Consumer and Corporate Affairs
Consommation et Corporations

Legal Metrology and
Laboratory Services Branch

Requirements and Specifications

for

APPROVAL OF TYPE

of

Electricity Meters and Auxiliary Devices

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AUTHORITY

Under the authority of the Electricity Inspection Act and the Regulations thereto:

(i) No meter or device intended for use in the measurement of electricity for sale shall be admitted to verification or be put into revenue service until it or the type to which it belongs has received approval of the Standards Branch for such service.

(ii) Every type of meter or device shall conform to such tests as are prescribed by the Director of Standards, the specifications for which shall be published from time to time and be available to manufacturers and, if changed, shall not be made effective until a day which gives reasonable notice of the changed requirements.

NOTE: *Instrument Transformers are not included herein but are subject to Standards Branch "Requirements for Approval of Type of Instrument Transformers — July 1970".*

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PART I — REQUIREMENTS

CONTENTS

PART I — REQUIREMENTS

1. SCOPE

This PART I sets forth the rules and procedures for obtaining approval of type.

2. DEFINITIONS

2.1 Definition of Type. In this document, the "type" of a device means the designation assigned to it by the manufacturer for the purpose of distinguishing its particular design and construction from other designs, models or patterns. Such type designation shall embrace only those ranges and ratings that are essentially similar in appearance and performance.

2.2 Other Definitions. All other definitions pertaining to this document are contained in PART II.

3. APPLICATION FOR APPROVAL OF TYPE

3.1 Who can apply. Any manufacturer, manufacturer's agent, utility or person desiring to use or sell any device for revenue electric metering purposes in Canada shall, unless such device is already approved, make an application in writing for approval of type.

NOTE: *Generally speaking, approvals are requested by and issued to a manufacturer or his agent. Under special circumstances exceptions to this rule will be considered.*

A letter of application together with other pertinent material as outlined below shall be sent to:

Chief, Electricity & Gas Division
Department of Consumer & Corporate Affairs,
Tunney's Pasture, Ottawa, Ontario.

3.2 What is required. The application for approval shall be accompanied by the following information;

(i) A complete list of all types, ratings and/or ranges for which approval is sought.

(ii) Operation and performance characteristics of the type or types, nameplate information, connection diagrams, etc. This information shall consist of material, such as typed or printed specifications, drawings, brochures and catalogue sheets necessary to provide a comprehensive understanding of the equipment.

In addition, if there are variations in construction or performance of the various sizes of a type, these shall be delineated.

(iii) Manufacturer's test results on representative samples of the type or types. Preferably, these should be the same samples as are submitted to the Laboratory.

3.3 Rejection of Application. If on the basis of information submitted a type of device obviously cannot meet the requirements set forth herein, the application for approval will be rejected and the applicant advised of the reasons.

4. SUBMISSION OF SAMPLES

4.1 Where to send. Normally, after the submitted documentary material has been examined and the Chief, E&G Division is satisfied that all necessary information has been provided, the applicant will be requested to submit specified types and sizes for examination and test by the Standards Laboratory.

Such samples shall be forwarded to:

Chief, Standards Laboratory
Department of Consumer & Corporate Affairs,
Tunney's Pasture, Ottawa, Ontario.

4.2 Representative Samples

4.2.1 The samples submitted shall be representative of the production of the type, and the manufacturer's test data indicating the ability of the type or types to meet the accuracy requirements for billing metering purposes shall accompany the submission.

Where approval is being sought in advance of the establishment of regular production, prototype design samples may be accepted but the applicant must advise the Branch that these are not production samples. In such case, any approval granted may be tentative, pending tests on production samples at a later date.

4.2.2 The number of samples on which approval of type tests are performed shall be determined by the Chief, E&G Division in accordance with the circumstances.

4.2.3 The Standards Laboratory may retain one of the samples of an approved device for the purpose of comparison with production models.

Normally, a sample will be retained only if its value does not exceed $50.00 and if it is of a type expected to have large volume production.

4.3 Condition of Samples

4.3.1 The applicant shall ensure that the samples submitted are in good condition, tested and properly adjusted before shipping.

4.3.2 Samples submitted for test will be treated and tested with care but the Standards Laboratory cannot be held responsible for any damage received by the equipment during shipment to or from the Laboratory or while undergoing test.

5. APPROVAL SPECIFICATIONS AND TESTS

5.1 Usual Devices. Except as otherwise provided in subsection 5.2, a device shall be subject to all the appropriate specifications and tests outlined in Part III.

5.2 Unusual Devices. Where a device because of its unique design, principle of operation, or unusual function does not fall strictly into the categories covered by Part III, such device shall be judged and tested against the most appropriate clauses and such other improvised criteria applied as may be deemed suitable in the circumstances having due regard to its intended use.

6. GRANTING OF APPROVAL

6.1 General Approval. Where a device has been examined and found to meet all the requirements for Approval of Type, the device or the type to which it belongs may be granted General Approval.

General Approval may be granted to a specific rating of a type or to a full or partial range of ratings.

6.2 Special Approval. When it is desired to grant approval to a single unit or a limited number of units or when there is no expectation of further production of similar units, Special Approval may be granted.

Normally, under Special Approval, the description of the device or devices is stated in the approval letter along with the location where the device or devices will be installed or used.

6.3 Special Cases. In special cases where the device, because of some feature or features, does not completely meet the requirements of this document, the Chief, E&G Division may, at his discretion and for cause, grant approval.

6.4 Limitation of Approval. General Approval granted to a particular type of device applies only to those devices that are in strict accord with the approval notice. If it is proposed to make any alteration in the design, construction or characteristics of an approved device, descriptive information shall be submitted before any of the altered devices are sold, offered for sale, or used. The Branch will then decide if such alteration may be accepted as immaterial or if examination of an altered sample is required. If the latter, further samples as required shall be submitted.

6.5 Rejection or Withholding of Approval. Where a device fails to meet all the requirements of this document and where the points of failure are numerous or of considerable consequence, the applicant will be advised that approval is not granted and the reasons for such rejection explained.

Where failure to meet the requirements includes only items of relatively minor significance and where it appears that such defects as exist can be readily corrected by the manufacturer, approval will be withheld pending receipt and test of corrected samples or in some cases assurance from the manufacturer that the defects will be corrected.

In cases where the device meets all the requirements of this document but nevertheless fails to measure up to all the claims made for it by the manufacturer on the nameplate or in his literature, approval may be withheld until the claims have been modified to conform to the facts.

6.6 Withdrawal of Approval. The Chief, E&G Division reserves the right to select at any time samples of an approved device for the purpose of comparison with the approved sample. He also reserves the right to withdraw approval of any device if, for any reason, he deems the type unsuited for further service or if the current production is not in accord with the original approval.

In these circumstances due notice of such action will be given to the manufacturer concerned.

6.7. Test Results. The applicant will be supplied with the results of the tests carried out on the sample device, on request.

7. COSTS

7.1 Fees. There are no fees charged in connection with approval of type examination and testing. However, there are certain expenses and some of these must be borne by the applicant.

7.2 Shipping Costs. Devices sent to the Standards Laboratory for approval must be shipped "PREPAID" and will be returned "COLLECT". Unless otherwise instructed, the Standards Laboratory will endeavour to return devices to the sender by the same means and carrier as received.

7.3 Customs Clearance. It is the responsibility of the applicant to arrange for customs clearance of any samples sent from outside Canada. A list of Ottawa customs brokers will be supplied on request.

PART II — DEFINITIONS

PART II — DEFINITIONS

Accuracy Rating of a null balancing instrument. The limit which errors will not exceed when the instrument is used under any combination of rated operating conditions, expressed as a percent of the span.

Ambient Temperature. The temperature of the medium, such as gas or liquid, in which the device or apparatus under examination is immersed.

Approval Test. The testing of one or more meters or other items under various controlled conditions to ascertain the performance characteristics of the type of which they are representative.

Auxiliary Timing Device. A timing device which controls certain functions of other meters or devices but which is separately housed.

Block Interval Demand Meter. (see Integrated Demand Meter)

Case (of a Meter). The complete outside enclosure.

Chart. Graduated material upon which a pen or stylus draws a record, or upon which is printed a record, of the quantity or quantities being measured by an instrument.

Common Mode Interference. A form of interference which appears between any measuring circuit terminal and ground.

Cover (of a Meter). That part of the case which is removable, for access to working parts and adjustments.

Creep. A meter is said to creep if the rotor makes a complete revolution when the voltage coils are energized with rated voltage and with no current in any current coil.

Cumulative Demand Meter. A demand meter in which the operation of the maximum demand resetting device adds the prevailing maximum demand to the sum of the previous maximum demands.

NOTE: *The maximum demand for the period may then be obtained by subtracting the previous reading from the new reading.*

Current Range. The range of currents for which the meter is designed.

Damping Characteristic (of a null balancing instrument). The maximum overshoot (if any) beyond the point of final rest, expressed in percent of span.

Dead Band (of a null balancing instrument). The range through which the measured quantity can be varied without initiating response, expressed in percent of span.

Demand. The rate at which the particular quantity, i.e. active energy, reactive energy, etc., is being supplied to the load. Generally, it is indicated, recorded or computed as the average obtained over a specified time interval.

Demand Interval, of an integrating demand meter. The nominal duration of the consecutive equal intervals of time, which comprises the time the driving element of the maximum demand indicator is coupled to the receiving device, and the reset time.

Dielectric Tests. Tests consisting of the application of a voltage higher than the rated voltage for a specified time for the purpose of determining the adequacy against breakdown of insulation materials and spacing under normal conditions.

Disc Constant K_h. The registration, expressed in units of the quantity being measured per revolution of the disc.

Error

(a) **Absolute Error.** The value registered by the meter minus the true value.

(b) **Relative Error.** The ratio of the absolute error to the true value.

(c) **Percentage Error.** The relative error multiplied by 100. The percentage error is given by the following:

$$\text{Percentage error} = \frac{\text{Meter Registration} - \text{True Value}}{\text{True Value}} \times 100$$

External Circuit Resistance. The resistance of that part of the measuring circuit which is external to the instrument.

Frame (of a Meter). That part to which are affixed the working parts and adjustments.

Full Scale Value. The largest value of the actuating electrical quantity that can be indicated on the scale or, in the case of instruments having their zero between the ends of the scale, the full-scale value is the arithmetic sum of the values of the actuating electrical quantity corresponding to the two ends of the scale.

Indicating Demand Meter. A demand meter equipped with a scale over which a pointer is advanced so as to register maximum demand.

Integral Timing Device. One which is mounted within the case of the billing instrument.

Integrating Demand Meter (Block-Interval Demand Meter). A demand meter in which the demand is derived through integration of the measured quantity, with respect to time.

Interference. Any spurious voltage or current appearing in the circuits of the instrument.

Lagged Demand Meter. A demand meter in which the indication of the demand is subject to a characteristic time lag produced by either thermal or mechanical means.

Maximum Demand. The greatest of all demands which have occurred during a specified period of time, usually the billing period i.e. a month, two months, etc.

Maximum Demand Indicator. A mechanism intended for mounting in an electricity meter, which indicates or registers maximum demand.

Maximum Rated Current. The greatest current which the meter is designed to carry continuously. It coincides with the high end of the current range.

Meter Multiplier. The factor by which the register reading must be multiplied to obtain the registration in the stated units.

Minimum Rated Current. The smallest current at which the device is required to meet certain accuracy requirements. It coincides with the low end of the current range.

Multi-Rate Meter. A meter provided with a register having more than one set of dials or drums, each set becoming operative at times corresponding to different rates of charge.

Normal Mode Interference. A form of interference which appears between measuring circuit terminals.

Percentage Registration. The ratio of the actual registration of the meter to the true value of the quantity being measured, expressed as a percentage.

Power Factor. The ratio of the active power to the apparent power.

Pulse Initiator. Any device used with a meter to initiate pulses, the number of which is proportional to the quantity being measured.

Range, of an indicating or recording meter. The region covered by the span and expressed by stating the two end-scale values.

NOTE: *If the span passes through zero, the range is stated by inserting "zero" or "0" between the end-scale values.*

Rated Frequency. The frequency or frequencies for which the meter is designed.

Rated Voltage. The voltage or voltages for which the meter is designed.

Recording Demand Meter. A demand meter in which the indications of demand are recorded on a moving chart or tape.

Reference Temperature. The ambient temperature at which type testing is carried out and to which type tests at other temperatures may be referred.

Register. A device which registers the value of the quantity measured by the meter.

Register Ratio R_r (of an induction type integrating meter). The number of revolutions of the first gear of the register for one revolution of the first dial pointer.

Reset Time. The interval of time at the beginning, but within, each demand interval during which the coupling between driving element and receiving device is disconnected to allow the driving element to be restored to its initial position.

Response Period (of a lagged demand meter). The time required, for the meter indication to reach 90 percent of the final response to a step change in the measured quantity.

Sealing Device. Means whereby unauthorized access to the interior and adjustments of a meter may be effectively impeded.

Self Contained Meter. A meter designed to be connected directly to a power circuit, without the use of external devices such as instrument transformers or shunts.

Span. The algebraic difference between the end-scale values.

Strip Chart (roll type chart). A chart in the form of a roll or reel upon which the measured quantities are recorded.

Test Constant K_f (of a static watthour meter). The registration expressed in units of the quantity being measured per indication of the test device.

Test Device (of a static watthour meter). A device provided on static meters to facilitate high-speed manual and automatic testing.

Test Link. A device provided to isolate the current circuit from the voltage circuit, for the purpose of testing.

Test Period. The length of time during which a constant load is applied to a demand meter under test to ensure that the indication has reached its final value. For an integrating demand meter this period is equal to the demand interval; for a lagged demand meter the time is usually three to four times as long as the response period.

Thermal Convertor. A device which by means of thermocouples, generates a direct e.m.f. proportional to the a.c. quantity in the measuring circuit to which it is connected.

Timing Device. A clock, timing motor, or device, used to determine the demand interval, drive a chart, or actuate any mechanism of the billing instrument on a time basis.

Transducer. A device to receive energy from one system and supply energy, of either the same or a different kind, to another system in such a manner that the desired characteristics of the energy input appear at the output.

Transformer-Rated Meter. A meter designed for use with specific instrument transformer ratios. It thus indicates or records the primary quantity being measured.

Transformer-Type Meter. A meter designed to be used with instrument transformers.

Transient Overshoot. An excursion beyond the final steady-state value of output as the result of an input change.

Varhour Meter (Reactive Energy Meter). An integrating instrument which measures reactive energy in varhours or in suitable multiples thereof.

Watthour Meter. An integrating instrument which measures active energy in watthours or in suitable multiples thereof.

PART III — SPECIFICATIONS

CONTENTS

GENERAL

CONTENTS

SECTION 1 — GENERAL

1. SCOPE

These requirements apply to all appropriate types of meter or device which may be submitted for approval of type.

2. MECHANICAL REQUIREMENTS

2.1 Design & Construction. The design shall be suitable for the intended purpose and expected service conditions.

The construction shall be mechanically and electrically sound, and the materials, finish, etc., shall be such as to provide assurance of long life and sustained accuracy.

The meter or device shall be substantially shock-proof to withstand the handling encountered under normal conditions of transportation by common carrier.

2.2 Case. The meter or device shall have a substantially dust-proof and non-flammable case, not liable to distortion or damage due to normal changes of temperature, presence of moisture, or other normal conditions.

2.3 Inspection of Working Parts. Where applicable, provision shall be made for a clear view, with cover in place, of the register, the test dial and of those other working parts, the observation of which is necessary for efficient testing and reading of the meter.

2.4 Finish. The finish on the register face and nameplate shall be of durable material which will not fade, chip, flake, or discolour.

2.5 Terminals

2.5.1 Markings. In order to facilitate the proper connections, the terminals on the meter shall have clearly identifiable markings, as follows:

(a) For a self-contained single phase meter without accessories, sufficient identification will be the word "line" on the terminal cover of bottom-connected meters or on the base of a socket-type meter.

(b) For all others, a complete diagram of internal connections, satisfactorily located and secured, is required. If it is significant for proper operation, the phase sequence must be shown.

2.5.2 Sealing of Terminals. Except in the case of back-connected switchboard meters, provision shall be made so that the terminals may be effectively sealed against tampering.

2.5.3 Dimensions.

2.5.3.1 The current terminals shall be large enough to accommodate the proper cable size as given in Table 1.

TABLE 1

MINIMUM SIZE OF CURRENT TERMINALS

Maximum Current Rating of Meter Amps	Terminals Must Accommodate Lead Size Cu, AWG
Up to 10	12
Over 10, up to 20	8
Over 20, up to 30	6
Over 30, up to 60	4
Over 60, up to 100	2
Over 100, up to 200	1/0

2.5.3.2 The terminals of transformer-type meters shall be capable of making a sound electrical connection with one strand of No. 12 solid wire.

2.5.3.3 It must not be possible for the terminal cover to come in contact with the terminal screws when they are tightened on the largest size cable which can be accommodated.

2.6 Sealing. The meter or device shall be so constructed that access to the working parts and adjustments may be effectively prevented by such sealing arrangements as may be approved by the Department.

3. ELECTRICAL REQUIREMENTS

3.1 Adjustability. The number and range of adjustments has not been specified so as not to restrict design. However, the design shall be such that there is reasonable assurance that it will be possible to maintain correct calibration at any time throughout normal lifetime.

3.2 Insulation Level. The manufacturer shall certify that the insulation levels are in accord with the requirements of CSA C17.

3.3 Voltage Ratings. Preferred voltage ratings shall be: 120, 240, 345, 480, 600.

3.4 Temperature Rise. The current circuits shall be capable of meeting the temperature rise requirements set out in Clause 3.6 of CSA C17.

4. NAMEPLATES

4.1 Markings. Every meter, instrument or device shall have the following details indelibly and distinctly marked on one or more nameplates attached in such a way as to be clearly visible from the front, with cover in place:

i) Name or Mark of Manufacturer

ii) Type Designation

iii) Serial Number

4.2 Nameplate Location. It is preferred that the nameplate be attached to the base or meter mechanism; however it may be attached to the cover or scale provided that in such cases, the serial number is also permanently and predominantly

marked on the measuring element or base. Under no circumstances will the nameplate be permitted on the terminal cover.

5. PERFORMANCE REQUIREMENTS

5.1 Reference Conditions for Tests. Except when otherwise indicated the following standard test conditions shall apply:

i) the ambient temperature shall be 23°C ± 2°C

ii) the total harmonic content of the supply shall be less than 2%

iii) the supply shall be at rated frequency ±0.2%

iv) the voltage shall be the rated voltage ±0.3%

v) there shall be no significant stray magnetic field

vi) all voltage coils shall be connected in parallel and all current coils in series

vii) the voltage circuits shall have been energized for at least four hours and the current circuit(s) shall have been energized at each test value for a time sufficient to obtain stabilized performance

viii) the meter or device must be in its normal working condition. Except where the nature of the test requires otherwise, all registers, transmitting contacts, detents, etc., shall be in the normal state.

INDUCTION TYPE INTEGRATING METERS

CONTENTS

SECTION 2 — INDUCTION TYPE INTEGRATING METERS

1. SCOPE

These specifications apply to induction-type meters such as watthour and varhour meters which may be submitted for approval for billing purposes.

These specifications also apply to components of combination devices utilizing the essential elements of induction-type integrating meters.

They also apply to auxiliary devices (other than block interval demand attachments) which may be included within the meter case, such as transmitting contacts, prepayment devices, etc.

2. MECHANICAL REQUIREMENTS

2.1 Rotor

2.1.1 Direction of Rotation. Viewed from above the direction of rotation of the rotor shall be counterclockwise. The direction of rotation shall be clearly indicated by an arrow.

2.1.2 Markings

2.1.2.1 The edge and upper surface of the disc shall carry a conspicious permanent mark. A companion mark, known as a rotation index mark, is to be located on the nameplate, register, frame, or magnet in such a manner as to facilitate revolution counting. Other marks may be added for stroboscopic or other tests but such marks shall be so placed as to not interfere with the use of the main visible marks for revolution counting.

2.1.2.2 On self contained single phase meters, the disc shall carry the following markings, in black:

On the upper periphery, one hundred divisions, with every fifth division longer than the others, and every tenth division identified consecutively by the figures 10, 20, . . 90.

2.1.3 Provision for Photoelectric Testing. For single phase meters, two holes in the rotor disc shall be provided for photoelectric calibration. These shall be 180 degrees apart and at equal distance from the disc centre. If possible, the arrangement shall be such as to permit photo-electric testing with cover in place. For polyphase and combination meters this same provision is desirable but not mandatory.

2.2 Registers

2.2.1 Units. The unit in which the record is made, i.e. kilowatthours, megavarhours, etc., shall be marked in large letters on the register face. Recognized symbols are acceptable.

The register indication must be strictly in accord with the result computed from the number of disc revolutions, the disc constant as given on the nameplate, and the multiplier.

The zero of clock type dials must be at the 12 o'clock position.

It is not permissible to indicate above or below any individual dial or drum the magnitude of either the complete indication or of the divisions.

2.2.2 Multiplier. The meter multiplier, if other than unity, shall be marked permanently and prominently, preferably in red, on the register face.

2.2.3 Register ratio. The register ratio shall be permanently marked on the register in such a manner that it is visible without removing the register.

2.2.4 Markings. Except for the manufacturer's name, trade mark, the direction of rotation indicator, register ratio, rotation index mark, multiplier, or marks pertaining to the reading of the register, no markings of any kind shall be made on the register face. Where the register face and nameplate are integral, the above requirement will not apply but any markings must not be such as to interfere with ready, unambiguous, reading of the register.

2.2.5 Number of dials or drums. All registers must have at least 4 dials or drums.

All self-contained single phase meters shall have, exclusive of the test dial, either:

(a) 5 dials or drums
or

(b) 4 dials or drums and a multiplier of 10.

2.2.6 Test dials. All single phase meters shall be provided with a special test dial for testing the register. In the case of polyphase meters, if the lowest reading dial or drum requires more than one hour to make one complete revolution when the meter is running on maximum load or 100 amperes (whichever is the lesser) a test dial shall be provided.

The pointer of the test dial shall rotate at ten times the speed of the lowest reading dial or drum. It shall be located out of line with the other dials or be distinctly different in appearance. There shall be no figures on the test dial but it shall be divided into ten equal divisions. The direction of rotation shall be indicated by means of an arrow.

2.2.7 Backlash. The backlash in a register shall not exceed one-half of a division of the test dial or that dial which indicates the smallest increments of energy, unless the backlash can be taken up by running the meter for not more than 20 seconds at maximum load.

2.2.8 Clock registers. The minimum diameter of clock dial circles shall be .44 in.

Each dial shall be divided into ten equal and clearly numbered divisions. Preferably, the dials shall be distinctly separated from each other. The lowest reading dial shall be on the right, and shall rotate in a clockwise direction viewed from the front. The gearing shall be such that a complete revolution of any pointer shall cause the adjacent pointer on the left to advance one division.

Preferably the dial centres should lie in a straight line or on the arc of a circle, but in any case must be so located as to avoid any possibility of ambiguity in reading.

2.2.9 Cyclometer Registers. The test dial, in the case of a cyclometer type register, may be of either the drum or pointer type.

If the test dial is of the drum type, it must be divided into ten equal numbered divisions, must be marked "test dial", and a reference mark must be provided on the register face for accurate reading.

The arrangement of the cyclometer drums and the cut-outs in the register face, must be such that, with the exception of the fastest moving drum, one and only one digit is in full view at all times except when the drum is advancing from one position to another. The duration of this change period shall not exceed the time required for the fastest-moving drum to make one-tenth of a revolution.

All windows in the register face must lie in a straight line and be of the same size.

The size and shape of the numerals must be such that they are clearly legible.

3. ELECTRICAL REQUIREMENTS

3.1 Connections. The voltage circuit, if connected internally, shall be connected on the supply side of the current circuit.

3.2 Test Links. All self-contained meters shall be provided with test links by means of which the voltage circuit(s) may be isolated from the current circuit(s) for test purposes, without removing the cover.

3.3 Maximum Current Rating. The maximum current rating of the meter shall not be greater than that imposed by the following restriction:

The speed of the disc shall not exceed 120 r.p.m. when the meter is operating with maximum current in all current circuits and with all voltage circuits energized at rated voltage and with the proper phase relationship for unity power factor.

4. NAMEPLATES

In addition to the nameplate requirements given in clause 4 of section 1, every meter shall have the following details indelibly and distinctly marked on one or more nameplates attached in such a way as to be clearly visible from the front, with cover in place:

i) Rated Frequency
ii) Rated Voltage or Voltages
iii) Current Range or Rating
iv) Disc Constant
v) One of the following
- 1 - phase, 2 - wire
- 1 - phase, 3 - wire
- 2 - element
- 2½ - element wye
- 2½ - element, delta
- 3 - element

NOTE: *Accepted symbols are: Ø, EL, Y and* △

vi) In the case of transformer-rated meters, the following additional information
- Primary Watthour Constant
- Current transformer rating, e.g. 1000-5A
- Voltage transformer rating, e.g. 2400-120 volts

Space shall be provided for affixing the inspection numbers.

If the meter is fitted with accessories such as a reverse-running detent, re-transmitting contacts, etc., the nameplate shall so specify, and a diagram of connections must be provided if considered necessary by the Branch.

5. PERFORMANCE REQUIREMENTS

5.1 Reference Conditions for Tests. Except where the nature of the test requires otherwise the meter shall be mounted in its normal working position. The disc must be within 0.5 degrees of truly horizontal.

5.2 Reactive Energy Meters. In the tests which follow, where reactive energy meters are involved, the tests are to be carried out substituting reactive factor for power factor, where power factor = cos ϕ and reactive factor = sin ϕ.

5.3 Basic Test Currents. Basic test currents referred to repeatedly in this section are given in Table 2.

TABLE 2

BASIC TEST CURRENTS FOR INDUCTION METERS

Designation	Current, % Max.	Remarks
TC–1	Min. Current of range	
TC–2	2.5	Reference Low Load Current
TC–3	5.0	
TC–4	25.0	Reference High Load Current
TC–5	50.0	
TC–6	75.0	
TC–7	100.0	

When the basic test current designation is followed by the letters Pf, it shall designate the same test current at 0.5 power factor lag. Thus TC-5 Pf shall mean 50% maximum current at 0.5 power factor lag.

5.4 Adjustment Prior to Tests. Before commencing performance tests, the calibration shall be corrected, as nearly as practicable, to 100% registration.

Multi-element meters shall be calibrated with voltage circuits in parallel and current circuits in series.

In addition, polyphase meters shall be adjusted for minimum difference in registration when each current circuit is energized separately.

The calibration points, and limits of allowable deviation are as given in Table 3.

TABLE 3

TEST POINTS FOR PRIOR ADJUSTMENT

Test	Applies To	Current	Allowable Deviation % Registration
High Load	All Meters	TC–4	±0.1% from true registration
Low Load	All Meters	TC–2	±0.2% from registration at TC–4
Power Factor	1–Phase	TC–4 Pf	±0.5% from registration at TC–4
	Polyphase	TC–4 Pf	±0.3% from true registration
Balance *	Multi-element Meters	TC–4 each element separately	±0.3% from registration for each other element

** Does not apply to the split coil of a 2½ element meter.*

5.5 Creep. With no current in the current coils, the meter shall not make one complete revolution when any voltage from 80% to 120% of rated voltage is applied. For polyphase meters, polyphase voltage of proper phase sequence, is to be applied.

5.6 Load Performance. When the meter is tested for accuracy under standard reference conditions, the percentage errors shall not exceed those given in Table 4.

TABLE 4

ALLOWABLE LIMITS OF ERROR

Test Current	Max. Allowable Error	
	Self-contained Meters	Transformer Type Meters
From TC–1 to TC–2	±2%	±1.5%
Between TC–2 and TC–5	±1%	±0.75%
From TC–5 to TC–7	±2%	±1.5%
From TC–2 Pf to TC–4 Pf	±2.0%	±1.5%
Between TC–4 Pf and TC–7 Pf *	±2.5%	±2.0%

** TC-6 Pf for 2½ element wye meters.*

5.7 Performance with Individual Current Circuits

5.7.1 Single Phase, 3-wire meters and 3-wire element of 3-phase, 4-wire delta meters.

The percentage registration shall be determined for each of the two current circuits taken singly at TC-4, TC-3, and TC-4 Pf.

For any set of tests, i.e. inner and outer at one test current, the difference between the two values obtained shall not exceed 2.0%.

5.7.2 Polyphase meters. The percentage registration shall be determined with all voltage coils energized in phase at rated voltage and each current coil energized separately, in turn. Test current is not to exceed 150 A regardless of meter rating. In the case of 2½ element delta meters, the 3-wire element shall be tested with current coils in series. 2½ element wye meters shall be treated as having 3 elements. The maximum allowable errors are given in Table 5.

TABLE 5

ALLOWABLE LIMITS OF ERROR
POLYPHASE METERS — INDIVIDUAL ELEMENTS

Current	Max. Allowable Error
TC–1, TC–2	±2½%
TC–3 to TC–4 TC–3 Pf to TC–4 Pf	±1½%
TC–5 to TC–7 TC–5 Pf to TC–7 Pf	+3% or −2%

The difference between the registration for any one coil and that for any other coil shall not exceed 1½% at any current from TC-2 to TC-4. Before applying this requirement, the registration errors must be corrected (using one element as a reference) for the amount of unbalance at the original adjustment at TC-4.

5.8 Effect of Voltage Variation. A variation of the applied voltage of up to 10% above and below the rated (reference) voltage shall not affect the percentage registration by more than the values specified in Table 6.

Where the meter is given a voltage range, e.g. 115-120, the limits will apply from 10% below the lower voltage to 10% above the higher voltage.

TABLE 6

LIMITS TO EFFECT OF VOLTAGE VARIATION

Meter	Test Current	Max. Allowable Change In Percent Registration
1-Phase	TC–2 to TC–7 TC–2 Pf to TC–7 Pf	±1.0 ±1.5
Polyphase	TC–2 to TC–6 TC–3 Pf to TC–6 Pf	±1.0 ±1.5

5.9 Minimum Running Current. The rotor shall start and continue to rotate with unity Pf load current as follows:

For meters without auxiliary devices: 10% of minimum rated current.

For meters with auxiliary devices: 20% of minimum rated current.

For the purpose of this clause, auxiliary device means a device such as a reverse running detent or re-transmitting contact which by its nature tends to increase the minimum starting torque.

5.10 Effect of Variation of Frequency. At TC-4, a change of ±5% from the rated frequency shall not cause a change in the percentage registration of more than 1.0%.

5.11 Effect of Variation of Ambient Temperature.

5.11.1 Meters intended for outdoor service. Percentage registration tests shall be carried out at sustained ambient termperatures of −40°C, −7°C and 53°C. The test points and maximum allowable influence are as in Table 7.

TABLE 7

EFFECT OF AMBIENT TEMPERATURE VARIATION

Ambient Temperature	Test Current	Max. Allowable Difference Between Registration At Test Temperature And At Reference Temperature
−7°C & 53°C	TC–2 & TC–4 TC–4 Pf	±1.2% ±2.4%
−40°C	TC–2 & TC–4 TC–4 Pf	±3.0% ±5.0%

5.11.2 Meters designated as being intended for a limited temperature range.

For meters intended for indoor use only and which have been assigned a specific temperature range, the temperature influence shall not exceed the following:

Test Current	Max. Allowable Temperature Coefficient Over Specified Range
TC–2, TC–4,	.04%/°C
TC–4 Pf	.06%/°C

5.12 Effect of External Magnetic Field. The change in percentage registration, at any load between TC-2 & TC-7, at any power factor between unity and 0.5 lag, shall not exceed the stated limits when the meter is subjected to an external magnetic field equal in magnitude to that specified. The specified field is obtained by placing the meter at the centre of a circular coil 1.0 metre in mean diameter and having 100 ampere turns. The frequency of the coil current is to be the same as that applied to the meter. The phase of the coil current and the orientation of the coil shall be such as to produce maximum effect. For polyphase meters, the test voltages and currents are to be balanced polyphase.

Meter	Maximum Permissible Change In Registration
Single phase	1.5%
Polyphase	1.0%

5.13 Effect of Momentary Overload. Percentage registration shall be determined, for the meter, at TC-2, TC-4, and TC-4 Pf. The meter current circuit(s) (connected series aiding if applicable) shall then be subjected to a momentary overload current with rated voltage on the voltage coils. Following the overload application, the meter shall be allowed to remain one hour with voltage circuits only energized before retesting. The change in percentage registration shall not exceed the values shown in the table below:

Meter Type	Overload Current	Duration	Max. permissible effect
Self contained	20 × I max.	0.1 s.	1.0%
Transformer type	10 × I max.	0.5 s.	0.5%

5.14 Register Friction. The effect of register friction shall not be sufficient to affect the rate of rotation of the disc by more than 1.0% at TC-2.

For cyclometer type registers the test shall not include turnover of any counter through zero.

For clock type registers, the maximum friction shall not be more than twice the value permitted for the average friction.

For cyclometer type registers, the maximum friction, including that at turn over through zero, shall not be greater than 1.0% at TC-2.

5.15 Effect of Self-Heating. The effect of a sustained load for four hours shall not change the percentage registration by more than the following:

TC-4 — ± 1.0%
TC-4 Pf — ± 1.5%
TC-7 — ± 1.0%

The reference registration for these tests shall be the registration determined within 2 minutes of application of test current.

5.16 Effect of Tilt. Tilting a meter up to 3° from the vertical shall not affect the percentage registration by more than 1.0% at TC-2.

For test purposes, the four positions of tilt are specified as forward, backward, left and right. The position of true verticality shall be determined by using the plane of the stationary disc as the reference.

5.17 Effect of Current Surge. The meter shall be subjected to the effects of a transient surge (20 × 50 microsecond) of 20,000 amperes crest through a conductor positioned vertically 4 cm. behind the flat portion of the meter base. For S-base meters, the socket shall be in place. The effect of current surge on the registration at TC-4 shall be not more than ± 1.0%.

5.18 Interdependence of Adjustments. Where applicable, making a light load adjustment sufficient to change the percent registration at TC-2 by 2% shall not affect the registration at TC-4 Pf by more than 0.8%.

Where applicable, making an inductive load adjustment sufficient to change the percent registration at TC-4 Pf by 1% shall not affect the registration at TC-2 by more than 0.5%.

5.19 Polyphase Tests. Polyphase meters will be tested with balanced polyphase voltages and currents. The test points and allowable limits of error are as given in Table 8.

TABLE 8

TEST POINTS FOR POLYPHASE TESTS

Test Current	Maximum Allowable Deviation
TC–7	±2% from correct registration
TC–4	±1% from correct registration
TC–2	±1% from correct registration
TC–1	±2% from correct registration

In addition, the same tests shall be carried out with the phase sequence of the supply reversed. The same error limits shall apply. Where a definite phase sequence is specified for a meter, the test with phase sequence reversed is not required.

DEMAND METERS

CONTENTS

SECTION 3 — DEMAND METERS

1. SCOPE

These specifications apply to meters of the thermal, or integrating type, used for the measurement of demand in watts, volt amperes, or vars, which may be submitted for approval for billing purposes.

They also apply to demand elements which are components of energy demand meters.

They do not apply to thermal convertors, electronic transducers, null balancing instruments, or magnetic or paper tape recorders.

2. MECHANICAL REQUIREMENTS

2.1 Maximum Demand Indicators

2.1.1 Units. The unit in which the record is made, i.e. kilowatts, etc., shall be marked in large letters on the register face. Recommended symbols are acceptable.

2.1.2 Multiplier. The demand multiplier, if other than unity, must be marked permanently and prominently, preferably in red, on the scale or register.

2.1.3 Pointer and Scale Indicator

2.1.3.1 Pointers

2.1.3.1.1 General. Where applicable, the clearance between the portion of the pointer which traverses the scale and the scale itself shall not exceed 0.1 in. nor be less than 0.04 in.

The driving pointer, if it can be read when in contact with the driven pointer, shall indicate the same reading as the driven pointer.

The driving pointer shall be of a colour distinctly different from that of the driven pointer.

The driving pointer must not at any time, interfere with clear reading of the driven pointer indication.

2.1.3.1.2 Damping. There must be sufficient damping to ensure that when disengaged from the driving pointer, the driven pointer will remain in the correct reading position, unaffected by such vibration as may be encountered in normal service.

For grease-damped pointers —

With driving and driven pointers in the steady-state in-contact position:

(a) tapping the meter shall not cause the indication to increase by more than 1% of full scale.

(b) removal of the load shall not cause the driven pointer to be pulled back by more than 1% of full scale.

2.1.3.1.3 Reset Device. This device shall be such that, in its normal position, it does not affect either the maximum demand indicator or the driving element. Means shall be provided for sealing the resetting device in this position. Resetting of the maximum demand indicator shall only be possible either after breaking the seal or with a special tool.

It must not be possible to move the maximum demand indicator up-scale by means of the resetting device.

2.1.3.1.4 Reset Time. The reset time shall not exceed 1% of the demand interval, or 15 seconds whichever is the lesser.

This time is included in the demand interval.

2.1.3.2 Scales. Minimum scale length shall be as follows:

For thermal meters: 3.5 ins.

For integrating demand meters: 6.0 ins.

2.1.4 Clock Type Maximum Demand Indicators

2.1.4.1 General. All clock type indicators must have at least three dials.

Minimum diameter of clock dial circles shall be 0.44 in.

Each dial shall be divided into ten equal and clearly numbered divisions. Preferably dials shall be distinctly separated from each other. The lowest reading dial shall be on the right and shall rotate in a clockwise direction viewed from the front. The gearing shall be such that a complete revolution of any pointer shall cause the adjacent pointer to the left to advance one division.

2.1.4.2 Cumulative Clock Type Maximum Demand Indicators

Cumulative clock type indicators must have at least four dials.

The value represented by the smallest division of the dial with the fastest moving pointer shall be not more than one percent of full scale.

2.1.5 Cyclometer Type Maximum Demand Indicators

2.1.5.1 General. All cyclometer type demand indicators must have at least three digits.

All windows in the demand indicator face must lie in a straight line and be of the same size.

The size and shape of the numerals must be such that they are clearly legible.

The arrangement of the cyclometer drums and the cut-outs in the demand indicator face must be such that, with the exception of the fastest moving drum, one and only one digit is in full view at all times except when the drum is advancing from one position to the next.

2.1.5.2 Cumulative Cyclometer Type Demand Indicators. All cumulative cyclometer type demand indicators must have at least four digits.

The value represented by the lowest value digit (right hand viewed from the front) shall be not more than one percent of full scale.

2.2 Recording Meters

2.2.1 Chart width. Minimum width of chart is 4.0 ins.

2.2.2 Scales. When a recording meter is provided with a scale, the graduations thereon must be essentially identical to those on the chart.

3. ELECTRICAL REQUIREMENTS

3.1 Conections. The voltage circuit, if connected internally shall be connected on the supply side of the current circuit.

3.2 Tests Links. All self-contained meters shall be provided with test links by means of which the voltage circuit(s) may be isolated from the current circuit(s) for test purposes, without removing the cover.

3.3 Maximum Current Rating. The maximum current rating shall in no case be less than 50 times the minimum current rating.

3.4 Maximum Demand Rating. The full scale demand rating shall conform to the limits as given in Table 9:

TABLE 9

DEMAND METER FULL SCALE LIMITS

Meter	Full Scale Value	
	Lower Limit	Upper Limit
Single-Phase	$0.5 \times V \times I_M \times 1$	$1.05 \times V \times I_M \times 1$
2 el. & 2½ el. delta	$0.5 \times V \times I_M \times \sqrt{3}$	$1.05 \times V \times I_M \times \sqrt{3}$
Network	$0.5 \times V \times I_M \times 2$	$1.05 \times V \times I_M \times 2$
2½ el. & 3 el. Y	$0.5 \times V \times I_M \times 3$	$1.05 \times V \times I_M \times 3$

V = Rated Voltage
I_M = Maximum Rated Current

4. NAMEPLATES

4.1 Nameplate Marking. In addition to the requirements of clause 4.1 of Section 1, demand meter nameplates shall bear the following information:

i) Rated Frequency
ii) Rated Voltage or Voltages
iii) Current Range or Rating
iv) Response Period or Demand Interval
v) The Full Scale Demand Rating
vi) The Single Phase Test Constant if applicable
vii) One of the following:
- 1 - phase, 2-wire
- 1 - phase, 3-wire
- 2 - element
- 2 - element network
- 2 - element, 3-phase, 3-wire
- 2½ - element wye
- 2½ - element delta
- 3 - element

NOTE: *Accepted symbols are: Ø, EL, Y, Δ*

ix) In the case of transformer-rated meters, the instrument transformer ratios. They shall be expressed as in the following example: CT 1000-5 VT 2400-120.
x) For single phase transformer type meters the words "Transformer Type" in red.
xi) All information essential for determination of the demand from the meter indication.

If the meter is provided with accessories such as retransmitting contacts, etc., the nameplate shall so specify and a diagram of connections must be provided if considered necessary by the Branch.

The marking shall be indelible, distinct, and visible from outside the meter with cover in place.

Space must be provided for affixing an inspection number.

5. PERFORMANCE REQUIREMENTS

5.1 Integrating Demand Meters. The energy measuring element of an integrating demand meter shall comply with the requirements of Sections 1 and 2 with the exception of clause 5.14 of Section 2, register friction.

These tests shall be carried out with the maximum demand indicator coupled to the supporting meter, but with the indicating pointer(s) or drum(s) not being driven.

Excluding any error of the energy measuring element, the error of the maximum demand indication shall not exceed 0.75% of full scale.

For integrating demand meters, when the driving element is coupled with its supporting meter but the maximum demand indicator is not being driven, disconnection of the driving element shall not cause a greater variation than 1.5% in rotor speed at TC-2. For this test the position of the demand indicator is to be shifted as little as possible, i.e. just enough to ensure that the gears are out of mesh.

5.2 Thermally Lagged Demand Meters

5.2.1 Reference Conditions for Tests. Tests are to be made with the pusher pointer carrying the maximum demand pointer up scale to the calibration point from at least 10% of full scale below the calibration point.

The load is to be held constant for a time equal to four times the demand interval and then reduced to zero. The indication of the maximum demand pointer after disengagement of the pusher pointer is taken as the meter reading.

Except where otherwise stated, all loads are at unity Pf.

5.2.2 Adjustment Prior to Tests. Before commencing performance tests, the calibration shall be corrected as nearly as is practicable, to zero error, at zero and at a major scale division at or above ⅔ full scale.

The damping adjustment, if any, is to be set according to the manufacturer's instructions.

5.2.3 Load Performance, Unity Pf. The difference between the indicated or recorded value and the true value, at any load between 20% & 100% of full scale, shall not exceed 1.0% of full scale.

5.2.4 Effect of Variation of Power Factor. With a constant load of approximately 60% of full scale applied, changing the power factor from unity to 0.8 lag shall not cause a change in meter reading of more than 1.0% of full scale.

5.2.5 Performance with Individual Current Circuits. The meter indication shall be determined with all voltage coils in parallel at rated voltage and only one current coil carrying approximately rated current to give a constant load. This test is to be repeated for each current coil. The maximum allowable difference in indication between any two tests, is 1.0% of full scale value.

5.2.6 Effect of Voltage Variation. With a constant load applied, a variation of ± 10% of rated voltage shall not cause the meter indication to change by more than 1.0% of

full scale. This test shall be carried out with a load such as to give approximately 60% of full scale.

5.2.7 Effect of Variation of Ambient Temperature. The effect of ambient temperature variation shall not exceed the limits given in Table 10.

TABLE 10

EFFECT OF AMBIENT TEMPERATURE VARIATION

	Ambient	Test Point % Full Scale	Maximum Difference From Indication At Reference Temp.
Meters Intended for Outdoor service	From −7°C to +53°C	40	±1.0% full scale
		60	
		80	
	−40°C	60	±3.0% full scale
Meters intended for indoor service only & which have been designated as suitable for a specific temp. range		40	0.07% F.S./°C
		60	
		80	

5.2.8 Effect of Radiated Heat. Radiated heat applied as follows, shall not cause a change in the meter reading of more than 1.5% of full scale. This test shall be made at a load giving approximately 80% full scale. The radiated heat shall be applied from an infra-red heat lamp No. 250R40/1. The lamp shall be held in any position level with or above the level of the meter for a period of not less than 30 minutes and such that the distance between the nearest points of the lamp and the meter is 2 feet. The bulb, (250 watts R40, medium base, 115-125 volts) shall be operated at 250 watts.

5.2.9 Response Period. The time response characteristic shall be determined by test, at a load giving approximately ⅔ full scale. Constant load shall be maintained for a period of time equal to at least three response periods. The meter reading shall be within the following limits;

i) in one-eighth of the response period, between 10 and 30 percent of final reading

ii) in one response period, not more than 92% of final reading.

CHARTS

CONTENTS

SECTION 4 — CHARTS

1. SCOPE

This section applies to strip charts used with billing meters. It does not apply to tape intended for use in digital recorders.

2. CONSTRUCTION

2.1 Strength. The chart shall be sufficiently strong that it will not tear during normal operation of the instrument, nor during normal handling.

2.2 Smoothness. The chart shall have a hard smooth surface in order to present minimum resistance to the motion of the marking device. The surface shall be free from easily detachable particles which might tend to clog the marking device.

2.3 Alignment. The perforations shall be so sized and so spaced that the chart travels smoothly without tendency to ride up on the sprocket points when it is properly inserted in the recorder.

3. MARKINGS

3.1 Identification. The chart shall bear the name or trademark of the manufacturer or the supplier, and may include the manufacturer of the instrument in which it is intended for use. It shall also bear an identifying code number.

3.2 Graduations. The graduations on the chart shall be well defined and shall be clearly numbered so as to provide the maximum ease of reading and calculation. Where more than one quantity is to be recorded the graduations pertaining to each shall be clearly identified by the use of different colours or other suitable means, unless the scales for all quantities are identical. The parameter in the direction of motion (time) of the chart shall be clearly identified and the calibration marks numbered.

4. LEGIBILITY OF RECORD

When utilized with the ink recommended by the manufacturer or supplier, the charts shall produce a permanent clear, legible unblurred record, without blotting or running. Tests shall be made using clean, standard pens mounted to simulate the actual recording method. Charts which use other means of marking shall also produce a permanent, clear, legible, unblurred record.

5. ERROR

5.1 Humidity. With a change of relative humidity from 10% to 90% or vice versa, and the chart at 23°C ± 2°C the change in dimensions of the paper due to humidity alone shall not exceed 2.0%. Tests shall be made with samples taken both across and with the grain of the paper.

5.2 Markings. In no case shall the markings deviate from the correct position by more than 0.5% of full scale.

CLOCKS AND TIMING DEVICES

CONTENTS

SECTION 5 — CLOCKS AND TIMING DEVICES

1. SCOPE

This specification applies to clocks, timing motors or timing devices, whether incorporated within a billing instrument or separately housed as an auxiliary to such instrument.

2. PERFORMANCE REQUIREMENTS

2.1 Error. No clock or timing device shall have an error exceeding 0.2% when operated under rated conditions in an ambient temperature between 20°C and 25°C.

2.2 Effect of Voltage Variation. A variation of 10% above or below the nominal voltage shall not affect the timing of an electrically driven timing device by more than 0.1%. The motor of such a device shall start and run continuously at 80% of nominal voltage.

2.3 Effect of Temperature Variation. A sustained change in ambient temperature between −7° and +53°C shall not affect the accuracy of a timing device by more than 0.01% per °C.

Unless a device is restricted to indoor use, a sustained change in ambient temperature between −7°C and −40°C shall not affect the accuracy of a timing device by more than 0.02% per °C.

2.4 Extreme Conditions. Unless restricted to indoor use, any timing device shall continue to operate at −40°C with 90% of rated voltage.

2.5 Spring Driven Devices. The accuracy of a spring driven timing device shall not be affected by more than 0.2% by the tightness of the spring.

2.6 Carry-Over Devices. Where a timing device is equipped with a carry-over feature which operates in the event of a supply failure the carry-over feature shall not have an error exceeding ± 5.0% under any of the above conditions.

TRANSDUCERS AND THERMAL CONVERTORS

CONTENTS

SECTION 6 — TRANSDUCERS AND THERMAL CONVERTORS

1. SCOPE

These specifications apply to thermal convertors and transducers which may be submitted for approval for billing purposes. These devices have a d.c. output which is some function of their a.c. inputs, either watts, volt amperes or vars.

This specification is written to pertain to devices of this nature which are designed for use in the secondaries of transformers, i.e. for 120 volts and currents of less than 10 amperes. However, devices of this type designed to meter higher voltages and/or currents may also be submitted for approval. They will be considered in the light of this and other related specifications, due discretion being used in the application of the various clauses.

2. MECHANICAL REQUIREMENTS

The mechanical requirements are set out in Section 1, sub-section 2.

3. ELECTRICAL REQUIREMENTS

3.1 Power Supply. Preferred power supply rating is 120V, 60 Hz.

3.2 Preferred Current Rating. Preferred current rating shall be 5 amps with a maximum current of 10 amps.

4. NAMEPLATES

4.1 Markings. In addition to the requirements of clause 4.1 of Section 1, nameplates of transducers and thermal convertors shall bear the following information:

i) Rated Frequency

ii) Rated Voltage

iii) Input current range or current rating and maximum current

iv) K, with units, where K = output in d.c. per input in a.c.

v) One of the following:
1 - phase, 2-wire
1 - phase, 3-wire
2 - element
2½ - element wye
2½ - element delta
3 - element

NOTE: *Accepted symbols are: Ø, EL, Y and* △

vi) For a transducer, the maximum resistance which may be connected across its output terminals.

vii) For thermal convertors, the response period.

The markings shall be indelible, distinct and clearly visible with the device cover in place. Space shall be provided for affixing an inspection number.

4.2 Nameplate Location. Under no circumstances will the nameplate be permitted on the terminal cover.

5. PERFORMANCE REQUIREMENTS

5.1 Reference Conditions for Tests. Except where otherwise indicated the following standard test conditions shall apply.

i) for polyphase devices the applied voltage shall be balanced polyphase.

ii) for current output transducers, the output circuit load resistance shall be 50% of the maximum load resistance.

iii) all circuits shall have been energized for a sufficient time to attain stable output.

iv) for thermal convertors, the final value shall not be taken until the load has been applied for at least four response periods.

5.2 Reactive Devices. In the tests which follow where reactive devices are involved, the tests are to be carried out substituting reactive factor for power factor, where power factor = $\cos \phi$ and reactive factor = $\sin \phi$.

5.3 Adjustment Prior to Tests. Before commencing performance tests, the calibration shall be corrected as nearly as practicable to zero error, both at zero current input and at rated input.

5.4 Performance Requirements

5.4.1 Unity Power Factor. A complete load curve, with increasing and decreasing unity power factor loads shall be obtained for the device. The d.c. output at any point from 1% rating to 100% rating shall not differ from the calculated value by more than 0.5% of rated output.

5.4.2 Power Factor Variation. With a constant load applied, changing the power factor from unity to 0.5 lag shall not cause a change in d.c. output of more than 0.5% of rated output.

5.4.3 Element Balance. Polyphase devices shall be tested with each current element in turn carrying rated current at both unity and 0.5 Pf.

The maximum difference between any pair of elements shall be 0.5% of rated output.

5.4.4 Voltage Variation. With a constant load applied, a variation of ± 10% of rated voltage shall not cause the device output to change by more than 0.5% of rated output. This test shall be made at approximately 50% rated output. The power supply voltage shall be varied simultaneously with the metering voltage.

5.4.5 Frequency Variation. With a constant load applied, a variation of ± 5% of rated frequency shall not cause the device output to change by more than 0.25% of rated output. This test is to be carried out at approximately 50% rated load.

5.4.6 Ambient Temperature Variation. The maximum allowable influence on accuracy due to variation of ambient temperature shall be .035% of rated output per °C.

This influence will be determined by comparing the error (at approximately 50% rated load) under reference conditions with that at −7°C and at 53°C.

If the nameplate indicates a more restricted range, the test shall be carried out at temperatures within this range.

5.4.7 Response Period of a Convertor. The time response characteristic shall be determined by test at a unity Pf load of approximately two thirds maximum. The load shall be maintained constant for the test duration. The output shall be within the following limits:

i) in one eighth of the response period, from 10 to 30% of final output.

ii) in one response period, not more than 92% of final output.

5.4.8 Output Resistance (of a transducer). The output of a transducer shall not change by more than 0.25% rated output with any value of resistance up to that marked on the nameplate connected across its output terminals. This requirement shall apply for any load from 10% — 100% rated load.

5.4.9 Output Ripple. Device output ripple shall be less than 1% peak to peak of the rated output.

5.4.10 Output at Zero Load. The output at rated voltage and zero current shall not exceed 0.1% of rated output.

5.4.11 External Magnetic Field. The change in output shall not exceed 0.5% rated output when the device is placed in a magnetic field at the center of a 100 ampere turn coil of 1.0 metre mean diameter. The coil current shall be of the same frequency as that of the device input but its orientation and phase shall be that which produces maximum effect. For polyphase devices, the test voltages and currents shall be balanced polyphase. This requirement shall apply for any load from 10% — 100% rated load.

5.4.12 Effect of Momentary Overload. The device shall be subjected to an overload on the current circuit(s) of 10 × I max. for 0.5 sec with rated voltage applied. The device shall remain for one hour with voltage circuits only energized before retesting. The maximum change in output shall be 0.5% of rated output. This test is to be carried out at approximately 50% rated load.

5.4.13 Phase Sequence Effect. The output of polyphase devices shall be determined under reference conditions. The test shall then be repeated with the phase sequence reversed. The maximum difference between the two tests shall be 0.5% of rated output. This requirement shall apply for any load from 10% — 100% rated load.

5.4.14 Effect of Self-Heating. The effect of a sustained load at maximum rated current at unity Pf for four hours shall not change the error by more than 0.3%.

The reference error for this test shall be that determined within two minutes of application of test current.

NULL BALANCING INSTRUMENTS

CONTENTS

SECTION 7 — NULL BALANCING INSTRUMENTS

1. SCOPE

These specifications apply to indirect-acting electrical measuring instruments of the automatic null-balancing type used for the measurement of demand in watts, vars, or volt-amperes.

They also apply to auxiliary devices such as re-transmitting devices which may be included within the instrument case.

2. MECHANICAL REQUIREMENTS

2.1 Indicating Scale. For each recorded quantity there shall be an indicating pointer. The scale graduations must be similar to those on the chart.

2.2 Scale and Chart Visibility. The instrument shall be so designed that the scale and chart may be easily read with cover closed. On strip-chart instruments a portion of the most recent record shall be visible with the cover closed.

2.3 Scale Width. Minimum scale width is 4.0 inches.

2.4 Terminals. The terminals shall be legibly marked and information shall be provided to identify the proper connections.

2.5 Sealing. Construction shall be such that access to the working parts may be prevented by means of a door lock or other suitable device.

3. ELECTRICAL REQUIREMENTS

3.1 Range Selection. If a recorder has provision for changing the range by means of interchangeable range modules, each module must be clearly identified. Provision shall be made for sealing so that range changing cannot be accomplished without breaking the seal.

4. NAMEPLATES

In addition to the requirements of clause 4.1 of Section 1, every instrument shall have the following details indelibly and distinctly marked on one or more nameplates visible from the front with cover closed:

i) Voltage and frequency of power supply

ii) Designation of the unit of measurement and multiplier if other than 1.

The following information shall be legibly marked on the instrument and accessible from the front but need not be visible with cover closed:

i) Chart identification number

ii) Maximum external resistance

iii) Response-time designation: Span step-response time for single point instruments or time per point for multiple point instruments

iv) Range of measured quantity.

5. PERFORMANCE REQUIREMENTS

5.1 Reference Conditions for Tests. Except when otherwise indicated, the following standard test conditions shall apply:

i) The operating power supply voltage and frequency shall be the rated value ± 0.5%.

ii) External test circuits shall be isolated from ground, and from the operating power supply. There shall be no potential applied between the test circuit and the instrument case.

iii) The chart ink recommended by the manufacturer shall be used.

iv) A resistance equal to 50% of the maximum external resistance shall be connected between the test source and the recorder input terminals.

5.2 Adjustment Prior to Tests

5.2.1 Before commencing performance tests it shall be established that the chart drive, inking, and pen or printing mechanisms are in proper operating condition.

5.2.2 The instrument shall be set up and all adjustments set in accordance with the manufacturer's instructions to give minimum error at zero and at a calibration point near ⅔ full scale.

5.3 Test Procedure

5.3.1 Copper wire is to be used for connecting the test source and the reference standard to the instrument under test.

5.3.2 The test source should be adjusted to bring the indication of the instrument under test to a cardinal scale point. This is to be done approaching the balance point from each direction. For a recorder, the pen mark on the chart is to be used as the instrument reading; for an indicating meter, the indicating scale is to be used.

5.4 Linearity. When the instrument is tested for accuracy under standard reference conditions, the error, at any cardinal scale point, shall not exceed 0.5% of full scale.

5.5 Dead Band

5.5.1 Maximum dead band shall be 0.2% of full scale.

5.5.2 The method of determining the dead band shall be as follows:

(a) The input is to be set to a value giving approximately midspan deflection.

(b) The input is increased until the indication of the instrument under test has increased by approximately 0.5% of full scale.

(c) The input is to be slowly reset to the original value. The instrument reading is then observed.

(d) The input is reduced until the indication of the instrument under test is less than the first reading (c) by about 0.5% of full scale.

(e) The input is now slowly reset to the original value. The instrument reading is observed.

(f) The difference between the readings obtained in (c) and in (e), expressed in percent of full scale, is the dead band.

5.6 Transient Overshoot

5.6.1 Method of Test. The instrument is allowed to balance near one end of the span. An abrupt change in measured signal equivalent to approximately 90 percent of span is applied to the instrument. The amount of overshoot beyond the point of final balance expressed in percent of span is the transient overshoot. Test is repeated for opposite direction of balancing action.

5.6.2 Permissible value. Maximum permissible transient overshoot is 0.2 percent of span.

5.7 Span Step-Response Time. An abrupt change in the measured quantity equivalent to 99% of span is applied and the instrument allowed to balance. The test is repeated for opposite direction of balancing action. The measured span step-response time must not differ from the manufacturer's stated value by more than 10%.

5.8 Effect of Variation of Ambient Temperature. A variation in the ambient temperature of 15°C above or below the reference value shall not affect the performance by more than the limits given in the following table:

Effect On	Permissible Limits
Error	0.3% of span
Dead Band	0.2% of span
Span step-response time	10%
Transient Overshoot	0.15% of span

5.9 Effect of Interference. The maximum allowable influence due to interference, as determined by the test detailed below, shall be as follows:

	Max. allowable influence, in % of span, due to	
Effect On	Common Mode Interference	Normal Mode Interference
Error	0.1	0.2
Dead Band	0.1	0.2

5.9.1 Common mode interference — method of test (Refer to Fig. 1). With the instrument balanced at approximately mid-span, common mode interference shall be artificially introduced by applying a voltage of operating power supply frequency between each measuring circuit terminal and the case. This voltage shall be adjustable in magnitude and shall be applied through a blocking capacitor to prevent grounding the input terminals. Means shall be provided for continuously shifting the phase angle of the applied voltage. The rms magnitude shall be measured by a voltmeter connected between the instrument case and the measuring circuit terminal and this voltmeter should preferably be of the battery operated electronic type.

The rms magnitude of the common mode interference voltage shall be adjusted to be equal to the span of the instrument, and the phase angle varied through 360 degrees.

5.9.2 Normal mode interference—method of test (Refer to Fig. 2). With the instrument balanced at approximately mid-span, normal mode interference shall be artificially introduced by applying a voltage of operating power supply frequency between the measuring circuit terminals. This voltage shall be adjustable in magnitude and isolated from the operating power supply and ground by a suitable transformer. A blocking capacitor shall be used to prevent loading the d.c. measured quantity. The r.m.s. magnitude of this voltage shall be measured by a voltmeter connected to the input terminal and this voltmeter shall preferably be of the battery-operated electronic type. Means shall be provided for continuously shifting the phase angle of the applied voltage.

The r.m.s. magnitude of the normal mode interference shall be adjusted to be 20% of the span and the phase angle shall be varied through 360 degrees.

5.10 Effect of External Circuit Resistance. The effect of inserting maximum external resistance shall not cause a change (from reference conditions) exceeding the following limits:

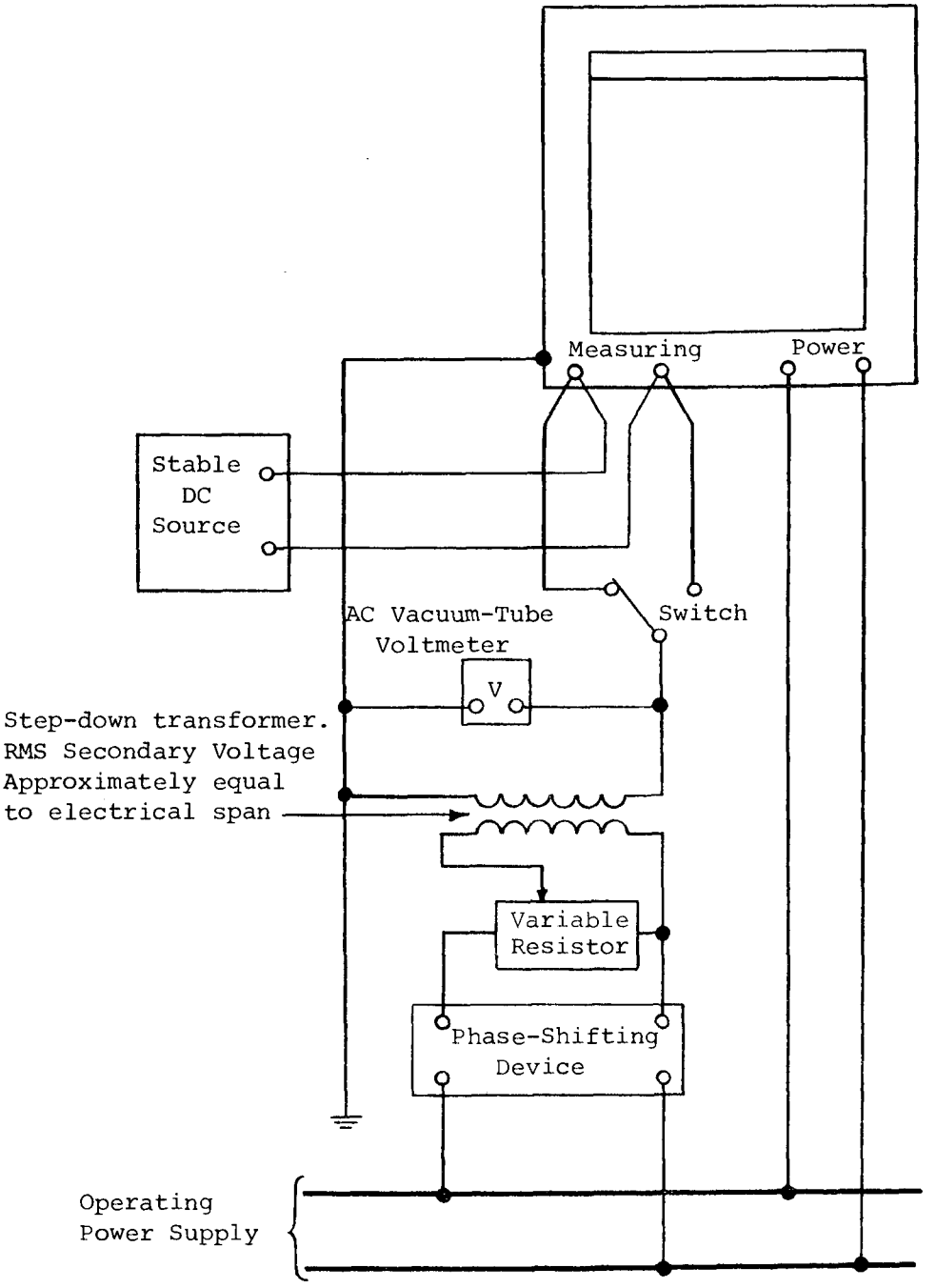
Error	0.15% of span
Dead band	0.15% of span
Span step response time	10%
Transient Overshoot	negligible

5.11 Influence of External Magnetic Field. The instrument shall be placed at the centre of a circular coil 1.0 m in mean diameter and having 100 ampere turns. The frequency of the coil current is to be the same as that of the instrument operating power supply. The phase of the coil current and the orientation of the coil shall be adjusted to produce maximum effect. The maximum allowable influence is as follows:

i) On instrument accuracy:	0.6% of span
ii) On dead band	0.25% of span

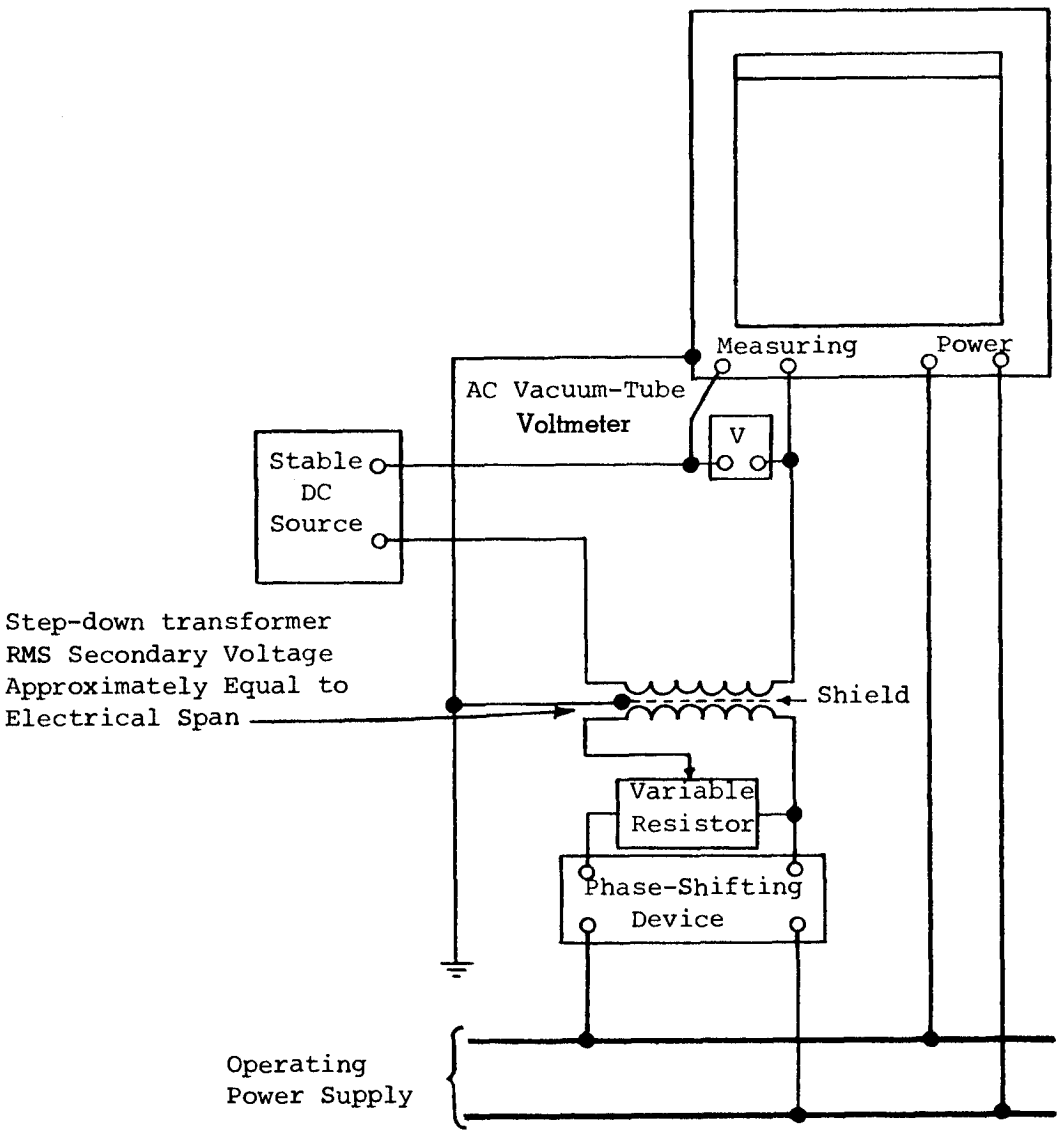
5.12 Effect of Variation in Operating Power Supply Voltage. A variation in the operating supply voltage of 10% above or below the reference value shall not affect the performance by more than the limits given below:

Effect on	Permissible Limit
Error	0.2% of span
Dead band	0.1% of span
Span step-response time	10%
Transient overshoot	0.2% of span



Test for Common Mode Interference Influence

FIG. 1



Test For Normal Mode Interference Influence

FIG. 2

STATIC INTEGRATING METERS

CONTENTS

SECTION 8 — STATIC INTEGRATING METERS

1. SCOPE

These specifications apply to solid state energy meters such as watthour and varhour meters which may be submitted for approval for billing purposes.

This specification is written to pertain to devices of this nature which are designed for use with instrument transformers. Should similar devices intended for direct connection be submitted they will be considered in the light of this and other related sections, due discretion being used in the application of the various clauses.

2. MECHANICAL REQUIREMENTS

2.1 Registers

2.1.1 Units. The unit in which the record is made, i.e. kilowatthours, megavarhours, etc., shall be marked in large letters on the register face.

The zero of clock type dials must be at the 12 o'clock position.

It is not permissible to indicate above any individual dial or drum the magnitude of either the complete indication or of the divisions.

2.1.2 Multiplier. The meter multiplier, if other than unity, shall be marked permanently and prominently, preferably in red, on the register face.

2.1.3 Markings. Except for the manufacturer's name, trade mark, multiplier, or marks pertaining to the reading of the register, no markings of any kind shall be made on the register face. Where the register face and nameplate are integral, the above requirement will not apply but any markings must not be such as to interfere with ready, unambiguous, reading of the register.

2.1.4 Number of digits. All registers must have at least four digits.

2.1.5 Registers. Register arrangements have not been specified so as to not inhibit freedom of design. The design shall, however, be such that the indication is clearly legible and unambiguous.

3. ELECTRICAL REQUIREMENTS

3.1 Power Supply. Preferred power supply rating is 120V, 60 Hz.

3.2 Testing. Each meter shall be provided with a testing device to facilitate calibration (in some manner analogous to counting the disc revolutions of an induction watthour meter).

4. NAMEPLATES

The requirements are the same as those given in Clause 4.1 of Section 2, "Induction Type Watthour Meters", except that for "disc constant", substitute "test constant".

5. PERFORMANCE REQUIREMENTS

5.1 Reference Condition for Tests. In addition to the conditions specified in Clause 5.1 of Section 1, the following standard test condition shall apply unless otherwise indicated:

For polyphase meters, the applied voltage and current shall be polyphase and the phase sequence shall be as marked on the connection diagram.

5.2 Reactive Energy Meters. In the tests which follow where reactive energy meters are involved, the tests are to be carried out substituting reactive factor for power factor, where power factor = $\cos \phi$ and reactive factor = $\sin \phi$.

5.3 Adjustment Prior to Tests. Before commencing performance tests, the calibration shall be corrected, as nearly as practicable, to 100% registration.

Polyphase meters will be adjusted to have minimum difference in registration between elements when each element is tested separately with normal polyphase voltage on all other elements.

5.4 Load Performance. When the meter is tested for accuracy under reference conditions, the registration errors shall not exceed those given in the following table.

5.4.1 Single phase meters and polyphase meters with balanced load.

Current	Power Factor	Percentage Error Limit
Any value from min. to max.	1.0	±0.75%
Any value from min. to max.	0.5 lag	±1.0%

5.4.2 Polyphase meters carrying a single phase load, but with balanced polyphase voltages applied to the voltage circuits.

Current	Power Factor Of The Element Under Test	Percentage Error Limit
Any current from min. to max.	1.0	±1.5
Any current from min. to max.	0.5 lag	±2.0

5.5 Effect of Voltage Variation. A variation of the applied voltage of up to 10% shall not affect the percentage registration by more than 0.2%. This test shall be carried out at minimum and maximum rated current at unity Pf, and at 50% rated current at unity Pf and at 0.5 Pf lag. The power supply voltage is to be varied simultaneously with the metering voltage.

5.6 Minimum Running Current. The meter shall start and continue to register with unity Pf load current of 2% of minimum rated current.

5.7 Effect of Variation of Frequency. At 50% maximum current, unity Pf, a variation in frequency of 5% shall not cause a change in percentage registration of more than 0.2%.

5.8 Effect of Variation of Ambient Temperature. The maximum allowable influence on accuracy due to variation of ambient temperature shall be .035% per °C.

This influence will be determined by comparing the error (at approximately 50% rated load) under reference conditions with that at −7°C and at 53°C.

If the nameplate indicates a more restricted range, the test shall be carried out at temperatures within this range.

5.9 Effect of External Magnetic Field. The change in percentage registration, at any load between TC-2 & TC-7, at any power factor between unity and 0.5 lag, shall not exceed the limits given in Table 11 when the meter is subjected to an external magnetic field equal in magnitude to that specified. The specified field is obtained by placing the meter at the centre of a circular coil 1.0 meter in mean diameter and having 100 ampere turns. The frequency of the coil current is to be the same as that applied to the meter. The phase of the coil current and the orientation of the coil shall be such as to produce maximum effect. For polyphase meters, the test voltages and currents are to be balanced polyphase.

TABLE 11

LIMITS TO EFFECT OF EXTERNAL MAGNETIC FIELD

Meter	Maximum Influence
Single Phase	1.0%
Polyphase	0.5%

5.10 Effect of Momentary Overload. Percentage registration shall be determined at 25% maximum current, unity Pf. Each current circuit shall then be subjected singly and in turn to a current of 10 times maximum, unity Pf, for 0.5 s, with all voltage coils energized.

Any change in registration resulting from this shall not exceed 0.5%.

5.11 Effect of Self-Heating. The effect of a sustained load at maximum rated current, unity Pf for four hours shall not change the percentage registration by more than 0.3%.

The reference registration for this test shall be that determined within two minutes of application of test current.

5.12 Output at zero load. The registration at rated voltage and zero current shall not exceed 0.05% of the registration at 25% maximum current, unity Pf.

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Requirements and specification for approval of type of electricity meters and auxiliary devices

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