Office of Utilities Regulation

Electricity Meter Testing in Jamaica

Protocol on Administrative and Testing Procedures

OFFICE OF UTILITIES REGULATION

December 13, 2005

OFFICE OF UTILITIES REGULATION
Protocol on Administrative and Testing Procedures
Document No: Ele 2005/07

DOCUMENT TITLE AND APPROVAL PAGE

DOCUMENT NUMBER: ELE 2005/07

1. **DOCUMENT TITLE:** Electricity Meter Testing In Jamaica – Protocol on Administrative and Testing Procedures

2. **PURPOSE OF DOCUMENT**

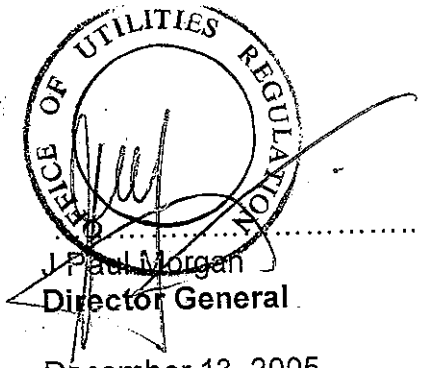
To prescribe the administrative and testing procedures for electricity revenue meters installed by Jamaica Public Service Company Ltd. at customer locations to measure the consumption of electrical energy.

3. **RECORD OF REVISION**

4. **APPROVAL**

This document is approved by the Office of Utilities Regulation and becomes effective on December 19, 2005.

On behalf of the Office:



J. Paul Morgan
Director General

December 13, 2005

TABLE OF CONTENTS

METER TESTING ADMINISTRATIVE AND OPERATIONAL PROTOCOL

1. INTRODUCTION

Electrical energy measurements for revenue purposes have been correctly treated in many countries as a legal measurement and therefore meters that measure this commodity undergo independent accuracy verification on an ongoing basis. Countries organize differently to carry out this accuracy verification check on electricity meters.

In Jamaica the Office of Utilities Regulation (OUR) has the responsibility to ensure that the power utility company carries out electricity meter verification checks in a manner that commands public confidence. Section 4, sub-section 5 (a), (b), (c) and (d) of the Office of Utilities Regulation Act 1995 (amended 2000) (the Act) as well as the terms of the All Island Electricity Licence 2001 (the Licence) granted to Jamaica Public Service Co Ltd. (JPS) in Schedule 2 Overall Standards, code EOS8 (a) and (b).empowers the OUR to require on-going meter accuracy checks of the revenue meters. However these meter accuracy checks have not been demanded nor have they been implemented by the JPS.

The Office of Utilities Regulation (OUR) pursuant to its powers under the Act 1995 (amended 2000) and the JPS License has now considered it necessary to order implementation of a meter testing programme in which the tolerance on meter measurements will stay within acceptable levels on a continuous basis.

This protocol is issued pursuant to the Office of Utilities Regulation's Directive Ele 2005/06 dated December 6, 2005 made to JPS to govern the testing and verification of electrical meters to be used for revenue billing purposes in Jamaica.

The Office of Utilities Regulation wishes to recognize the invaluable contribution of Mr Roosevelt DaCosta who served as Consultant in the preparation of this document.

2. AIM OF THIS METER TESTING PROGRAMME

The aim of the meter testing programme outlined in this protocol is to create an environment in which measurement of electricity for revenue purposes meets ± 2% tolerance on an on-going basis and in so doing to develop confidence in the measurement process.

3. DEFINITIONS, SYMBOLS AND ACRONYMS

In this manual the following words, phrases and symbols shall have the meaning ascribed to them in the ANSI C12.1 – 2001 and the ANSI C57-2001 which standards shall be applicable for the purposes of testing electricity meters, and the Consumer and Corporate Affairs (CCAC) – Canada Standards LMB – EG – 04 which standard shall be applicable for the purposes of sampling. Some of the definitions from both standards are reproduced hereunder for convenience only. In the event that there is a conflict, doubt or discrepancy in the definitions set out hereunder the referenced ANSI and CCAC Standards shall prevail:

3.1 Acceptance Sampling: Means the process of accepting or rejecting a lot of meters by inspecting a sample in accordance with a predetermined sampling plan. The object is to ensure that the lots of acceptable quality have a high probability of acceptance.

3.2 Acceptable Quality Level (AQL): The maximum percent nonconforming that, for the purposes of sampling inspection, can be considered satisfactory as a process average.

3.3 Accreditation: Procedure by which an authoritative body (BSJ initially, Jamaica Accreditation Service finally) gives formal recognition to a body or person (JPS) that it is competent to carry out specific task(s) to ISO / IEC Guide 2: 1996 (scope) after the facilities of the said body or person has been evaluated by the accreditation body along established criteria (ISO 17020, 17024, 17025 & ISO Guide 65) and declared to be in full conformance and with measurements traceable to the national physical standards. Accreditation involves periodic audit visits to the body or person accredited to assess whether the quality of workmanship, equipment and environment remains within acceptable standards.

3.4 Ampere-squared Hour Loss Meter: A meter which measures power line-losses (copper losses) by integrating the square of the line current over time.

3.5 Accuracy: The extent to which a given measurement agrees with the defined value.

3.6 Batch: A distinctive group of meters arrived at through shipment or manufacturing limitation and having the same manufacturer, model and type designation.

3.7 Bureau of Standards Personnel: Any person(s) duly authorized to perform relevant duties on behalf of the Bureau of Standards, Jamaica.

3.8 Bureau (BSJ): means Bureau of Standards, Jamaica.

3.9 Calibration: A comparison between a source of known accuracy called a primary measurement standard and the measuring instrument whose accuracy is not known, and is to be found.

3.10 Characteristic: Any distinct property or attribute of a meter that can be described and measured to determine conformance or non-conformance to specified requirements.

3.11 Compliance Sampling: A specialized form of sampling having the object of ensuring that a batch of unacceptable quality has a high probability of rejection.

3.12 Coupling-capacitor Voltage Transformer (CCVT): A voltage transformer comprised of a capacitor divider and an electromagnetic unit so designed and interconnected that the secondary voltage of the electromagnetic units is substantially proportional to, and in phase with, the primary voltage applied to the capacitor divider for all values of secondary burdens within the rating of the coupling-capacitor voltage transformer.

3.13 Creep: A condition of watt-hour meters in which the measuring device or rotor moves continuously under no-load conditions with the voltage coils of the meter energized. A meter is considered to be creeping if on no-load the rotor makes one complete revolution in ten (10) minutes or less.

3.14 Current Transformer: A device which has its primary winding connected in series with the conductor carrying the current to be measured or controlled and a secondary winding which provides a small fraction of the conductor current. This secondary current is used for the measurement or control.

3.15 Defect: A departure of a quality characteristic from its intended level or state that occurs with a severity sufficient to cause a meter not to satisfy normal usage requirements.

3.16 Defective Meter: A meter containing one or more defects.

3.17 Disposition: An action taken to resolve a nonconformance.

3.18 Demand: The maximum of the average watt-hour, vars or volt-amperes experienced over a short sampling period (typically fifteen minutes) and this maximum is defined to be the demand for a larger

period (typically a year) starting at the month at which a new maximum occurs.

3.19 **Demand Meters:** Meters capable of measuring single or three phase demand in kilowatts, kilovars or kilovoltamperes. Their Registers may be by indicating pointer on a scale, by clock or cyclometer dial, by a line on a chart, by painting on a tape, by pulse on a magnetic tape, by coded punching on a paper tape, by digital display or storage means or some other approved method of recording or indicating. These meters may measure only kilowatts, kilovars, kilovolt-amperes or any combination of these three parameters.

3.20 **Electricity Meters:** A device that measures and registers the integral of an electrical quantity with respect to time.

3.21 **Electrical Energy:** The integral of active power with respect to time.

3.22 **Energy/Demand Meters:** Meters which have housed in a single case an integrating energy meter along with a demand element. The demand element may be dependent upon the integrating energy meter (as in the case of integrating demand or block interval attachments) for the determination of the demand or essentially independent of the integrating energy meter (as in the case of thermal devices). The construction of the whole combination may be such that the demand element is not an attachment and cannot be separated from the integrating element.

3.23 **Field:** The location where the meter is installed.

3.24 **Field Sample:** A sample taken from meters in field installation to decide on whether a particular batch should remain in installation, be withdrawn for repairs or be discarded.

3.25 **Field Testing:** This is testing done at the location of the installed meter.

3.26 **Homogeneous Meter Group:** A lot or population of meters from which a random sample is selected that, as far as is practicable, consists of meters of the same basic type or model designation, having the same general construction, produced by the same manufacturer, and have the same relationship of parts.

3.27 **Impulse Receiver:** A device which interprets impulses of either or both polarities sent from a transmitting source. The impulses exclude low-frequency and direct current components.

3.28 **Impulse Transmitter:** A device which generates and transmits medium and high frequency components.

3.29 **Integrating Energy Meter:** A meter which measures electrical energy over time by integrating (finding the area under) a load curve or load duration curve.

3.30 **Jamaica Public Service Company Limited (JPS):** The power utility company in Jamaica that retails power to industrial, commercial and residential customers as well as Local Authorities and thereby own the meters used to measure electrical energy for revenue purposes.

3.31 **Limiting Quality Level (LQL):** A quality level, in a sampling plan, which corresponds to a specified and relatively low probability of acceptance.

3.32 **Lot:** Means a collection of homogeneous meters available for inspection at one time. The collection will pass or fail as a whole based on the results of tests on a sample drawn from this collection.

3.33 **Manufacturer:** Any person, group of persons or organization or a group of organizations that fabricate meters, which will be used for revenue purposes in Jamaica.

3.34 **Maximum Standard Deviation (MSD):** Under given conditions, the largest acceptable standard deviation.

3.35 **Meter Shop:** A building or part thereof where meters are inspected, repaired, tested and adjusted.

3.36 **National Standards:** Standard electrical quantities (in the form of equipment) that are maintained by the BSJ which are traceable to the Systeme Internationale (SI) at the Bureau Internationale des Pois et Measures (BIPM).

3.37 **Nonconformity:** A departure of a quality characteristic from its intended level or state that occurs with a severity sufficient to cause a meter not to meet a specification requirement.

3.38 **Nonconforming Unit:** A meter containing one or more nonconformities.

3.39 **Notification:** This should be in the form of a written letter to the party stating the intention to purchase electrical energy meters or accessories of a particular manufacturer, model and type; accepting the terms and conditions of conclusions drawn or instructions presented.

3.40 **Office of Utilities Regulations (OUR):** The organization with the authority to regulate the utilities and balance the interest of these utilities with that of their customers.

3.41 **Outlier:** A meter containing one or more outlying observations with respect to accuracy. An outlying observation deviates markedly from the observations of the other meters in the sample.

3.42 **Pattern Approval:** An inspection and testing process designed to establish that the performance characteristics of an electrical meter or measuring accessory model, conforms to the standards and regulations in force.

3.43 **Polyphase Meters:** Meters which make electrical current, voltage, watt-hour, vars or voltampere measurements between all three lines (phases) of an electrical system and present the result as a vector addition of all three phases.

3.44 **Potentiometer Recorders:** A power measuring device in which the voltage imbalance between the external circuit and the potentiometer circuit may be detected by a galvanometer or electronic amplifier and the external sensing element is a variable voltage.

3.45 **Power Factor:** The ratio of active power to apparent power.

3.46 **Pre-field Meters:** Meters that are being readied for field installation. These may be new or repaired meters.

3.47 **Prepayment Meters:** Meters which enable the user to buy a specific amount of electrical energy by coin insertion. Activation occurs when the coins are released and the supply of electrical energy is cut off when the amount of money is inserted is exhausted.

3.48 **Pulse:** A change of state of an electrical signal that conveys an event or information.

3.49 **Pulse Initiator:** Any device, mechanical or electrical, used with a meter to initiate pulses, the number of which are proportional to the quantity being measured. It may include an external amplifier or auxiliary relay or both.

3.50 **Pulse Recorder:** The unit that receives and registers the pulses.

3.51 **Q-hour Meter:** An electricity meter that measures the quantity obtained by effectively lagging the applied voltage to a watt-hour

meter by sixty degrees (60°). This quantity is used with watt-hours in calculating quadergy (var-hours)

3.52 Quadergy: The integral of reactive power with respect to time.

3.53 Quality Statistic: The value which is a function of the tolerance limit, the sample mean and the estimate of the standard deviation of the meter lot.

3.54 Random Sampling: The process of selecting sample meters such that all meters under consideration have an equal and independent probability of being selected.

3.55 Re-verification Check: Tests done to establish whether a particular lot of meters previously rejected but have undergone repairs or corrections, have now met all Acceptance Testing requirements.

3.56 Recalibration: This is a repetition of the calibration process to determine the accuracy of a meter or measuring instrument which has spent some time in operation. Recalibration includes effecting any necessary repairs to restore the meter to acceptable level of accuracy.

3.57 Remote Energy Recorders & Summators: Pulse receiving type remote energy reading recorders and summators which provide an output that is proportional to the rate at which the particular quantity, (i.e. active energy, reactive energy, etc.) is being supplied to the load. They require connection to an appropriate receiving device in order for the demand and/or energy measured to be determined.

3.58 Representative Sample: A sample size which when tested should mirror the characteristics of the entire batch or shipment from which it was drawn.

3.59 Sample: A quantity of meters randomly selected from a larger collection of meters and providing information that can be used as a basis for making a decision concerning the larger collection of meters.

Samples should be drawn from a shipment or field installed batch of electrical meters or accessories bearing the same manufacturer, model and type designation and chosen by the Third Party's Inspector when the tests and inspections are to be carried out by that body.

3.60 Sampling Plan: A specific plan that states the number of meters to be inspected and the associated decision.

3.61 **Seal Vintage Year:** This is the date for recalibration of the meter stamped on the meter seal.

3.62 **Single Phrase Meters:** Meters which make electrical current, voltage, watt-hour, vars or volt-ampere measurements between one line of an electrical system and ground or between two lines of an electrical system.

3.63 **Solid State Transducers:** Devices in which the output D.C. millivolts respond instantly to changes in load and are proportional to the instantaneous product of the input volts and amperes. Solid state transducers operate on what is termed mark-space-amplitude multiplication or amplitude/pulse width modulation.

3.64 **Suitability Evaluation:** This is a series of tests done to determine the ability of the meter to operate and maintain its tolerance under local working conditions, these tests are done for:

a) Pattern Approval

b) Clearance of field installed meters which have undergone repairs and are to be returned to the field.

3.65 **Thermal Converters:** Devices which are similar in operating principle to thermal demand meters, but instead of indicating demand by means of a pointer on a scale, they produce a D.C. output in millivolts which varies directly with the input quantity. For demand purposes the output voltage may be recorded by a potentiometer recorder.

3.66 **Total Harmonic Distortion (THD):** The ratio of the root-mean-square of the harmonic content (excluding the fundamental) to the root-mean-square value of the fundamental quantity, expressed as a percentage.

3.67 **Torque Balance Converter:** A device used to convert millivolts from thermal converters into milliamperes in order to overcome interference picked up by the telemetering transmission lines. To complete the telemetering process the milliamperes must be reconverted into millivolts by passing them through a fixed resistor.

3.68 **Torque Balance Telemeter Transmitters:** Devices with primary measuring elements (electrical and mechanical) that are similar to polyphase watthour and varhour meters but with restrained discs. Since the discs do not rotate there is no register. The torque balance mechanism which supplies the force required to balance the

rotational torque of the disc, produces a D.C. millamperes output proportional to the total load on the primary elements, with a polarity matching the direction of the current flow.

3.69 Traceability: A property of measurement whereby it can be related to appropriate measurement standards (generally international or national) through an unbroken chain of comparisons.

3.70 Trade: Includes any transaction for the transferring or rendering of money for goods or services on the basis of measure.

3.71 Trader: The person(s)/institutions who/which intend(s) to purchase and/or use electrical energy measuring equipment for trade purposes.

3.72 Type Approval: A verification process which entails establishing that the characteristics of any electrical meter or measuring accessory model, conforms to the standards and Order (regulations) in force.

3.73 Verification Checks: These are tests done to establish that every shipment of new meter imported or manufactured locally conforms to the Patter Approval tests previously done.

3.74 Voltage Transformer: An instrument transformer intended to have its primary winding connected in shunt with a power circuit, the voltage of which is to be measured or controlled.

3.75 Voltage-withstand Tests: Tests made to determine the ability of insulating materials and spacings to withstand specified over-voltages for a specified time without flashover or puncture.

3.76 Watthour Meter: An electrical meter that measures active power integrating the product of the instantaneous voltage and instantaneous current over time. This device has both current and voltage coils and the unit in which the integral is usually measured is kilowatthour.

3.77 Symbols

c	the acceptance number which denotes the number of permissible nonconforming meters within a sample.
f	a factor that relates the Maximum Standard Deviation (MSD) to the difference between U and L.
k or k_i	the acceptability constant.

L the lower tolerance limit.

m the number of outliers found in a sample.

n the number of meters in the sample.

n_{max} the maximum permissible number of meters in a sample.

n_{min} the minimum permissible number of meters in a sample.

N the number of meters in a lot.

o the number of permissible outliers in a sample.

r the number of nonconforming units found in a sample.

s the estimated (from the sample) standard deviation of the lot.

n the upper tolerance limit.

x_i the measured value of a characteristic in the i^{th} meter of a sample.

$\bar{x}$ the mean value of x_i for the sample of meters.

$\sum$ "the sum of"

$\geq$ "greater than or equal to"

$\leq$ "less than or equal to"

$>$ "greater than"

$\sqrt{}$ "square root of"

3.78 Acronyms

BIPM Bureau Internationale des Pois et Measures

NIST National Institute for Standards and Technology (of the USA)

NPL National Physical Laboratory (of the United Kingdom)

NRC National Research Council (of Canada)

PTB Physicalisch Techniche Bundesanstalt (National Physical Laboratory of Germany)

SI Systeme Internationale (Metric Units of Measurements)

4. REVISION OF PROTOCOL & APPLICABLE VERSION OF STANDARDS

Revision to this protocol may occur only at the times outlined below:

i) When the ANSI C.12 .1 – 2001, ANSI C.57 – 2001 and CCAC LMB-EG-04 Part 1 to which this Protocol is fixed undergoes a version change that the OUR wishes to adopt.

ii) At the renegotiation of the JPS license which is on a 5 year cycle.

iii) Review of the BSJ testing performance which will be on a 2 year cycle.

iv) Review of BSJ testing contract which will be on a 10 year cycle.

v) Review of the Accreditation Body contract performance which will be on a 2 year cycle.

5. SCOPE OF WORK REQUIRED & RESPONSIBLE ORGANIZATION

This protocol specifies the OUR requirements for type approval, acceptance, calibration quality, compliance and electricity consumers requested testing for all electricity meters to be used for revenue purposes in Jamaica.
The OUR requires that the following testing and services be carried out by the institution named:

(i) Pattern Approval of new models of electricity meters and associated accessories shall be carried out by the BSJ.

(ii) Acceptance Testing of imported Type Approved meter shipments as well as JPS repaired meters shall be carried out by the BSJ.

(iii) Pre-field Tolerance Adjustment on new meters above 12kVA shall be carried out by JPS but shall be subjected to audit under an accreditation programme.

(iv) Compliance Testing of field installed meters shall be carried out by JPS but shall be subjected to audit under an accreditation programme.

(v) Electricity Consumers Requests for Verifying Meter Accuracy shall begin with the JPS and follow the process hereinafter specified.

(vi) Accreditation of JPS meter calibration / repair facilities and meter field testing programme shall be done by an Accreditation Body approved by the BSJ. Initially, the BSJ may be asked to be the Accreditor.

6.0 PATTERN APPROVAL OF NEW METER MODELS

6.1 Objectives of Pattern Approval

i) No new models of electricity meter to be used in revenue determination, shall be introduced in service within Jamaica, without getting type approval from the BSJ

ii) JPS shall cause any new meter model intended for use in electrical measurements for revenue purposes to be pattern approved by BSJ before introduction in the field.

6.2 Standards Governing Pattern Approval

Pattern approval of electricity meters shall conform to ANSI C.12 .1 - 2001and ANSI C.57.2001 or any later version prescribed by the OUR.

6.3 Measurement Traceability for Pattern Approval

i) The BSJ shall traceably define and maintain the kilowatthour for Jamaica through its Watt and Time Primary National Standards that must be directly traceable to the Systeme Internationale (SI) at the BIPM either through direct or indirect (NIST, BIPM, PTB, etc.) calibration or measurement comparison programmes.

ii) The BSJ is responsible to ensure that all test standards and equipment, control and measuring instruments for laboratory services including space conditioning system are traceable to the SI by calibration to the abovementioned primary national standards.

iii) The BSJ shall document the traceability system that applies to each pattern approval and show it on the type approval certificate that is given to JPS.

6.4 Meter Tolerance & its Measurement Accuracy

I) Meters submitted for type approval by JPS or its Suppliers shall be able to measure electrical energy to within ± 1% and the manufacturer shall furnish information on the capability of the meter to maintain such accuracy over time.

ii) The BSJ shall use laboratory Power Standards, to measure electrical power being consumed by type approved meters,

which are able to measure the following parameters to the tolerance assigned:

a) For the High Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.05%

b) For the Mid Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.075%

c) For the Light Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.1%

d) For measurements at 0.5 Power Factor the tolerance on energy measurement shall be 0.1%

6.5 Pattern Approval Requirements

a) Notification

i) The JPS, its agents, purchaser, successors, suppliers or manufacturers shall notify the BSJ in writing of any new meter model and accessory which it intends to introduce into service in Jamaica for the measurement of electrical energy for revenue purposes.

ii) Such notification letter shall request pattern approval (type testing) so JPS, its agents, purchaser, successors, suppliers or manufacturers can know whether the meter model can be purchased for field installation in Jamaica.

iii) JPS shall be responsible for notifying all of its prospective meter suppliers or manufacturers of the requirement for pattern approval of new meter models.

b) Organization Responsible for Meter Sample Submission

i) The BSJ shall accept meters for type approval from JPS, its suppliers or manufacturers.

ii) Type approvals requested by prospective suppliers of JPS shall be done by the BSJ for the account of the supplier.

iii) Type approval certificates shall be issued to the organization bearing the cost for the type approval testing.

c) BSJ to be Notified of Changes to Approved Meter Models

The BSJ shall be notified by JPS of all changes to type approved meter models even if the change is considered insignificant by the manufacturer and unworthy of model change status.

d) Changes to Approved Models that Require New Type Approval

Significant changes (changes which could impact on measurement tolerance) to type approved meter models will require that a new set of Pattern Approval tests be conducted.

e) BSJ's Right to Accept the Pattern Approval of Others

The BSJ shall reserve the right to pattern approve all new meter models or to accept Pattern Approval Certificates from suitably accredited parties.

f) General Testing Conditions

The BSJ shall ensure that in carrying out pattern approval tests the following test conditions are met on a sustained basis:

i) Test voltages shall be held constant to within ±1.0%

ii) Test currents shall be held constant to within ±1.0%

iii) Test phase angle shall be held constant to within ±2°

iv) Test frequency shall be held constant to within ±0.2%

v) Total harmonic distortion (THD) of the applied voltage and current shall not exceed ±2.0% during test.

vi) The ambient temperature of the test laboratory shall be maintained at 23°C with tolerance that depend upon the effects of temperature on the standards used and the meter or accessories under test.

g) External Magnetic Field

Strong magnetic fields may affect the performance of standard meters. The BSJ shall ensure that meters to be pattern tested are kept sufficiently far away from energized transformers and loops of current test leads to avoid any magnetic influence.

h) Meter Accuracy Check

Each meter model that undergoes Type Approval Testing shall have a tolerance check done at the High Load unity power factor and Low Load unity power factor to establish that the meter operates within the ± 1% tolerance allowed.

6.6 Pattern Approval & Meters in Service or Ordered

i) Meter models already in use by JPS or for which firm and provable orders are already in place before the Directive takes effect shall be excluded from the pattern approval requirement.

ii) Existing meter models shall be exempted from Pattern Approval Testing but not from Acceptance Testing (section 7.0).

6.7 Pattern Approval Sample Size

At the time of pattern approval notification or sometime thereafter the JPS or its prospective suppliers shall furnish **three samples** of the meter and/or accessories together with circuit diagram, manufacturer's recommended calibration, connection and operation procedure as well as any other pertinent information for the pattern approval testing.

When the meter sample represents a given basic type with several versions then:

a) For different current ratings – one sample of each of the current rating is required.

b) For different voltage rating – one sample of each voltage type is required. However if the meter has Auto-ranging for voltages then multi-sampling is not required.

c) For different number of elements – one sample for each element type is required.

d) For four-wire wye and four-wire delta meters of the two-element – one sample is required if meter can auto-configure.

6.8 Tests Required for Pattern Approval

The BSJ shall perform the applicable tests stipulated in ANSI C.12.1 - 2001 and ANSI C.57.2001 and in addition carry out the following:

i) A thorough inspection check to determine if damage exists to any part(s) of the sample meter(s) or its accessories. This inspection check shall be done to Section 4.3 of ANSI C 12.1 – 2001.

ii) A meter tolerance check at the High Load unity power factor and Low Load unity power factor to establish that the meter operates within the ± 1% tolerance allowed.

Table No. 1 (for this protocol) shows the full slate of tests from which the type approval tests for each meter type shall be chosen. The section of ANSI C.12.1 - 2001 in which they can be found is also given.

Table No. 1

TYPE APPROVAL TESTS FOR THE VARIOUS METER TPYES

TESTS PERFORMED IN SERIES (√)	DESCRIPTION OF TPE APPROVAL TESTS	SECTION IN ANSI C.12.1
	No Load	Test # 1
	Starting Load	Test # 2
	Load Performance	Test # 3
	Effect of Variation of Power Factor	Test # 4
	Effect of Variation of Voltage	Test # 5 or 5a
	Effect of Variation of Frequency	Test # 6
	Equality of Current Circuits	Test # 7
	Internal Meter Losses	Test # 8
	Temperature Rise	Test # 9
	Effect of Register Friction	Test # 10
	Effect of Internal Heating	Test # 11
	Effect of Tilt	Test # 12
	Stability of Performance	Test # 13
	Independence of Elements	Test # 14
(√)	Insulation	Test # 15
(√)	Voltage Interruptions	Test # 16
(√)	Effect of High Voltage Line Surges	Test # 17
	Effect of External Magnetic Field	Test # 18
	Effect of Variation of Ambient Temperature	Test # 19 or 19a
	Effect of Temporary Overloads	Test # 20
	Effect of Current Surges in Ground Conductors	Test # 21
	Effect of Superimposed Signals	Test # 22
	Effect of Voltage Variation-secondary Time Base	Test # 23
	Effect of Variation of Ambient Temperature-secondary Time Base	Test # 24
(√)	Electrical Fast Transient / Burst	Test # 25

TESTS PERFORMED IN SERIES (√)	DESCRIPTION OF TPE APPROVAL TESTS	SECTION IN ANSI C.12.1
	Effect of Radio Frequency Interference	Test # 26
	Radio Frequency Conducted and Radiated Emission	Test # 27
(√)	Effect of Electrostatic Discharge (ESD)	Test # 28
	Effect of Storage Temperature	Test # 29
(√)	Effect of Operating Temperature	Test # 30
(√)	Effect of Relative Humidity	Test # 31
	Mechanical Shock	Test # 32
	Transportation Drop	Test # 33
	Mechanical Vibration	Test # 34
	Transportation Vibration	Test # 35
	Weather Simulation	Test # 36
	Salt-spray	Test # 37
	Rain-tightness	Test # 38

See Table 3 in section 4.7.1 of ANSI C.12.1 – 2001 for the contents belonging to this table.

6.9 Approval Criteria for Pattern Test Certification

The criteria for granting type approval to a submitted meter model shall be the following:

i. No observed non-conformities from the visual inspection made before tests are conducted.

ii. Performed all the functions specified in the various tests safely, accurately and reliably without any failure.

iii. No sign of physical damage on the meter samples as a result of the various tests conducted.

iv. If from the graph of failures based on the number of meter samples used versus the failures obtained in the different tests, the sample falls within the pass zone. See table No 2 in ANSI C.12.1 - 2001.

6.10 Models found Acceptable

When a meter model successfully passes the pattern approval tests, the BSJ shall:

i. Issue a Pattern Approval Certificate, which enables the JPS, its agents, purchasers and successors to freely purchase or have manufactured this specific model at any time in perpetuity.

ii. Ensure that the Pattern Approval Certificate contain a statement that says "The BSJ attests that all required ANSI C12 and ANSI C57 performance tests have been conducted and found to be satisfactory".

6.11 Models found Unacceptable

i. Meter sample models, which do not pass the pattern testing criteria, shall not be used in Jamaica for measuring electrical energy for revenue purposes and shall not be given a type approval certificate.

ii. The BSJ shall return all meters sent to it by JPS for type approval testing along with a report outlining the reasons for failure.

6.12 Time-Frame for Conducting Pattern Approval Test

i. Meters for type approval shall be submitted to the BSJ not later than six (6) weeks prior to the expected procurement date.

ii. Notwithstanding the fact that type approval tests shall not be unduly rushed, the BSJ shall endeavour to keep the duration of a type approval process within six (6) weeks.

iii. If the BSJ fails to type approve a meter within the stipulated timeframe of six (6) weeks, then the OUR shall issue such instructions as it deems appropriate to satisfy the need for pattern approval and to enable JPS to maintain its operating schedule.

6.13 Cost for Conducting Pattern Approval & Who Pays

The cost for conducting pattern approval inspections and tests shall be borne by the organization requesting such approval. See Schedule No. 1 for the cost of pattern approval.

7.0 ACCEPTANCE TESTING OF IMPORTED AND REPAIRED METER BATCHES

7.1 Objectives of Acceptance Testing

i) The BSJ shall conduct acceptance testing on all batches of imported meters to determine whether they conform to the standards that led to their type approval or for those batches pre-dating type approval to establish that they meet acceptable tolerance and safety standards.

ii) The BSJ shall conduct acceptance testing on all batches of repaired meters or on all repaired meters that cannot be batched to determine if their tolerance falls within acceptable limits.

iii) No new meter from a batch shall be installed in the field without an acceptance test certificate being issued for the batch.

7.2 Standards Governing Acceptance Testing

Acceptance testing shall conform to the relevant areas of ANSI C.12.1 - 2001 and ANSI C.57.2001 or the latest OUR approved version.
In addition Consumer and Corporate Affairs Canada Standard LMB-EG-04 Part 1 shall be used as the sampling plan standard.

7.3 Measurement Traceability for Acceptance Testing

The BSJ shall traceably define and maintain the kilowatthour for Jamaica through its Watt and Time Primary National Standards that must be directly traceable to the Systeme Internationale (SI) at the BIPM either through direct or indirect (NIST, BIPM, PTB, NRC, NPL, etc.) calibration or measurement comparison programmes.

The BSJ shall ensure that all test standards and equipment, control and measuring instruments for laboratory services including space conditioning system being traceable to the SI by calibration to the abovementioned primary national standards.

The traceability system that applies to the measurement equipment used in the acceptance testing process shall be documented and shown on or appended to the type acceptance testing certificate supplied to the JPS.

7. 4 Meter Tolerance & its Measurement Accuracy

i) The BSJ shall subject all imported meter shipments and JPS repaired meters to acceptance testing to ensure that their tolerance on electrical energy measurements fall within ± 1%.

ii) The BSJ shall use laboratory Power Standards for the measurement of electrical power consumed in acceptance testing. The BSJ shall use measurement equipment which is able to measure the following parameters to the tolerance assigned:

a) For the High Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.05%

b) For the Mid Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.075%

c) For the Light Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.1%

d) For measurements at 0.5 Power Factor the tolerance on energy measurement shall be 0.1%

7.5 Acceptance Testing Requirements

i) JPS shall notify the BSJ of **all** imported shipments of electrical meters and their accessories as well as JPS Field repaired meters and shall allow the BSJ to select a representative sample of each meter model from every batch for Acceptance Testing.

ii) Acceptance Testing will determine whether the meters purchased or repaired are representative of the sample previously type approved or in the case of models which were not type approved, whether their accuracy fall within the required limit of ± 1%.

iii) Meters above 12kVA rating shall satisfy all the requirements of Acceptance Testing before they will be permitted to undergo JPS Meter Shop calibration for field installation.

iv) Meters rated at 12kVA and below shall satisfy all the requirements of Acceptance Testing before they will be eligible for field installation

v) The BSJ shall complete its Acceptance Testing of each imported shipment of meters within five (5) days of taking samples, failing which the JPS shall take such other steps as are necessary to determine the acceptability of the shipment

vi) The BSJ shall give written notice to JPS immediately after making its decision to accept or reject a lot of imported meters. This will enable the JPS to commence pre-field installation or calibration forthrightly. The duly signed and approved Acceptance Certificate can be issued later.

vii) The sampling plans in this section are based on an Acceptable Quality Level (AQL) of 1.0 %.
With respect to a single accuracy quality characteristic, the probability of acceptance for meter lots containing 1.0 % or less non-conformities is greater than 90%.

viii) The BSJ shall return all meters sent to it by JPS for acceptance testing (verification checks) in the condition in which it was received and shall apply the BSJ seal to each meter prior to its return. Failure to do so will result in an investigation by the OUR that could result in the BSJ compensating the JPS for the cost of the damaged meter(s).

vix) Meters for testing shall be transported and handled in appropriate packaging to prevent damage

7.6 Acceptance Sample Selection Process

i) Meters for the Acceptance Sampling Plan shall be chosen from meter lots by the BSJ using the random sampling method.

ii) All lots shall consist of homogenous meter groups which are formed from the same meter type, model, tolerance, rating and shipment.

iii) All meters within a lot shall be individually identified on a list.

iv) When a meter chosen for the sample cannot be tested due to a defect, another meter shall be drawn from the lot at random. However, this defective meter may be cause for rejection of the lot depending on the sampling plan and the nature of the defect.

v) Every meter to be taken from the custody of JPS by the BSJ shall be sealed by the JPS prior to delivery to the BSJ.

7.7 Acceptance Tests Sample Size

The sample size for Acceptance Testing shall be arrived at by using table 1 of the Consumer and Corporate Affairs Canada Standard LMB-EG-04 Part 1 shown in this document as Table No. 2.

Table No. 2

Acceptance Sample Size & Associated Statistics

N	n	k	c	f	MSD*
90 or less	15	1.79	0	0.248	0.496
91 to 150	20	1.82	0	0.242	0.484
151 to 280	25	1.85	0	0.238	0.476
281 to 500	35	1.89	0	0.232	0.464
501 to 1,200	50	1.93	1	0.227	0.454
1,201 to 3,200	75	1.98	2	0.223	0.446
3,201 to 10,000	100	2.00	2	0.220	0.440

* Calculated from the formula **MSD = f . (U – L)**; applicable where U and L are + 1.0 % and – 1.0 % (See **DEFINITIONS** for meaning of N, n, k, c, f, MSD, U & L)

7.8 Tests Required for Acceptance Sampling

i) Each meter sample chosen shall be inspected by the BSJ for nonconformities (r) similar to ANSI C.12.1-2001 section 4.3. This inspection shall help to establish the identity of the meters and confirm whether they belong to previously type approved groups.

The result of the inspection shall be recorded.

ii) Each meter sample shall be load tested at two or more of the following points depending on the meter type:

- Full Load Test shall be – 100%of meter test amperes at unity power factor. {For the meter with 100A rated current, the test current is 15A, hence Full Load Test ampere would be 15A}.

- Light Load Test shall be- 10% of meter test amperes at unity power factor.

- Power Factor shall be – 100% meter test amperes at 50% lagging power factor. The Power Factor Test shall be applicable only to polyphase meters.

iii) The configuration of the test set-up shall be according to ANSI C12.1- 2001

iv) Full Load and Light Load tests shall be done for each meter in the sample and the results recorded. BSJ's watt-hour Working Standard shall be connected in series with each sample meter and shall also be read exactly at the full and light load test points. The percentage over or under registration of the tested meter shall be calculated from the following formula

$$\text{\% over/under Registration Of Tested Meter} = \frac{\text{Registration of Tested Meter} - \text{Registration of Std. Meter}}{\text{Registration of Std. Meter}} \times 100$$

Each watt-hour meter sample will now have a high load and a light load percentage registration which can be over registration (+), zero registration or under registration (-). Each of this percentage registration is accorded the expression x_i

v) Tabulate the series of High Load (H.L.) percentage registrations in one column of a table and add them algebraically to obtain the High Load Σx_i
Similarly tabulate the series of Low Load (L.L.) percentage registrations in a second column of the table and add them algebraically to obtain the Low Load Σx_i

vi) Calculate the meter samples High Load mean value $\bar{x}_{HL}$ using the formula $\bar{x}_{HL} = \sum x_i/n$ and record it.

vii) Calculate the meter samples Light Load mean value $\bar{x}_{LL}$ using the formula $\bar{x}_{LL} = \sum x_i/n$ and record it.

viii) Calculate the meter sample High Load standard deviation value s_{HL} using the formula $s_{HL} = \sqrt{\{\sum(x_i - \bar{x})^2 / (n - 1)\}}$ and record it.

ix) Calculate the meter sample Light Load standard deviation value s_{LL} using the formula $s_{LL} = \sqrt{\{\sum(x_i - \bar{x})^2 / (n - 1)\}}$ and record it.

Sample statistics computation and decision criteria shall be as outlined in the Acceptance Sampling Plans section of LMB-EG-04

7.9 Meter Lot Acceptance Criteria

The Acceptance Sampling Plan to be used in the verification and re-verification of new meter batches is as defined in the Consumer and Corporate Affairs Canada Standard LMB – EG - 04. Specifically, a lot of meters shall be considered acceptable if the following inequalities are satisfied simultaneously:

a) $\bar{x} + k.\, s \leq U$ (for each test point)

b) $\bar{x} - k.\, s \geq L$ (for each test point)

c) $s \leq f\,.\,\{U - L)$ (for each test point) and

d) $r \leq c$

Where: k, f and c are as specified in the DEFINITION section of this protocol or the Acceptance Sampling Section of the Consumer and Corporate Affairs Canada, Standard LMB – EG - 04. For values of k, f, c and r see Table No 2 in this protocol or Table No1 in the Acceptance Sampling section of Standard LMB-EG-04

U & L are the upper and lower tolerances as defined in the DEFINITION section of this protocol and agreed on by all parties as **+ 1%** and **– 1%** respectively.

7.10 Meter Lots Found Acceptable

i) A meter lot shall be accepted if the sample tested meets all the following criteria from Section 3 of Standard LMB-EG-04:

- All four inequalities of section 7.9 above have been met.
- None of the sample meters has defects which could affect its safety or registration accuracy.

ii) The BSJ shall issue an Acceptance certificate for every lot of meters passing the Acceptance Sampling tests.

Such certificate that specify that the JPS is authorized to install meters from the accepted lot or to undertake pre-field calibration on every meter in the lot so as to bring its tolerance as close as possible to zero before field installation.

iii) The JPS shall adjust to as close as possible to zero tolerance every meter sized above 12kVA from an accepted lot of meters before they are dispatched for field installation.

iv) The JPS may immediately dispatch for field installation every meter sized at 12kVA and below that have met all the Acceptance Test criteria without adjusting them to as close as possible to zero tolerance.

v) The BSJ shall return to JPS all meters received for Acceptance Testing in the condition in which they were originally received.

7.11 Meter Lots found Unacceptable

i) Lots from which meter samples have been drawn shall be rejected by the BSJ if:

- The meter samples are found to have nonconformities that can affect the safety and performance of the meter, which are outside the specified limits of Table No2 in this protocol or Table No1 in the Acceptance Sampling Plan section of LMB-EG-04 or

- Failed any of the inequalities of section 7.9 above

ii) JPS may re-submit rejected meter lots for re-testing (Acceptance Testing) after all meters in the lot have been examined and all nonconforming or defective meters have been removed and/or repaired.

iii) JPS shall re-export or scrap meter lots that are not serviceable.

7.12 Time-Frame for Conducting Acceptance Tests

i) The BSJ shall ensure that Acceptance Testing for imported meter lots shall not exceed 5 days.

ii) Should the BSJ face problems beyond its immediate control it shall notify the OUR and copy such notification to the JPS.

iii) After consultations with JPS and the BSJ the OUR may issue instructions regarding securing acceptance testing for a batch of meters if the BSJ is unable to meet the stipulated timeline.

7.13 Costs for Conducting Acceptance Testing & Who Pays

The cost for conducting Acceptance Testing and the associated inspections shall be paid for out of the BSJ Standards Compliance Funds. See Schedule No 1 for how payments are to be recovered.

8.0 TOLERANCE QUALITY CHECK ON PRE-FIELD CALIBRATED METERS

8.1 Objectives of Tolerance Quality Check

i) The JPS shall adjust the tolerance on every electricity meter, used for revenue determination and rated above 12kVA, so that it measures as close to zero tolerance as possible before it is dispatched for field installation.

ii) The quality of the electricity meter tolerance adjustment (calibration) shall be monitored by The Accreditor of JPS Meter Shop and Meter Testing Services and the level of auditing shall be such that will instill confidence and recognition by the OUR and BSJ.

8.2 Background to Tolerance Quality Checks

i) JPS shall be responsible for tolerance adjustment or calibration checks of all new meters above 12kVA rating or repaired meters prior to field installation or re-installation to measure electricity consumption for revenue purposes.

ii) The purpose of the pre-field installation tolerance adjustment or calibration shall be to ensure that the all meters in the named categories is adjusted to read as close as possible to zero over- reading or under-reading.
Against the background of just in time purchasing of meters by JPS, pressures usually arise to get the meters into the field very quickly. Meters calibrated under un-pressurized or normal calibration circumstances can have measurement tolerances that are not close enough to zero. Pressurized calibrations are prone to even greater tolerances hence control is needed to keep tolerances as close as possible to zero.

iv) JPS shall be responsibility to keep meter tolerances at the barest minimum on a sustained basis.

v) JPS shall use the technique of accreditation of its Meter Shop and services to control the quality of work turned out by this facility.

vi) The Accreditation Body that JPS hires for its Meter Shop and services accreditation shall be approved by the OUR and BSJ.

vii) The terms of the accreditation shall include a mechanism for sustained control of measurement tolerances for meters prepared for field installation.

viii) The Accreditor's methodology to accomplish quality monitoring of meter tolerance adjustment shall be to take random samples of meters adjusted for field installation at unspecified times (any time) for tolerance (calibration) assessment checks by a third party laboratory.

8.3 Standards Governing Tolerance Quality Checks

The Accreditor for the JPS meter shop shall use the relevant laboratory space conditioning, laboratory equipment accuracy, meter test points, tolerance on meter measurements, operational procedures, record keeping, the quality of staff and all other performance requirements from the latest version of ISO/IEC Guide 2: 1996 and criteria based on ISO/IEC – 17020, 17024, 17025 and ISO Guide 65, ANSI C.12.1-2001 and ANSI C.57- 2001 for all pattern approvals.

8.4 Traceability for Tolerance Quality Checks

i) The Acreditor shall ensure that whatever laboratory does the pre-field calibration quality checks on its behalf have measurement traceability through the BSJ to the SI for its physical standards, test equipment, control and measuring instruments for laboratory services including space conditioning system

ii) The Accreditor shall ensure that the JPS Meter Shop has measurement traceability to the SI for all its physical standards, test equipment, control and measuring instruments for laboratory services including space conditioning system.

iii) To the extent that the Accreditor finds that JPS does not have traceable measurements on an ongoing basis, it shall suspend or withdraw its accreditation license and notify the OUR and BSJ.

iv) The traceability system that applies to the JPS meter calibration process as well as the calibration quality checks shall be documented and shown in the Accreditor's Quality Manual.

8.5 Tolerance Quality Check Requirements

a) Obtaining Accreditation

i) The JPS shall contract an OUR and BSJ recognized Accreditation Body within six (6) months of this meter testing protocol taking effect, and have them conduct a pre-accreditation audit of their meter calibration / repair shop. The result of this audit shall point to issues which

JPS must immediately address in order to qualify for accreditation.

ii) Within one year of this meter testing protocol taking effect, the JPS shall obtain accreditation of its Meter Shop.

iii) The accreditation contract shall allow for random sampling and testing of meters which have been calibrated for field installation, in order to check the quality of the calibration.

iv) The Accreditation Body shall arrange for assessment tests to determine the quality of the JPS calibration.

v) Initially the JPS may contract the BSJ directly to undertake the calibration quality check while it await the establishment of the National Accreditation Body and the Accreditor it will appoint.

b) General Test Conditions for JPS Meter Shop & Calibration Quality Evaluator

General test conditions for JPS Meter Shop and Calibration Quality Evaluation Laboratory shall meet all the requirements of Section 3.10 of ANSI C12.1 - 2001.

c) External Magnetic Field

Strong magnetic fields may affect the performance of standard meters. The Accreditor shall ensure that meters to undergo calibration quality checks at the JPS Meter Shop and Calibration Evaluator Lab are kept sufficiently far away from energized transformers and loops of current test leads to avoid any magnetic influence.

8.6 Sample Size of Meters for Tolerance Quality Checks

i) The sample size for new lots of meters rated above 12 kVA shall be the same as that used for Acceptance Testing. This is reproduced in Table No. 3 below for convenience.

ii) The sample size for repaired meters shall also comply with that of Table No3 below if homogenous lots of sufficient size (minimum lot size in Table No3) can be assembled.

Where homogenous lots of sufficient size cannot be assembled the Accreditor shall draw meter samples randomly in sufficient numbers to give him comfort in the tolerance adjustment check

and assessed them individually against the zero tolerance requirement.

Table No. 3

Sample Size for Tolerance Quality Checks

SIZE OF PRE-FIELD CALIBRATED METER BATCHES	SAMPLE SIZE FOR TOLERANCE QUALITY CHECKS
90 or less	15
91 to 150	20
151 to 280	25
281 to 500	35
501 to 1,200	50
1,201 to 3,200	75
3,201 to 10,000	100

8.7 Tests to Determine Tolerance Quality

The load test of ANSI C.12 .1 – 2001 shall be used to determine the points and method for conducting the tolerance quality check but with one exception. Load tests will therefore be conducted at the following points:

- High Load – 100% of meter test current at 100% power factor.
- Light Load – 10% of meter test current at 100% power factor.

The meters under test shall be compared with the Standard Meter at these load points and the percentage over or under reading calculated to determine the tolerance on measurements.

8.8 Acceptance Criteria for Tolerance Quality Checks

a) The Accreditation Body's criteria for acceptance of meters that have their measurement tolerance quality checked shall be as follows:

   i) For the High Load test the tolerance shall be ± 1.05%

   ii) For the Light Load test the tolerance shall be ± 1.1%

b) For meters which cannot be batched and sampled, acceptance shall be based on individual meter comparison High and Low loads determination with the above values.

c) For meters that can be batched and sampled, acceptance sampling techniques, analysis and decision criteria of sections 7. 7, 7.8 and 7.9 shall be used.

8.9 Time-Frame for Conducting Tolerance Quality Checks

The Accreditor shall ensure that testing to assess the quality of the pre-field tolerance adjustment (calibration) does not take more than 5 days in view of the need for JPS to get these meters in the field. The five days shall include the time taken to take delivery and return the meters to JPS.

8.10 Cost for Tolerance Quality Checks & Who Pays

The cost for conducting tolerance adjustments (calibration) quality checks on meters calibrated for field installation shall be paid for by the JPS. The charge for this quality check by the Accreditation Body shall be part of the package for the accreditation.

9.0 COMPLIANCE TESTING OF FIELD INSTALLED METERS

9.1 Objectives of Compliance Testing

i. To bring the full complement of JPS field-installed meters into compliance with a ± 2 % tolerance on electrical energy measurement for revenue purposes.

ii. To use random sampling together with a statistical sampling plan method developed specifically for electrical and gas meters to achieve the above objective.

iii. If the first meter sample fails the batch (lot) from which it was taken, the JPS shall be given the option of withdrawing the meter batch from service or re-sample the batch through an increased sample size or double sample.

If the enlarged sample also fails the batch from which it was taken, then the JPS shall have the choice of withdrawing the meter batch from service or proceed to 100% sampling and testing in order to remove the meters with unacceptable tolerance.

iv. Meters (lots or individuals) that have been withdrawn from service can only be returned to service through the process of repairs (if needed), tolerance adjustment (recalibration), acceptance testing (by JPS), lot or individual meter clearance for field re-installation by the Accreditor.

v. To ensure that the quality of the JPS sampling, field testing programme and Meter Shop calibration & repairs are always meeting the standards of the OUR.

9.2 Standards Governing Compliance Testing

JPS shall use the relevant laboratory tests conditions, laboratory equipment accuracy, meter test points, tolerance on meter measurements and all other performance requirements from the latest version of ANSI C.12.1 - 2001 and ANSI C.57.2001 for all compliance testing.

In addition Consumer and Corporate Affairs Canada Standard LMB-EG-04 Part 1 shall be used as the sampling plan standard.

9.3 Measurement Traceability for Compliance Testing

Measurement traceability is the mechanism which will ensure that the kilowatthour billed to the JPS customer is the same as that measured at the BSJ or at the institution that defines the kilowatthour for the entire world, the Bureau Internationale des Pois et Measures (BIPM).

It is the responsibility of the BSJ to traceably define and maintain the kilowatthour for Jamaica through its watt and time primary national standards that must be directly traceable to the Systeme Internationale (SI) at the BIPM either through direct or indirect (NIST, BIPM, PTB, etc.) calibration or measurement comparison programmes.

Compliance testing will require the use of fixed and traveling watt-hour working standards; portable meter test kit; multi-meter computer controlled test bench; standardized test voltages, current, phase angle, mains frequency and waveform distortion as well as laboratory ambient temperature control. The BSJ is responsible to ensure that all these test equipment, service supplies and space conditioning control/measuring instruments are traceable to the SI by calibration to the abovementioned primary national standards.

The traceability system that applies to the measurement equipment used in a specific compliance testing process shall be documented and shown on or appended to the type approval certificate given to the JPS.

9.4 Compliance Testing Requirements

i) JPS shall be responsible for carrying out Compliance Testing of its field installed meters in accordance with the terms of its License and with the agreed modification(s) of the Consumer and Corporate Affairs Canada Standards (LMB-EG-04 PT1).

ii) The OUR shall be responsible for verifying that JPS fulfills the requirements for Compliance Testing and that the procedures used for Compliance Testing are in accordance with the standards referenced in this Protocol.
In fulfilling this responsibility the OUR will rely on the Accreditation Body for results of the quality checks it makes and the confidence it reposes in the meter testing facilities and services of the JPS.

The Office is responsible for directing JPS to any action required on the basis of the compliance test results.

iii) Prior to the commencement of the compliance meter testing programme, JPS shall review its installed meter population and shall define meter lots on a set of criteria that as far as practical meet the requirements for developing a National Meter Sampling Map (NMSM). JPS shall submit its proposal to the OUR for approval.

iv) The OUR in fulfilling its approval function may constitute and chair a committee comprising the JPS, the Accreditor and BSJ representatives to ensure that the JPS' NMSM segments the island's field installed meter population into the best possible homogenous lots for the purposes of sampling and testing to determine these meter measurement tolerance.

v) The OUR's approach to reviewing the National Meter Sampling Map will include review of the logic behind the breaking down of the island into geographic locations by meter types

vi) The JPS shall within 4 months of agreement on a "National Meter Sampling Map" prepare a report on the general status of metering within each sample area. Each report shall have a listing of the meters within that sampling area with the following information:

- An inspection number (assigned in ascending order of magnitude)
- The serial number of the meter (or last 3 digits of the serial number).
- The model designation
- Age of the meters (guesstimate if cannot be ascertained)
- The current range (10A, 20A, 50A, 100A, 200A, etc)
  In addition to the abovementioned information on the meter, the list shall contain
- The Address for the meters
- The total number of meters in the lot or sample area.

- The lot identification number
- The meter manufacturer's name
- The recommended seal years of the meter.

vii) New meters entering the field will be placed in their own batches while existing meters will be placed in their own batches according to the sampling plan methodology approved by the OUR.

viii) Prior to conducting Compliance Testing of any selected lot of meters JPS shall submit the list of meters in the lot and the randomly selected list of meter samples to be tolerance checked to the OUR for approval. The OUR shall in accordance with the agreed Standards, indicate their approval or otherwise of the list within five (5) days. In any case of disapproval the OUR shall outline the reasons in writing.

ix) A listing of meters explicitly defines the lot. Meters can be withdrawn but no meters shall be added subsequently to the lot.

x) Under no circumstances shall the Accreditor or his agent conduct any on site meter testing without the JPS being represented unless extenuating circumstances arises in which the OUR specifically instructs the Accreditor or his agent in writing so to do.

xi) JPS shall be responsible for breaking the seal on all its meters unless the extenuating circumstances of x) above come into force

xii) The Accreditor or his agent in fulfillment of his responsibilities and to develop full confidence in the JPS compliance testing programme shall be free to conduct observations and verification of JPS field tests and/or independent meter tests in any geographic sample area in order to:

a) Satisfy himself that the on-site sample measurements of JPS for specific meters are in congruence with his.

b) Satisfy himself that an entire meter batch covering a particular geographic area has been sampled, tested and analyzed to his satisfaction.

In this case the Accreditor or his agent shall carry out testing and analysis of tolerance results on the identical sample meters used in the JPS tests to establish parity between results.

Every site to be visited by the Accreditor or his agent shall require the JPS to be present to break the seal and witness the tests.

xiii) The Accreditor shall notify the JPS in writing (copy to the OUR) of his intension to conduct non-simultaneous compliance testing of field installed meters in a particular location.

xiv) The JPS shall not unreasonably withhold its representation from the Accreditor or his agent field testing site visits and where such unreasonable withholding of representation has been determined the OUR shall take appropriate action.

xv) Compliance Testing and sampling shall be used to determine whether a lot of field installed meters are within the prescribed measurement tolerance and determine any further action which the OUR might direct JPS to implement with respect to safeguarding the accuracy of revenue-purpose meters.

xvi) The sampling plans in this section are based on a Limiting Quality Level (LQL) of 1.0 %.

With respect to a single accuracy quality characteristic, the probability of acceptance for meter lots containing 1.0 % or more positive-valued nonconformities is 5% or less and the probability of acceptance for lots containing 1.0% or more negative-valued non-conformities is 5% or less for Level 1 tolerances (± 2%) and 10% or less for all other tolerance levels.

9.5 Compliance Sample Selection Process

i) Meters for the Compliance Sampling Plan shall be chosen from the meter lots (mentioned above) by the JPS using the random sampling method.

ii) As far as practical and possible, lots shall consist of homogenous meter groups which are formed from the same meter type, model, tolerance, rating and shipment.

iii) All meters within a lot shall be individually identified on a list.

iv) All sample meters selected but not involved in the final calculations shall be accounted for and the reasons for exclusion shall be reported. Evidence of deliberate exclusion may disqualify the results of the sample.

v) Meters which are damaged during field testing shall be presented to the Accreditor or his agent with a satisfactory, written explanation of the cause of the damage prior to a decision being rendered on the lot's acceptability. These damaged meters shall not be counted as outliers.

9.6 Compliance Tests Sample Size

i. The size of samples (n_{max}) for compliance testing shall be arrived at by using Table II of the Consumer and Corporate Affairs Canada Standard LMB-EG-04 Part 1 shown below as Tables No 4.

ii. Notwithstanding the above clause 9.5 i), the JPS may elect to choose a sample size corresponding to a larger lot size. All decision criteria shall then be based on the values of table 4 associated with this larger lot size.

iii. If after analyzing the results of a single sample, the JPS believe that analysis of a larger sample would result in a more favourable outcome, the JPS may elect to have one additional sample drawn from the lot. The statistics shall then be calculated based on the combination of the two samples and the decision criteria shall be based on the values in Table 5.

iv. The size of the additional sample shall be equal to the difference between the value of n_{max} in table 5 and the value of n_{max} in table 4 according to the size of the lot [or the larger lot size where clause 9.5 ii) has been used]

Table No. 4

Compliance Sampling Statistics (Single Sampling)

N	n_{min}	n_{max}	k_1	k_2	o	MSD
500 or less	25	28	3.158	2.952	0	0.5962
501 to 1,000	50	55	2.862	2.735	1	0.6504
1,001 to 2,500	75	83	2.748	2.649	1	0.6739
2,501 to 5,000	100	110	2.684	2.601	2	0.6877
5,001 to 10,000	150	165	2.611	2.546	2	0.7043
10,001 to 15,000	200	220	2.570	2.514	3	0.7139
15,001 to 25,000	250	275	2.542	2.493	4	0.7206
25,001 to 50,000	300	330	2.522	2.477	5	0.7255

Table No. 5

Compliance Sampling Statistics (Double Sampling)

N	n_{min}	n_{max}	k_1	k_2	o	MSD
500 or less	50	55	2.862	2.735	1	0.6504
501 to 1,000	100	110	2.684	2.601	2	0.6877
1,001 to 2,500	150	165	2.611	2.546	2	0.7043
2,501 to 5,000	200	220	2.570	2.514	3	0.7139
5,001 to 10,000	300	330	2.522	2.477	5	0.7255
10,001 to 15,000	400	440	2.494	2.456	6	0.7324
15,001 to 25,000	500	550	2.475	2.442	8	0.7371
25,001 to 50,000	600	660	2.462	2.431	9	0.7404

9.7 Tests Required for Compliance Sampling

i) Each meter sample chosen shall be inspected by the JPS for non-conformities (o) similar to section 6.8 i) and any defects recorded. This inspection shall help to establish the identity of the sample meters and confirm whether they are legitimate members of the defined parent lot. If a sample selected is not found in the field then a replacement sample is selected.

ii) Each meter sample shall be accuracy tested at two or more of the following points depending on the meter type and ANSI C.12.1 - 2001:

- Full Load test shall be – 100%of meter test amperes at unity power factor.
- Light Load test shall be- 10% of meter test amperes at unity power factor.
- Power Factor test shall be – 100% meter test amperes at 50% lagging power factor.

iii) Meter tests shall be done using the relevant meter test standard and equipment. The configuration of the test set-up shall be in accordance with ANSI C12.1-2001.

Accuracy of meters tested shall be expressed as a percentage difference (plus/minus) between the tested meter registration and the reference standard's registration (see the formula below).

$$\text{\% over/under Registration Of Tested Meter} = \frac{\text{Registration of Tested Meter} - \text{Registration of Std. Meter}}{\text{Registration of Std. Meter}} \times 100$$

Each watt-hour meter sample will now have a High Load over, zero or under percentage registration which we can label "HL x_i" Likewise we will have a series of Light Load over, zero or under percentage registrations which we can label "LL x_i"

iv) The meter samples High Load mean value $\bar{x}_{HL}$ is now calculated using the formula $\bar{x}_{HL} = \sum x_i/n$

v) The meter samples Light Load mean value $\bar{x}_{LL}$ is now calculated using the formula $\bar{x}_{LL} = \sum x_i/n$

vi) The meter sample Full Load standard deviation value s_{FL} can now be calculated using the formula $s_{HL} = \sqrt{\sum[(x_i - \bar{x})^2 / (n - 1))}$

vii) The meter sample Light Load standard deviation value s_{LL} can now be calculated using the formula $s_{LL} = \sqrt{\sum[(x_i - \bar{x})^2 / (n - 1)]}$

viii) The number of outliers (m) shall be counted. An observation is considered to be an outlying observation if the following criteria are met:

a) $x_i > +2.0\ \%$ and $x_i > \bar{x} + 2.s$ **or**

b) $x_i < -2.0\ \%$ and $x_i < \bar{x} - 2.s$

ix) The statistics calculated for the sample shall be determined by excluding all observations from meters classified as outliers, unless the exclusion would cause the outright rejection of the lot.

9.8 Meter Lot Compliance Criteria

i) The compliance Sampling Plan to be used in the verification and re-verification of field installed meter lots is as defined in the Consumer and Corporate Affairs Canada Standard LMB – EG - 04. Specifically, a lot of meters shall be considered acceptable if the inequalities of Level 1 below are satisfied simultaneously:

Level 1 Criteria

i) $\bar{x} + k_1 . s \leq +2.0\ \%$ (for each test point)

ii) $\bar{x} - k_1 . s \geq -2.0\ \%$ (for each test point)

iii) $s \leq MSD$ (for each test point)

iv) $m \leq o$; and

v) $n_{min} \leq n \leq n_{max}$

ii) A ± 2% tolerance on electrical energy measurements may be difficult to obtain for several meter lots in the field. Jamaica is seeking to implement a ± 2% tolerance on the measurement of electrical energy as against Canada that has ± 3%.

The OUR may wish to adopt a higher percentage tolerance on measurement as an interim measure. The criteria for ± 2.5%, ± 2.75% and ± 3% are given in Levels 2, 3 and 4 respectively for possible consideration. It is important to note that the satisfaction of each level criterion means different seal year extension

a) Level 2 Criteria

i) $\bar{x} + k_1 . s \leq +2.5\ \%$ (for each test point)

ii) $\bar{x} - k_2 . s \geq -2.5\ \%$ (for each test point)

iii) $m \leq o$; and

iv) $n_{min} \leq n \leq n_{max}$

b) Level 3 Criteria

i) $\bar{x} + k_1 . s \leq +2.75\ \%$ (for each test point)

v) $\bar{x} - k_2 . s \geq -2.75\ \%$ (for each test point)

vi) $m \leq o$; and

vii) $n_{min} \leq n \leq n_{max}$

c) Level 4 Criteria

i) $\bar{x} + k_1 . s \leq +3.0\ \%$ (for each test point)

ii) $\bar{x} - k_2 . s \geq -3.0\ \%$ (for each test point)

iii) $m \leq o$; and

iv) $n_{min} \leq n \leq n_{max}$

Where: k_1, k_2, MSD, o, n_{min} and n_{max} are as specified in Table 3 (for single sampling) or Table 5 (for double sampling) according to the lot size; and n is the actual number of sample meters contributing to the sample statistics.

See the DEFINITION section of Consumer and Corporate Affairs Canada, Standard LMB – EG – 04 for the definition of k_1, k_2, MSD, o, n_{min} and n_{max}

9.9 Compliance Sampling decision Rules

a. A lot of meters will be considered acceptable if the sample meters satisfy all the inequalities for Level 1 Criteria {see sections 9.6 viii) and 9.7 i)}.

b. The OUR shall decide whether it will temporarily accept meter lots satisfying Levels 2, 3 and 4 Criteria {see section 9.7 ii)}.

In Canada lots for which sample meters satisfy all the Levels Criteria result in the following seal life extension:

- Level 1 Criteria – 8 years seal life extension.
- Level 2 Criteria – 6 years seal life extension.

- Level 3 Criteria – 4 years seal year extension.
- Level 4 Criteria – 2 years seal life extension.

c. Meters within a sample will be considered acceptable if all the following conditions are met:

   a. The lot is considered acceptable

   b. The meter's accuracy does not exceed the specified verification tolerances (± 2%)

   c. The meter conforms to all other specified requirements

   d. The meter is free from defects and non-conformities which could affect its ability to meet specified requirements

d. JPS shall submit compliance test results to the OUR giving the details of the test statistics and other findings for:

   - Lots that are acceptable; indicating the suggested seal year extension.

   - Lots for which the sample failed to satisfy the inequalities and conditions of iii) above.

e. The Accreditor or his agent shall provide its report on the audits of the JPS compliance testing procedures to the OUR (copy to JPS) to facilitate verification of the test results. The Accreditor's report shall indicate:

   a. The detailed meter sample numbers for the random sample selected and how it compares with that of the JPS.

   b. Details of site measurements made and how they compared with the JPS.

   c. Detail statistical calculation of the compliance tests done and how they compare with that of the JPS.

   d. The conclusions and recommendations from the compliance testing and how these compare with the JPS.

9.10 Compliance Sample Action by the OUR

i) Arising from the JPS results and the Accreditor audit report of a meter compliance sampling test submitted, the OUR shall take one of the following action:

a. Grant a seal life extension of the meter lot if it agrees that the sample meters have fully satisfied the criteria given in Section 9.8 i) above. The seal life extension could be according to section 9.8 ii) above.

b. Reject any lot recommended as acceptable by JPS but for which the OUR identifies errors or deficiencies in the test procedures and/or report. In such cases the OUR shall indicate the basis of its overrule in writing.

c. Instruct the JPS to withdraw the entire meter lot from service.

d. Permit the JPS to resample the meter lot either by an enlarged sampling or double sampling.

e. Instruct the JPS to move on to 100% sampling and testing if re-sampling finds the lot to be still out of tolerance. Hundred percent (100%) sampling and testing will allow JPS to withdraw from service only the out of tolerance meters.

ii) JPS shall have 10 days to respond to the written rulings of the OUR and such response shall also be in writing.

9.11 Time-Frame for Conducting Compliance Tests

JPS shall complete compliance testing and submit its reports to the OUR in accordance with the schedule agreed with the OUR. The Accreditor or his agent shall submit its audit reports on the date scheduled for JPS to report to the OUR.

9.12 Cost for Conducting Acceptance Testing & Who Pays

The cost for conducting compliance testing audits, shall be paid for by the OUR. See the Cost schedule for details.

10.0 ELECTRICITY CONSUMERS REQUESTS FOR METER VERIFICATION CHECK

10.1 Objectives of Meter Verification Check

i) To assure every JPS customer that he/she has the right always to have his/her meter checked for measurement accuracy on request.

ii) To make access to a meter verification check affordable to every JPS customer by offering one free per annum.

iii) To prevent unjustified meter verification requests from flooding the JPS as well as incurring enormous uncontrollable expense, by charging for the second check unless the result shows the meter to be out of the ± 2% tolerance allowed.

10.2 Authorization for Meter Verification Check

i) Under the terms of its license the JPS shall grant to its customers one free meter accuracy check per annum.

ii) Subsequent meter accuracy checks can be requested on conditions to be outlined below.

iii) The OUR may, in accordance with Clause 3 of Directive – Ele2005/06, require that a consumer's meter be tested for registration accuracy by the BSJ or any approved meter testing agency. Tests on individual meters should be in accordance with ANSI C12.1 – 2001 and the test criteria should be ± 2% for registration accuracy. The meter shall also conform to all other specified requirements and be free from defects and non-conformities which could affect its ability to meet safety and registration accuracy

10.3 How to Request a Meter Accuracy Check

i) JPS shall notify its customers that request for a meter verification check must begin with that company.

ii) Customers who choose to send their complaints and request for verification check to the OUR or the Bureau of Standards these organizations shall respond as outlined below.

iii) Meter accuracy checks requested through the OUR shall be sent first to the JPS for response within a three week time frame. Once the JPS responds, the response will be communicated to the complainant by the OUR.

If the JPS fails to respond within the given time then the OUR shall ask the BSJ to do the evaluation within 3 weeks and notify the JPS of its action.

The JPS shall cooperate with the BSJ evaluation by being present at the site to break the seal of the meter to be investigated. Once the BSJ responds in the time requested, the result shall be communicated to the complainant and JPS by the OUR

iv) Meter accuracy checks requested through the BSJ shall be sent to the OUR by the BSJ. The OUR shall request the JPS response within three weeks and if it is honoured the response shall be sent by the OUR to the complainant with a copy to the BSJ.

If the JPS does not respond within the three weeks then the OUR shall ask the BSJ to undertake the meter accuracy check in three weeks and notify the JPS of its action. The JPS shall cooperate with the BSJ evaluation by being present at the site to break the seal of the meter to be investigated Once the BSJ responds in the time requested, the result shall be sent by the OUR to the complainant with a copy to JPS.

v) If a complainant insists that they are unhappy with the JPS meter accuracy check and wants an independent check, then the BSJ shall be asked by the OUR to do the accuracy check and the JPS shall be notified of this action.

The JPS shall cooperate with the BSJ evaluation by being present at the site to break the seal of the meter to be investigated.

On receiving the BSJ's response, the OUR shall notify the complainant of the results with a copy to JPS.

10.4 Payment for Meter Accuracy Check

The JPS is duty bound by the terms of its license to offer free of charge one meter accuracy check to its customers on request. Notwithstanding that responsibility of JPS, action must be taken to prevent exploitation of the JPS by unscrupulous customers who frivolously request meter accuracy checks that create unnecessary expenses for the JPS. The following payment liability shall be put in place:

i) If a complainant requests a meter accuracy check then the JPS shall carry out the check and if the result shows that the meter is within tolerance, the complainant shall not compensate the JPS if a previous check was made more than a year ago.

However if the complainant had requested a meter accuracy check within the last year then he/she must pay the JPS for the meter accuracy check.

ii) If a complainant requests a meter accuracy check, the JPS shall carry out the check and if the result shows that the meter is out of the ± 2% tolerance, the complainant shall not compensate the JPS.

iii) If the OUR request the BSJ to do a meter accuracy check because the JPS fails to respond in the allotted time, then the JPS shall pay the BSJ for the cost incurred to do the check.

iv) If a complainant insists that an independent source (the BSJ) carries out the meter accuracy check and the meter is found to be out of the ± 2% tolerance then the JPS will pay the BSJ for the test. The OUR shall endorse the BSJ claim so the payment from JPS will be honoured in good time.

If the BSJ test shows the meter to be in tolerance then the complainant shall compensate the BSJ. The OUR shall do the collection from the complainant on behalf of the BSJ.

11.0 ACCREDITATION OF JPS METER SHOP & METER TESTING SERVICES

11.1 Objectives of Accreditation

i) The JPS shall seek accreditation from a recognized and BSJ approved source for its Meter Shop and Meter Testing Services within 6 months of signing to this Protocol.

ii) JPS shall use Accreditation as a tool for ensuring that its Meter Shop and Meter Calibration Services are of a standard that commands recognition and confidence by the most demanding evaluators.

11.2 Standards Governing the Accreditation

The Accreditor shall offer an accreditation service that is internationally recognized, having a scope proscribed by ISO/IEC Guide 2: 1996 and criteria based on ISO/IEC – 17020, 17024, 17025 and ISO Guide 65.

11.3 Measurement Traceability and Accreditation

i) The Accreditor shall ensure that traceable calibrations are beingmade by the BSJ for measuring equipment and standards used in the JPS Meter Shop and Field Testing Services. In checking the traceability status of BSJ measurement Standards the Accreditor shall look for evidence of unexpired direct traceability to the Systeme Internationale (SI) through calibrations by the BIPM or indirect traceability to the SI through calibrations or measurement comparison programmes with NIST, PTB, NRC, NPL, etc

ii) The Accreditor shall ensure that the BSJ traceability to the SI has been properly, completely and comprehensively passed on to all JPS standards, test equipment, control and measuring instruments for laboratory services including space conditioning system that will impact on the Meter Shop and Field Testing work. The Accreditor shall look for current calibration certificates, internal records and stickers

11.4 Meter Tolerance & Its Measurement Accuracy

i) The Accreditor shall ensure that meters calibrated by JPS in its Meter Shop shall be able to measure electrical energy to within ± 1% and the Accreditor shall satisfy himself through random

third party calibration checks that this level of measurement accuracy is being sustained on an on-going basis.

ii) The JPS shall use Portable Power Standards, to measure electrical power being consumed by field meters under test, which are able to measure the following parameters to the tolerance assigned:

a) For the High Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.1%

b) For the Mid Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.125%

c) For the Light Load test current at 1.0 Power Factor the tolerance on energy measurement shall be 0.15%

d) For measurements at 0.5 Power Factor the tolerance on energy measurement shall be 0.2%

11.5 Services to be Accredited

i) The JPS' Meter Shop repair facilities that handles a few thousand repairs per annum.

ii) The JPS Meter Shop calibration facilities that handles many, many thousands of meter calibrations per annum. Meter calibrations will emanate from the following activities:

- Pre-field calibration (adjustment) of meters above 12kVA that has fully satisfied Acceptance Testing criteria.
- Acceptance Testing of field repaired meters otherwise known as recalibration of field repaired meters.
- Calibration or Field Testing of Installed meters to determine tolerance level.
- Consumer requested meter verification checks.

iii) Field installed meter testing service.

11.6 Approaches to Accreditation

Accreditation is a procedure by which an authoritative body (such the International Accreditation Service, Inc. [IAS]) gives formal recognition that a body (laboratory, inspection agency, etc.) or

person (signatory) is competent to carry out specific tasks (scope) to ISO / IEC Guide 2:1996. The criteria for accreditation is ISO / IEC – 17020, -17024, -17025; ISO Guide 65.

- Accreditation assures the client that the procedures are technically valid.

- Accreditation recognizes the technical competence of the organization staff.

- Accreditation assures the client that the results are technically valid.

- Accreditation endorses the quality management system.

i) A consistently good job shall be given by the Accreditor so that public confidence in the measurement of electricity for revenue purposes will grow rapidly to the point where customers recognize that JPS has an interest in fair measurements and is taking all reasonable steps to protect to bring it about and preserve it.

ii) Meter Testing quality monitoring requirements shall be opened to change as public confidence in the measurement process grows. One cannot commence a meter testing program by reposing more confidence than the public has in it. The process must convince even the cynic that every effort is being made to get fair trading of this commodity. Once trust takes root effort to reduce the level of scrutiny can be considered.