SPECIFICATION FOR A FULLY AUTOMATED METER TEST BENCHES FOR TESTING SINGLE PHASE AND THREE PHASE ENERGY METERS FOR ETHIOPIAN ELECTRIC UTILITY (EEU)

Technical Specification
1. Introduction – Technical Specification

Need for Project
RTI is the implementing partner to the U.S. Agency for International Development’s Power Africa East Africa Energy Program (“EAEP”) under the Power Africa initiative. Power Africa is a partnership among the U.S. Government, African Governments, the private sector, international organizations, NGOs, and bilateral and multilateral partners to double access to electricity in sub-Saharan Africa by adding 30,000 MW of new power generation and 60 million new residential and business connections. It is aimed at supporting economic growth and development by increasing access to reliable, affordable, and sustainable power in Africa.

Project Description
The Project consists of the following:

The works in this contract include procure and put into service of 2 (Two) No. new fully automated meter test benches for testing Three-phase and Single PHASE energy meters.

It is anticipated that the equipment will be commissioned and put into service no later than 5 months from signing the contract.

Summary Scope
EEU is seeking to improve its meter testing facility and therefore requires “turn-key” proposals from bidders for supply of the following:

a) The contract is on a turnkey basis and includes for the complete design manufacture, assembly, testing, inspection, supply (including all delivery costs), installations, commissioning, 10 days of training (to be undertaken in Addis Ababa) of 2 (Two) No. new fully automated meter test benches, and maintenance for period of 12 months from the date of commissioning.

The location of the meter test benches will be the Ethiopian Electric Utilities (EEU) meter workshop located in Addis Ababa and the price for (a) above should be based on the meter test benches located in Addis Ababa.

The remaining part of this document covers the technical details required of the meter test bench(es) and whilst it is comprehensive bidders should advise, or clarify, in the event they believe there are missing and/or inconsistent details.
2. General Conditions & Requirements

System of Units
In all documents, such as correspondence, technical schedules, and drawings, metric units of measurements shall be employed.

The Meter Test Benches shall be in compliance with Systems International d'Units (SI) system of units in accordance with the provisions of ISO 31 and ISO 1000.

Standards and Codes

2.1.1 Standards

The meter test bench(s) offered must comply with all the relevant technical codes of the International Organization for Standardization (ISO) and latest relevant IEC Publications of practice relating to meter test benches in force at the date of delivery. Bidders should also appraise themselves of local legislation, standards and codes of practice that exist in Ethiopia.

Goods and special guarantees beyond the scope of ISO and IEC shall conform at least to the DIN, VDE or equivalent in English language edition.

The offered equipment and work must be performed according to the most recent relevant codes, standards, accident prevention regulations and legal regulations.

The Bidder must clearly state with his proposal the standards and codes, he intends to apply.

All the recommendations contained in the relevant applicable standard shall be considered as mandatory requirements.

2.1.2 Codes

Typical codes/regulations will include, but not be limited to, IEC 62053, IEC62052-11, IEC62053-11, -21, -22, -23, -24, EN 50470-1, -2, -3, ISO/IEC 17025, IEC 736 for construction, and allow testing of meters in compliance with IEC62056-11, IEC62056-21, - 22, -23, IEC 521, IEC 687 and IEC 1036.

Project Location and Environmental Conditions

The Project is located in Addis Ababa, Ethiopia.

The supplied equipment and materials shall be suitable for normal operation under the environmental conditions of the area. The basic environmental conditions of the area are provided in Table below.

Site Environmental Conditions
<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>2,600m above sea level</td>
</tr>
<tr>
<td>Annual rainfall</td>
<td>1,250mm</td>
</tr>
<tr>
<td>Exceptional rains</td>
<td>June to September with up to 100 thunderstorm days per year</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>70%</td>
</tr>
<tr>
<td>Wind velocity (height above ground level)</td>
<td></td>
</tr>
<tr>
<td>0 – 30m</td>
<td>35m/s</td>
</tr>
<tr>
<td>30-50m</td>
<td>45m/s</td>
</tr>
<tr>
<td>Ambient air temperatures</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>25οC</td>
</tr>
<tr>
<td>Minimum</td>
<td>-5οC</td>
</tr>
<tr>
<td>Maximum</td>
<td>45οC</td>
</tr>
<tr>
<td>Seismic zone</td>
<td>Zone 4</td>
</tr>
</tbody>
</table>

**Design, Standardization and Interchangeability**

All works and facilities shall be designed to facilitate future inspections, maintenance, repairs and cleaning.

The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance.

All equipment performing similar duties shall be of the same type and manufacture in order to limit the stock of spare parts, training, and documentation required and maintain uniformity of plant and equipment to be installed.

**Materials and Workmanship**

Materials used in the manufacture of the specified equipment shall be of first-class quality and of the kind, composition, and physical properties best adapted to their various purposes in accordance with the best engineering practice.

All equipment shall conform to the applicable standards as to material, workmanship, design, and tests.

Tolerances, fits, and finishes shall conform to the best modern shop practices in the manufacture of finished products of a nature similar to those covered by this Specification.

All equipment shall be of rugged durable construction, designed for frequent operation.

The materials used for this Project shall be selected carefully for the purpose intended and with due consideration of site conditions and climatic environment. Higher-grade material shall be used in every case where ordinary material may be insufficient.

The Contractor shall indicate in the respective Technical Schedules the proposed materials and their applicable standards for all major items of the supply.

All work shall be performed and completed in a thorough workmanlike manner and shall follow the best modern practice in the manufacture of high-grade equipment. All work shall be performed by workmen skilled in their respective trades.
Documentation

2.1.3 Documentation Required with the Bid

Unless otherwise stated in the particular sections of this Technical Specification the following documents shall be included in the offer:

a) Project implementation schedule (Gantt chart).

b) Technical Data Schedules and Price Lists (BoQ) in accordance with the appropriate Sections of this Technical Specification;

c) Point by point compliance, differences or any deviations from this hereby Technical Specification must be clearly indicated.

d) The submission shall be supported by catalogues, technical manuals of the components and description of the related functions and operations and type tests where appropriate.

e) Any available test certificates for all specified type and routine tests may be submitted along with the technical offer.

f) Acceptance or not of the submitted test certificates will be subject to Buyer’s approval.

g) Any other documentation, data and information as it might be required by appropriate Sections of this document or other parts of Tender Dossier.

Quality Assurance

The manufacturer shall possess ISO 9001: 2008 Quality Assurance Certificate for the design, manufacture and testing of Three Phase Energy Meter Test Bench. The bidder shall submit a copy of the ISO Certificate certifies as true copy of the original from the manufacturers, along with the offer.

Tests

The tests shall be carried out in accordance with IEC standards.

2.1.4 Type tests

- High voltage power-frequency wet withstand test
- Temperature rise test
- Short – time current tests
- Peak (momentary) short circuit current tests
- Determination of errors
- Lighting impulse withstand test

Bidder must submit the equipment type test report and certificate, which must be from a national or international accredited laboratory, along with the bid. Type test report should not be older than 5 years, from the date of issue of purchase order.
2.1.5 Routine tests

- High voltage power-frequency dry withstand test
- High voltage power frequency wet withstand test
- Over voltage withstand test

2.1.6 Functional Test

The materials (Meter Test Benches) used by the contractor in performance of the contract should be subject to inspection and testing by approved engineers during manufacture and certificates presented. The approval or the passing of any such inspection or test will not, however prejudice the right of the purchaser to reject the material if it fails to comply with the specification when erected or to give complete satisfaction in service. The costs of all tests and inspection shall be borne by the contractor and shall be deemed to be included in the contract price. Before any material or component is packed or dispatched from the main or sub-contractor’s works, the contractor should ensure that all necessary tests have been successfully carried out and certified.

Warranty Period
The warranty period shall be 12 months from the date of commissioning.

Training
Training shall be provided on basic function of Meter Test System Benches and in two tranches of 5 days each. The first tranche of 5 days will be around the date of commissioning with the second tranche of 5 days to be held until requested by EEU. All training will take place in Addis Ababa, Ethiopia.

Bidders to include the full cost (including staff costs and organizational additions – e.g. hotel costs, per Diems, etc.) of 5 days training for 15 staff members in Addis Ababa for each of the two blocks of training. The training shall constitute a combination of theoretical and practical training including as a minimum:

- Providing knowledge of the overall system concept
- Extended knowledge of the functions of all system components
- Routine tests and adjustment procedures

Test run of the system (to a reasonably possible extent)

CONCLUSION
Within this document we have set out the requirements for the submission of proposals for 2 (Two) No. new fully automatic meter test benches as per tender documents the supply CONFIGURATION, DESIGN AND INSTALLATION
2.1.7 CONFIGURATION

Bidders will price for 2 (Two) No. fully automated meter test benches for testing single phase and three phase energy meters, which each meter test bench have a configuration of a 40 position single phase and three phase energy meter calibration, (i.e. the test bench shall have the capability to calibrate single and three phase energy meters).

Each test bench will be required to calibrate: 20 x energy meters while the other 20 x energy meters are being removed after calibration and replaced with un-calibrated energy meters. This operation ensures a constant flow of 20 x energy meters being calibrated. The accuracy of the each meter test bench shall be class 0.02% (To calibrate energy meters of accuracy class 2 to class 0.5%).
2.2 Meters required to be tested

The meter test system shall provide testing facilities for all meters deployed by EEU, these include:

**Single Phase two/three wire active/reactive/apparent Energy Meters**
- Post-paid Ferraris and Static energy meters
- Pre-paid Static energy meters

**Three Phase three/four wire active/reactive/apparent Energy Meters**
- Post-paid Ferraris and Static direct energy meters;
- Post-paid Ferraris and Static indirect (CT/VT) energy meters
- Post-paid Ferraris and Static half-indirect (CT) energy meters
- Post-paid direct meters
- All types of Pre-paid Static energy meters (future).

**Tests and functional checks to be carry out**

The meter test system shall be designed to carry out the following test and functional checks:

- Accuracy test in all four quadrants (active, reactive and apparent energy)
- No-load test (Creep test)
- Starting Current test
- Energy and Power Register test (dial test)
- Meter Constant test
- Pulse input and output test
- Influence quantity test (voltage, frequency, harmonic distortion, etc.)
- Calibration of reference standard (stationary and portable) having lower accuracy than the employed reference standard
- Pre-warming
- Allow users to test the meter in case the meter has no impulse (i.e. LED lump damaged) and without scanning.

The test system shall be suitable for simultaneous testing of meters with identical circuits and ratings but having different meter constants. The test system shall contain multistage safety, protection, control and monitoring circuit, which accepts wide range of the mains voltage and effectively eliminate the necessity of using an external voltage stabilizer.

2.2.1 Operating principal and the system arrangements

The system shall employ the Reference Standard. The error of the meter under test will be determined by counting pulses generated by Reference Standard Meter within gating time defined by the pulses of the meter under test. The later pulses can origin from:

- Photoelectric scanning head which can detect mark on the meter disc, LED flashes and simulated mark on LCD;
- Low voltage outputs of the meter under test

Implementation can be achieved with the Three Phase Meter Test Equipment. The offer shall comprise 2 (Two) No. fully automated meter test benches for testing single phase and three phase energy meters, and each of them shall comprise:
• Three phase power source, which consist of:
  o 3 x Voltage Integrated Source
  o 3 x Current Integrated Source
  o Reference Standard
  o System Controller
  o Frequency generator

• Meter Suspension Rack, consisting of two racks (both with two sides) suitable for mounting of 40 three/single phase meters and each position will be equipped with:
  o Individual Stand Controller with local display and keyboard – Error evaluation system
    - Keyboard: 3 keys: Reset/Start, Stop and one function key whose allocation changes depending in the test being performed.
  o Scanning Head and Scanning Head Carriages
  o Pulse connection panel to test low voltage input/output pulses of the energy meter
  o Current and Voltage Connection Panel
  o Leads and cables
  o Isolating Current Transformer
  o Optical Port Reader
  o USB Port Reader
  o Quick Connecting Device with accompanying Top Fixing Device

• All necessary accessories required to operate the whole equipment properly shall be provided;
• Software and Hardware package
• Newest generation computer set with 2 monitors and A4 laser printer
• UPS for computer and printer of the system.

All components of the proposed system are controlled by the Windows based software which also performs additional tasks as monitoring, measuring, recording, visualization and archiving data. The software also allows for defining meter type, tests, test sequence, printing reports, exporting data, automatic meter readout, etc.

2.2.2 Meter Test System components

Power Source
The Power Source shall be designed to generate the AC current and voltage required for meter testing, built on a three-phase digitally controlled electronic amplifier system using “Digital Fourier Transformation” (DFT) technology for regulation of the output signals. The main components of the Power Source will be:

• Voltage Integrated Source (3 no)
• Current Integrated Source (3 no)
• Reference Standard Meter
• Control Unit

The power stage of the source will be driven by an on-board DSP signal generator. The internal DSP controlled digital feedback loops and advance algorithm ensures the quick setting, high stability and very low distortion in the output current and voltage signals. The system allows setting of phase angle and harmonic in each channel required for testing. The output voltage & current will be independent from each other, isolated and free from main supply. Additional precise regulation system makes the Power Source able to generate high quality signal (pure sinus) even at wide range of the load (resistive,
capacitive, inductive or hybrid). A multilevel protection system in the source protects it against overload, short circuits, overheats and make operation of the device reliable and safe. The automatic setting and adjustment of the Power source makes it highly reliable device and guarantees continuity of work. The source is equipped with an isolated serial interface and can be operated by PC or other controlling device. The communication protocol is provided to control output settings as well as to access all internal registers.

Three Phase Reference Standard
The three Phase Reference Standard is a four quadrant three phase, simultaneous measuring instruments that registers both forward and reverse energy flow and provides voltage, current, power and energy (Active, Reactive, Apparent) information. The three Phase Standard has 0.02% accuracy for all measurement functions. Accuracy specification includes the variables of stability, traceability, uncertainty and test system errors. The equipment should be lightweight and with a low parasitic load.

Meter Suspension Rack
The “Meter Suspension Rack” shall be constructed using aluminium, and be easy to assemble and disassemble. The offered system shall consist of two racks (both with two sides), suitable for the mounting of 40 Single/Three phase meters. Each test position shall be equipped with:

- Individual Stand Controller with local display and keyboard - Error evaluation system
- Multifunction Photoelectric Scanning Head for electromechanical and electric meters
- Pulse connection panel to test low voltage input/output pulses of the energy meter
- Voltage and Current Connection Panel
- Leads and cables
- Isolating Current Transformer
- Free wire connections for current
- Quick Connecting Device with accompanying Top Fixing Device

It is assumed that the meter test benches will be fitted with the normal safety features as required under the standards.

Individual Stand Controller
The individual Stand Controller shall be responsible for the following tasks:

- Performing test on the basis of pulse received from tested meter and reference standard
- Display the test status, accuracy test result and remaining time in case of time dependant tests
- Pulse counting & pulse output testing
- Transferring data to the host computer
- Equipped with the local keyboard (start/stop and Fn button) it enables remote control of the power source
- Blocking and unblocking the test position (also known as disable the particular test position)
- Stop the test voltage for the test position
- Stop the ICT
- Communicating with meter under test by means of serial port as per the relevant IEC standard.

A. Test performance
It is a basic function of the controller. The controller performs the test independently. Before performing the test, it receives data related to the test parameters and the information which inputs/outputs of the meter are to be used. The tests results are presented on the local display and also transferred to the host computer. During the calibration and for possible intervention inside the meter, the test may be paused (the voltage to the meter is cut off) and/or reset/resumed and/or repeated using the controller keyboard.

B. Remote control of the power source
This is a useful function when adjusting meters. It enables remote changeover of load characteristics, directly from the controller keyboard. The load type can be switched from balanced to single phase, power factor from pF=1 to pF=0.5 and vice versa.

C. Control of auxiliary equipment
The controller is equipped with RS 232 and RS 485 universal serial ports for IEC standard communication. Due to this port, the tests can run fully automatically, e.g. while checking the registers, the initial and final register readouts may be obtained from the tested meter automatically, without engagement from the operator.

D. Pulse inputs/outputs
The controller has the possibility of operating simultaneously a number of impulse outputs of the meter under test and controlling its inputs.

2.2.3 Photoelectric Scanning head
The scanning had is suitable for sensing of marks from electromechanical meters and LED blinking of electronic meters. The design should enable the test to operate reliably under various ambient light conditions. Operational modes are changed automatically. The mechanical construction of the instruments allows for very easy positioning up/down, right/left, forward/backward and rotating around the vertical axis. All scanning heads installed at one side of the suspension rack can be easily moved forward/backward with one hand only. Protection class: IP 54 (IEC 60529), or better.

2.2.4 Optical Communication Head
Shall have the possibility of reading all types of meters and parameterize electronic meters through PC.

2.2.5 Hand Held Terminal
For recording, entry and transfer of meter specific data at meter test system (e. g. serial no. or owner no., etc.) to the Software. The device shall be equipped with a barcode scanner and supports the scanning of codes at highly complex meters. The device shall have cradle and all required cables.
Isolation current transformers (ICT)

The meter test bench shall have active isolation current transformers (one three phase isolation current transformer per meter test position. That is a total of 40 x isolation current transformers).

The ICTs shall perform the following functional purpose:

- Accommodate single or three-phase energy meters without closed links between the current and voltage measuring circuits - “voltage links”
- Accommodate single or three-phase energy meters with closed links between the current and voltage measuring circuits with internal current isolation switches which may be or go open circuit before or during a test.
- Accommodate CT or PT connected meters

The ICT shall be on a communication bus and the software shall be able to control, reset and report on faulty / open circuit situations of the energy meter.

The ICTs shall be able to go into a “self-protect” mode when an energy meter current circuit is open circuit or if its burden is too high.

The energy meter test bench shall be able to operate normally with any number of ICTs in “self-protect mode”.

As the ICT’s provide an additional load, the power output of the current source needs to be approximately twice as high as would be necessary without the current transformers

ICT shall have a maximum of at least 50 mOhm burden capability.

ICT shall have a maximum of 0.5V voltage output.

ICT shall have a dynamic operation range of 1mA to at least a minimum of 120A.

The accuracy of the ICTs shall be class 0.02% over the entire operating range.

More technical details for the ICT’s are included in Appendix 6.

Technical Data Schedules
Bidder shall complete the attached checklist for specifications and scope of works and submit as part of their bid.