TECHNICAL SPECIFICATION
FOR
ENERGY METERING SYSTEM

1.0 The energy metering system specified herein shall be used for tariff metering for bulk, inter-utility power flows, in Northern Region. One static type composite meter shall be installed for each EHV circuit, as a self-contained device for measurement of active energy (MWh) transmittals in each successive 15-minute block and certain other functions, as described in the following paragraphs.

2.0 The meters shall be suitable for being connected directly to voltage transformers (VTs) having a rated secondary line-to-line voltage of 110 V, and to current transformers (CTs) having a rated secondary current of 1A (model-A) or 5A (model-B). Any further transformers/transducers required for their functioning shall be in-built in the meters. Necessary isolation and/or suppression shall also be built-in, for protecting the meters from surges and voltage spikes that occur in the VT and CT circuits of extra high voltage switchyards.

3.0 The active energy (Wh) measurement shall be carried out on 3-phase, 4-wire principle,with an accuracy as per class 0.2 S of IEC-687 1992-06 (second edition). In model-A (for CT secondary rating of 1A), the energy shall be computed directly in CT and VT secondary quantities, and indicated in watt-hours. The meters shall compute the net active energy (Wh) sent out from the substation busbars during each successive 15-minutes block, and store it in its memory alongwith plus/minus sign. It shall also display on demand the net Wh sent out during the previous 15-minutes block, with a minus sign if there is a net Wh receipt.

4.0 Further, the meter shall continuously integrate and display on demand the net cumulative active energy sent out from the substation busbars upto that time. The cumulative Wh reading at each midnight shall be stored in the meter's memory. The register shall move backwards when active power flow back to substation busbars.

5.0 The meter count the number of cycles in VT output during each successive 15-minutes block, and divide the same by 900 to arrive at the average frequency. This shall be stored in the meter's memory as a 2-digit code which shall be arrived at by subtracting 49 from the average frequency, multiplying by 50 and neglecting all decimals. For example, 49.89 Hz shall be recorded as 44. In case the average frequency is less than 49.0, it shall be recorded as 00. In case it is 51.0 Hz or higher, it shall be recorded as 99. The average frequency of the previous 15-minutes block shall also be displayed, on demand in hertz.

6.0 The meter shall continuously compute the average of the RMS values of the three line-to-neutral VT secondary voltage as a percentage of 63.51 V, and display the same on demand. The accuracy of the voltage measurement/computation shall be atleast 0.5%, a better accuracy such as 0.2% in the 95-105% range being desirable.

7.0 The meter shall also compute the reactive power (VAR) on 3-phase, 4-wire principle, with an accuracy as specified in clause 11.0, and integrate the reactive energy (VARh) algebraically into two separate registers, one for the period for which the average RMS voltage is 103.0% or higher, and the other for the period for which the average RMS voltage is below 97.0%. The current reactive power (VAR), with a minus sign if negative, and cumulative reactive energy (VARh) readings of the two registers shall be displayed on demand. The readings of the two registers at each midnight shall also be stored in the meter's memory. In model-A (for CT secondary rating of 1A), the reactive power and reactive energy transmittals shall be computed in VAR/VARh directly calculated in CT and VT secondary quantities. When lagginhg reactive power is being sent out from substations busbars, VAR display shall have no sign and VARh register shall move forward. When reactive power flow is in the reverse direction, VAR display shall have a negative sign and VARh registers shall move backwards.

8.0 In the model-B (for CT secondary rating of 5A), all computations, displays and memory storage shall be similar except that all figures shall be one fifth of the actual Wh, VAR and VARh worked out from CT and VT secondary quantities.

9.0 The meters shall fully comply with all stipulations in IEC Publication 687 1992-06 (Second Edition) for 0.2S class Static watt-hour meters, except those specifically modified by this specification. The reference ambient temperature shall be 30°C.

10.0 Errors shall be reasonable for all power factor angles from 0° to 360°.

11.0 For reactive power (VAR) and reactive energy (VARh) measurements, IEC-145 should be generally complied with, to the extent applicable. Limits of errors shall however be half (50%) of those permitted vide clause 8.2.1 of IEC-145 (for 3.0 accuracy class).

12.0 Each meter shall have a test output device (visual) for checking the accuracy of active energy (Wh) measurement. The preferred pulsing rate is twenty (20) per Wh for Model-A and four (4) per Wh for Model-B. It shall be possible to couple this device to suitable testing equipment also.

13. No rounding off to the next higher last decimal shall done for voltage and frequency displays.

14.0 The three line-to-neutral voltages shall be continuously, monitored, and in case any of these falls below about 70%, a normally flashing lamp provided on meter's front shall become steady. It shall go off if all three voltages fall below 70%. The time blocks in which such a voltage failure occurs/persist shall also be recorded in the meter's memory. The lamp shall automatically resume flashing when all VT secondary voltages are healthy again. The two VARh registers specified in clause 7.0 shall remain stay-put while VT supply is unhealthy.

15.0 The meters shall normally operate with the power drawn from the VT secondary circuits. The total burden imposed by a meter for measurement and operation shall not exceed 10 VA on any of the phases. An automatic backup for continued operation of the meter's calendar-clock, and for retaining all data stored in its memory, shall be provided through a long-life battery, which shall be capable of supplying the required power for at least two years. The meters shall be supplied duly fitted with the batteries, which shall not require to be changed for atleast ten years, as long as total VT supply interruption does not exceed two years. The meters shall not require any separate auxiliary supply for their operation. All displays may disappear on loss of VT supply.

16.0 Each meter shall have a built-in calendar and clock, having an accuracy of one minute per month or better. The calendar and clock shall be correctly set at the manufacturer's works. The date (year-month-day) and time (hour-min-sec) shall be displayed on the meter front (when VT supply has been connected), on demand. Only limited clock adjustment shall be possible at site, using the DCD. When an advance or retard command is given, six subsequent time blocks shall be contracted or elongated by ten seconds each. The meter shall not accept another clock correction command for seven days. All clock corrections shall be registered in the meter's memory and suitably shown on print out of collected data.

17.0 Each meter shall have a unique identification code, which shall be marked permanently on its front, as well as in its memory. All meters supplied to POWERGRID as per this specification shall have their identification code starting with "NP", which shall not be used for any other supplies. "NP" shall be followed by a dash and a four digit running serial number, further followed by a dash and "A" for Model-A, and "B" for Model-B, for the use with CT secondaries of 1A and 5A respectively.

18.0 Each meter shall have atleast one seven (7) - character, seven-segment electronic display, for indication of the following (one at a time), on demand :

i) Processor's identifiifcation code and model : nP1234A.

ii) Date (year month day) : 910329 d

iii) Time (hour min sec) : 195527 t

iv) Cumulative Wh reading : 12345.6 C

v) Average frequency of the previous block :49.89 F.

vi) Net Wh transmittal during the previous block : - 28.75 E.

vii) Average % voltage : 99.2 U.

viii) Reactive power (VAR) : 106.5 r.

ix) Voltage - high VARh register reading : 01234.5 H.

x) Voltage - low VARh register reading : 00123.4 L.

19.0 A touch key or push button shall be provided on the meter front for switching on the display and for changing from one indication to the next. The display shall switch off automatically about one minute after the last operation of touch key/push button. When the display is switched on, the parameter last displayed shall be displayed again, duly updated.

20.0 Each meter shall have a non-volatile memory in which the following shall be automatically stored :

i) Average frequency for each successive 15-minute block, upto second decimal, with plus/minus sign.

ii) Net Wh transmittal during each successive 15-minute block, upto second decimal, with plus/minus sign.

iii) Cumulative Wh transmittal at each midnight, in six digits including one decimal.

iv) Cumulative VARh transmittal for voltage high condition, at each midnight in six digits including one decimal.

v) Cumulative VARh transmittal for voltage low condition, at each midnight, in six digits including one decimal.

vi) Date and time blocks of failure of VT supply on any phase, as a star (*) mark.

21.0 The meters shall store all the above listed data in their memories for a period of ten (10) days. The data older than (10) days shall get erased automatically.

22.0 Each meter shall have an optical port on its front for tapping all data stored in its memory. Portable or hand held data collection devices shall also be separately provided for this purpose, one for each substation, to serve as the interface between the meters specified above and the local personal computers (PC). The overall intention is to tap the data stored in the meter's memories once a week, and transmit the same to a remote central computer using STD or other communication links, through the local PC. It shall also be possible to obtain a print out (hard copy) of all data collected from the meters, using the local PC.

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23.0 The whole system shall be such as to provide a print out (both from the local PC, and from remote central computer) of the following form :

	55	+16.28	56	+15.95	55	+15.32	54	+15.66
23	55	+14.93	55	+14.26	54	+14.85	56	+15.17
NP-1234-A		12345.6	01234.5		00123.4		91-03-29	
	57	+14.72	56	* +13.83	55	* +13.57	53	+12.91
01	52	+13.34	51	+12.76	52	+14.11	52	+15/28

24.0 The meters shall be supplied housed in compact and sturdy, metallic or moulded cases of non-rusting construction and/or finish. The cases shall be designed for simple mounting on a plane, vertical surface such as a control/relay panel front. All terminals for CT and VT connections shall be arranged in a row along the meter's lowerside. Terminals shall have a suitable construction with barriers and cover, to provide a secure and safe connection of CTs and VTs through stranded copper conductors of 2.5 sq. mm. size.

25.0 All meters of the same model shall be totally identical in all respects except for their unique identification codes. They shall also be tatally sealed and tamper proof, with no possibility of any adjustment at site, except for clock correction.

26.0 The meters shall safely withstand the usual fluctuations arising during faults etc. In particular, VTs secondary voltage 115% of rated applied continuously and 190% of rated for 3.0 seconds, and CT secondary current 150% of rated applied continuously and 30 times of rated applied for 0.5 seconds shall not cause any damage to or maloperation of the meters.

27.0 The meters shall also withstand without any damage or maloperation reasonable mechanical shocks, earthquake forces, ambient temperature variations, relative humidity etc. They shall have an IP-51 category dust-tight construction, and shall be capable of satisfactory operation in an indoor, non-air conditioned installation.

28.0 The meters shall continue to function, as specified above, in case of failure of one or two phases of VT supply. In case of a complete VT supply failure, the computation of average frequency (as per 5.0) shall be done only for the period during which the VT supply was available in the 15-minute block. Any time block contraction or elongation for clock correction shall also duly accounted for.

29.0 The harmonic shall be filtered out while measuring Wh, VAR and VARh, and only fundamental frequency quantities shall be measured/computed.

30.0 Either the meters shall have built-in facility (eg. test links in their terminals) for insitu testing, or a separate test block shall be provided for each meter.

31.0 Portable/hand-held data collection devices (DCD) :

These shall be tailor-made for tapping all data stored in a meter's memory, and faithfully transferring it to the local PC. Each device shall be supplied complete with

i) a lead with optical head for coupling it to the meter,

ii) a lead for plugging it to a personal computer;

iii) an internal battery for powering the devices;

iv) a case for safely carrying it about

v) a battery charger

The total arrangement shall be such that one (1) operator can carry out the whole operation himself, in about (5) minutes per meter.

32.0 The DCD shall have a key for starting the data tapping from the coupled meter's memory, a key to start data transfer to the PC, and a lamp, which would light up on completion of data collection, remain 'on' while the data is held in the device and would go 'off' when all data has been transferred to the PC. Data tapping operation shall not erase the data from the meter's memory, or effect the meter operation in any way. The memory of the DCD shall get automatically cleared when the data has been transferred to the PC. DCDs shall also have the necessary provision for meter clock correction.

33.0 The Contractor shall develop the necessary software which would enable a local IBM-Compatible PC to (i) accept the data from the DCD and store it in its memory, (ii) display the collected data on PC's screen, with forward/backward rolling, (iii) print out the data collected from one or more meters, starting from a certain date and time, as per operator's instructions, (iv) transmit the collected data through an appropriate communication link to the central computer, starting from a certain date and time, as per operator's instructions, and (v) store the collected data on a floppy disc.

34.0 The above software shall further ensure that absolutely no tampering (except total erasures) of the collected metering data is possible during its handling by the PC. The software shall be suitable for the commonly available PCs, and shall be supplied to Owner in a compatible form to enable its easy loading into the PCs available (or to be installed by the Owner/others) at the various substations.

35.0 **Meter Testing Equipment**

A set of complete equipment required for in-situ functional checking and rough testing of accuracy of the meters shall be supplied to the Owner. It shall include secondary voltage and current injection equipment (3-phase, balanced, variable power factor), precision instruments, timing device etc., which have a sturdy construction suitable for frequent transportation. The equipment shall be easily portable,and shall generally comply with IEC-736.

36.0 In addition to the above,a test output pulse counting device, with an accurate built-in timer, shall be provided, for independent checking of Wh measurement accuracy against Owner's precision instruments.

37.0 **Quality Assurance**

The quality control procedure to be adopted during manufacture of the specified equipment shall be mutually discussed and finalised in due course, generally based on the established and proven practices of the manufacturer.

38.0 **Testing**

All equipment, after final assembly and before despatch from manufacturer's works, shall be duly tested to verify that it is suitable for supply to the Owner. In particular, each and every meter shall be subjected to the following acceptance tests :

i) Verification of compliance with Table-9 of IEC-687 1992-06 (Second edition), in both directions of power flow.

ii) Test of the register ratio and the impulse value of the transmitting device, for both directions.

iii) Verification that VARh measurement errors are within 50% of values permitted in Table-I of IEC-145, for both directions of power flow.

iv) Effect of ± 10% variation in measuring circuit voltage, on accuracy of Wh and VARs measurement.

v) Power loss.

vi) Dielectric properties.

vii) Starting and running with no-load for Wh and VARh, in both directions.

viii) Functional checks for display and memory.

ix) Accuracy of the calendar and clock.

x) Accuracy of voltage and frequency measurement.

39.0 Any meter which fails to fully cmply with the specification requirements shall be liable to be rejected by the Owner. However, the Owner may purchase such meters at a reduced price in case of marginal non-compliance, at his solediscretion.

40.0 **Type Tests**

One (1) out of every hundred (100) meters shall be subjected to the complete range of type tests as per IEC-687, after final assembly. In case of any failure to pass all specified tests, the contractor shall arrange to carry out the requisite modifications/replacements in the entire lot of meters at his own cost. After any such modifications and final assembly, two (2) meters selected out of the lot by the Owner's representative shall be subjected to the full range of type tests. The lot shall be accepted by the Owner only after successful type testing.

41.0 The meters used for type testing shall be separately identified, duly marked, and supplied to the Owner in case they are fully functional and as good as other (new) meters, after necessary touching up/refurbishing. In case this is not possible, the contractor shall provide their replacements at no extra cost to Owner.

42.0 The Contractor shall arrange all type testing specified above, and bear all expenses for the same.

43.0 **Installation and Commissioning**

The static energy meters specified above shall be installed at various EHV substations owned by the Owner, SEBs and other agencies, throughout India. The exact location and time-table for installation shall be finalised by the Owner in due course, and advised to the contractor, such that contractor's responsibility inthis respect ends within six (6) months of completion of all supplies.

44.0 The Contractor shall be responsible for total installation and commissioning of the meters (alongwith test blocks, if separately provided) as per Owner's advise, including unpackingand inspection on receipt at site, mounting the meters on existing control/relay panels, connection of CT and VT circuits including any required rewiring, functional testing, commissioning and handling over. The contractor's personnel shall procure/carry the necessary tools, equipment, materials and consumables (including insulated wire, lugs, ferrules, hardware etc.).

45.0 As a part of commissioning of DCDs the contractor shall load the software specified in clauses 33 and 34 into the PCs at the respective substations, and fully commission the total meter reading scheme. He shall also impart the necessary instructions to substation engineers.

46.0 Following technical information shall be furnished by the Bidders in their offers :

i) Foreseen dimensions of proposed meter.

ii) Expected weight of proposed meter.

iii) Foreseen dimensions of DCD.

iv) Expected weight of DCD.

v) Details of Meter testing equipment proposed to be supplied.

vi) Dimensions and weight of the test block, if separately provided.