescribes performance, marking and labelling, sampling and criteria for conformity, test methods and measurement of ballast for fluorescent lamps for general lighting service.

1.2 This standard covers ballasts for use on a.c. supply at 50 Hz or 60 Hz associated in TIS 236, “Fluorescent Lamps”. Inverter ballast for fluorescent lamps for use on d.c. supply is not included in this standard.

1.3 Requirements associated with ballast prescribed in this standard are intended to indicate performance without for each purpose.

1.4 This standard also performance includes all those features of reference ballast construction and performance which are considered necessary to assure accurate and reproducible results when testing ballasts, particularly with regard to the selection of reference lamps.

2. Definitions

For the purpose of this standard, the following definitions apply:

2.1 BALLAST : A unit inserted between, the supply and one or more discharge lamps, which by means of inductance, capacitance or resistance, singly or in combination, serves mainly to limit the current of the lamp to the required value. It may also included means for:

(1) transforming from the supply voltage and arrangements which help to provide starting voltage and pre-heating current;
(2) preventing cold starting;
(3) reducing stroboscopic effect;
(4) correcting the power factor and/or suppressing radio interference.

2.2 REFERENCE BALLAST: A special inductive-type ballast designed for the purpose of providing comparison standards for use in testing ballasts and for the selection of reference lamps given in Appendix A. It is essentially characterized by a stable voltage-to-current ratio, which is relatively uninfluenced by variations in current, temperature and the magnetic surroundings, as outlined in this standard.

2.3 LAMP: Fluorescent lamp which is of tubular from either straight or U-shaped or curved in which most of the light is emitted by a layer of fluorescent materials excited by the ultra violet radiation from the electrical discharge through low pressure mercury vapor between two cathodes.

2.4 REFERENCE LAMP: A lamp selected for testing ballasts as specified in Appendix B.

2.5 STARTER: A switch intended for the help of preheating the cathode of fluorescent in a short time in order to light the lamp.

2.6 CALIBRATION CURRENT: The value of the current on which are based the calibration and control of the ballast. Such a current should always be approximately equal to the running current of the lamps for which the reference ballast is suitable.

2.7 SUPPLY CURRENT: The current applied to complete circuit of lamp and ballast.

2.8 TYPE TEST: The test carried out on samples of ballasts and/or capacitors for the purpose of acceptance of the lot.

2.9 ROUTINE TEST: The test carried out on all ballasts and/or capacitors to check requirements which are likely to vary during production.

2.10 PARALLEL PRE-HEATING: Type of heating* (or pre-heating) supplied by a low tension winding of the ballast directly connect to the cathode terminations of the lamps. Note: *This type of heating circuit is only practiced with lamp operated without starters.

2.11 SERIES PRE-HEATING: Type of heating or pre-heating I which a cathode is connected in series with ballast and starter, before the lamp has started.

2.12 MAIN TRANFORMER: A device to increase or decrease the voltage without any effect on the induction of ballast.

2.13 CATHODE HEATING TRANSFORMER: A transformer for the purpose of preheating the cathode of a lamp which may from part of a starterless ballast.

2.14 CHOKE: An inductor used as a ballast or part of a ballast connected in series with a lamp.

2.15 SWIRLING: Whirling light which moves in lamps.

2.16 OVER-ALL POWER FACTOR: The power of the combination of a ballast and the lamp for which the ballast is designed.

2.17 WORKING VOLTAGE: The highest r.m.s. voltage which may occur across any insulation, transient being neglected, in open circuit conditions or during lamp operation.

2.18 SUPPLY VOLTAGE: The voltage applied to the complete circuit of lamp and ballast.

2.19 PEAK VOLTAGE: The maximum value oft he voltage during half cycle of an a.c. current.

2.20 RATED VOLTAGE: The voltage marked accordingly to the design on the ballast.

2.21 AUXILIARIES: Devices for controlling or starting the operation of a fluorescent lamp other than the main switch and/or fuse through which the lamp circuit is supplied, but including capacitors used in association with the lamp circuit.

2.22 SUPPRESSOR CPACITOR: Capacitor used for suppressing interference at radio frequency.

2.23 NORMAL CONDITIONS: Conditions in which the ballast and fluorescent lamp are expected to work.

2.24 ABNORMAL CONDITIONS: Conditions in which one or more of the following apply.

(1) The lamp or one of the lamps in not inserted.
(2) One of the cathodes of a lamp is broken or de-activated.
(3) A lamp does not start although the cathode circuits are intact because the lamp is de-activated.
(4) One starter is short-circuited.
(5) The lamp is operated, but with rectifying effect.

2.25 RECTIFYING EFFECT: The effect which may occur at the end of lamp life when one cathode either is broken or has insufficient electron emission resulting in the arc current in consecutive half-cycles being unequal.

2.26 RATED MAXIMUM OPERATING TEMPERATURE OF A CAPACITOR, symbol t_c: The highest permissible temperature which may occur at any place on the outer surface of the capacitor to ensure sufficient life.

2.27 RATED MAXIMUM OPERATING TEMPERATURE OF A BALLAST WINDING, symbol t_w: The highest permissible temperature of a ballast winding which gives and expectancy of ten years continuous service at that temperature.

2.28 RATED TEMPERATURE RISE OF A BALLAST WINDING, symbol Δ t: The declared temperature rise of the winding.

2.29 LIVE PART: The Part which is concerted directly to the supply circuit or to a circuit which has a potential difference above earth.

3. Performance

3.1 Ballasts shall be so designed and constructed that in normal use their performance is reliable and without danger to the user or surroundings. Live part shall be of brass, copper or other functionally suitable material and shall be in accordance with the requirements in clauses 3.2 to 3.26.

3.2 Marking

Ballast marking in accordance with clause 4 shall be durable and easily legible. Compliance is checked by the test specified in clause 6.2.

3.3 Protection against accidental contact.

3.3.1 Ballasts shall be so constructed and enclosed that they are sufficiently protected against accidental contact with live parts and the enclosures of the ballasts shall have no opening access to live parts other than those necessary for their use and working. Lacquer or enamel is nor deemed to be adequate protection or insulation for the purpose of this requirement.

3.3.2 Parts providing protection against accidental contact shall have adequate mechanical strength and shall not work loose in normal use. It shall not be possible to remove them without the use of tools.

Compliance is checked by the test specified in clause 6.3.

3.4 Protection against electric shock

Ballast in which a capacitor is enclosed with a capacity exceeding 0.5 μF shall be provided with an adequate discharge device so that the voltage across the capacitor, one minute after disconnection of the ballast from a source of supply at rated voltage, will not exceed 50 V.

3.5 Terminals for external wiring

When terminals are provided they shall meet the following requirements.

3.5.1 Terminals shall permit the connection of conductors with cross-sectional areas as follows:

terminals for supply wires : 0.5 to 2.5 mm□

terminals for other external wires : 0.5 to 1.5 mm□

3.5.2 Screw terminals shall be so fixed that when the clamping means are tightened or loosened, they will not work loose; internal conductors are not subjected to stress and creepage distances and clearances are not reduced below the values specified in clause 3.15.

3.5.3 Screw terminals shall be so designed that provision is made for the conductor to be clamped between two metal surfaces and that they allow connection to be made with sufficient contact pressure without damage to the conductor. A conductor shall be considered to be damaged if it shows deep incisions or shearing.

3.5.4 Any screw terminals for external wiring shall be so placed that when the connection of the conductors is correctly made, there is no risk of accidental contact between live parts of opposite polarity or between such parts and accessible metal parts.

3.5.5 All external screw terminals shall be so located that the wires can easily be introduced and connected and so that the cover, if any, can be fixed without the risk of damage to the wires.

Compliance is checked by the test given in clause 6.9(3).

3.6 Lead connection

This clause applies only to ballast with lead connection.

3.6.1 The lead shall be stranded conductor with the minimum cross-sectional area of 1 mm^2 and minimum length of 150 mm.

3.6.2 The lead shall be of the voltage not less than that of the rated voltage and shall be suitable for the voltage involved.

3.6.3 The insulation of a lead shall be in all cases resistant to the temperature of 75□ C or higher and be not less than 0.79 mm thick.

3.6.4 The part where the lead passes through the enclosure shall be provided with cover in order to protect insulation from being worn out.

3.6.4 Grip shall be provided for the lead inside the ballast so as to cut off the tightening strength of lead connection from the terminal or the mains terminal in ballast.

3.7 Provision for earthing

The earthing terminal, if any, shall be of a type in which the conductor is secured by means of a screw, which shall not work loose in normal use; it shall be placed near to

the mains terminals and shall be clearly and indelibly marked with the symbol 

This symbol shall not be placed on screws, removable washers or other easily removable parts.

The screws or other parts of the earthing terminal shall be made of brass or other non-rusting material and all the contact surfaces shall be bare metal. It shall nopt be possible to loosen the earthing terminal screw without the aid of a tool.

3.8 Voltage across capacitors

These requirements apply to capacitors enclosed in a ballast having a capacitors more than 0.1 μF. At rated frequency, the voltage across a capacitors incorporated in a ballast shall comply with the following requirements.

3.8.1 Under normal conditions, when the ballast is tested at the rated supply voltage, the voltage across the capacitor shall not exceed the rated voltage of the latter.

3.8.2 Under abnormal conditions, when is tested at 110% of its rated supply voltage, the voltage across the capacitor shall not exceed its test voltage.

If the test voltage is not marked, it is deemed be equal o 1.3 times the rated voltage of the capacitor.

3.9 Moisture resistance, insulation resistance and voltage endurance

3.9.1 The ballast shall be moisture resistant. It shall not show any appreciable damage after being subjected tot he humidity test described in clause 6.4.1.

3.9.2 The insulation resistance between poles and that between live parts and external parts including fixing screws shall not be less than 2 MΩ. The test is specified in clause 6.4.2.

3.9.3 The ballast shall withstand a voltage test. When the test voltage corresponding to the value of Table 1 is applied between poles and between live parts and external parts including the wrapping tinfoil for 1 minute, neither the flashover nor breakdown shall occur.

Compliance is checked by the test given in clause 6.4.3.

Table 1
Test voltage
(clauses 3.9.3, 3.13.4(2), 6.4.3, 6.4.4, 6.6.2.2 and 6.6.3.2)

Working voltage (U) V	Test voltage V
up to and including 42 above 42 but not exceeding 1000	500 2 U + 1000

The test voltage shall be based on the rated voltage of the ballast if the voltage is higher than working voltage.

3.9.4 If a capacitor is connected between live parts and external metal not required and shall be replaced by a measurement of the leakage current given in clause 3.10.

3.9.5 Ballast shall have adequate inter-turn insulation.

No short-circuit shall occur between windings.

Compliance is checked by the test given in clause 6.4.4.

3.10 Leakage current

These leakage current of the ballast connected to a voltage equal to 1.1 times the rated supply voltage at rated frequency shall not exceed 0.5 mA.

Compliance is checked by the test given in clause 6.5.

3.11 Capacitor

These requirements apply to capacitor having a capacitance over 0.1 μF intended to be incorporated in ballasts or supplied as separate elements for use in fluorescent lamp circuit.

3.11.1 Thermal endurance

During the test as prescribed in clause 6.6.1, there shall be no leakage of filling compound. No flashover nor breakdown shall occur.

3.11.2 Voltage endurance

No flashover nor breakdown shall occur during the test as specified in clause 6.6.2.

3.11.3 Moisture resistance

No flashover nor breakdown shall occur during the test as specified in clause 6.6.3.

3.12 Thermal endurance of windings

The winding of the ballast shall withstand the thermal endurance test described in clause 6.7.

Ballast without t_W marking shall be considered as having t_W 90□C.

After the test conforming to clause 6.7, when the ballasts have returned to room temperature, they shall satisfy the following requirements.

(1) The ballast shall start and operate a lamp;

(2) The watt loss of the ballast measured under normal operating conditions at rated supply voltage, shall not have changed by more than 10% from the value measured before the endurance test;

(3) The insulation resistance between the winding and the case measured at approximately 500 V d.c. shall not be less than 1 MΩ;

(4) The ballast shall withstand a voltage test according to clause 6.4.3, the test voltage, however, shall be twice the working voltage.

3.13 Limitation of ballast heating

In any test on the limitation of ballast heating, there shall be no seepage of compound or varnish. Minor seepage which shows no tendency to fall away shall be neglected.

Ballast without t_W marking

3.13.1 The temperature rise of the ballasts shall not exceed the approximate value given in Table 2 for the tests under normal and abnormal conditions.
Compliance is checked by the test given in clause 6.8.1.

3.13.2 Ballast with t_W or t_W and Δt marking
The temperature rise of the ballasrt shall not exceed the approximate values given in Table 2 for the tests under normal and abnormal conditions.
Compliance is checked by the test given in clause 6.8.2.

3.13.3 If other materials or manufacturing methods are used than those indicated in Table 2, they shall not be exposed to temperature higher than those which are proved to be permissible for these materials.

3.13.4 After these heating tests and after cooling down, the ballast shall comply with the following requirements.

(1) The ballast marking shall not be removed and shall still be legible.

(2) The ballast shall withstand withour damage a voltage test according to clause 3.9.3, the test voltage being reduced to 75% o the values given in Table 1, but not less than 500 V.

(3) The watt losses of the ballast, under normal conditions, shall not vary by more than 10% from those measured before the heating test.

Table 2
Temperature rise
(clause 3.13)

Parts	Normal operation		Abnormal operation
	at 100% of rated voltage °C	at 110% of rated voltage °C	at 110% of rated voltage °C
a. Ballasts without t_W marking			
Winding of enamelled or varnished wire:			
- with layers separated by paper or the like		70	135
- with layers not separated by paper or the like		60	135
b. Ballasts without t_W marking			
Winding of enamelled or varnished wire:			
- for t_W = 90°C	55		135
95°C			142
100°C			150
105°C			158
110°C			165
115°C			173
120°C			181
125°C			188
130°C			195
c. Ballast with t_W and Δt marking			
Winding of enamelled or varnished wire:			
- for t_W = 90°C	Δ t*		135
95°C			142
100°C			150
105°C			159
110°C			165
115°C			173
120°C			181
125°C			188
130°C			195
d. For all ballasts			
Capacitor enclosures		t_C - 35	1.15 t_C - 35 or t_C - 25 (2)
Test hood (on the outside)		60	100
Parts made of			
- wood-filled phenolic moulding		85	
- mineral-filled phenolic moulding		120	
- urea moulding		65	
- melamine moulding		75	
- laminated. Resin-bonded paper		85	
- rubber		45	
- thermoplastic material		(3)	

Note: (1) The values of temperature rises in Table 2 are based on an ambient temperature normally equal to 30±2°C.
(2) Whichever is the greater.
(3) The temperature rise of thermoplastic materials, other than that use for the insulation of the wiring which provides protection against contact with live parts or supporting such parts is also determined. The value so obtained will serve in order to establish the conditions of the test of clause 6.10.

3.14 Screws and nuts

3.14.1 Screwed connections, electrical or otherwise, shall withstand the mechanical stressed occurring in normal use.

3.14.2 Screws transmitting contact pressure, and screws which are operated when mounting and connecting the ballast and have a nominal diameter less than 3 mm shall screw into metal and shall be in good condition for the next use.
Compliance is checked by the test given in clause 6.9.

3.14.3 Screw in engagement with a thread of insulating material shall have a length of engagement of at least 3 mm plus one-third of the nominal screw diameter, except that this length needs not exceed 8 mm. Correct introduction of the screw into the screw hole or nut shall be ensured.
Compliance is checked by inspection, by measurement and by manual test.

3.14.4 Self tapping screw shall not be used for the connection of current carrying parts.
Compliance is checked by inspection.

3.14.5 Screws and rivets which serve as electrical as well as mechanical connection shall be locked against loosening. Spring washers may provide satisfactory locking. For rivets, a non-circular shank or an appropriate notch may be sufficient. Sealing compound which softens on heating provides satisfactory locking only for screw connections not subject to torsion in normal use.
Compliance is checked by inspection and/or by manual test.

3.14.6 Current-carrying parts shall be of copper, an alloy containing at least 50% copper, or other metal no less resistant to corrosion than copper and having mechanical properties no less suitable.
Compliance is checked by inspection and/or by chemical analysis.

3.15 Creepage distances and clearances

Creepage distances and clearances shall not be less than the values given in Table 3 when measured with suitable equipment. The values between brackets apply to creepage distances and clearances completely protected against dirt.
Hermetically sealed or compound-filled distances are not checked.
The contribution to the creepage distance of any groove less than 1 mm wide is limited to its width. Any air gap of less than 1 mm an insulating computing the tool air path. A metal enclosure shall have an insulating lining if, in the absence of such a lining, the creepage distance or clearances between live parts and the enclosure would be smaller than the value prescribed in table 3.

Table 3
Creepage distance and clearance in air
(clause 3.15)

Description	Creepage distance and clearance (mm)		
	up to 24 V	above 24 V up to 250 V	above 250 V up to 500 V
Creepage			
1. Between live parts of different polarity	2	3(2)	5
2. Between live parts and accessible metal parts which are permanently fixed to the auxiliary, including screws or devices for fixing covers or fixing the auxiliary to its support	2	4(2)	6
Clearance			
3. Between live parts of different polarity	2	3(2)	5
4. Between live parts and accessible metal parts which are permanently fixed to the auxiliary, including screws or devices for fixing covers or fixing the auxiliary to its support	2	4(2)	6
5. Between live parts and a flat supporting surface or a loose metal cover	2	6	10

3.16 Resistance to heat

External parts of insulating materials, providing protection against electric shock, and parts of insulating materials retaining live parts in position, shall be sufficiently resistant to heat. The diameter of the impression shall not exceed 2 mm.

Compliance is checked by the test given in clause6.10.

3.17 Resistance to corrosion

3.17.1 Ferrous parts, the rusting of which may endanger the safety of the ballast, shall be adequately rust-protected. Protection by varnish is deemed to be adequate for the outer surface of iron cores.

Compliance is checked by inspection.

3.17.2 Contacts and other parts made of rolled copper or copper alloy sheet, the failure of which might impair safety, shall be free from the possibility of stress corrosion cracking.

Compliance is checked by the test specified in clause 6.11.

3.18 Open-circuit voltages at terminations of lamp or starter

When ballasts are designed to operate lamps in parallel circuits, the relevant requirements shall be met for each separate lamp, even under the most adverse load conditions.

3.18.1 For lamp when operated at any voltage between 90% and 110% of its rated voltage and at rated frequency shall provide the following open-circuit voltages:

(1) At terminations of the starter, a voltage (r.m.s.) of at least the values given in the third column of Table 4;

(2) At lamp terminations, a peak voltage (excluding the surge of the starter) not exceeding the values given in the fourth column of Table 4.

The test is specified in clause 7.2.1.

Table 4
Open-circuit voltages for lamps operated with starter
(clauses 3.18.1 and 7.2.1)

Rated lamp wattage W	Nominal dimensions of lamp (length x diameter) mm	Minimum open-circuit voltage at terminations of starter V (r.m.s.)	Minimum open-circuit voltage at lamp terminations V (peak)
13	525 x 15	180	400
20	600 x 38	95	400
30(T8)	900 x 25	180	400
32	circular lamp	180	400
40	1200 x 38	180	400
65	1500 x 38	180	400
80	1500 x 38	180	400
85	1800 x 38	216	400
90	1500 x 54	132	270
125	2400 x 38	-	-

3.18.2 For lamps operated without a starter

A ballast, when operated at any voltage between 90% and 110% of its rated voltage and at rated frequency, shall provide an open-circuit voltage at lamp terminations such that:

(1) its r.m.s. value is at least the value given in the third column of Table 5 or 6:

(2) its peak value does not exceed the value given in the fourth column of Table 5 or 6.

Compliance is checked by the test specified in clause 7.2.2.

Table 5
Open-circuit voltages for lamps operated without starter (low-resistance cathodes)
(clauses 3.18.2 and 7.2.2)

Rated lamp wattage W	Nominal dimensions of lamp (length x diameter) mm	Minimum open-circuit voltage at lamp terminations V (r.m.s.)	Minimum open-circuit voltage at lamp terminations V (peak)
20	600 x 38	180	345
40	1200 x 38	205	420
65	1500 x 38	220	475
85	2400 x 38	-	-
215 (T12)	2400 x 38	400	800
215 (PG-17)	2400 x 54	400	800

Table 6
Open-circuit voltages for lamp operated without starter (high-resistance cathodes)
(clauses 3.18.2 and 7.2.2)

Rated lamp wattage W	Nominal dimensions of lamp (length x diameter) mm	Minimum open-circuit voltage at lamp terminations V (r.m.s.)	Minimum open-circuit voltage at lamp terminations V (peak)
20	600 x 38	180	345
40	1200 x 38	205	420
80	1500 x 38	220	475
85	1800 x 38	270	560
125	2400 x 38	315	630

3.19 Pre-heating conditions

3.19.1 For lamp operated with starter

A ballast, when operated at any voltage between 90% and 110% of its rated voltage and at rated frequency, shall provide a pre-heating current whose ratio to the nominal running current is within the limits 0.9 and 2.1

Test shall comply with clause 7.3.1.

3.19.2 For lamp operated without starter

With a resistance of the objective value specified in the second column of table 11 and 11 B substitute for each cathode, the ballast shall deliver a voltage at this load of the least 3.05 v for low-resistance cathode lamps and at least 8 v for high resistance cathode lamps.

Test shall comply with clause 7.3.2.

3.20 Power and current output

3.20.1 For lamp operated with starter

The ballast shall limit the power and current delivered to a reference lamp to be not less than 92.5% for the power and not more than 115% for the current of the corresponding values delivered to the same lamp when operated with a reference ballast. Both the reference ballast and the ballast under test shall have the same rated frequency and each shall be operated at its rated voltage.

Moreover for any other supply voltage between 90% and 110% of its ratio value, the power delivered by the ballast to the reference lamp shall lie between the limits of 85% of the power delivered of its rated voltage and the limit of 115% of the power delivered to the lamp by the reference ballast when supplied at 110% of its rated voltage.

Test shall comply with clause 7.4.1.

3.20.2 For lamp operated without starter

The ballast shall limit the arc current delivered to the reference lamp to a value not exceeding 115% of that delivered to the same lamp when it is operated with a reference ballast.

The reference ballast shall have the same rated frequency as the ballast under test and each of them shall be operated at its rated voltage.

Test shall comply with clause 7.4.2.

The power supplied to the lamp after excluding the losses in the heating circuits external to the lamp shall be estimated by the luminous flux of the reference lamp. When the latter is supplied alternatively, first by the reference ballast, and secondly by the ballast under test, the luminous flux shall not be reduced by more than 10%.

3.21 Overall power factor

The measured overall power factor shall not differ from the marked value by more than 0.05, when the ballast is operated with one or more reference lamps and the whole combination is supplied at the rated voltage and frequency. For high power factor ballasts, the measured value shall in no case be less than 0.85.

Compliance is checked by the test as specified in clause 7.5.

3.22 Current consumed from supply

At the rated voltage and frequency, the current consumed from the supply shall not differ by more than ±10% from the value marked on the ballast when the latte is operated with a reference lamp.

Compliance is checked by the test as specified in clause 7.6.

3.23 Maximum current in any lead to a cathode

This clause applies only to ballasts for lamps operated without starter. In normal operation and at a supply voltage of 110% of the rated value, the current flowing in any one of the cathode terminations shall not exceed the value indicated in Table 7 or Table 8, applying to low-and high-resistance cathode lamps respectively.

The test is carried out in accordance with clause 7.7.

Table 7
Maximum current in any lead to a cathode (low resistance cathodes)
(clauses 3.23)

Rated lamp wattage W	Maximum current in any lead to a cathode A
20	0.65
40	0.75
65	1.10
85	-
215	-

3.24 Lamp operating current waveform

Th waveform of the current delivered in the steady state to a reference lamp associated with the ballast supplied at rated voltage and at rated frequency shall comply with the following conditions:

Table 8
Maximum current in any lead to a cathode (high-resistance cathodes)
(clauses 3.23)

Rated lamp wattage W	Maximum current in any lead to a cathode A
20	0.65
40	0.75
80	1.60
85	1.30
125	1.60

(1) Successive half-cycles shall present similar forms on an oscilloscope and their peak values shall be equal to within 5%.
If measurement with the oscilloscope leaves any doubt, the requirement shall be deemed as met if any even harmonic component does not exceed 0.025 of the fundamental current.

(2) The maximum ratio of peak value to root-mean-square value shall mot exceed 1.7 for all values of supply voltage between 90% and 100% of the nominal voltage and 1.8 for values above 100% and up to 110%.

Test shall comply with clause 7.8.1 or 7.8.2, whichever is applicable.

3.25 Voltage across terminals of voltage operated starter (if any)

When a ballast is operating with a reference lamp and is connected to any voltage between 90% and 110% of the rated supply voltage at rated frequency, the voltage at the starter terminals shall not exceed the values given in Table 9.

These limits shall apply both when the lamp is first ignited and after it has warmed up.

When ballasts are designed to operate lamps in parallel circuits, the relevant requirements shall be net for each separate lamp, even under the most adverse load conditions.

3.26 Protection against magnetic influence

The ballast shall be suitably protected against magnetic influence. The variation of the current caused by the proximity of the steel plate shall not exceed 2% of its value in normal operation.

Compliance is checked by the test prescribed in clause 7.9

Table 9
Maximum voltage across starter terminals
(clauses 3.25)

Rated lamp wattage W	Maximum voltage across starter terminals V
13	105
20	68
30 (T8)	128
32	100
40	128
65	132
80	128
85	160
90	95
120	-

4. **Marking**

4.1 At least there shall be figure, letter or symbol clearly and durably marked on the ballast giving the following information.
(1) Name of manufacturer or of factory or trade mark.
(2) Wiring diagram indicating clearly the position of terminals.
(3) In the case of a ballast having a capacitor supplied as separate element or incorporated, the repetition on the ballast of the rated voltage, capacitance and , if necessary, the rated maximum operating temperature and/or the test voltage of the capacitor is recommended.
It shall be clearly indicated on the ballast as having capacitor.
(4) Rated supply voltage(s), frequency and supply current(s).
(5) Rated wattage, and if necessary, the designation of the type or types of lamp for which the ballast is designed. If the ballast is to be used with more than one lamps, the number and wattage for each lamp is to be indicated.
(6) Power factor. If the power factor is less than 0.95 leading, it shall be followed by the letter “C”.

4.2 Ballasts with a rated maximum operating temperature of the winding shall be marked with the claimed value following the symbol t_w. Values increase in 5°C steps. Preferred values are the following: 90, 105 and 120°C.

4.3 Ballast with t_w marking may also be marked with the rated temperature rise of the winding following the symbol $\triangle$ t. Preferred values are the following : 40, 55, 70 and 85°C.

4.4 Capacitors, other than those having a capacitance of 0.1 μF, or less, intended to be supplied as separate elements for use in fluorescent lamp circuits shall be clearly and durably marked with the following.
(1) Name of manufacturer or of factory or trade mark
(2) Capacitance
(3) Rated voltage
(4) Test voltage (if this is greater than 1.3 times the rated voltage)
(5) Frequency or rated range of frequency
(6) Rated maximum operating temperature (t_c), minimum permissible value is 50°C

4.5 Foreign language used for the marking in clauses 4.1-4.4, if any, shall correspond to that in Thai.

4.6 Any person who manufactures products complying with this standard, may use the Standards Mark in connection with his products only after having received a license from the Industrial Product Standards Council.

5. **Sampling and criteria for conformity**

5.1 Sampling

Random sampling shall be carried out as follows ;

5.1.1 Eighteen samples shall be taken, ie 7 for thermal endurance test on windings, 4 for other tests and the other 7 are reserved for thermal endurance retest in ten case the first 7 samples fail the test.

5.1.2 For capacitor which is incorporated in a ballast or supplied as separate element, 15 samples of capacitor shall be taken, i.e. 10 for thermal endurance test and 5 for moisture resistance and voltage test.

5.2 Criteria for conformity

5.2.1 Ballasts shall be considered as complying with the standard when they meet the requirements in clauses 5.2.1.1 and 5.2.1.2 or clauses 5.2.1.1 and 5.2.1.4, whichever is applicable.

5.2.1.1 Four of the samples taken as prescribed in clause 5.1.1 shall pass all the tests as given in Appendix C, unless otherwise specified.

5.2.1.2 If not less than 6 out of the other 7 of the samples taken as prescribed on clause 5.1.1 pass the test for thermal endurance of windings, the lot shall be deemed to meet the requirement for thermal endurance of windings.

5.2.1.3 If more than 2 samples taken as prescribed in clause 5.2.1.2 fail the test for thermal endurance of windings, the lot shall be rejected.

5.2.1.4 If 2 of the samples taken as prescribed in clause 5.2.1.2 fail the test for thermal endurance of windings, the test shall be repeated on 7 reserved ballasts and all samples shall pass the test.

5.2.2 Ballast having capacitor incorporated or supplied as separate element shall meet the requirement prescribed in clause 5.2.1 and all capacitors taken as prescribed in clause 5.12 shall meet all requirements for capacitors.

6. **Tests**

6.1 General test requirements

Inspection shall be used for the performance for which the tests are not specified.

6.1.1 Tests for ballasts and capacitors are type tests.

6.1.2 Unless otherwise specified, ballast shall be tested in order in accordance with the list in Appendix C. should a lamp be required for any test, the requirement for reference lamp in Appendix B shall be followed.

6.1.3 Each test shall be made under the conditions specified in clause 6.1.4, unless otherwise specified.

6.1.4 Ambient temperature

Measurements shall be made in a draught-free room and at an ambient temperature within the range 23°C to 27°C. For those tests which require constant lamp performance, the ambient temperature of the lamp shall not vary by more than 1°C during the test.

Three thermometers at least will be hung in different places around and in the same plane with the ballast at a distance of approximately 1 m from the ballast. The average of the 3 measurements throughout the test shall be considered as an ambient temperature. Each measurement shall be based on the average from every thermometer.

6.1.5 Supply voltage and frequency

6.1.5.1 Test voltage and frequency

Unless otherwise specified, each ballast to be tested and also the reference ballast, shall be operated at its own rated supply voltage and at its rated frequency. The reference ballast shall be of the same frequency rating as the ballast under test.

When a ballast is marked for use on a range of supply voltages or has different separate rated supply voltages or has different separate rated

supply voltages, any voltage for which it is intended may be chosen as the rated nominal voltage.

6.1.5.2 Stability of supply voltage and frequency

For the majority of the tests, the supply voltage and frequency shall be maintained constant within ±0.5%. However, during the actual measurement, the voltage shall be adjusted to within ±0.2% of the specified testing value.

For tests of long duration (e.g. endurance test) , the variation of voltage may be ±2% and frequency ±1% of the specified values.

6.1.5.3 Supply voltage waveform

The total harmonic content of the supply voltage shall not exceed 3%, harmonic content being defined as the root-mean-square (r.m.s.) summation of the individual harmonic components using the fundamental as 100%.

Note : The power source used shall have an impedance that is low relative to the impedance of the ballast.

6.1.6 Instrument characteristics

6.1.6.1 Potential circuit

Potential circuits of instruments connected across the lamp shall not draw more than 3% of the nominal running current.

6.1.6.2 Current circuits

Instruments connected in series with the lamp shall have a sufficiently low impedance such that the voltage drop shall not exceed 2% of the objective lamp voltage.

Where measuring instruments are inserted into parallel heating circuits. The total impedance of the instruments shall not exceed 0.5 Ω.

6.1.6.3 Measurements

Instruments intended for measuring r.m.s. values shall be essentially free from errors due to waveform distortion.

6.2 Durability of marking

Compliance is checked by trying to remove the marking by rubbing lightly for 15 seconds with a piece of cloth soaked with water and another with petrol for further 15 seconds.

6.3 Protection against accidental contact

Compliance is checked by means of the test finger shown in Figure 1, using an electrical indicator to show contact. This finger is applied in all possible positions, if necessary, with a force of 30 N.

It is recommended that an appropriate lamp be used for the indication of contact and that the voltage be not less than 40 V.

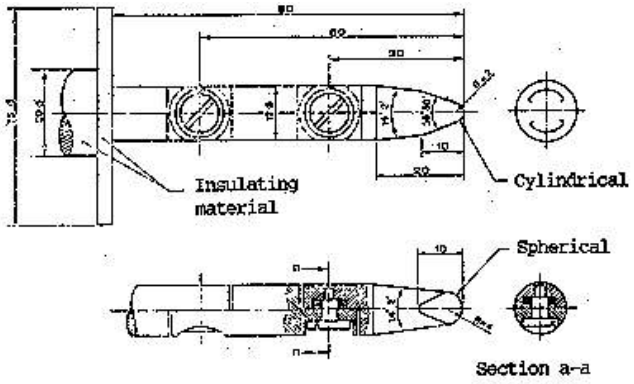
6.4 Moisture resistance, insulation and voltage

6.4.1 Humidity test

The ballast is placed for 48 h in a humidity cabinet containing air with a relative humidity maintained between 93% and 95%. The temperature of the air, at all places where ballast can be located, is maintained within ±2°C of any convenient value t between 20°C and 30°C.

Before being placed in the humidity cabinet, the sample is brought to a temperature between t and t ±4°C.

The ballast shall be mounted in accordance with the manufacturer's instruction (if any). Cable entries (if any) shall be left open. If knock-outs are provided, one of them shall be opened.



Note : 1. The tip of the test finger is spherical cut of cylindrical.
2. Tolerances on angles : ±5′
3. Tolerances on linear dimensions
25 mm and under : 0.05 mm
over 25 mm : 0.02 mm

Figure 1 Standard test finger
(clause 6.3)

6.4.2 Insulation test

Insulation test is made immediately after the test in clause 6.4.1.

Before the insulation test, visible drops of water, if any, shall be removed by means of blotting paper.

Ballasts having an insulating cover or envelope shall be wrapped with tinfoil.

The insulation resistance shall be measured with d.c. voltage of approximately 500 M, 1 min after application of the voltage,

The insulation resistance is then measured:

6.4.2.1 between live parts of different polarity which can be separated;

6.4.2.2 between live parts and all external metal parts including the tinfoil wrapping of external parts of insulating materials.

6.4.3 Voltage test

The voltage test shall be made immediately after the test in clause 6.4.2.

The voltage test shall be made with an appropriate a.c. voltage as specified in Table 1 at rated frequency for 1 min between the same parts as specified above. Initially, not more than half the specified voltage is applied, the voltage is then raised rapidly to the prescribed value.

6.6.4 Inter-turn insulation test

The test for the inter-turn insulation shall be made immediately after the test in clause 6.4.3.

The winding shall be submitted for 1 min to a voltage equal to 5 times the voltage occurring in normal use and steady state, at not less than 5 times the rated frequency. The test voltage shall not, however, exceed the value specified in Table 1.

Occurrence of short-circuited turn between windings is checked by measuring the watt losses of the ballast before and after the test.

6.5 Measurement of leakage current

Figure 2 shows the circuit diagram for the measurement of leakage current.

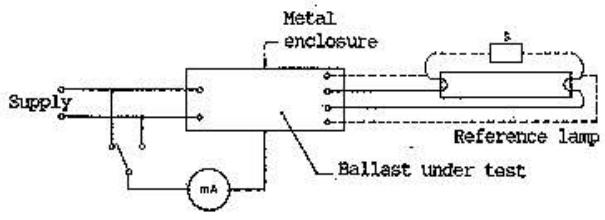


Figure 2 Circuit diagram to be used for measurement of current leakage
(clause 6.5)

Ballast with external parts of insulating materials shall be wrapped with tinfoil.

The resistance of the measuring circuit shall be 2 000±50Ω. One end of the measuring instrument shall be connected to an external part or the wrapping tinfoil and the other to a switch.

6.6 Capacitor

6.6.1 Thermal endurance test

The test is made on 10 samples placed in an oil bath at a temperature equal to the rated maximum operating temperature of the capacitor, plus 10°C or plus 15%, whichever is the higher. The temperature is maintained within ±2°C of the specified value. An a.c. voltage of a frequency of 50 Hz or 60 Hz equal to the test voltage or, if the test voltage is not marked, 1.3 times of the rated voltage shall be applied to terminals.

6.6.2 Voltage test

The test is made on 5 samples in air at the rated maximum operating temperature, plus 10°C or plus 15% whichever is the higher.

The temperature is maintained within ±2°C of the specified value.

6.6.2.1 Between terminals

The capacitors shall be subjected for 1 h to an a.c. voltage of a frequency of 50 Hz or 60 Hz equal to the test voltage, or if the test voltage is not marked, 1.3 times the rated voltage and for 1 min to an a.c. voltage equal to 2.15 times the rated voltage applied between terminals.

6.6.2.2 Between terminals and external parts

After the test in clause 6.6.2.1, the test voltage as specified in Table 1 of a frequency of 50 Hz or 60 Hz shall be applied to the terminals connected with the external parts for 1 min. Initially, not more than half the specified voltage is applied, the voltage is then raised rapidly to the prescribed value. Ballasts having an insulating cover or envelope shall be wrapped with tinfoil.

6.6.3 Moisture resistance

After the test in clause 6.6.2, and after having cooled down to ambient temperature, the capacitor shall be placed for 500 h in the humidity cabinet containing air with a relative humidity maintained between 93% and 95%. The temperature of the air, at all places where capacitors can be located, is maintained within 1°C of any convenient value t between 20°C and 30°C.

6.6.3.1 Between terminals

The capacitor shall be removed from the humidity cabinet. Visible drops of water, if any, shall be removed by means of blotting paper.

The test voltage of a frequency of 50 Hz or 60 Hz equal to 2.15 times of the rated voltage shall be applied between the terminals for 1 min.

6.6.3.2 Between terminals and external parts

After the test in clause 6.6.3.1, the test voltage as specified in Table 1 of a frequency of 50 Hz or 60 Hz shall be applied to the terminals connected to the external parts for 1 min. Initially, not more than half the specified voltage is applied, the voltage is then raised rapidly to the prescribed value. Ballast having an insulating cover or envelope shall be wrapped with tinfoil.

6.7 Thermal endurance of windings

The test is carried out on 7 ballasts drawn in accordance with clause 5.1.1. Before the test, the ballasts shall satisfy the following requirements.

(1) They shall start and operate a lamp.
(2) The watt loss of the ballast under normal operating conditions at rated supply voltage shall be measured.

The test is carried out in an appropriate oven. Figure 3 shows a suggested design of oven.

The ballast shall function electrically in a manner similar to that in normal use. In the case of capacitors or other auxiliaries which should not be subjected to the test, these shall be disconnected and reconnected again in circuit but outside the oven. It is

recommended that the manufacture supplies special ballasts with these parts removed and any necessary additional connections brought out from the ballast.
In general, to obtain normal operating conditions, each ballast shall be tested with the appropriate lamps but for certain inductive type ballasts the lamps may be replaced by equivalent resistances adjusted to maintain the mean value of current through the ballast. The lamps or the equivalent resistance shall always be kept outside the oven.
The ballast shall be earthed.
The batch of 7 ballasts is placed in the cabinet as shown in Figure 3 and the rated voltage shall be applied to the ballasts.
However, if it is possible to control the temperature of the winding of all samples to be equal to those in Table 10, the size of oven may be neglected. The purpose of the instruction of how to place ballasts in the oven is to test the ballasts regardless of their amount.
The oven thermostats are then varied in such a way that the internal temperature of the oven attains a value such that the temperature of the hottest winding in the ballast is approximately equal to the objective value given in Table 10.
At the end of its test, the relevant ballast is disconnected from the supply, but is not removed from the oven until the tests on the other ballasts have been completed.
The test period for each ballast commences from the time the ballast is connected to the supply. The objective test temperatures, given in Table 10, should correspond to a working life of 10 years′ continuous operation at the rated maximum operating temperature t_w.
They are calculated on the basis of the following formula.

$$\log L = \log L_o + 4\,500\left(\frac{1}{T} - \frac{1}{T_W}\right)$$

Where L = objective test life in days
L_O = 3 652 days
T = theoretical test temperature in K
T_W = rated maximum operating temperature in K

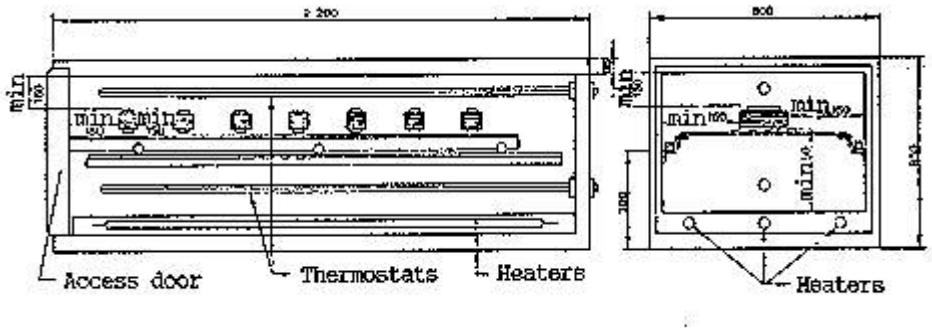


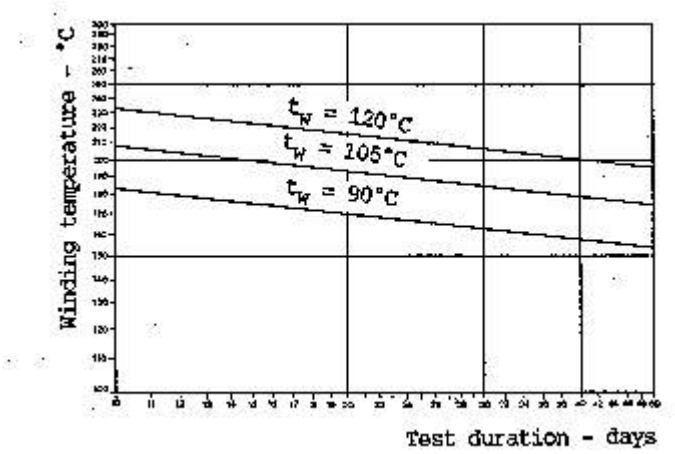
Figure 3 Dimensions and layout of typical heating cabinet
(clause 6.7)

The manufacturer shall be free to adopt a test period of either 15 or 30 days. After 4 h the actual temperature of the winding is determined by the increase-in resistance method and, if necessary, the oven thermostats are readjusted to approximate as closely as possible the objective test temperature. A daily reading of the air temperature in the oven as prescribed in Figure 3 shall be taken to ensure that the thermostats are maintaining the correct value to within ±2°C. The winding temperatures are measured again after 24 h and the final test period for any ballast shall be determined from the curve given in Figure 4. The permissible difference between the actual temperature of the hottest winding of any of the ballasts under test and the objective value shall be as follows.

- The final test period shall not be less than 10 days for an objective life of 15 days :
- The final test period shall not be more than 50 days for and objective life of 30 days.

Table 10
Objective test temperature
(clause 6.7)

Rated maximum operating temperature °C	Objective test temperature for life test period of °C	
	15 days	30 days
90	176	163
95	183	170
100	191	177
105	199	185
110	207	192
115	215	199
120	223	207
125	231	214
130	239	221



Test duration - days

Figure 4 Relation between winding temperature and test duration
(clause 6.7)

6.8 Limitation of ballast heating

Before the test, the following inspection and measurement shall be carried out.

(1) Resistance of each winding at ambient temperature shall be measured.
(2) The ballast shall start and operate lamp.
(3) Watt loss of the ballast at normal operating conditions at rated supply voltage shall be measured.

The ballast shall be placed in a hood in which the temperature is 30±2°C. For the test under abnormal conditions, the condition shall be the most adverse load condition stated in clauses 2.24(1) to 2.24(4). Test under condition given in clause 2.24(5) applies only to starterless ballasts. In the case where a ballast is designed for more than one lamp, only the starter whose failure would cause the highest temperature rise, shall be short-circuited, the unaffected lamps burning normally.

6.8.1 Ballasts without t_w marking

Ballsats shall be tested under normal and abnormal conditions at 1.1 times the rated supply voltage and at the rated frequency with appropriate lamps until steady temperature rises are attained. Temperature rises shall be determined from the difference between the actual temperature of the winding and the ambient temperature of the sample.

Lamps shall be deemed to be appropriate if they take, under the prescribed test conditions, a current not deviating by more than 2.5% from current a reference lamp would take.

Temperatures are measured on windings by resistance method by means of a thermocouple. For the test to check for any occurrence of short-circuited turns during the test, measurement of watt loss of the ballast at normal operating conditions at rated supply voltage and rated frequency is made before and after the test. The temperature of the winding shall be calculated on the basis of the following formula.

$$t_2 = \frac{R_2}{R_1}(K + t_1) - K$$

Where t_2 = objective temperature in °C
R_2 = resistance of windings in steady state in Ω
t_1 = initial temperature of windings or ambient temperature at the beginning of the test in °C
R_1 = resistance of windings at the temperature t_1 °C in Ω
K = 234.5 for copper and 228.1 for aluminum

(1) Test under normal conditions
Ballsats are operated with lamps burning normally.
The lamps shall be placed in such a way that the heat generated does not contribute to the temperature rise of the ballast.
Note : If the ballast is a simple impedance in series with the lamp, the test and measurement may be made without lamp provided that the current is adjusted to the value corresponding, in normal operation, to a supply voltage of 1.1 times its rated value,

(2) Test under abnormal conditions
The two cathodes of the lamp shall be replaced by equivalent resistances as specified in Table 11, Table 11 A or Table 11 B.

Table 11
Equivalent resistance of cathodes for lamps operated with starters
(clauses 6.8.1 and 7.3.1)

Rated lamp wattage W	Equivalent resistance of both lamp cathodes Ω
13	120
20	50
30 (T8)	50
32	50
40	40
65	25
80	25
85	25
90	10
120	25

Table 11 A
Equivalent resistance for lamp with low-resistance cathodes operated without starters
(clauses 3.19.2, 6.8.1, 7.2.2, 7.3.2 and 7.7)

Rated lamp wattage W	Equivalent resistance of both lamp cathodes Ω
20	10
40	10
65	6
85	3.2
215	3.2

Table 11 B

Equivalent resistance for lamp with high-resistance cathodes operated without starters

(clauses 3.19.2, 6.8.1, 7.2.2, 7.3.2 and 7.7)

Rated lamp wattage W	Equivalent resistance of both lamp cathodes Ω
20	27
40	20
80	12
85	12
125	12

6.8.2 Ballasts with t_w marking or ballasts with both t_w and △ t mariking

The ballasts shall be tested under the same conditions as those without t_w marking, except for the following conditions.

6.8.2.1 Ballasts with t_w marking

The test is first made at the rated supply voltage until stable conditions are reached, then the temperature rises of the windings are measured. After this, the supply voltage is adjusted to 1.1 times the rated value in order to check the temperature rises of every component. The test under abnormal conditions is made under 1.1 times the rated supply voltage only.

6.8.2.2 Ballasts with both t_w and △ t marking

In addition to the condition specified in clause 6.8.2.1 above, ballasts with both t_w and△ t marking shall be tested for normal conditions under conditions of normal supply in the arrangement of mounting in the test hood as shown in Figure 5.

When the supporting surface is a metal plate, the ballast is mounted in the test hood spaced at the two ends by steel spacers, 2 mm in thickness, of a width equal to that of the ballast and of a length equal to m + 10 m (see Figure 5). These conditions of mounting should permit each spacer to extend 10 mm under the body of the ballast.

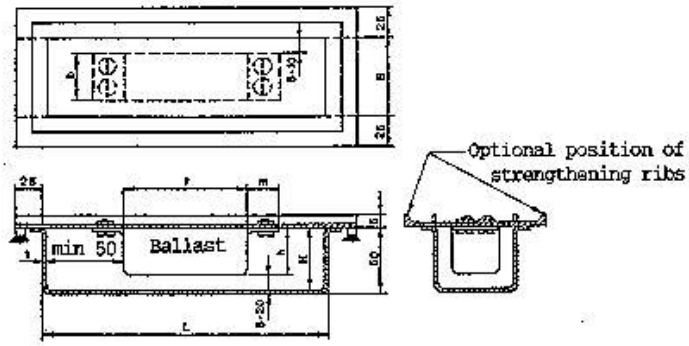


Figure 5 Hood of heating

(clause 6.8.2.2)

6.9 Screws and nuts

Compliance is checked by inspection and, for screws and nuts transmitting contact pressure, and which are operated when mounting or connecting the ballast, by the following test:

(1) The screws or nuts shall be tightened and loosened

10 times for screws in engagement with a thread of insulating material

5 times for nuts and other screws.

(2) Screws in engagement with a thread of insulating material shall be completely removed and reinserted each time.

(3) When testing terminal screws and nuts, a solid conductor of the largest cross-section specified in clause 3.5.1 shall be placed in the terminal. The test is made by means of a test screwdriver or suitable spanner applying a torque as show in Table 12. The conductor is removed each time the screw or nut is loosened.

Column 2 applies to screws without heads (i.e. the screws which when tightened do not protrude from the hole).

Column 3 applies to other screws and to nuts.

Table 12
Torque
(clause 6.9)

Nominal diameter of screw mm	Torque Nm	
	Screws without heads	Other screws or news
Up to and including 2.8	0.2	0.4
Over 2.8 up to and including 3.0	0.25	0.5
Over 3.0 up to and including 3.2	0.3	0.6
Over 3.2 up to and including 3.6	0.4	0.8
Over 3.6 up to and including 4.1	0.7	1.2
Over 4.1 up to and including 4.7	0.8	1.8
Over 4.7 up to and including 5.3	0.8	2.0
Over 5.3 up to and including 6.0	-	2.5

6.10 Resistance to heat

Enclosures and other external parts of insulating material are subjected to a ball pressure test by means of the ball pressure apparatus shown in Figure6.

The surface of the part under test is placed in the horizontal position and a steel ball of 5 mm diameter is pressed against this surface by a force of 20 N.

The test is made in a heating cabinet for 1 h at temperature which is 50±5°C in excess of the temperature rise of the relevant part specified in Table 2. For parts retaining live parts in position with a temperature less than 125°C, the test shall be made in a heating cabinet at a temperature of 125°C. After 1 h, the ball is removed and the diameter of the impression measured.

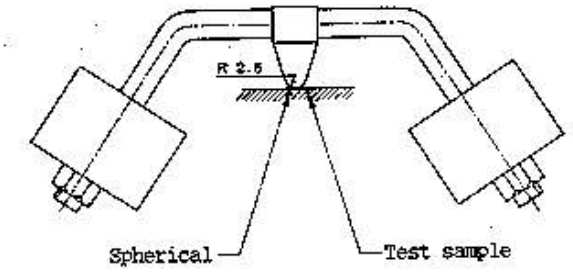


Figure 6 Ball-pressure apparatus
(clause 6.10)

6.11 Cracks caused by the corrosion of copper

The surface of the sample shall be carefully cleaned, varnish being removed by acetone and grease or fingerprint by petroleum spirit. The sample shall be kept for 1 h in a saturated solution of mercuric chloride (H_gCl_2) in water at a

temperature of 20±5°C, then the samples shall be washed in running water. After leaving for 24 h, the sample shall show no cracks.

7. Measurement

7.1 General requirements

The general requirements of the measurement shall be in accordance with clause 6.1.

The performance without recommended means of measurement shall be measured by suitable measuring devices and methods.

To protect against magnetic influence, no magnetic materials shall be allowed within 25 mm of any surface of the reference ballast or the ballast under test, unless otherwise specified.

7.2 Open-circuit voltage at terminations of lamps or starter

7.2.1 For lamp operated with starter

For the measurement of the voltage complying with column 3 and column 4 of Table 4, each starter shall be removed.

7.2.2 For lamps operated without starter

For the measurement of the voltage complying with column 3 and column 4 of Table 5 or Table 6, each lamp cathode shall be replaced by a resistance of the objective value given in Table 11 A or Table 11 B of both single or multi-lamp ballasts for parallel circuits.

For the checking of open-circuit voltage at lamp terminations, the maximum value of the four measurements between lamp terminals is taken.

7.3 Pre-heating

7.3.1 For lamps operated with starter

For the measurement of the pre-heating current as required in clause 3.19.1, the lamp cathodes are each replaced by a resistance of the values given in Table11.

7.3.2 For lamps operated without starter

For the measurement of the pre-heating voltage, as required in clause 3.19.2, a resistance of the objective value specified in Table 11 A or Table 11 B shall substitute for each cathode and with a supply voltage of 90% of the rated voltage and at rated frequency, the measurement shall take account of the resistance.

7.4 Power and current output

7.4.1 For lamps operated with starter

Figure 7 gives an example of a suitable testing circuit when measuring the power and current output.

Measurements shall be made with the starting device taken out of circuit. In the lamp circuit, potential circuits shall not be connected across the starter circuit.

When measuring the voltage of the lamp, the potential circuit of the wattmeter shall not be opened.

When measuring the power of the lamp, The voltmeter circuit shall not be opened, no correction shall be made for the wattmeter consumption (the common connection being made next to the wattmetre as the example of circuit shown in Figure 7).

To reduce the new stabilization period of the lamp after transference from one ballast circuit to another, a quick switching technique should be adopted. During the switching, the connections of the individual pins or contacts to the same reference lamp shall not be changed.

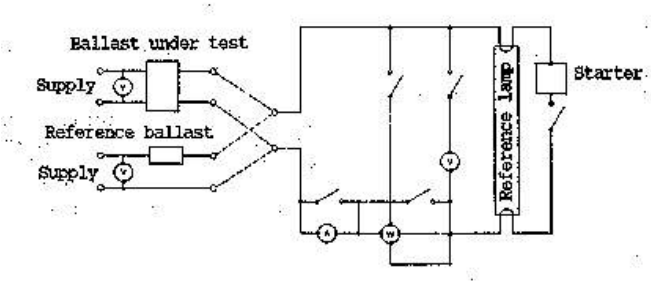


Figure 7 Circuit diagram to be used for measurement of power and current output (lamp with starter)
(clause 7.4.1)

7.4.2 For lamps operated without starter

Figure 8 gives an example of suitable test circuit. It consists essentially of:

7.4.2.1 A changeover switch, preferably quick-acting, allowing the reference lamp to be connected either to the ballast under test or the reference ballast.

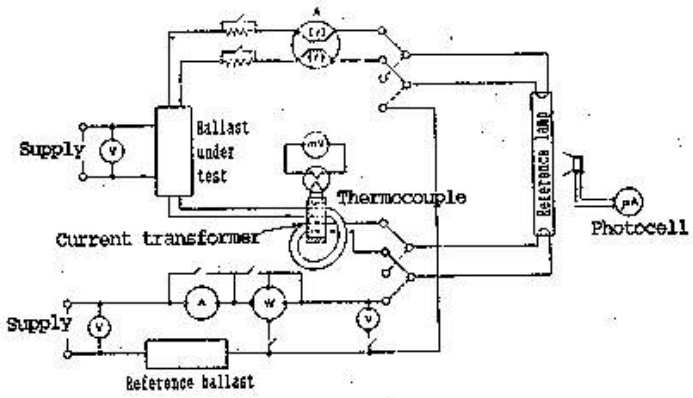


Figure 8 Circuit diagram to be used for measurement of power and current output (lamp without starter)
(clause 7.4.2)

7.4.2.2 A means of measuring the current supply to the lamp. Since in the general case of circuits for operation without starter, none of the accessible conductors carries the actual lamp current to be measured, the method of test using a current transformer is required.

A suitable current measuring device (e.g. a thermocouple connected to a millivoltmeter) is connected to the secondary terminals of this transformer. The combination of two conductors leading to one lamp cathode is wound round the core or inserted in the hole of the current transformer. The measured value is the sum of the vector of the two currents in the windings as in the lamp current.

7.4.2.2 A means of measuring photometrically a proportionate indication of the luminous flux of the lamp. It is not necessary to place the lamp in the integrating sphere. It is sufficient to place a photo-electric cell at a given distance from the lamp and directed to the central portion, provided that suitable precautions are taken to shield the photo-electric cell from other radiation and to prevent any relative movement of the lamp and the photo-electric cell throughout the test.

7.5 Overall power factor

Figure 9 gives the recommended circuit for the determination of overall power factor.

7.6 Current consumed from supply

Either Figure 11 or 12 shall be used for the measurement of current consumed from supply.

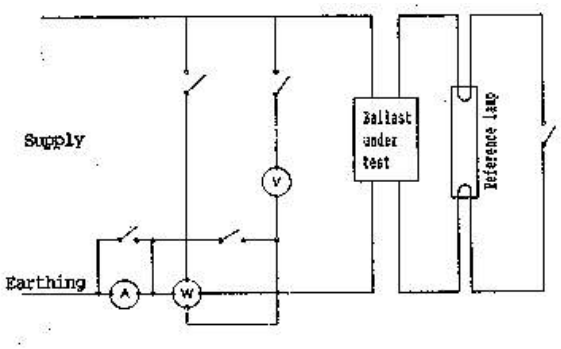


Figure 9 Circuit diagram for determination of overall power factor
(clause 7.5)

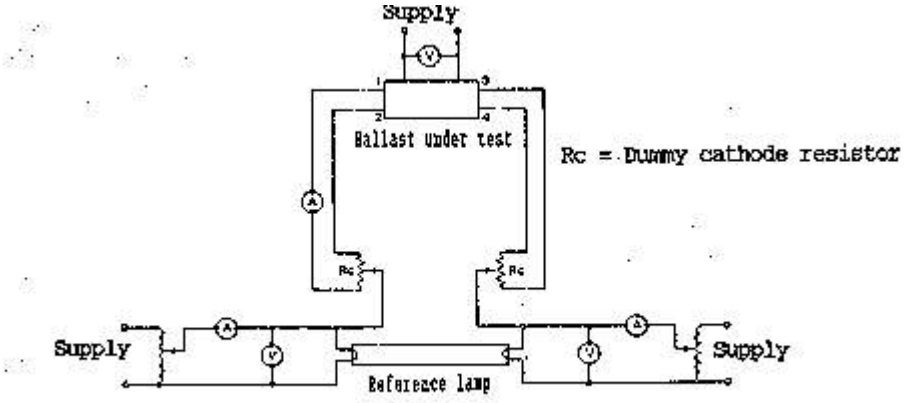


Figure 10 Circuit diagram to be used for measurement of maximum current in any lead to a cathode
(clause 7.7)

7.7 Maximum current in any lead to a cathode

Figure 10 shows the circuit diagram proposed for measurement of maximum current in any lead to a cathode.

The circuit is chosen in order to provide for normal operation of the ballast, while making the test independent of the position of the hot spot on the cathode. The dummy cathode resistances shall have the objective values specified in Table 11 A or Table 11 B to substitute the cathodes and the lamp circuit is connected to the mid-point of the resistor (R_C).

In order to ensure normal working conditions for the ballast, the reference lamp cathodes are heated by independent circuits at a voltage corresponding to the voltage which would be supplied to the cathodes by the ballast under test, at the test voltage. Measurements are made for the four conductors 1, 2, 3 and 4.

7.8 Current waveform

7.8.1 For lamps operated with starter

Figure 11 shows the circuit diagram to be used for measurement of current waveform as specified in clause 3.24.

The peak value of the lamp current shall be determined by means of the resistor R connected in series with the winding inserted to the earth and a calibrated cathode-ray oscilloscope.

The resistor R introduced in the circuit shall be in accordance with sub-clause 6.1.6.

During each measurement, the resistor not in use shall be short circuited and the apparatus not in use disconnected. The capacitor of 0.01 μF value shall replace the capacitor in starter. Care must be taken during each test to ensure a sufficiently low impedance of the supply for the different frequencies involved.

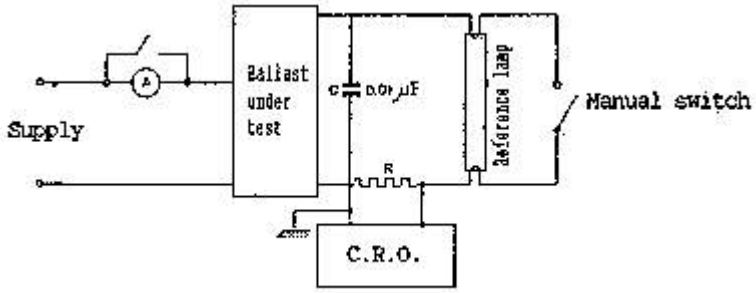


Figure 11 Circuit diagram to be used for measurement of current waveform (clause 7.6 and 7.8.1)

7.8.2 For lamps operated without starter

Figure 12 shows the circuit diagram to be used for measurement of current waveform as specified in clause 3.24.

A current transformer described in clause 7.4.2.2 shall be applied for the determination of the waveform or peak value of the current supplied to the lamp.

A non-inductive resistor is connected across the secondary winding of the current transformer with regard to the reflected impedance as specified in clause 6.1.6 and the cathode-ray oscilloscope is connected across the mentioned resistor.

7.9 Protection against magnetic influence

The test shall be made on the ballast in normal operation with a lamp. A steel plate shall be successively moved into proximity at a spacing of 1 m from each face of the ballast. This plate shall be brought into contact with the face of the ballast used for fixing. The steel plate shall be 1 mm thick and of length and width greater than those of the ballast under test.

During this operation, the current absorbed by the ballast at rated voltage and frequency shall be measured.

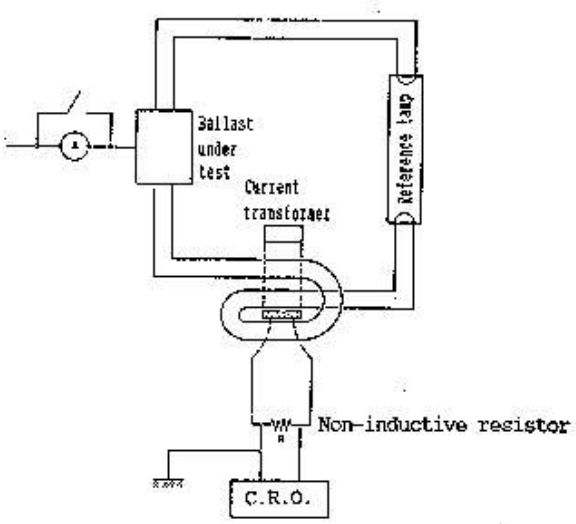


Figure 12 Circuit diagram to be used for measurement of current waveform (lamp without starter)
(clauses 7.6 and 7.8.2)

Appendix A
Reference ballasts
(clause 2.2)

A.1 Marking

At least there shall be number, letter or symbol clearly and durably marked on the reference ballast giving the following information.

(1) The words “reference ballast” in Thai or English
(2) Name of manufactured or factory, trade mark or responsible supplier
(3) Serial number
(4) Rated lamp wattage and calibration current
(5) Rated supply voltage and frequency

A.2 Design characteristics

A.2.1 General design

A reference ballast is a self-inductive coil, with or without an additional resistor, designed to give the operating characteristics of clause A.3. It is always operated with a starter, without respect to the type of lamp with which it is used.

A2.2 Protection

The reference ballast shall be protected against magnetic influence in such way that its ratio of voltage to current for the calibration current shall not be changed by more than 0.2% when testing according to clause A.4.3 in geometric symmetry condition. Moreover, it shall be protected against mechanical damage. The protector may be by means of a steel case.

A.3 Operating characteristics and temperature rise

A.3.1 Rated supply voltage and frequency

The rated supply voltage and frequency of a reference ballast shall be in accordance with the value given in Table A.1 or Table A.2.

A.3.2 Ratio of voltage to current

The ratio of voltage to current of a reference ballast shall conform to Table A.1 or Table A.2, subject to the following tolerances :

(1) ±0.5% at the calibration current voltages
(2) ±3% at any other value of current from ±50% to ±115% of the calibration current

A.3.3 Power factor

The power factor determined at the calibration current shall be as shown in Table A.1 or Table A.2 subject to tolerance of ±0.005.

A.3.4 Temperature rise

When the reference ballast is operated in an ambient air temperature or between 20°C and 27°C at calibration current and rated frequency, the steady steel temperature rise of the ballast winding shall not exceed 25 when measured by the resistance method.

Table A.1
Lamp types and characteristics of reference ballasts at 50 Hz
(clause A.3.1, A.3.2 and A.3.3)

Rated lamp wattage W	Characteristics of reference ballast			
	Rated Voltage V	Calibration current A	Ratio voltage/current Ω	Power factor
13	220	0.165	1070	0.12
20	127	0.37	270	0.12
30 (T8)	220	0.36	480	0.10
32	220	0.45	415	0.10
40	220	0.43	390	0.10
65	220	0.67	240	0.10
80	240	0.865	223	0.06
85(1)	240	0.865	223	0.06
85(2)	350	0.55	480	0.06
125	350	0.94	300	0.06

Note : (1) High resistance cathode
(2) Low resistance cathode

Table A.2
Lamp types and characteristics of reference ballasts at 60 Hz
(clauses A.3.1, A.3.2 and A.3.3)

Rated lamp wattage W	Characteristics of reference ballast			
	Rated Voltage V	Calibration current A	Ratio voltage/current Ω	Power factor
13	236	0.165	1200	0.075
20	118	0.38	240	0.075
03(T8)	236	0.355	548	0.075
40	236	0.43	439	0.075
90	150	1.5	78.5	0.075
125	400	1.5	215	-

A.4 Measurement made on the reference ballast

A.4.1 Measurement of ration of voltage to current

Figure A.1 gives a typical testing circuit for measurement of ratio of voltage to current. No correction need be made for the current drawn by the voltmeter, provided that the voltmeter complies with the requirements of clause 6.1.6.1. If the frequency is not exactly the rated value (f_n), a correction to the measured voltage shall be applied in accordance with the following formula:

Voltage at f_n = voltage at frequency $f \times \frac{f_n}{f}$

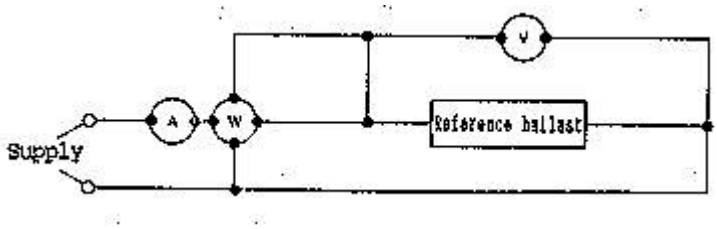


Figure A.1 Circuit diagram for measurement of Voltage/current ratio
(clause A.4.1)

A.4.2 Measurement of power factor

Figure A.2 gives a typical circuit for the determination of the power factor. In measuring the power factor, the instrument losses shall be taken into account.

A.4.3 Checking of protection against magnetic influence

A mild steel plate 12.5 mm thick and of length and width at least 25 mm greater than those of the reference ballast shall be moved and placed at 25 mm from each face of the ballast enclosure in geometric symmetry condition.

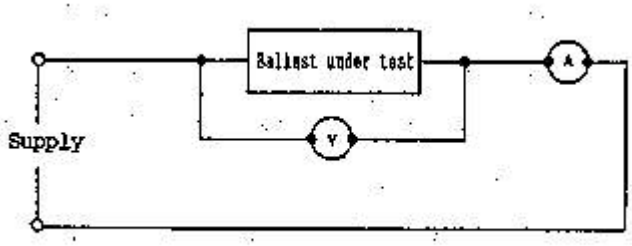


Figure A.2 Circuit diagram for determination of power factor
(clause A.4.2)

Appendix B
Reference lamps
(clauses 2.4 and 6.1.2)

B.1 Reference lamp is a lamp which has been aged for at least 100 h, when associated with a reference ballast under normal testing conditions at an ambient temperature of 25°C, neither lamp wattage, lamp voltage nor lamp current shall device by more than 2.5% from the objective values for wattage, voltage and current given in TIS 236.

B.2 Resistance of the cathodes

For lamps operated without starter, the resistance of the cathodes shall not differ from the objective value for the type of lamp by more than 10%.

A reference lamp shall be of a type designed for that ballast.

The waveform of the current supplied in the steady stage to a reference lamp associated with a reference ballast shall show substantially the same wave-shape in successive half-cycles.

B.3 Mounting and connections of reference lamps

In order to make the reference lamps repeat their electrical values with the consistency, it is recommended that the lamps be mounted horizontally and allowed to remain permanently in their test lampholders. The terminations of the reference lamp in the testing circuit shall be the same as those in the circuit aging the lamp. Letter B in Figure B.1 shows the lamp terminations connected with the main circuit.

B.4 Reference lamp stability

B.4.1 Before carrying out measurements, a lamp shall be brought to a condition of a stable operation. A lamp shall not show swirling or any abnormal operating condition.

B.4.2 The characteristics of a lamp shall be checked immediately before and immediately after each series of tests.

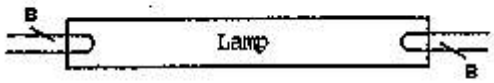


Figure B.1 Connection of reference lamp
(clause B.3)

B.5 Selection of reference lamps

B.5.1 Figure B.2 gives a recommended circuit for selecting reference lamps with starter.

After the lamp has struck, the starting device shall be taken out of the circuit.

When stable burning conditions are reached, the current, voltage and power of the lamp shall be measured for compliance with clause B.1.

When measuring the voltage or power of the lamp, the potential circuit of wattmeter shall be disconnected. When measuring lamp watts, the circuit of voltmeter shall be disconnected and no corrections shall be made for the wattmeter consumption (the common connection being made on the wattmeter according to the typical circuit shown in Figure B.2).

B.5.2 Figure B.3 gives a recommended circuit for selecting reference lamps without starter.

The voltage of per-heating for low resistance cathodes shall be 3.6 V and for high resistance cathodes shall be 8 V.

When stable burning conditions are reached, the current, voltage and power of the lamp shall comply with clause B.1.
When measuring the voltage of the lamp, the potential circuit of the wattmeter shall be disconnected. When measuring lamp watt the circuit of the voltmeter shall be disconnected and no corrections shall be made for the wattmeter consumption (the common connection being made on the wattmeter in accordance with the typical circuit as shown in Figure B.3).

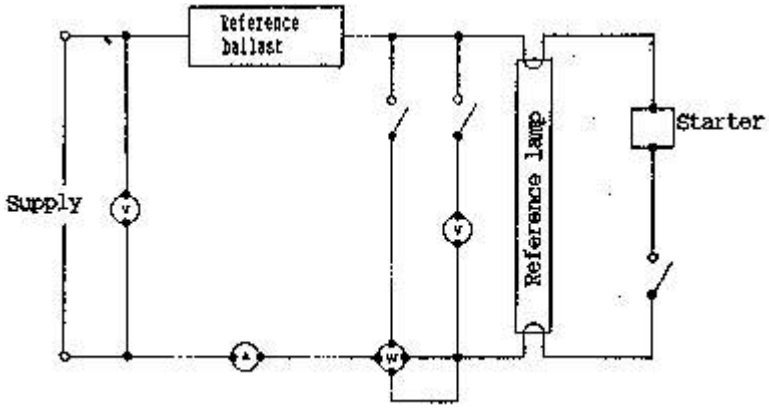


Figure B.2 Circuit diagram for selection of reference lamp (lamp with starter) (clause B.5.1)

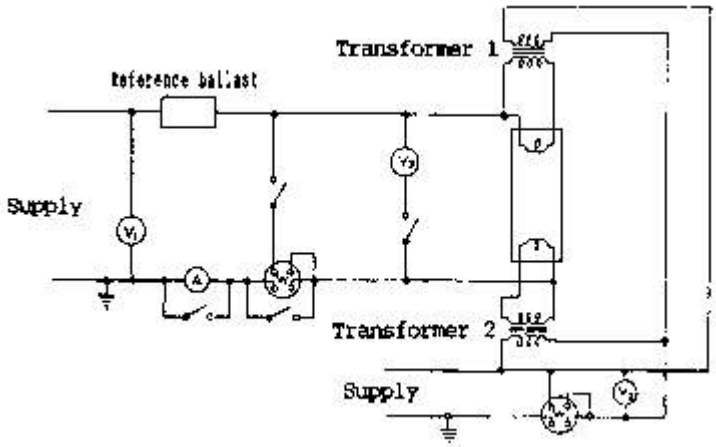


Figure B.3 Circuit diagram for selection of reference lamp (lamp without starter) (clause B.5.2)

Appendix C
Type tests
(clauses 5.2.1.1 and 6.1.2)

No.	Test item	Test as in clause	Note
1.	General requirements	6.1	
2.	Marking	6.2	
3.	Protection against accidental contact	6.3	
4.	Protection against electric shock	6.1	
5.	Terminals for external wiring	6.9(3)	
6.	Lead connection	6.1	
7.	Provision for earthing	6.1	
8.	Voltage across capacitors	6.1	Only for capacitor of more than 0.1 μF capacitance
9.	Moisture resistance, insulation resistance and voltage resistance	6.4	
10.	Leakage current	6.5	
11.	Capacitor	6.6	
12.	Limitation of ballast heating	6.8	
13.	Screws and nuts	6.9	
14.	Creepage distances and clearances	6.1	
15.	Resistance to heat	6.10	
16.	Resistance to corrosion	6.11	
17.	Open-circuit voltage at terminations of lamp or starter	7.2	
18.	Pre-heating	7.3	
19.	Power and current output	7.4	
20.	Overall power factor	7.5	
21.	Current consumed form supply	7.6	
22.	Maximum current in any lead to a cathode	7.7	
23.	Current waveform	7.8	
24.	Voltage across terminals of voltage operated starter	7.1	
25.	Protection against magnetic influence	7.9	
26.	Resistance to heat of windings	6.7	Separate samples required