1. **Introduction**

This document provides the final report of the joint Measurement Canada (MC) and electricity industry Workgroup (WG) on recommendations for establishing electricity legal units of measure outside an approved meter. This report has been amended in consideration of the comments received during the public consultation which was held on the MC website in November and December 2007. A summary of the JWG response to public and industry submissions will be published in a separate document and posted on the MC website.

The format of this report is summarized as follows:

1. **Introduction**: provides information on the document’s construction and project background.
2. **LUM WG Membership and Mandate**: provides information on the LUM WG membership and mandate.
3. **Terminology Recommendations**: provides a listing of the terminology used in this document and recommended for application by MC in Agency publications for type approval, verification, and installation and use specifications.
4. **Fundamental Principles and Requirements for the Calculation of PLUM Outside an Approved Meter**: provides the general requirements (4.1) and specific requirements (4.2 to 4.5) including an implementation policy (4.5.5) recommended for the calculation of processed legal units of measurement outside an approved meter.
5. **General Principles & Requirements for Data Initiators, Data Recorders, and Conversion Devices and Functions**: provides general principles and requirements recommended for type approval and verification of data initiators, data recorders, and conversion devices and functions.
6. **Specification Requirements – Data Initiator**: provides specific requirements recommended for type approval (6.2), verification (6.3), and policy implementation (6.4) applicable to data initiators.
7. **Specification Requirements – Data Recorders**: provides specific requirements recommended for type approval (7.3), verification (7.4), and policy implementation (7.5) applicable to data recorders.
8. **Specification Requirements - Conversion Devices and Functions**: provides specific requirements recommended for type approval (8.2), verification (8.3), and policy implementation (8.4) applicable to conversion devices and functions.
9. **Data Transportation Requirements**: provides general considerations (9.1), specific assessment criteria for type approval (9.2), assessment methodology policy (9.3), and policy implementation (9.4) recommendations applicable to data transportation.
10. **Loss Compensation**: provides policies recommended for the application of transformer and line loss compensation specifications in billing calculations.
11. **Key Performance Indicators**: provides key performance indicators recommended to evaluate the implementation of the WG recommendations in this document.

12. **Standards Maintenance Cycle**: provides recommended policy on the review cycle for the maintenance of standards established pursuant to the WG recommendations.

13. **Appendix 1**: provides examples of vars energy flow on a customer site.

14. **Appendix 2**: provides a summary of conversions of SLUM to PLUM.

15. **Appendix 3**: provides a summary of the requirements applicable to SLUM and PLUM indications.

### 1.1. Background

In 2005, Measurement Canada (MC) solicited the participation of electricity industry stakeholders in a consultation on the establishment of legal units of measurement for time-related electricity demand outside approved electricity meters. This initiative resulted from a larger public consultation that was carried out by the Agency in 2003 entitled *New Directions in the Regulation of Electricity and Gas Meters*. The New Directions consultation was initiated to address marketplace driven changes stemming from deregulation and the potential impact that these changes may have on electricity or gas utility’s means of establishing the basis of the charge for electricity or gas, and the information available to consumers. During the New Directions consultation, MC met with electricity and gas industry representatives and consumers to consider the Agency’s position and future regulatory direction with regard to several measurement-related topics including the establishment of legal units of measurement outside of an approved meter. The consultation and development of the resultant base policies was completed in February 2004.

In general, the New Directions consultation concluded that the establishment of legal units of measure outside of an approved meter is a metering and billing process which appears to be of primary interest to the electricity measurement sector with regard to demand measurement and the potential use of interval or load profile consumption data obtained from approved electricity meters. Regarding the current regulatory requirements applicable to electricity demand measurement, the *Electricity and Gas Inspection Regulations* (EGIR) do not include provisions that recognize the establishment of time-related electricity demand outside an approved meter. As a result of the New Directions consultation, MC recommended that the establishment of regulatory requirements be pursued under the authority of paragraph 28(1)(l) of the *Electricity and Gas Inspection Act* to potentially permit the establishment of time-related demand in this manner, subject to the following conditions:

- The determination of energy consumption must be done in an approved meter;
- The use of load profile data (time stamping of energy measurement data) for the purpose of deriving demand units of measurement must be done in an approved meter.

As the calculation of time-related demand will be performed outside an approved meter, typically through generic computer billing systems, the establishment of this policy will be contingent on the following factors:
(1) Security and integrity of measurement data used in the calculation of time-related demand

The establishment of time-related demand outside an approved meter will typically involve the use of telemetering systems to duplicate and transfer load profile (time-stamped energy consumption) data from the approved meter to the computerized utility billing system. The accuracy of time-related demand calculation is dependent on the security and integrity of the energy consumption data provided by the telemetering system.

(2) Calculation of time-related demand and VA & VA hour measurement

In order to recognize the determination of time-related demand which is established outside an approved meter within the structure of the EGIR, standard algorithms will need to be identified for each of the demand units of measurement: watt, var, and volt-ampere (VA). The respective algorithms and any associated provisions for their use will be included within the EGIR regulations established for this purpose.

(3) Retention of calculated time-related demand

Pursuant to paragraph 11(m) of the EGI Regulations, the calculation of time-related demand outside an approved meter will require the inclusion and retention of records for each billing period that contain the metering information used by the contractor in establishing a charge.

1.2. Measurement Canada and Electricity Industry Workgroups

In the fall of 2006, two separate MC and electricity industry workgroups were launched to further review and discuss the issues associated with the establishment of legal units of measurement (LUM) for time-related demand outside an approved meter (LUM Workgroup) as well as establishment of methodologies pertaining to the determination of VA demand and VA-hour energy (VA Workgroup).

Regarding the LUM Workgroup, although the scope of this group initially focussed on LUMs pertaining to electricity demand metering, it was determined that other variations of the establishment of LUMs outside an approved meter were possible (e.g., totalization, establishing volt-amperes). Consequently the scope of review was expanded to include these variations of LUM. At the outset, the group summarized the main concerns under review as follows:

(1) the Electricity and Gas Inspection Act (EGIA) and Regulations do not currently recognize the establishment of electricity units of measurement outside an approved meter;
(2) the accuracy of time-related demand calculation is dependent on the security and integrity of the energy consumption data provided by telemetering systems. There appears to be a need to safeguard the security and integrity of the consumption data being transported outside an approved meter;
(3) there are inequity concerns as a result. Mitigation strategies need to be developed to address this.

The proposed legal recognition of the establishment of legal units of measurement for time-related electricity demand outside an approved meter should benefit both consumers and industry by providing criteria and requirements which will ensure that electricity demand determined in this manner will meet the accuracy and integrity standards currently applied to the establishment of such units in approved electricity meters.
2. LUM Workgroup Membership and Mandate

2.1. Membership

The LUM WG members are listed below:
- Vuong Nguyen, Engineering Division, MC
- George Smith, Pacific Region, MC
- Guy Dacquay (Chair), Utility Metering Division
- Reg Byman, Manitoba Hydro
- Wayne Cross, BC Hydro
- Clarence Batterink, Elster Metering
- Roger Ersil (observer), Powerstream
- Mike Tarr (Facilitator), Canadian Electricity Association

2.2. Mandate

The mandate of the LUM WG is directly related to addressing the general policies and requirements for the establishment of legal units of measurement outside of an approved meter, which includes other variations of the establishment of LUMs (e.g., totalization). The process utilized for this review will be based upon the agreed National Standard System (NSS) style process that is documented in MC’s Intervention Implementation Manual as accepted by the executive members of both MC senior management and the CEA Distribution Council.

3. Terminology Recommendations

The Workgroup established a terminology listing to ensure that consistent terms and interpretations were being used. It is recommended that Measurement Canada (MC) type approval, verification, and installation and use specifications be amended to include the following terminology as applicable:

**Ancillary Device or Function** means a device or function used in conjunction with an approved meter and connected in an approved manner.

**Conversion Device or Function** means an internal or external ancillary device or function that converts input SLUM data (from one or more approved and verified meters) into other LUM (for example, the conversion of Wh and varh data into VAh or VA demand). Conversion devices or functions may include a totalizing function that summates identical LUM data, which may be multiplied by a fixed multiplier.

**Rationale:** The term “conversion” device has been proposed as this terminology is consistent with that used in the natural gas industry for similar functions, and it is considered a more encompassing expression than the term “totalizer” commonly used in the electricity industry. This change will ensure that the conversion function term can be applied to both approved meters and systems outside an approved meter. The specific requirements for the regulation of conversion devices and functions are included in this document.

**Cumulative Register** means a non-resettable energy register which accumulates the total energy measured by the meter (Wh, varh, VAh, and joule).
Data Initiator means a device or function that provides SLUM data. Included are devices or functions that produce pulses or register readings.

Rationale: The expression “pulse initiator” is too restrictive and needs to be revised to reflect the application of alternate technologies.

Data Recorder means an internal or external ancillary device or function, which records SLUM data. Included are devices or functions such as internal or external pulse recorder, interval function, load profile function, or mass memory function.

Rationale: Refer to rationale for Data Initiator.

Function means a feature within a device that performs a specified action.

Interval Data means periodic energy measurement data recorded during a pre-determined time interval (e.g., represents kWh/1 minute, or kWh/5 minutes, or kWh/15 minutes etc.) regardless of the applied methodology. (Refer also to definition for “Load Profile Data”).

Legal Unit of Measure (LUM) means a legal unit of measure as defined in the Electricity and Gas Inspection Act and Regulations and can be used for the sale of electricity. (Reference: LUM-0511-04-V2: Principles for Establishing Legal Units of Measurement).

Load Profile Data is a collection of contiguous interval data that is recorded with real time (date/hours/minutes/seconds). The load profile may be used to produce time-related electricity demand, or perform multi-rate metering and totalizing applications.

Rationale: It has been determined that “interval data” constitutes the fundamental data used, regardless of the application. It had been decided not to address other similar expressions for the data that are not commonly recognized by the industry.

Processed LUM (PLUM) means a legal unit of measure that has been derived outside an approved and verified meter from one or more SLUM, recognized units of measure, metrology constants or multipliers (as applicable), through a mathematical algorithm.

Source LUM (SLUM) means an approved and verified legal unit of measure extracted from an approved and verified meter. Examples: Wh, varh, Vah, joule, W, var, VA

Totalize means the process of combining SLUM data from two or more meters into similar or different LUM using algorithms authorized by Measurement Canada.

Note: This process is typically performed by a conversion device or function.

Validation means to check or prove the validity of a process, and to make or declare the process legally valid.

NOTE: Wherever the expression “authorized by MC” is stated within this document, it means that the subject requirement shall comply with the requirements established pursuant to the VA and LUM WG Recommendations, and MC specifications.
4. Fundamental Principles and Requirements for the Calculation of PLUM Outside an Approved Meter (PLUM Options)

4.1. General Policies

*Policy Recommendation:* It is recommended that MC type approval, verification, and installation and use specifications be amended to include the requirements in section 4, as indicated within the subsections below.

4.1.1. PLUM calculated outside of an approved and verified meter shall be capable of being validated using the same criterion that is used to verify a corresponding SLUM contained within an approved and verified meter (refer to clause 4.1.2). Validation shall be performed as prescribed in clause 4.1.9.

4.1.2. PLUM shall meet the same accuracy and resolution criteria as the corresponding SLUM. Consequently, the value of a PLUM calculated outside an approved meter shall not exceed an error +/- 1.0%, relative to the true value, with a resolution of 0.1%. This permits the establishment of a measurement error budget comprising of the error of the meter in relation to the standard (e.g. +/- 0.5%) and the error of the PLUM in relation to the meter (e.g. +/- 0.5%).

Note:
1. The instrument transformer accuracy and errors introduced by secondary leads and non-Blondel are excluded from the measurement error budget. The measurement error budget for the meter applies only to individual meters. For example, if the meter error during verification is determined to be 0.5%, the remaining error budget for the validation of PLUM is 0.5%. The calculation portion of the error budget is typically addressed by system design.
2. The calculation of error "relative to the true value" means establishing the error of the value determined by the measurement process in relation to the value that would be determined using a reference meter, certified and traceable to national standards, corrected for any known bias error indicated on the certificate.

*Rationale:* This method is consistent with the principles and requirements applied for gas measurement systems. It allows the industry the flexibility of selecting the appropriate combination of meter and ancillary devices required for establishing LUM outside an approved meter in accordance with these requirements. SLUM/PLUM energy and maximum demand may be calculated and/or displayed in multiple locations including, but not limited to, the following:

- Energy SLUM cumulative register
- Maximum demand SLUM register
- Energy SLUM display
- Maximum demand SLUM display
- Energy locally calculated from SLUM load profile data
- Maximum demand locally calculated from SLUM load profile data
- Energy locally calculated from SLUM KYZ output pulses
- Maximum demand locally calculated from SLUM KYZ output pulses
- Energy PLUM remotely calculated from an energy SLUM cumulative register
4.1.3. PLUM calculated from multiple points of metering shall meet the same accuracy and resolution criteria that they would be required to meet if they were calculated as a SLUM. The purpose of totalizing is to measure the electrical quantities of two or more separate circuits, and combine those values in a manner that is representative of the quantities that would be measured if the loads were supplied from a single circuit. The quantities of concern are those which are subsequently produced as legal units of measure for use in the trade measurement of electricity. The error is calculated on the basis of the maximum errors of the worst contributing meter (it is not cumulative).

4.1.4. Where electricity is supplied by two or more separate circuits, the following demand measurement options shall apply:

(a) the maximum demand is measured for each individual circuit, or;
(b) the coincidental maximum demand is determined for each of the circuits, or;
(c) the demand is totalized in a manner that is representative of the quantities that would be measured if the power were supplied from a single circuit, using an algorithm authorized by Measurement Canada (note that the use of current transformers connected for the purpose of summation is permitted).

Example diagrams of acceptable totalization scenarios are contained in Appendix 1 which demonstrate the relationship between individual supply megavolt-amperes (MVA), coincidental supply MVA, and totalized MVA in two configurations which demonstrate the effect of the positioning of the tie bus, whether positioned before or after the meter (note: meters M1 and M2 represent one metering position after the switch and meters M3 and M4 represent a metering position before the switch).

4.1.5. It is recommended that only LUM measurements be used as the basis for establishing a charge or credit for VA demand, and leading or lagging varh. For example, the establishment of a credit for leading varh should be based upon the leading varh measured over the entire billing period, rather than basing the credit on an artificial VA demand which is calculated by the discarding of leading varh values within a single demand interval. Electricity distributors may use the var/varh measured values as they see fit in establishing the basis for a charge or credit. Where the electricity distributor wants to establish a charge or a credit for reactive energy, it should be done based on the measured values of reactive energy and not based on VA demand values.

4.1.6. The Workgroup recommends that varh quantities used to calculate VA/VAh be measured and registered based on the quadrant in which they occur. Varh quantities shall be measured on a continuous accumulation of incremental values, the registration shall indicate in which quadrant they were measured. This principle is similar to the principle of measuring and recording “watthours delivered” vs. “watthours received” in separate individual energy registers, and as such will ensure a uniform and equitable calculation of VA/VAh.
4.1.7. For the purpose of establishing processed LUM outside an approved meter, it is recommended that:

(a) VA demand measurement be performed using a standard method;
(b) reactive energy measurement be performed using a standard method; and
(c) alternate forms of VA demand calculation not be used as a substitute for reactive energy measurement.

4.1.7.1 Implementation Policy: The policies for this section shall be implemented on January 1, 2012. Where demand meters currently in service are capable of providing SLUM that would enable the calculation of PLUM in accordance with these recommendations, the calculation of PLUM shall be made in accordance with these recommendations as of this date. However, existing demand measurement calculation methods that use contributing meters/functions that are not capable of providing SLUM in the manner required by these recommendations may continue to remain in effect until the end of the service life of those meters currently in use.

Rationale: For current meter designs, in consideration of potential costs associated with the implementation and to address the issues raised by the industry regarding stranded assets, the selection of the end of the service life of demand meters as the sunset period will enable contractors to plan and phase in the use of new technology required to support the application of VA demand measurement done in accordance with the both the VA and LUM Workgroup Recommendations. This will also allow manufacturers to continue with their current meter designs (ie. Electromechanical and combination electromechanical with electronic demand modules incorporating fixed algorithms).

4.1.8. The establishment of PLUM has been categorized as follows (each addressed individually within section 4):

- Calculating Energy PLUM from Energy SLUM Cumulative Registers (subsection 4.2)
- Calculating Maximum Demand PLUM from a Maximum Demand SLUM Register (subsection 4.3)
- Calculating Energy PLUM from SLUM Load Profile Data (subsection 4.4)
- Calculating Maximum Demand PLUM from SLUM Load Profile Data (subsection 4.5)

4.1.9. Where PLUM is derived outside of an approved and verified meter, the process shall be subject to validation based upon the following actions:

(a) Validate SLUM data by determining the approval and verification status of the applicable function(s) of the contributing meter(s)*, and retaining record of all applicable source meter data (note: the validation process does not require the examination of each meter used to establish a PLUM);

(b) Validate applicable data transported to each destination;
(c) Validate the process of converting valid SLUM data to PLUM; retain transported source meter data; and, retain PLUM data;

(d) The validation method and frequency shall be documented by the contractor and is subject to MC review (note: the Agency will examine the method to determine if the measurement information used for establishing a bill can be traced back to its source);

(e) The validation results shall be retained by the contractor for audit purposes.

4.1.9.1. Implementation Policy: The policies for this section shall be implemented on January 1, 2012.

4.1.10. Regarding the establishment of time-related demand LUM outside an approved meter, where utility tariffs are structured on the basis of different demand response intervals (ie. 15, 20, 30 or 60 minute demand intervals - these response intervals can be either block-type or sliding window type which are not required to be determined with a sliding-window sub-interval) that affect the basis of determination of the demand LUM which are not recognized as meeting the criteria established by the VA WG for standardized demand calculations, the LUM WG recognizes the VA WG recommendation that such applications be subject to varied MC intervention levels (low and high).

The low intervention model would reflect the one applied by MC in the gas sector whereby requiring:
- a formal agreement between respective non-vulnerable parties;
  
  Note: Where a tariff structure is in use, this requirement could be met by advising customers that the tariff structure is subject to low intervention by MC, providing a description of the scope and applicable conditions, and providing an option for customers to not participate and be subjected instead to high MC intervention. This could be communicated either via the tariff conditions or by letter sent to the customer.
- the use of MC approved meters; and
- the establishment of a dispute resolution method outside of MC which the contractor would establish and the parties would be subject.

The high intervention model would require a 15 minute demand interval (integration period) with 5 minute (sliding window) subintervals.

4.1.11. With regards to the application of an alternate demand calculation methods for VA LUM for example, such applications are considered to affect the fundamental LUM (the WG recognizes the specific direction and parameters recommended by the VA WG with regards to how the fundamental VA LUM is determined). In reviewing the federal electricity and gas inspection legislation, the WG recognizes that MC’s jurisdiction includes the establishment of LUM outside of an approved meter, and concludes that the technical method for establishing the LUM must be consistent and scientifically supportable (as has been defined in both the LUM and VA WG recommendations). The WG also recognizes that utilities over the years have applied various rate applications which have involved the manipulation of LUM and that have been accepted in some cases by their customers. In principle, the WG recognizes the need for cost recovery mechanisms related to infrastructure costs that can be done through a
representative surcharge approved through the rate process. However, the fundamental LUM in terms of what it represents cannot be manipulated for that purpose. In this regard, the WG recommends that a “no regulatory intervention” option be considered by the industry relative to a specific market level where appropriate.

**Rationale:** Following is a summary of the the extent of MC’s authority with respect to the regulation of LUM used in utility rate applications (in particular, the LUM adjusted by way of multipliers and other correction factors).

Section 3 of the Electricity and Gas Inspection Act (EGIA) prescribes that the units of measurement for the sale of electricity are the watt hour, var hour, volt-ampere hour, and the joule. Reference to the sale of electricity must be noted here. Section 28 of the EGIA gives authority to the Governor-in-council to make regulations:

(i) establishing or providing for the establishment of specifications for meter type approval, verification, sealing, and installation and use;
(ii) prescribing additional or alternate units of measurement to what is prescribed in section 3; and
(iii) prescribing the conditions and manner of determination of units of measurement referred to in the EGIA.

Further to item (ii) above, subsection 5(1) of the Electricity and Gas Inspection Regulations (EGIR) prescribe that where the amount of electricity supplied and the time-related demand for electricity supplied are the joint basis of a charge for electricity sold to a purchaser, the unit of measurement for the sale of such electricity shall be, with respect to the amount of electricity sold, a unit referred to in paragraph 3(1)(a) of the EGIA and, with respect to the time-related demand for electricity sold: the watt, var, and the volt-ampere. Subsection 5(2) of the EGIR further prescribes that where the unit of measurement for the sale of electricity is the volt-ampere or volt-ampere hour, vector addition shall be used to determine the total number of such units in a combination of polyphase circuits.

Further to item (iii) above, an example to demonstrate the use of multipliers or corrections that can be applied to a LUM can be found in the legislative provisions specific to gas measurement. Section 35 of the EGIR prescribes that a volume of gas measured by any meter that registers in units of volume shall be converted to standard volume by using the following equation, namely, \( V_s = V_r \times P_m \times T_m \times (F_{pv})^2 \)

Where:
- (a) \( V_s \) is the standard volume;
- (b) \( V_r \) is the volume registered by the meter;
- (c) \( P_m \) is the pressure multiplier established for the meter pursuant to section 36;
- (d) \( T_m \) is the temperature multiplier established for the meter pursuant to section 38 or 39, whichever is applicable; and
- (e) \( F_{pv} \) is the supercompressibility factor established for the meter pursuant to section 40.

The above example comes from the provisions specific to gas measurement, where the basic LUM is defined as the “standard volume” that is traceable to the
primary meter. Pressure, temperature and supercompressibility correction factors are then applied.

The above legislative references are considered to clearly demonstrate the legal authority of MC with respect to legal units of measurement used for the sale of electricity (whether established within or outside of a meter). For comparison purposes, readers are encouraged to review the authority clauses contained in provincial energy acts. In recognition of these requirements the WG has re-affirmed that, the two main purposes of the LUM project are to:

• ensure that whether a LUM is established in a primary device or externally, that the process or methodology used is consistent; and
• ensure that the purported amount delineated on the final bill is based on an approved LUM. It should be noted that this precept does not restrict the use of “surcharges” that can be applied to a final bill to recover infrastructure or delivery costs.

In addition, the goal of MC’s volt-ampere (VA) LUM project is to define appropriate algorithms that could be used to calculate VA, whether that calculation is done inside the meter or externally. The scope of the VA work objectives was expanded to also include the establishment of demand LUM.

In summary, from MC’s perspective, there is a requirement to ensure that the measured consumption that is identified or “purported” on the bill is directly traceable to the fundamental LUM that has been used. Beyond that, the contractor has the ability to add as many surcharges as they want for line loss, delivery charges, time-of-use (TOU), infrastructure maintenance, etc.

4.1.12. With respect to the recommendations provided in 4.1.10 and 4.1.11, the WG recommends that a joint MC/industry workgroup (comprised of representative metering and billing groups from major utilities) be established to explore the establishment of a regulatory amendment which would define the applicable market level scope and either the outright exemption (statutory) or conditional exemption (e.g., establishment of applicable market scope, contractual or tariff-based agreement of parties, etc) from MC intervention.

4.2. Calculating Energy PLUM from Energy SLUM Cumulative Registers

4.2.1. **Policy Recommendation:** Energy SLUM cumulative registers may be remotely read and multiplied by a fixed multiplier and/or totalized outside of an approved and verified meter to create energy PLUM subject to the following conditions.

4.2.2. **General Requirements**

(a) The energy SLUM(s) shall be stored in cumulative register(s) in the meter(s). The Workgroup recommends that the type approval requirements clearly specify that an accuracy test be performed on each energy SLUM cumulative register (the current MC type approval specifications do not appear to require this test). Notes 2 and 4

(b) The energy SLUM cumulative register(s) shall be visually displayed. Notes 2, 3, 4
**Rationale:** The display requirements are for data integrity purposes. This requirement was established to support the telemetering policy in MC bulletin Gen-33. Under this policy, telemetering devices are permitted to be used without verification on the condition that a purchaser can see the measurement values consumed. Further development of a standard communications protocol may allow for an alternate ancillary display that may not have to be part of the meter's type approval.

(c) The energy PLUM algorithm shall be in accordance with MC requirements. Note 4

### 4.2.3. Single Point of Metering Requirements

(a) A Wh energy SLUM may be converted into a Wh energy PLUM.

(b) A varh energy SLUM may be converted into a varh energy PLUM.

(c) A VAh energy SLUM may be converted into a VAh energy PLUM.

(d) Wh and varh energy SLUM shall not be converted into a VAh energy PLUM. Note 4

(e) VAh and Wh energy SLUM shall not be converted into a varh energy PLUM. Note 4

(f) VAh and varh energy SLUM shall not be converted into a Wh energy PLUM. Note 4

### 4.2.4. Multiple Points of Metering Requirements

(a) Wh energy SLUM may be totalized into a Wh energy PLUM (the direction of the value must be considered). Note 4

(b) varh energy SLUM may be totalized into a varh energy PLUM (the quadrant/direction of the value must be considered). Note 4

(c) VAh energy SLUM shall not be totalized. Note 4

(d) Totalized Wh energy SLUM and totalized varh energy SLUM shall not be converted into a VAh energy PLUM. Note 4

(e) The meters shall be read on the same day. Note 4

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Note 1: Type-approval specifications - already prescribed in LMB-EG-07
Note 2: Type-approval specifications – new requirements to be developed and included in LMB-EG-07 and/or associated procedures
Note 3: Applicable policies also included in MC bulletin Gen-33 (no verification required)
Note 4: To be included in Installation and Use specifications - to be developed by MC
Note 5: A summary of the possible conversions of SLUM to PLUM is presented in Appendix 2.

### 4.2.5. Implementation Policy

The policies for this section shall be implemented effective January 1, 2012.

### 4.2.6. General Rationale & Notes:
(a) As per the telemetering policies in MC Bulletin GEN 33, the remote reading function and process is not subject to verification since the energy SLUM cumulative register(s) shall be displayed by their respective meter(s). An example of this is multiplying a Wh meter SLUM by the voltage transformer (VT) and current transformer (CT) ratio in the billing system to create a Wh PLUM.

(b) Regarding the use of “average power factor” in billing applications, the Workgroup recognizes that this value is used as a form of penalty fee and whereas it may be calculated from a Wh energy SLUM cumulative register and a varh energy SLUM cumulative register, it is not a PLUM. This is deemed to be a contract related matter that falls outside of Measurement Canada’s jurisdiction.

(c) Applicable Sources of Inequity:
- Incorrect source of energy (use of wrong meter or wrong register)
- Incorrect identification of SLUM (use of wrong units of measure)
- Incorrect meter reading dates
- Incorrect multiplier

4.3. Calculating Maximum Demand PLUM from a Maximum Demand SLUM Register

4.3.1. Policy Recommendation: A maximum demand SLUM register may be remotely read and multiplied by a fixed multiplier outside of an approved and verified meter to create a maximum demand PLUM subject to the following conditions.

4.3.2. General Requirements

(a) The maximum demand SLUM shall be stored in register(s) in the meter. The Workgroup recommends that the type approval requirements clearly specify that an accuracy test be performed on each maximum demand SLUM register (the current MC type approval procedures do not appear to require this test).

Rationale: The telemetering policies in MC Bulletin GEN 33 does not address maximum demand SLUM reset and/or previous maximum demand SLUM retention. Historically there has been no means to validate previous maximum demand SLUM readings. Therefore, it is recommended that the previous maximum demand SLUM readings be recorded in the meter and be capable of being retrieved.

(b) The maximum demand SLUM register(s) shall be visually displayed.

Rationale: The display requirements are for data integrity purposes. Further development of a standard communications protocol may allow for an alternate ancillary display that may not have to be part of the meter’s type approval.

(c) For new meters only, a minimum of 12 previous maximum demand SLUM readings shall be recorded within the meter. These readings shall be retrievable locally from the meter.
Note: The previous maximum demand SLUM readings are not required to be displayed by the meter. For example, they may be retrieved with a local ancillary device. (e.g. hand-held terminal, remote reader or computer).

(d) The maximum demand SLUM(s) shall be reset at the end of the billing period. Example methods include but are not limited to the following:
- Manually at the meter;
- Automatically by the meter;
- Remotely. \(^{Notes \ 1, 4}\)

(e) The maximum demand PLUM algorithm shall be in accordance with MC requirements. \(^{Note \ 4}\)

4.3.3. Single Point of Metering Requirements \(^{Note \ 6}\)

(a) A W maximum demand SLUM may be converted into a W maximum demand PLUM.

(b) A var maximum demand SLUM may be converted into a var maximum demand PLUM.

(c) A VA maximum demand SLUM may be converted into a VA maximum demand PLUM.

(d) W and var maximum demand SLUM shall not be converted into a VA maximum demand PLUM. \(^{Note \ 4}\)

(e) VA and W maximum demand SLUM shall not be converted into a var maximum demand PLUM. \(^{Note \ 4}\)

(f) VA and var maximum demand SLUM shall not be converted into a W maximum demand PLUM. \(^{Note \ 4}\)

4.3.4. Multiple Points of Metering Requirements \(^{Note \ 6}\)

Maximum demand SLUM shall not be totalized. \(^{Note \ 4}\)

Note 1: Type-approval specifications - already prescribed in LMB-EG-07
Note 2: Type-approval specifications - new requirements to be developed and included in LMB-EG-07 and/or associated procedures
Note 3: Applicable policies also included in MC bulletin Gen-33 (no verification required)
Note 4: To be included in Installation and Use specifications - to be developed by MC
Note 5: Verification Specifications – new requirements to be developed and included in S-E-02 – for paragraph 8.3.1(c), examining the programming configuration would be deemed sufficient for the purpose of verification.
Note 6: A summary of the possible conversions of SLUM to PLUM is presented in Appendix 2.

4.3.5. Implementation Policy

(a) Subject to clauses 4.3.5 (b) to (d), the policies in 4.3 shall become effective on January 1, 2012.
(b) Subject to clause 4.3.5 (d), MC shall amend the type approval specifications and/or procedures for electricity meters to include the applicable requirements. These new requirements will apply to new electricity meter designs as of the policy implementation date specified in 4.3.5(a).

(c) The policy in clause 4.3.5 (b) does not apply to electricity meters submitted for a revision to their current type approval for the purpose of updating meter firmware.

(d) All demand meters currently used in the applications specified in 4.3 (remotely read maximum demand) that do not comply with the requirements specified in 4.3 may remain in use only until the end of their service life.

*Rationale:* For current meter designs, in consideration of potential costs associated with the implementation and to address the issues raised by the industry regarding stranded assets, the selection of the end of the service life of demand meters as this sunset period will enable contractors to plan and phase in the use of new technology required to support the application of VA demand measurement done in accordance with the both the VA and LUM Workgroup Recommendations. This will also allow manufacturers to continue with their current meter designs (i.e., Electromechanical and combination electromechanical with electronic demand modules incorporating fixed algorithms).

4.3.6. General Rationale & Notes

(a) As per the telemetering policies in MC Bulletin GEN 33, the remote reading function and process is not subject to verification since the meter shall display the present maximum demand SLUM register(s).

(b) Recording of previous maximum demand SLUM readings is a new type approval requirement that will enable local validation of previous maximum demand readings directly from the meter. Maximum demand readings on current meters are erased following each demand reset. This proposed requirement coincides with international type approval specifications for electricity meters.

(c) The implementation policy recommendations of section 4.3.5 were established in consideration of cost-benefit impact on electricity contractors.

(d) Applicable sources of inequity:
   - Incorrect source of demand (use of wrong meter or wrong register)
   - Incorrect identification of SLUM (use of wrong units of measure)
   - Incorrect meter reading dates
   - Incorrect multiplier.

4.4. Calculating Energy PLUM from Energy SLUM Load Profile Data

4.4.1. **Policy Recommendation:** Energy SLUM load profile data may be remotely read and multiplied by a fixed multiplier and/or totalized outside of an approved and verified meter to create energy PLUM subject to the following conditions.
4.4.2. General Requirements

(a) The SLUM load profile functionality, including the time stamping feature, shall be type approved and verified. \(^{Notes\ 2, 4, 5}\)

(b) The corresponding energy SLUM(s) shall be stored in cumulative register(s) in the meter(s). The Workgroup recommends that the type approval requirements clearly specify that an accuracy test be performed on each energy SLUM cumulative register (the current MC type approval specifications and/or procedures do not appear to require this test). \(^{Notes\ 2, 4}\)

(c) The corresponding energy SLUM cumulative register(s) shall be visually displayed. \(^{Notes\ 2, 3, 4}\)

**Rationale:** The display requirements are for data integrity purposes. Further development of a standard communications protocol may allow for an alternate ancillary display that may not have to be part of the meter’s type approval.

(d) The energy PLUM algorithm shall be in accordance with MC requirements. \(^{Note\ 4}\)

4.4.3. Single Point of Metering Requirements \(^{Note\ 6}\)

(a) Wh energy SLUM load profile data may be converted into a Wh energy PLUM.

(b) varh energy SLUM load profile data may be converted into a varh energy PLUM.

(c) VAh energy SLUM load profile data may be converted into a VAh energy PLUM.

(d) Wh and varh energy SLUM load profile data shall not be converted into a VAh energy PLUM. \(^{Note\ 4}\)

(e) VAh and Wh energy SLUM load profile data shall not be converted into a varh energy PLUM. \(^{Note\ 4}\)

(f) VAh and varh energy SLUM load profile data shall not be converted into a Wh energy PLUM. \(^{Note\ 4}\)

4.4.4. Multiple Points of Metering Requirements \(^{Note\ 6}\)

(a) Wh energy SLUM load profile data may be totalized into a Wh energy PLUM (the direction of the value must be considered). \(^{Note\ 4}\)

(b) varh energy SLUM load profile data may be totalized into a varh energy PLUM (the quadrant/direction of the value must be considered). \(^{Note\ 4}\)

(c) VAh energy SLUM load profile data shall not be totalized. \(^{Note\ 4}\)
(d) Totalized Wh energy SLUM load profile data and totalized varh energy SLUM load profile data may be converted into a VAh energy PLUM on the condition that:

(i) The load profile interval length does not exceed five minutes;  
(ii) VAh energy shall be calculated for each interval on an interval-by-interval basis; and  
(iii) The calculation of VAh energy shall be done in accordance with the requirements recommended by the VA Workgroup.  
(iv) Each meters' real-time clock used in load profile applications shall be synchronized relative to each other with a maximum tolerance of 9 seconds.

**Rationale:** The time synchronization tolerance in 4.4.4(d)(iv) was chosen to assure the integrity of the load profile data. The synchronization time tolerance of 9 seconds between contributing meters was chosen to minimize the error in the conversion to a VAh energy PLUM due to time difference (it is recognized that a tighter tolerance will result in a higher degree of accuracy). This value is considered to be achievable for current technology.

(e) Each meter clock shall be synchronized to a time reference traceable to a national standard, with a maximum tolerance of +/- 90 seconds.

**Rationale:** The time synchronization tolerance in 4.4.4(f) was chosen to assure the integrity of the load profile data. The time tolerance of 90 seconds in relation to real time was chosen to ensure that currently available technologies would be capable of meeting this requirement (it is recognized that a tighter tolerance will result in a higher degree of accuracy).

Note 1: Type-approval specifications - already prescribed in LMB-EG-07
Note 2: Type-approval specifications - new requirements to be developed and included in LMB-EG-07 and/or procedures.
Note 3: Applicable policies also included in MC bulletin Gen-33 (no verification required)
Note 4: To be included in Installation and Use specifications - to be developed by MC
Note 5: Verification Specifications – new requirements to be developed and included in S-E-02 – for paragraphs 8.4.1.3 (a) & (e), examining the programming configuration would be deemed sufficient for the purpose of verification.
Note 6: A summary of the possible conversions of SLUM to PLUM is presented in Appendix 2.

4.4.5. **Implementation Policy**

(a) Subject to clauses 4.4.5(b) and 4.4.5(c), the policy of 4.4 shall become applicable on January 1, 2012.

(b) MC shall amend the type approval specifications and procedures for electricity meters such that the time clock used with a meter's load profile data functions is capable of being synchronized with an external time reference. These new requirements will apply to new electricity meter designs as of the policy implementation date specified in 4.4.5 (a).
(c) MC shall establish installation and use requirements for time synchronization processes for SLUM load profile data in accordance with the requirements of 4.4.4 (e) and (f). These shall become applicable at time of authorization.

4.4.6. Rationale & Notes:

(a) As per the telemetering policies in MC Bulletin GEN 33, the remote reading function and process is not subject to verification since the energy SLUM cumulative register(s) shall be displayed by their respective meter(s).

(b) Regarding the use of “average power factor” in billing applications, the Workgroup recognizes that this value is used as a form of penalty fee and whereas it may be calculated from Wh SLUM load profile data and varh SLUM load profile data, it is not a PLUM. This is deemed to be a contract related matter that falls outside of Measurement Canada’s jurisdiction.

(c) The implementation policy recommendations of section 4.4.5 were established in consideration of cost-benefit impact on electricity contractors.

(d) Applicable sources of inequity:
   - Incorrect source of time or energy
   - Incorrect identification of SLUM (use of wrong units of measure)
   - Incorrect meter register
   - Incorrect meter multiplier
   - Incorrect pulse weight
   - Incorrect interval length
   - Inappropriate frequency of calculation or synchronization of Wh or varh used in the calculation of VAh PLUM.
   - For multiple points of metering, there is an increased potential for a VAh calculation error due to the 5-minute calculation interval.

4.5. Calculating Maximum Demand PLUM from SLUM Load Profile Data

4.5.1. Policy Recommendation: Energy SLUM load profile data may be remotely read and multiplied by a fixed multiplier and/or totalized outside of an approved and verified meter to create maximum demand PLUM subject to the following conditions.

4.5.2. General Requirements

(a) The SLUM load profile functionality, including the time stamping feature, shall be type approved and verified. Notes 2, 4, 5

(b) The corresponding energy SLUM(s) shall be stored in cumulative register(s) in the meter(s). The Workgroup recommends that the type approval requirements clearly specify that an accuracy test be performed on each energy SLUM cumulative register (the current MC type approval specifications and/or procedures do not appear to require this test). Notes 2, 4

(c) The corresponding energy SLUM cumulative register(s) shall be visually displayed. Notes 2, 3, 4
Rationale: The display requirements are for data integrity purposes. This requirement was established to support the telemetering policy in MC bulletin Gen-33. Under this policy, telemetering devices are permitted to be used without verification on the condition that a purchaser can see the measurement values consumed. Further development of a standard communications protocol may allow for an alternate ancillary display that may not have to be part of the meter’s type approval.

(d) The maximum demand PLUM algorithm shall be in accordance with MC requirements. Note 4

(e) The length of a demand interval shall be 15 minutes, comprised of 3 five-minute sub-intervals (pursuant to the VA Workgroup Recommendation for Sliding Window Demand). For a totalization application where VAh is calculated, the interval length shall be as short as possible with a maximum sub interval length of 5 minutes. Notes 4, 6

(f) The maximum permissible error for the demand interval length shall be ± 0.1% of the demand interval value stated on the meter (e.g., 1 second for a 15 minute interval). This would be verified during both type approval and data validation. For the purpose of data validation, the time error per download frequency (e.g., every 24 hours) divided by the number of 15 minute intervals downloaded since the last time synchronization represents the average demand interval timing error. Notes 2, 4.

Rationale: This requirement is based on a metrological practice in which the contributing elements for the measurement are 10% of the total allowable tolerance (in this case, the tolerance for the meter is 1% so the contributing demand interval tolerance is 0.1%).

(g) The SLUM load profile data in the contributing meter shall have adequate accuracy and resolution such that the calculated maximum demand PLUM shall not exceed an error tolerance of +/- 1.0%, relative to the true value*, with a resolution of 0.1% (note: instrument transformer errors are not included). Notes 4, 5, 8

(h) The SLUM load profile data obtained from a meter used to establish a maximum demand PLUM shall be retained in the meter owner’s records in accordance with the Electricity and Gas Inspection Regulations. Note 4

(i) The maximum demand PLUM selection criteria shall not include time intervals where the time has been adjusted or data integrity is questionable. Note 4

(j) Whenever SLUM load profile data is remotely read, the corresponding cumulative energy SLUM register(s) shall also be remotely read and stored for the purpose of validation. Notes 2, 4

Rationale: Utilities are currently known to be purchasing new meters for application in establish maximum demand in the billing system whereby the load profile data in the meter is only being verified for functionality and not for accuracy. The WG also recognizes that using the corresponding cumulative energy registers for validation of load profile data is not the most precise method, however, with a daily download frequency of meter data (i.e., every
24 hours) using the maximum 5 minute data interval, the maximum timing error would be 0.35% per day.

(k) The maximum demand SLUM shall be calculated and visually displayed by the meter using the same algorithm used to remotely calculate the maximum demand PLUM.

(l) The maximum demand SLUM shall be reset at the end of the billing period. Example methods include but are not limited to the following:
   - Manually at the meter;
   - Automatically by the meter;
   - Remotely. Notes 1, 4

(m) For new meters only, a minimum of 12 of the following most recent values shall be recorded within the meter and shall be retrievable locally from the meter:
   - Maximum demand SLUM reading;
   - The time and date of the maximum demand SLUM; and
   - The time and date of the reset. Notes 2, 4

(n) For new installations, where instrument transformers are used, the instrument transformer error shall not exceed 0.6%. Note 4

4.5.3. Single Point of Metering Requirements Note 7

(a) Wh energy SLUM load profile data may be converted into a W maximum demand PLUM.

(b) varh energy SLUM load profile data may be converted into a var maximum demand PLUM.

(c) VAh energy SLUM load profile data may be converted into a VA maximum demand PLUM.

(d) Wh and varh energy SLUM load profile data shall not be converted into a VA maximum demand PLUM. Note 4

(e) VAh and Wh energy SLUM load profile data shall not be converted into a var maximum demand PLUM. Note 4

(f) VAh and varh energy SLUM load profile data shall not be converted into a W maximum demand PLUM. Note 4

4.5.4. Multiple Points of Metering Requirements Note 7

(a) Wh energy SLUM load profile data may be totalized and converted into a maximum W demand PLUM (the direction of the value must be considered). Note 4

(b) varh energy SLUM load profile data may be totalized and converted into a maximum var demand PLUM (the quadrant/direction of the value must be considered). Note 4
(c) VAh energy SLUM load profile data shall not be totalized.  

(d) Totalized Wh energy SLUM load profile data and totalized varh energy SLUM load profile data may be converted into a maximum VA demand PLUM on condition that:

(i) The load profile interval length does not exceed five minutes (note that a one minute interval length would permit a higher calculation frequency for totalized VAh).  

(ii) Maximum VA demand shall be calculated for each interval on an interval-by-interval basis; and  

(iii) The calculation of maximum VA demand shall be done in accordance with the requirements recommended by the VA Workgroup. 

(iv) The following algorithm shall be used to calculate VAh on a interval by interval basis (this example uses the measurements from two contributing meters):

\[
\text{Totalized Vah} = \sqrt{(Whd1 + Whd2)^2 + ((Q1 varh1 + Q1 varh2) - (Q4 varh1 + Q4 varh2))^2}
\]

Note:
Q1 + Q4 represents delivered watts. 
Q1 - Q4 represents net vars corresponding to delivered watts. 
Vars are expressed in absolute terms.

(e) Each meters’ real-time clock used in load profile applications shall be synchronized relative to each other with a maximum tolerance of 9 seconds. If this tolerance is exceeded, the data obtained since the last successful synchronization verification shall not be considered coincidental for the purposes of totalizing demand (under these circumstances, the utility and purchaser will need to negotiate a suitable settlement). 

**Rationale:** The time synchronization tolerance in 4.5.4(e) was chosen to assure the integrity of the load profile data. The synchronization time tolerance of 9 seconds between contributing meters was chosen to minimize the error in the conversion to a VAh energy PLUM due to time difference (it is recognized that a tighter tolerance will result in a higher degree of accuracy). This value is considered to be achievable for current technology.

(f) Each meter clock shall be synchronized to a time reference traceable to a national standard, with a maximum tolerance of +/- 45 seconds. 

**Rationale:** The time synchronization tolerance in 4.5.4(f) was chosen to assure the integrity of the load profile data. The time tolerance of 45 seconds in relation to real time was chosen to ensure that currently available technologies would be capable of meeting this requirement (it is recognized that a tighter tolerance will result in a higher degree of accuracy).
4.5.5. Implementation Policy

(a) Subject to clauses 4.5.5 (b) and 4.5.5(c), the policy of 4.5 shall become applicable on January 1, 2012.

(b) MC shall amend the type approval specifications and or procedures for electricity meters to include the applicable requirements. These new requirements will apply to new electricity meter designs as of the policy implementation date specified in 4.5.5(a).

(c) Currently approved demand meters used in the application described in 4.5 that do not meet the requirements of 4.5 may remain in service until the end of their service life. These demand meters shall not be eligible for seal extension.

**Rationale:** For current meter designs, in consideration of potential costs associated with the implementation and to address the issues raised by the industry regarding stranded assets, the selection of the end of the service life of demand meters as the sunset period will enable contractors to plan and phase in the use of new technology required to support the application of VA demand measurement done in accordance with the both the VA and LUM Workgroup Recommendations. This will also allow manufacturers to continue with their current meter designs (ie. Electromechanical and combination electromechanical with electronic demand modules incorporating fixed algorithms).

4.5.6. Rationale & Notes:

(a) For a single point-of-metering, the display or storage requirements allows for local validation of the remotely calculated maximum demand PLUM. However, local validation is not possible where a maximum demand PLUM is remotely calculated from a totalization of multiple points-of-metering.

(b) Use of 0.6% accuracy current transformers (CTs) and 1.2% accuracy voltage transformers (VTs) are currently acceptable. It should be noted that the error introduced by using 1.2% accuracy VTs exceeds the currently permitted demand error. 0.6% VTs are commonly available. Where practicable, use of 0.3% accuracy VTs and CTs is recommended. However, it is recognized that for low CT
ratio and high fault current applications, 0.3% accuracy CTs may not be available. It is recommended that this requirement be revisited following the issue of the new CSA C6044 series of instrument transformer standards.

(c) The implementation policy recommendations of section 4.5.5 were established in consideration of cost-benefit impact on electricity contractors.

(d) Applicable sources of inequity:
   - Interval duration is less than 15 minutes
   - Incorrect source of demand (use of wrong meter or wrong register)
   - Incorrect identification of SLUM (use of wrong units of measure)
   - Incorrect meter reading dates
   - Incorrect meter multiplier
   - Incorrect source of time or energy
   - Incorrect meter register
   - Incorrect calculation of demand
   - Incorrect pulse weight
   - Use of non-consecutive sub-intervals
   - Incorrect selection process for determining largest interval
   - Inappropriate frequency of calculation or synchronization of Wh or varh used in the calculation of VAh and VA PLUM.

5. General Principles & Requirements for Data Initiators, Data Recorders, and Conversion Devices and Functions

5.1. To qualify for use in trade measurement, data initiators, data recorders and conversion devices or functions used in the generation of SLUM shall be approved and verified. Different applications, such as the totalization of energy, performing demand calculations, or the totalization of Wh and varh to calculate VAh, may require different levels of verification criteria.

5.2. PLUM generated outside of an approved and verified meter shall be based on SLUM and other associated metering data that is both valid and metrologically suitable for the intended application. The criteria for metrological suitability will vary depending upon how the data is used and the potential impact on the accuracy of the PLUM being generated. In order to achieve and maintain the established level of measurement accuracy, the source metering data (e.g, load profile data) used in the generation of PLUM data shall comply with appropriate verification criteria.

5.3. Since the verification criteria may vary with the intended application, it is necessary to identify the verified functions in relation to their intended use. For example, data initiators (e.g. pulse initiators, register data initiators, etc.) identified for use in demand calculations require a higher resolution than those used in Wh energy applications. The evaluation criteria for data initiators (that transfer measurement data), the data recorders (used to store and transfer that data), and the conversion devices (used to process the data), should be performance-based in relation to their subsequent use in generating LUM.
5.4. Verification and Validation Recommendations
(Recommended Revisions to MC Electricity Meter Verification Specification S-E-02)

5.4.1. Data initiators, data recorders, and conversion devices shall be evaluated in relation to their potential subsequent use in the calculation of PLUM outside of an approved meter, as indicated on the record of inspection. (New requirement for section 6.5.2 and 6.5.3 of S-E-02).

Rationale: These devices can be used for different applications requiring different levels of inspection criteria.

5.4.2. The recommendations made by the Workgroup on the verification requirements require changes to the following applicable sections of MC Specification S-E-02 (effective date 2006-04-01):

- 5.7 Documentation
- 5.8 Nameplate Markings
- 6.2 Nameplate (Technical Requirements)
- 6.5.2 Pulse Initiator Requirements
- 6.5.3 Pulse Record
- 6.5.4 Reverse Operation
- 6.6.1 Programmed Parameters
- 6.6.2 Multi-register Functions
- 6.6.4 Multiplier
- 6.6.5 Demand Interval
- 6.6.6 Demand Type
- 6.6.7 Pulse Constants
- 6.6.8 Pulse Output Detent
- 6.6.9 Programmable Register Detent
- 6.6.10 Loss Compensation

There are various options available in determining the appropriate method for insertion of the necessary additional specification requirements, since the requirements often overlap more than one section. As a result, any proposed revision of S-E-02 should involve consultation with the original authors in order to develop the most appropriate course of action.

5.4.3. Regarding Inspection Documentation, a new requirement shall be added to Specification S-E-02: subsection 5.7.1(3) - Inspection Certificate.

A record of inspection shall indicate the verification status and applicable LUM function(s) of each data initiator, data recorder, and conversion device in relation to their potential subsequent use in the calculation of PLUM outside of an approved meter.

Examples:
- Data Initiators:
  o Energy only
  o Energy & Demand
Data Recorders:
- Energy only
- Energy & Demand

Conversion Devices:
- Totalizing Wh and/or varh Energy only, or
- Conversion to VAh Energy and/or Demand

**Note:** Meters incorporating data initiators and/or recorders that represent functions that are not verified and identified on the record of inspection for the intended application (e.g., demand or conversion calculations) will not be eligible for subsequent use in the establishment of PLUM.

**Rationale:** There is a need to clearly identify on the record of inspection whether or not the metering function has been verified to the additional criteria required for PLUM (e.g., energy only; demand; conversion to energy and/or demand).

6. Specification Requirements – Data Initiator

6.1. Source of Inequity

Potential sources of inequity relating to data initiators include the following:
- Inaccurate data produced by the data initiator
- Incorrect calculation of produced data (e.g. wrong VAh algorithm)
- Incorrect data multiplier (wrong pulse weight or multiplier)
- Insufficient data resolution for the application (e.g. demand or totalizing)
- Incorrect output in relation to time (pulse busts or buffered data)
- Incorrect time stamping of data
- Incorrect data output selection (e.g. selection of wrong pulse output)
- Incorrect data detent
- Incorrect data direction or quadrant
- Incorrect identification of SLUM (wrong units of measure).

6.2. Type Approval Requirements

(Recommended Revisions to MC electricity meter type-approval specification LMB-EG-07)

**Policy Recommendation:** In addition to the requirements prescribed in section 12 of LMB-EG-07, in order to calculate PLUM from pulse-based data recorders, the data initiators used to supply the SLUM pulses shall meet the following requirements.

6.2.1. Amend section 12-2.1 of LMB-EG-07 to add that data initiators shall only be capable of generating pulses that are representative of the quadrant or direction of energy flow (i.e., Wh, varh) as indicated by the pulse initiator identifier.

**Rationale:** The VA Workgroup recommendations address this issue in theoretical terms. For the purposes of legal metrology, the proposed VA definition does not give contractors the option to exclude capacitive or inductive vars in the calculation of total VA or VAh. However, if a utility wishes to calculate a penalty...
or credit or some other consideration for capacitive or inductive power factor, measuring kvarh can facilitate this. Refer to clause 4.1.6.

6.2.2. Amend section 12-3.2 of LMB-EG-07 such that any interval data provided through data initiators used for the purpose of demand calculation is capable of being recorded to a resolution of 0.1% at 20% I_max.

Rationale:
- The current requirements for pulse initiators are not adequate for calculating PLUM to achieve the intended measurement accuracy.
- The current requirement is 25 pulses per minute at 50% I_max. The same meter operating at 20% I_max would produce 10 pulses per minute, or 150 pulses over a 15-minute demand interval, which provides 0.67% resolution. The objective of the revision is to improve the resolution to 0.1% under expected operation conditions.

6.3. Verification, Installation, and Use Requirements
(Recommended Revisions to S-E-02)

6.3.1. Amend the title in S-E-02 section 6.5.2 by replacing “Pulse Initiator” with “Data Initiator”.

Rationale: Refer to definition for “Data Initiator”

6.3.2. Replace term “pulse initiator” with “data initiator” (S-E-02 section 6.5.2 revision) (Refer to Appendix for decision rationale.)

Rationale: Refer to definition for “Data Initiator”

6.3.3. Data initiators which produce interval data that are capable of being used as the fundamental means for establishing time-related demand shall have the following functions verified:

(a) Normal mode demand interval (S-E-02 section 6.6.5)

(b) Demand type (S-E-02 section 6.6.6)

(c) Pulse constant (S-E-02 section 6.6.7: Revise to read “pulse constant or data multiplier”)

Rationale: New technology will not necessarily produce only pulses, but may also produce other forms of data that are not pulse-based data.

(d) Pulse output detent and quadrant data (S-E-02 sections 6.6.8 and 6.6.9: Revise to include a specific clause for data initiators to include single quadrant pulses); and

Rationale: Currently not included in the specifications but required for use in the calculation of PLUM outside the meter.
(e) Programmable register detent (S-E-02 section 6.6.9: Revise title to read “Programmable Register Detent and Quadrant Data”). *(Refer to Appendix for decision rationale.)*

Rationale: Currently not included but required for use in the calculation of PLUM outside the meter.

Note: For the above items, examination of the programming configuration would be deemed sufficient for the purpose of verification.

6.3.4. Each data initiator shall be verified to ensure that it is capable of generating data that is representative of only the quadrant or direction of energy flow indicated by the identifier (e.g. “delivered Wh”, “+Wh”, “Wh quadrant 1”, “varh quadrant 1”, etc.). Examination of the programming configuration would be deemed sufficient for the purpose of verification. (New requirement for S-E-02 section 6.5.2)

Rationale: currently not included in the specifications but required for use in the calculation of PLUM outside the meter.

6.3.5. Data initiators that are to qualify for use as the fundamental means for establishing time-related demand shall be verified at a test load of 25% Imax for the intended application, and shall not exceed an error of +/- 1.0%, relative to true value*, with a resolution of 0.1%, within a time interval length not exceeding 15 minutes. (S-E-02 section 6.5.2 (2): revision)

* Note: The calculation of error "relative to the true value" means establishing the error of the value determined by the measurement process in relation to the value that would be determined using a reference meter, certified and traceable to national standards, corrected for any known bias error indicated on the certificate.

Rationale: the current requirement provides insufficient resolution required for the intended application.

6.3.6. Regarding the application of resolution requirements for time-of-use, it has been decided by consensus to not make a recommendation in this regard as this is deemed to be outside of MC jurisdiction.

6.4. Implementation Policy

The policies for this section shall be implemented effective January 1, 2012, subject to MC policy bulletin Gen-06.

7. Specification Requirements – Data Recorders

7.1. Source of Inequity

Potential sources of inequity relating to data recorders include the following:
- Inaccurate recording of energy or demand SLUM data
- Incorrect meter source (e.g. data from the wrong meter)
- Recording incorrect data (e.g. right meter, wrong data)
- Incorrect identification of received data
- Incorrect identification of recorded data
- Incorrect source of demand (use of wrong register)
- Incorrect data multiplier (wrong pulse weight or multiplier)
- Incorrect retention of data resolution (e.g., rounding or truncating data)
- Insufficient data resolution for the application (e.g., demand or totalizing)
- Incorrect recording of data direction or quadrant
- Incorrect recording of data in relation to the interval (e.g., buffered data)
- Incorrect time stamping of interval data
- Incorrect time source (e.g., time zone)
- Insufficient recording of meter time synchronization for the application
- Insufficient interval frequency for the application (e.g., 3 minutes)
- Incorrect identification of the recorded data.

7.2. Terminology

The Workgroup recognizes that the term “pulse recorder” used in current Measurement Canada approval specifications for electricity meters (LMB-EG-07) is too restrictive and needs to be expanded to include different technical approaches to recording the amount of energy used over a specific time interval. It is deemed necessary to amend this terminology to “data recorder” in the applicable approval and verification requirements in light of the different technical approaches for recording measurement data.

7.3. Type-Approval Requirements

(Recommended Revisions to LMB-EG-07)

7.3.1. Policy recommendation: It is recommended that a new type-approval specification be added to LMB-EG-07 to establish requirements for “Data Recorder” used in the establishment of demand.

7.3.2. Scope: These type-approval specifications apply to all data recorders. The Workgroup recommends the establishment of a revised type approval requirement for clause 13-5.1.2 of LMB-EG-07 that prescribes the accuracy of any computed output value of the conversion device or function, in comparison to input values (absolute data values which does not account for any errors at the source) of the conversion device or function: Maximum Permissible Error = +/- 0.01% (revised from +/- 0.1%).

Rationale: This requirement is needed to evaluate the accuracy of computing totalized or converted SLUM data from input values. It is clarified that the accuracy sought at the output is in relation to the calculation of the absolute input values performed by the device processor, which do not include errors associated with the source meter(s).

7.3.3. Generic Administrative Requirements

(a) “Pulse Recorders” to be re-named “Data Recorders.”

Rationale: Reflects change in technology being used for recording data (i.e., interval function, load profile function, mass memory).

(b) Include a terminology section in LMB-EG-07 to include definition for “data recorder”.

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(c) The marking requirements in section 12-4, 13-4, and 15-4 of LMB-EG-07 shall apply, as applicable depending on the technology in use.

7.3.4. Generic Technical Requirements

(a) Amend 13-3.2.1 (Main Time Base) and 13-3.3.5 of LMB-EG-07 (Carry-over Time Base) such that the accuracy of a data recorder for any demand interval is +/- 0.2%.

*Rationale: The current specifications do not include requirements for time accuracy of demand intervals.*

(b) The requirements in 13-2, 13-3.1, and 13-3.3 of LMB-EG-07 shall apply.

(c) If the data recorder is a stand-alone device (outside of a source meter), all of the requirements of section 3 of LMB-EG-07 and the mechanical requirements in 15-2 of LMB-EG-07 shall apply.

(d) The requirements in 15-3.1 of LMB-EG-07 shall not apply.

(e) The requirements in 15-3.2 and 15-3.3 of LMB-EG-07 shall apply.

7.3.5. Generic Metrological (Accuracy) Requirements

(a) Test Conditions (New Requirement): The reference equipment used for testing shall not affect the performance of the function or device under test.

(b) Section 3-5.1 of LMB-EG-07 (reference conditions for test) shall apply.

*Rationale: These requirements address the influence of equipment on the function or device under test.*

7.3.6. Performance under Normal Operating Conditions – New Requirements

(a) Accuracy (new requirement): Maximum Permissible Error for recorded values versus input values: +/- 0.05%.

*Rationale: The tolerance is consistent with the current requirements for a pulse-based recorder (reference: LMB-EG-07: section 13-5-1.1).*

(b) Test duration for demand: shall not exceed 15 minutes.

*Rationale: The above requirement is based on the minimum demand interval of 15 minutes and will provide the appropriate resolution for the application.*

7.3.7. Registration with Zero Data Input - New requirements (reference: 15-5.1 of LMB-EG-07)

(a) Accuracy: Maximum permissible error = zero registration.

(b) Test condition (additional)= No input applied.
(c) Test duration: (refer to criteria for test duration established for meter verification in S-E-02, clause 7.3.3.1.2).

   **Rationale:** These requirements ensure that no input is recorded when no SLUM are applied.

7.3.8. Resolution and Data Storage Specification

The resolution criterion for the input data values is prescribed in section 5 for data initiators. The storage register of the data recorder shall be capable of retaining data to the same resolution as that provided by the input data value.

7.3.9. Effect of Temperature (Stand-alone Device): New requirements (reference: 15-5.6 of LMB-EG-07)

Accuracy: Range of test = -40 to +53 degrees Celsius or the rated temperature range, whichever is less.

   **Rationale:** This requirement is needed to evaluate the demand measurement accuracy of the device or function under the influence of ambient temperature.

7.3.10. Effect of Supply Voltage Variation (Stand alone Device) - New requirements (reference: 15-5.5 of LMB-EG-07)

Device tested while varying supply voltage +/- 10% of rated voltage or voltage range of the device under test.

   **Rationale:** This requirement is needed to evaluate the demand measurement accuracy of the device or function under the influence of supply voltage variation.

7.3.11. Effect of External Magnetic Field (Stand alone Device) - New Requirement

Clause 15-5.7 of LMB-EG-07 shall apply.

   **Rationale:** This requirement is needed to evaluate the demand measurement accuracy of the device or function under the influence of external magnetic field.

7.3.12. Effect of EMI Susceptibility (Stand alone Device) - New requirement

(a) Clause 15-5.11 of LMB-EG-07 (reference to clause 3-5.2) shall apply.

   **Rationale:** This requirement is needed to evaluate the demand measurement accuracy of the device or function under the influence of EMI susceptibility.

(b) Clauses 13-5.2 to 13-5.4 of LMB-EG-07 shall not apply.

(c) The requirements of 15-5.4, 15-5.5, 15-5.8, and 15-5.10 of LMB-EG-07 shall not apply.

   **Rationale:** Already evaluated in the source meter.
7.4. Verification, Installation, and Use Requirements  
(Recommended Revisions to S-E-02)

7.4.1. Data recorders used strictly for duplicating energy measurement data are exempt from verification. (S-E-02 section 6.5.3(1): revision required to reflect the telemetering policy in Gen-33).

7.4.2. Data recorders shall retain data to the same resolution as that provided by the data initiator. (New requirement for installation and use).

**Rationale:** This requirement will ensure that data resolution is maintained throughout the transfer of measurement information.

7.4.3. Data recorders that may be used as the fundamental means for establishing time-related demand shall be verified to confirm that:

(a) The pulse constant is correct (S-E-02 section 6.6.7);

(b) The recorder has identified any applicable pulse detent values provided by the corresponding data initiator (S-E-02 section 6.5.3: new marking requirement to be added for data recorders), and that the programmable register is recording only detent values (S-E-02 section 6.6.9).

(c) Data is recorded in relation to the correct quadrant (S-E-02 section 6.5.3: new requirement to be added for data recorders; section 6.6.8: revision required to include single quadrant pulses)

(d) The demand interval length (S-E-02 section 6.6.5: new requirement to be added for data recorders), and the demand type (S-E-02 section 6.6.6) are correct.

**Note:** For the above requirements, examination of the programming configuration would be deemed sufficient for the purpose of verification.

7.5. Implementation Policy

The policies for this section shall be implemented effective January 1, 2012, subject to MC policy bulletin Gen-06.

8. Specification Requirements - Conversion Devices and Functions

8.1. Source of Inequity

Potential sources of inequity relating to conversion devices and functions include the following:

- Incorrect selection of source meter (e.g. data from the wrong meter)
- Incorrect selection of data from the meter (right meter, wrong data)
- Incorrect identification of energy data used in the conversion process
- Incorrect data multiplier (e.g. wrong pulse weight or multiplier)
- Incorrect meter multiplier
- Incorrect CT and/or VT multipliers
- Incorrect installation configuration multipliers (e.g. x 0.5)
- Incorrect retention of data resolution (e.g. rounding or truncating data)
- Insufficient data resolution for the application (e.g. demand or totalizing)
- Incorrect meter time and date (in relation to the reference)
- Incorrect time reference (e.g. wrong use of time zone or DST)
- Insufficient control of meter time synchronization for the application
- Incorrect time stamping of interval data
- Incorrect processing of data in relation to the time interval
- Incorrect use of data direction or quadrant
- Insufficient calculation frequency for the application (e.g. 3 minutes)
- Incorrect interval length (demand)
- Incorrect sub-interval length (demand)
- Incorrect use of non-consecutive sub-intervals
- Incorrect selection of the interval with the peak demand
- Incorrect algorithm(s) used to process energy and demand data
- Incorrect identification of the processed data.

8.2. Type Approval Requirements
(Recommended Revisions to LMB-EG-07)

8.2.1. It is recommended that type approval requirement for clause 13-5.1.2 of LMB-EG-07 be amended to add a requirement that prescribe the accuracy of any computed output value of the conversion device or function, in comparison to input values (absolute data values which does not account for any errors at the source) of the conversion device or function: Maximum Permissible Error = +/- 0.01% (revised from +/- 0.1%).

Rationale: This requirement is needed to evaluate the accuracy of computing totalized SLUM data from input values. It is clarified that the accuracy sought at the output is in relation to the calculation of the absolute input values performed by the device processor, which do not include errors associated with the source meter(s). The systemic error associated with the use of a conversion device or function within a system will be addressed in section 4.

8.3. Verification, Installation, and Use Requirements
(Guidelines and Recommended Revisions to S-E-02)

8.3.1. Conversion devices or functions shall retain data to the same resolution as that provided by the input SLUM data. (New requirement not previously addressed in S-E-02 for conversion devices; new requirement for installation and use)

8.3.2. Conversion devices or functions that may be used as the fundamental means for establishing time-related demand shall be verified to confirm that:

(a) The demand interval length (S-E-02 section 6.6.5: new requirement to be added for data recorders), and the demand type (S-E-02 section 6.6.6) are correct;
(b) The pulse constant is correct (reference: S-E-02 section 6.6.7);
(c) The recorder has identified any applicable pulse detent values provided by the corresponding data initiator (reference: S-E-02 section 6.5.3: marking requirement), and that the programmable register is recording only detent values (reference: S-E-02 section 6.6.9);
(d) The data is recorded in relation to the correct quadrant (reference: S-E-02 section 6.6.8)

Note: For the above requirements, examination of the programming configuration would be deemed sufficient for the purpose of verification.

8.3.3. Conversion devices that are used for totalizing Wh and varh interval data from multiple meters, but not used for calculating electricity demand or VAh, shall be evaluated to verify that the relationship of coincidental data is maintained within a tolerance of 90 seconds.

Rationale: this time tolerance is consistent with Provincial electricity market requirements.

8.3.4. Conversion devices used to calculate a totalized VAh and VA demand, by means of corresponding Wh and Varh interval data from multiple contributing meters, shall be evaluated to verify that the relationship of coincidental data is maintained within a tolerance of 9 seconds.

Rationale: The 9 second time tolerance represents 1% of the 15-minute demand interval.

8.3.5. Conversion devices used to calculate VAh and VA demand, by means of corresponding Wh and Varh interval data from multiple contributing meters, shall be evaluated to verify the performance of the function for each interval, and that the sub-interval length does not exceed three (3) minutes.

Rationale: As per VA Workgroup recommendations (Calculation of VA LUM).

8.3.6. Conversion devices shall be evaluated to verify that the input data is converted accurately to the intended units of measure. The accuracy of any computed output value, in comparison to input values, shall be evaluated to a maximum permissible error of ±0.1%. (Refer to Appendix for decision rationale.)

Rationale: The accuracy tolerance for computations above is consistent with those prescribed for other computation functions, which equal to ten times the amount of the proposed type approval requirement of 0.01% (conventional metrological principle for verification).

8.4. Implementation Policy:

The policies for this section shall be implemented effective January 1, 2012, subject to MC policy bulletin Gen-06.

9. Data Transportation Requirements

9.1. General Data Transportation Considerations
The data transport requirements presented in this document at this time does not address the recognition of communications protocol as several key elements have not yet been established (i.e., provision of a protocol authenticity/certification tool and capability to secure meter readings). The application of recognized communications protocols remains an important consideration and will be evaluated further (in consideration of the assessment criteria specified in 9.2) once clear requirements have been created in this regard.

9.2. Assessment Criteria for the Type-approval of Data Transportation

9.2.1. Policy Recommendation: The following criteria shall be applied for the transportation of SLUM and associated data\(^1\) from an approved metering device used to externally calculate a PLUM:

(a) The integrity of the transported data\(^1\) used to calculate a PLUM shall be ensured through the correct retrieval and representation of that SLUM data.

(b) The data being transported from the source meter shall not be altered\(^2\) during transportation.

(c) The transported source meter data shall be capable of being authenticated at the destination where the PLUM is calculated and have means to indicate if the metered data had been altered\(^2\).

Note 1: The expression “data” is used as it may include metrological, time, and meter identification information.

Note 2: The expression “altered” means that the data has been changed either as a result of system error or tampering.

9.3. Assessment Methodology Policy Recommendation

A measurement system using an approved data transportation method will be evaluated by using the data validation method described in 4.1.9. The contractor will be responsible for developing and implementing the validation method which reflects the criteria specified in 9.2.1. This method may also be subject to MC review.

9.4. Implementation Policy

The policies for this section shall be implemented effective January 1, 2012.

10. Loss Compensation

10.1. Policy Recommendation: An agreement shall be established between the contractor and purchaser to apply transformer and line loss specifications in billing calculations under condition that the original uncompensated data (as read from the meter) be retained in meter records.

Rationale: The retention of data will enable the resolution of any potential disputes.

10.2. Implementation Policy

The policy for this section shall be implemented effective January 1, 2012.
11. Key Performance Indicators

11.1. Policy Recommendation: The following key performance indicators shall be used to evaluate the implementation of the requirements established in this document:

(a) Frequency of time adjustments in remotely read meters;

(b) Marketplace Monitoring (the performance of ancillary devices used for PLUM applications and the validation of PLUM);

(c) Monitor MC disputes and utility-resolved complaints involving remotely read meters (the performance of ancillary devices used for PLUM applications and the validation of PLUM).

12. Standards Maintenance Cycle

12.1. The standards policies and requirements established pursuant to these recommendations shall be reviewed five years following authorization and implementation.
Appendix 1 - Example (1): Vars Energy Flow on a Customer Site
(Switch Closed – Meter configuration example 1: M1 & M2;
Meter configuration example 2: M3 & M4)

Appendix 1 - Example (2): Vars Energy Flow on a Customer Site
(Switch Open – Meter configuration example 1: M1 & M2;
Meter configuration example 2: M3 & M4)
## Appendix 2: Summary of Conversions of SLUM to PLUM

**Key:**
- **SLUM:** Source Legal Units of Measure
- **PLUM:** Processed Legal Units of Measure
- **Energy** is shown in red.
- **Demand** is shown in blue.
- **Load Profile** is shown in green.
- \(X_1\): Meter 1
- \(X_2\): Meter 2
- \(X_T\): Totalized

<table>
<thead>
<tr>
<th>Document Reference</th>
<th>Meter(s)</th>
<th>SLUM</th>
<th>PLUM</th>
<th>Conversion Acceptable?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 4.2</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td><strong>Energy PLUM from</strong></td>
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<td>Wh₁</td>
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<tr>
<td><strong>Energy SLUM</strong></td>
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<td>var₁</td>
<td>var₁</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Cumulative</strong></td>
<td></td>
<td>VA₁H₁</td>
<td>VA₁H₁</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Registers</strong></td>
<td></td>
<td>Wh₁ &amp; var₁</td>
<td>VA₁H₁</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VA₁H₁ &amp; Wh₁</td>
<td>var₁</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VA₁H₁ &amp; var₁</td>
<td>Wh₁</td>
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<tr>
<td><strong>Multiple</strong></td>
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<tr>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Wh₁ &amp; var₁</td>
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<td>No</td>
</tr>
</tbody>
</table>

| **Section 4.3**    |          |      |      |                        |
| **Max Demand PLUM** | Single   | W₁  | W₁  | Yes                    |
| **from**           |          | var₁ | var₁ | Yes                    |
| **Max Demand**     |          | VA₁ | VA₁ | Yes                    |
| **SLUM Registers** |          | W₁ & var₁ | VA₁ | No                     |
|                    |          | VA₁ & W₁ | var₁ | No                     |
|                    |          | VA₁ & var₁ | W₁ | No                     |
| **Multiple**       |          | W₁ & W₂ | W₁ | No                     |
|                    |          | var₁ & var₂ | var₁ | No                     |
|                    |          | VA₁ & VA₂ | VA₁ | No                     |

| **Section 4.4**    |          |      |      |                        |
| **Energy PLUM from** | Single   | Wh₁ | Wh₁ | Yes                    |
| **SLUM Load Profile** |          | var₁ | var₁ | Yes                    |
| **Data**           |          | VA₁H₁ | VA₁H₁ | Yes                    |
|                    |          | Wh₁ & var₁ | VA₁H₁ | No                     |
|                    |          | VA₁H₁ & Wh₁ | var₁ | No                     |
|                    |          | VA₁H₁ & var₁ | Wh₁ | No                     |
| **Multiple**       |          | Wh₁ & Wh₂ | Wh₁ | No                     |
|                    |          | var₁ & var₂ | var₁ | No                     |
|                    |          | VA₁H₁ & VA₁H₂ | VA₁H₁ | No                     |
|                    |          | Wh₁ & var₁ | Wh₁ | No                     |

| **Section 4.5**    |          |      |      |                        |
| **Max Demand PLUM** | Single   | Wh₁ | W₁  | Yes                    |
| **from**           |          | var₁ | var₁ | Yes                    |
| **SLUM Load Profile** |          | VA₁ | VA₁ | Yes                    |
| **Data**           |          | Wh₁ & var₁ | VA₁ | No                     |
|                    |          | VA₁H₁ & Wh₁ | var₁ | No                     |
|                    |          | VA₁H₁ & var₁ | W₁ | No                     |
| **Multiple**       |          | Wh₁ & Wh₂ | W₁ | No                     |
|                    |          | var₁ & var₂ | var₁ | No                     |
|                    |          | VA₁H₁ & VA₁H₂ | VA₁H₁ | No                     |
|                    |          | Wh₁ & var₁ | VA₁ | Yes – See Note 1      |

**Note 1:** For sections 4.4 & 4.5, with regards to totalization, the VA calculation shall be performed using interval data on an interval-by-interval basis.
### Appendix 3: Summary of Indication Requirements

<table>
<thead>
<tr>
<th>LUM Established <strong>Within</strong> an Approved Meter (SLUM)</th>
<th>Conditions &amp; Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication provided as an integral part of a meter or ancillary device that can be approved with the meter. Note1</td>
<td>- all cumulative energy SLUM values and maximum demand SLUM shall be displayed;</td>
</tr>
<tr>
<td></td>
<td>- further development of a standard communications protocol may allow for an alternate ancillary display that may not have to be part of the meter’s type approval.</td>
</tr>
<tr>
<td></td>
<td>- load profile information does not need to be displayed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LUM Established <strong>Outside</strong> an Approved Meter (PLUM)</th>
<th>Conditions &amp; Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication of PLUM established outside an approved meter using measurement information obtained from one or more approved source meters.</td>
<td>- PLUM values do not need to be displayed</td>
</tr>
</tbody>
</table>