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**SPECIAL TERMS & TECHNICAL SPECIFICATIONS
FOR THE PROCUREMENT OF REMOTE TERMINAL UNITS
FOR THE ENERGY MANAGEMENT SYSTEM**

1. INTRODUCTION

The Independent Power Transmission Operator (IPTO) intends to purchase Remote Terminal Units (RTUs) to be connected to the Energy Management System (EMS).

These RTUs shall be installed at unmanned or partially manned 150KV and 400 KV Substations of the Power Transmission System and at Power Stations in order to enable the continuous supervision and telecontrol of their equipment from the Energy Control Centres (ECCs). These RTUs shall collect analogue signals (MW, MVAR, A, KV, etc) and digital signals (alarms, operating statuses of circuit breakers, disconnectors, earthing switches, etc) from the equipment of Substations and Power Stations and process and transmit respective data to the ECCs. Moreover, these RTUs shall receive, process and forward analogue and digital control signals from ECCs to the equipment of substations or power stations (open/close commands as digital control signals, analogue setpoints for generation regulation).

These RTUs shall initially communicate with IPTO's EMS, using the telecommunication protocol being installed on the EMS, which is used for communication with the existing RTUs in operation. This protocol is HNZ, as implemented with a proprietary architecture by ALSTOM for RTU EPC3250.

These RTUs shall also offer the protocols IEC-60870-5-101 and IEC-60870-5-104 for future use with the new SCADA/EMS of IPTO which is now in the procurement phase.

2. SPECIAL PROCUREMENT TERMS

The procurement of 25 RTUs will, in addition to the general terms, contain the following special terms:

2.1 Right to participate in the tender for the supply of the RTUs

As the reliable operation of the RTUs under supply is critical for the safe operation and control of the Greek Transmission System, only companies which have a proven experience in similar projects and can demonstrate the last ten (10) years the supply of at least fifty (50) RTUs that still are in successful operation in Power Transmission Systems, may participate in the tender procedure for the supply of the RTUs.

2.2 Commercial Terms of the Contract

Prior to the construction of the 25 RTUs, the Contractor shall submit a Sample RTU in order to be approved by IPTO, in terms of compatibility of operation and communication within the EMS.

The detailed description of ALSTOM's communication protocol for RTUs EPC3250 (HNZ protocol) that is used in EMS, shall be provided, through IPTO who is a licensed user for the Hellenic Power System, to those companies wishing to participate in the tender procedure for the awarding of the Project, in accordance with the terms of paragraph 2.2.8.

The price of each offered RTU shall include all the requested protocols (HNZ, IEC-60870-5-101 and IEC-60870-5-104). However each RTU will have activated only one of the above protocols at any time.

2.2.1 Approval of the Sample RTU

Within three (3) months from the date of coming into force of the Contract, the Contractor is obliged to deliver to IPTO the Sample RTU, which shall, upon connection to the EMS, operate efficiently and effectively. The three-month period is set as the entire period for the development of the appropriate communication protocol, including the time required for correcting any problems in the RTU software and hardware that may arise during the tests which will be performed by HTSO.

The time during which the RTU will be under testing at IPTO premises shall not be included in this three-month period.

The protocols IEC-60870-5-101 and IEC-60870-5-104 will not be tested by IPTO during the approval procedure of the sample RTU, but the Contractor shall provide certifications issued by authorized firms or from his customers that have already used these specific products of the Contractor.

2.2.2 Violation of the Contract - Termination

In case where, upon expiry of the three-month period plus the period of IPTO tests, the Sample RTU has not been delivered to IPTO or it has failed to pass the operation tests, IPTO reserves the right to terminate the Contract, upon written notification of IPTO to the Contractor, for this reason. The

Contract shall be terminated in accordance with the supply general contracting terms of IPTO.

In case where delay is due to Force Majeure, IPTO may extend this period upon justified request of the Contractor, to be also considered in accordance with the supply general contracting terms of IPTO.

Should termination of the Contract occur for the said reason, IPTO reserves the right to proceed to negotiations for signing a Contract for the procurement of the RTUs with the second best bidder of the Tender procedure.

2.2.3 Tests on the operation and communication of the Sample RTU with EMS

Upon connection of the Sample RTU to EMS, IPTO shall perform all tests for proper operation and communication with EMS, in the presence of a Contractor's representative. The absence of a Contractor's representative due to own responsibility shall not entail postponement or delay of scheduled tests.

The Sample RTU shall be equipped with the appropriate hardware and software in order to implement all operations described under the protocol and meet all technical requirements of paragraph 3. An indicative configuration of the Sample RTU is described in paragraph 5, while IPTO reserves the right to request the configuration of the Sample RTU to be expanded to maximum expandability, as specified in paragraph 3.6. In any case, Contractor must guarantee the maximum RTU expandability.

The tests should prove that the Sample RTU shall in no way interfere with the operation of the front end computers of the South Regional Control Centre (SRCC) and that all functions of the telecommunication protocol are fully performed by the Contractor's Sample RTU. Moreover, tests should prove that the Sample RTU meets all technical requirements of paragraph 3.

IPTO commits to perform up to four independent series of tests within the three months period which has been set for the development of the communication protocol and delivery of Contractor's Sample RTU. Should the Sample RTU fail to pass the fourth series of tests, the Contract shall be terminated, in accordance with the provisions of paragraph 2.2.2.

The period starting with the delivery of the Sample RTU to IPTO for performing of all tests until its return to the Contractor accompanied by test results is defined as an independent series of tests for the Sample RTU. In case of successful results, the Sample RTU shall be approved in accordance with the

provisions of paragraph 2.2.4. In case where IPTO considers that the RTU has failed in the tests and the Contractor remedies the defects identified, a new series of tests may commence.

2.2.4 Acceptance of the Sample RTU by the IPTO

Acceptance of the Sample RTU by IPTO shall be made in writing, when the Sample RTU has passed all tests that are referred in paragraph 2.2.3.

Written acceptance of the Sample RTU by IPTO shall entail the automatic continuation of the contract between IPTO and the Contractor.

2.2.5 Delivery Schedule

Upon acceptance of the Sample RTU, the Contractor shall proceed to the construction of the rest 24 RTUs, having the same operating features with the Sample RTU.

Within a period of four months from written acceptance of the Sample RTU by IPTO the elements specified in paragraphs 4, 6, 7, 8 and 9, shall be delivered partially or in whole at the delivery basis that will be specified by IPTO.

The supply general contracting terms of IPTO shall apply to the qualitative and quantitative delivery of the supply.

2.2.6 Warranty

The Contractor guarantees for the successful operation of the 25 RTUs and the spare parts for at least 24 months, counting from the date of successful delivery. If, during this period, any technical malfunction or defect occurs, concerning the hardware or software, not due to heedless use, or force majeure, the Contractor is obliged to repair or finish off, or replace it, in a way satisfactory to IPTO, free of any extra charges. The Contractor is also obliged to indemnify IPTO for any direct damage sustained by the latter due to the equipment malfunction, but the said indemnification shall not exceed fifty per cent (50%) of the total contract price.

2.2.7 Non Disclosure and Use Agreement

The terms of the Non Disclosure Agreement between IPTO and ALSTOM T&D are obligatory for the participants in the tender procedure for the supply

of 25 RTUs. The detailed description manual of the RTUs EPC3250 ALSTOM protocol (HNZ protocol) shall be given to those companies solemnly declaring experience on similar projects, having installed RTUs that are in operation in Power Transmission Systems, in order to make a cost estimate for the development of the described communication protocol for IPTO's EMS. The detailed description manual shall be given to the companies stated, upon signing of the Non-disclosure and Use Agreement of this protocol for purposes other than the performance of the specific project. The said Agreement shall be communicated to ALSTOM T&D the company that developed and owns the protocol.

3. TECHNICAL REQUIREMENTS

3.1 General requirements

The Contractor's RTUs shall operate with ALSTOM's communication protocol for RTUs EPC3250, performing all functions mentioned in the detailed description manual of this protocol. The definition of data and parameters in the Contractor's RTU database shall be made automatically through the use of the file that is generated by the EMS.

The 25 RTUs will be installed in 150KV and 400 KV Substations of the Power Transmission System and in Power Stations, which are subject to low frequency (50Hz and harmonics) and high frequency interference during transient system conditions (switching operations, failure events, etc) and therefore these RTUs should be protected and capable for continuous and uninterrupted operation without problems in such an environment.

3.2 RTU operations

Each RTU should perform at least the following operations:

3.2.1 Analogue Inputs

The features for the analogue inputs are the following:

- a) Current inputs ± 20 mA, 0-20 mA, (programmable option in the RTU database).
- b) Input resistance ≤ 500 ohm $\pm 1\%$.
- c) The sampling period for each input should be adjustable as integer multiple of 500msec, in accordance with the respective definition in the RTU database (indicative sampling periods 1sec, 2sec, 4sec, 10 sec and 900 sec).
- d) Analogue to digital converter resolution at least 12bits + sign+ overflow.
- e) Analogue to digital conversion time ≤ 6.5 msec.
- f) Linearity of analogue to digital converter $\leq 0.15\%$ of full scale, at 25⁰ C.
- g) Measurement accuracy $\leq 0,2\%$ of full scale, at 25⁰ C.
- h) Total sampling and conversion time from analogue to digital for 128 inputs < 1 sec.
- i) Galvanic isolation of inputs to the field of measurements.

3.2.2 Digital inputs

- a) Digital signals from the field of measurements are dry contacts. If digital inputs require a 48V DC input voltage, this can be provided by the uninterrupted 48V DC power supply system that exists in the Substation or the Power Station. Otherwise, the input voltage should be provided by the RTU.
- b) Sampling of digital inputs shall be made every 1msec or faster, while the change of status shall be confirmed within a period less than or equal to 2 msec.
- c) Digital inputs shall allow reception of single or double digital signals (programmable option in the RTU database).
- d) Galvanic isolation of inputs.
- e) An indicator lamp shall be provided for each digital input to indicate the status of the input.

3.2.3 Digital outputs

- a) Each digital output is a normally open dry contact, with DC load breaking capacity of 0.25 A at 125 VDC.

- b) Open and close commands shall always be executed from two different digital outputs.
- c) The simultaneous excitation of more than one digital outputs should be prohibited.
- d) When the RTU's Local/Remote switch (whose operation is described in paragraph 3.3.3) is at the LOCAL position, no digital output should be excited.
- e) An indicator lamp shall be provided for each digital output to indicate the status of the output.

3.2.4 Analogue outputs

- a) Analogue outputs 4 - 20mA. Minimum load capacity 500 Ohm.
- b) Digital to analogue converter resolution at least 8bits + sign.
- c) Linearity of digital to analogue converter $\leq 0.15\%$ of full scale, at 25⁰ C.
- d) Accuracy $\leq 0,5\%$ of full scale, at 25⁰ C.
- e) Ability to update outputs $\leq 10\text{msec}$.
- f) When the RTU Local/Remote switch is at the LOCAL position or in the case of communications failure with the ECC, no analogue output should change its value (each analogue output should retain the last value obtained while the switch was at the REMOTE position or the last value sent from the ECC before the communications failure).
- g) When resetting the RTU and during restart, the current at each analogue output shall have a value equal to or less than the minimum value on the pre-selected scale for the specific output ($\leq 4\text{mA}$) and shall retain that minimum value until a new one is received from the ECC.
- h) All analogue outputs shall have galvanic isolation to the field.

3.2.5 Logic Outputs

- a) Each logic output is a normally open dry contact, which can be instantly or permanently excited.
- b) Each logic output may be excited separately or simultaneously with another logic output.
- c) Each logic output is a normally open dry contact, with DC load breaking capacity of 0.25 A at 125 VDC.
- d) When RTU's Local/Remote switch is at the LOCAL position, no logic output should be excited.

- e) An indicator lamp shall be provided for each logic output to indicate the status of the output.
- 3.2.6** The RTU shall transmit to the ECC digital signals related to the operating status of RTU (e.g. alarm about cards failures, RTU reset, temperature alarms and others that are mentioned in the protocol manual) and also the status for executing telecontrol commands (RTU's Local/Remote switch position).
- 3.2.7** Synchronization of the RTU clock shall be made from the ECC, via the HNZ protocol.
- 3.2.8 Sequence of Events**
- a) For each digital signal defined in the Sequence of Events, the date and time of change of the status (time stamp) of the respective signal shall be recorded by the RTU.
 - b) The accuracy of time stamp shall correspond to the sampling rate (1 msec).
 - c) The RTU memory should be capable for the storage of at least the last 255 status changes with the respective time stamps.
- 3.2.9** Each RTU shall be equipped with two serial ports for telecommunication connection through two modems to the EMS. Asynchronous communication shall be supported at speeds from 300 to at least 19200 baud. The two serial ports of the RTU shall be identical and equivalent and shall be used alternatively by the EMS.
- 3.2.10** Each RTU shall be equipped with an input/output port for local connection to a PC in order to upload or download the application software or the database, check the RTU proper operation, get diagnostics etc.
- 3.2.11** It is desirable for the RTU to support remote database downloading and diagnostics reception from a remote PC, via an independent RTU communication port

3.3 Each RTU shall ensure at least the following:

- 3.3.1** The software and the database of the RTU shall be maintained for at least fifteen days, in case of total failure of its power supply.
- 3.3.2** A Watchdog shall be provided, as a dry contact that remains closed in RTU normal operating conditions, while opens in case of RTU malfunction, RTU RESET and during restart, loss of power supply, fault detection on any of its electronic cards provided for analogue, digital or logic outputs.
- 3.3.3** A Local/Remote switch shall be provided, in order to disable/enable the control of digital, analogue, logic outputs as described in paragraphs 3.2.3, 3.2.4, 3.2.5.
- 3.3.4** An external switch shall be provided for performing the RTU RESET.
- 3.3.5** Indicator lamps shall be provided to indicate the RTU status and its current source of supply.
- 3.3.6** The RTU shall maintain its uninterruptible operation with maximum reliability performance at ambient temperature range of 0° up to 50° C.
- 3.3.7** The RTU shall not be damaged, under storage conditions, at the temperature range of -20° up to 60° C and humidity in the range of 5% and 95%.
- 3.3.8** The RTU shall withstand to vibrations, knocks and earthquakes.
- 3.3.9** Each RTU must be expandable by at least 30%, in terms of capacity of the deliverable RTUs, without needing extra cabinet or raising requirements for a cabinet different from the one described in paragraph 4.1.

3.4 RTU power supply

The RTU shall be configured in order to be supplied by two independent sources, DC and AC, which are provided by the Substation or Power Station uninterrupted power supply systems:

- a)** 48 VDC with deviations in the range 42 VDC - 58 VDC
- b)** 220 VAC / 50Hz with deviations on voltage +15%, - 20%.

The RTU shall be tolerant to the above deviations on the input voltage.

The RTU shall normally be supplied by the 48V DC voltage source, which is defined as the main power supply, and in case of loss of the main power supply, there will be an automatic switching to the 220V AC voltage source without any disturbance to the RTU operation. Switching back to the main supply shall be automatically made upon its restoration.

Each supply device shall include galvanic isolation circuits, a ON /OFF circuit breaker, protection from overcurrent, overvoltage and respective operation indicator lamps.

All the 25 deliverable RTUs shall be equipped with supply devices fully capable to supply efficiently the RTU expandability, as it is described in paragraph 4.3.

3.5 RTU communication with the ECC

Each RTU shall communicate with the ECC through two different telecommunication channels and two modems respectively. The ECC shall define through the communication protocol to the RTU the channel through which it shall communicate with the ECC. The Contractor must ensure compatibility with all types of modems to be proposed by IPTO.

3.6 Maximum RTU expandability

The RTU software and hardware shall support at the same time at least the following, without requiring any CPU, memory or power supply upgrading:

- 128 analogue inputs.
- 448 single digital inputs
- 240 digital outputs.
- 64 logic outputs.
- 36 analogue outputs.

4. CONFIGURATION OF THE 25 RTUs TO BE DELIVERED

4.1 Description of RTU Cabinet

Each RTU shall be delivered in a cabinet of about 2.20m x 0.80m x 0.80m (H x W x D), of solid construction, with anti-corrosion protection and painted with electrostatic paint, and appropriate for floor mounting. It must also have a single common earthing lug.

Moreover, it must have the appropriate protection, according to the international standards, against the dust and humidity inside it (IP54).

The front and back side of the cabinet shall consist of doors that enable a 180° opening. The lower part of the cabinet shall have at least 8 glands for cable routing, and a removable frame to assist cabling works. This cabinet will not contain terminal blocks. This cabinet will have two ventilation openings, on top and bottom, protected with vents or mesh.

The cabinet shall be equipped with forced air circulation system, controlled by a thermostat, so that RTU could maintain its uninterrupted operation at the maximum specified ambient temperature of 50 °C.

Within the cabinet, there will be installed the RTU rack, the supply devices, the modems and the accessories.

The supply devices for the internal supply of each RTU will be properly connected and protected within the cabinet. Furthermore, a 220 V AC socket, with separate fuse of 2A and a protection cap, will be provided, for the power supply of the measuring instruments and tools that are used by the RTU maintenance personnel.

The two modems that are required for the telecommunication shall not be included in the deliverable RTUs. However the RTU cabinet shall have free space for the two modems to be installed on a standard 19'' sub-rack with height 6U at least.

4.2 Input/ Output cards

All analogue and digital input/ output cards shall be delivered together with the respective connector required for the connection of analogue and digital input/ output signals to each RTU card. The wiring shall be undertaken by IPTO.

4.3 Configuration of deliverable RTUs

The 25 deliverable RTUs shall have at least the following capacity.

- 192 digital inputs
- 64 analogue inputs
- 64 digital outputs (controls “Open/Close” for 32 switching devices)
- 8 analogue outputs
- 16 logic outputs.

The above capacities must be expandable by at least 30% in terms of the cards, without any other hardware or software addition.

5. Indicative configuration of the Sample RTU

The Sample RTU shall be configured appropriately to support the tests, providing at least the following:

- 192 digital inputs
- 64 analogue inputs
- 64 digital outputs
- 8 analogue outputs
- 16 logic outputs

6. Electronic card drawings- Software - Manuals

The 25 RTUs shall be accompanied by:

- a) nine (9) copies of the complete series of drawings of all electronic cards, of the power supply devices, signal cabling to the input/output cards and internal RTU cabling.
- b) nine (9) copies of the entire software (provided on floppy-disks or CD-ROMs) required for the installation, operation, tuning, configuration, extension, maintenance, troubleshooting (reception of diagnostics, etc) of the RTUs.

- c) nine (9) copies of the complete manuals which shall at least include the method of RTU installation, operating instructions, functionality of each electronic card, definition of information and parameters in the RTU database, tuning, reception of diagnostics, troubleshooting and maintenance, RTU mechanic characteristics (dimensions, weight, etc), power supply requirements, voltage and frequency tolerances.

7. Extension boards for RTU maintenance

The 25 RTUs shall be accompanied by seven (7) series of extension boards for maintenance, if such boards are provided by the manufacturer of the RTUs

8. Spare Parts

8.1 The offers for the 25 RTUs shall also include four (4) spare parts series. Each of the series will include:

- a) Electronic cards of the same type *and number* with those contained in one RTU, including the connector of each input/output card and connectors between all cards. For example if one RTU contains 3 Digital Input cards then the amount of the offered DI spare cards shall be 4 series x 3 cards = 12 DI cards together with the corresponding number of connectors.
- b) One power supply set identical to that of each RTU. (Four (4) power supply sets will be provided)

IPTO reserves the right to alter the quantities of the spare parts that will be contracted.

The Contractor commits to the availability of parts for at least ten (10) years from the date of coming into force of the Contract.

8.2 Participants in the tender procedure shall also submit, within their offers, separate prices for the RTUs, the Spare Parts and the Training.

Specifically for the Spare Parts, a pricelist of all spare parts (input/output cards, extension boards, power supply device, CPU, e.t.c.) which IPTO might require to purchase for the maintenance and extension of the RTUs under supply, shall be submitted.

Note that the offered price for the RTU must conform to the offered detailed price list of the software or hardware included in the RTU.

9. Training

The Contractor shall offer a 5 working days training for twenty (20) persons (technical personnel of IPTO) at the premises to be suggested by IPTO. The cost of the Training shall be included as a separate item in the offer of each Participant and will be used for the evaluation of the offer. The training outline shall be submitted by the Contractor together with his bid. The training schedule shall be determined in collaboration with IPTO. The Contractor will also be responsible for the installation and operation of an RTU (power supply, indicative inputs and outputs and connection to the SCADA of the Control Center) in the premises where the training will take place.

IPTO reserves the right, according to its needs, to decide whether to use or not the offered Training and respectively to include it in the Contract or not.

10. Regulations- Standards - Certifications

The items to be offered shall comply with the international regulations and standards concerning their operation in a High Voltage Substation or a Power Station environment and shall meet at least the requirements for:

- Dielectric withstand and galvanic isolation.
- Electrical and mechanical disturbances.
- Temperature operating conditions.
- Protection against humidity.
- Protection against particles and dust.
- Vibrations and knocks.

All necessary certificates must be submitted together with the bid.