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## Automated Protection Data Collection and Analysis System

### 1 General Requirements

IPTO S.A. as the Greek Transmission System Owner and Operator company has the obligation to monitor the performance and the reliability of the protection equipment of the Transmission System.

This task is currently made in the conventional way, i.e. it is made manually, it is in off-line and not in real-time mode. It is a post-event procedure; every day all relevant available information acquired in the preceded time, such as orders sheets of operations and disturbances issued by the dispatching centres, reports of events of the System Maintenance Direction, sequences of events of SCADA/EMS, alarms of historical information system of SCADA/EMS are at the disposal of the competent protection engineer for the continuous tracing of the disturbances/events and their analysis. For major events or for not correct automatic trips the data log files by the relays, the print outs of the local event or fault recorders or any other useful information are also requested and they are additionally considered for further analysis. The data incorporated in the modern numerical relays - hereafter named as Intelligent Electronic Devices (IEDs) too- (e.g. transients, digital, measurements etc) give information useful for other corporate activities too, such as the operations of the dispatchers, the maintenance staff, the planning engineers etc. All these documents / reports are transferred within company in hard copy, upon demand and after (usually) physical presence and action at site for their retrieval from their sources.

The Greek Transmission System is interconnected with the European grid by means of tie-lines, which connect certain boundary High Voltage substations with the corresponding substations of the neighbouring systems. The importance of the safe operation of these interconnections is great for the stability of the domestic System, for the stability of all the European system and for the reliable operation of the electricity market. Therefore events occurring at these lines and events generally at the substations where these lines are placed, which in present text are mentioned as key-substations, must be correctly, fast, thoroughly analyzed as well as between the two involved transmission companies mutually, checked and assessed.

To enable IPTO to securely collect and fast process the embedded files/data from the relays of certain key-substations in order to perform the tasks of disturbance analysis and fault / event statistics for these very relays, an automated Protection Data Collection and Analysis System (PDCAS) shall be provided under this inquiry.

This system is implemented as a separate autonomous subsystem (e.g. with respect to the SCADA/EMS e.a.). It has the infrastructure described in following text of this document. A general configuration of the PDCAS to be provided under the inquiry is shown in Doc 4.3. A list with the protection IEDS of the key-substations included in present inquiry is provided in Doc 4.4.

The aim of the Protection Data Collection and Analysis System is to provide the appropriate hardware and concentrator / communication interfaces to be plugged in the existing corporate communication terminals and the necessary specialized software for the whole application.

Bidders shall offer their best solutions for the PDCAS to the sense that this solution fully matches to the requirements of this specification.

The PDCAS shall be able to extract, manage, elaborate and analyze analogue and digital data. It will assist IPTO in the process of remote data / files / measurements collection, in the tailored-made extracting the critical information from the large amount of available data in a reliable and safe manner and the issue of appropriate reports. In addition PDCAS shall include an analysis tool with a user friendly HMI to assist the user to perform fault analysis by providing info existing at the log file of the relays and any other relevant data (type of fault, pre-fault conditions, fault location etc). Additionally it shall assist for protection systems' maintenance monitoring.

The bidder shall consider the proprietary F/W, S/W of the distinct IEDs, the existing telecommunication protocols from the S/S to the remote central master station. It shall offer the communication connection and its operation from the IEDs towards the corporate communication terminal at the S/S and the integrated S/W that elaborates files of all these devices. The system shall support various types of proprietary and standard formats and protocols from the equipment available at the substation level, as they are mentioned at Doc 4.4. Details concerning protocols are listed in chapter "Device Manager". For the consistency and the compatibility between the operating protocols, their functional mapping will be assured.

The system shall be secure and reliable and shall follow international standards such as IEC 60870-5-101 / -104 or 61850.

Specific substation data shall be kept at the substation as long as there is a lack of communication with central system and till Masterstation collects them. It shall be possible to retrieve these data locally by laptop (not included in present scope of supply).

Features are to be included to minimize the loss of data. Since many existing devices have small memory buffers and the buffers are frequently overwritten, features such as regular polling, polling on request and event driven polling of substation information shall be provided to reduce the risk of losing valuable data.

The system shall provide a powerful filing system that allows for archiving of large volumes of files with waveform, analogue and digital data as well as respective data extracted from these files. All data for a period of 5 weeks (operational history) shall be available in archives within the Protection Data Collection and Analysis System. The filing system must be based on the IEEE-Power Engineering Society – Protection System Relay Committee "Naming Convention for Time Sequence Data Files" or equivalent. Powerful sort and query engines shall be provided.

A translation engine shall be provided to translate actual recordings (files) of fault occurrences from their native format to the standard IEEE Standard P37.111, 1999: Common Format for Transient Data Exchange (COMTRADE) for Power Systems format and derivatives thereof, in case they are not already at the IEDs with this format. This translation engine shall also be capable for exporting data in a universal S/W format (Text, Word or Excel type or other compatible).

The bidder shall offer the powerful and most efficient single device (concentrators/gateway) that can support the future expansion of the system to other feeders of the substations.

The system shall be flexible and expandable according to the international practice of such systems. The bidder shall indicate the necessary preconditions or capabilities of its system for future eventual integration of new / additional IEDs and new or additional protection functions or automations, such as bus bar differential protection, transformer differential protection generator-block protections, high voltage reactors' protection,

high and medium voltage capacitors’ protection, load shedding schemes, underfrequency protection schemes, protections based on synchrophasors, line differentials), etc. The bidder shall also indicate preconditions for future connection of measuring devices, sensors, transducers etc. Nevertheless the equipment that it will offer will be dimensioned in order to cover in a reliable manner the very feeders that are included in present inquiry. Future expansions are not included in present inquiry.

Bidders shall inform with their Tender the functionalities implemented with the offered system in other projects they have executed.

## 2 Scope of Supply of Services and Goods

The system shall serve for the protection, disturbance data collection and evaluation of the key-substation of the power system. The bidder shall provide the following equipment, software and services:

- a) The Masterstation equipment and software shall be installed at the System Protection Department premises at the National Control Centre at Ag. Stefanos.
- b) The S/W for the protections’ data collection, database / file management, fault / data / communication evaluation, fault analysis, fault statistics etc.

### c) Substation equipment

The necessary heavy duty Industrial Type PCs [ abbrev. HDPC] /Gateways together with the respective hardware, circuitry (real or virtual, according bidder’s capability and existing IEDs capabilities) and software for retrieving, storing and transmitting the data locally at the substation level. The HDPC / Gateway will be configured according to the description in chapter “Substation Equipment” of present text at the five (5) S/S. The bidder shall consider the existing remote access ports and protocols of the IEDS, the corporate telecommunication terminal at each S/S and shall offer the appropriate local data concentrator / Gateways / communication interface devices.

The system shall acquire and process operational files from selected relays from 5 substations:

S/S Arachthos 400 kV	1 tie-line (HVDC) + 2 internal Transm. Lines
S/S Kardia 400 kV	1 tie-line + 4 internal Transm. Lines
S/S Thessaloniki 400 kV	2 tie-lines + 3 internal Transm. Lines
S/S N. Santa 400 kV	1 tie-line + 1 internal Transm. Line
S/S Meliti 400 kV	1 tie-line + 1 internal Transm. Line
Totals: Substations 5 (five)	6 tie-lines + 11 internal Transm. Lines

Table 1. List of S/S and feeders included at PDCAS (Location see at Doc 4.2)

Note: In case other equivalent / appropriate telecom network is developed by the company/user at the time of the realization of the project, this latter must be taken into consideration.

These S/S are open-air-insulated type. The relays for the 400 kV feeders are built in metal enclosed cubicles that are placed at distinct little-houses within the yard near the primary equipment they protect. One feeder is usually at each kiosk or if there is a «double transmission circuit», two feeders per kiosk. Via cables channels the cables run within the yard to the control room at the main S/S building. There are already channels/runways connecting the bay-kiosks with them and/or with the control room. Distance to Control Room –where the VPN port exist- could be from 200 m till 900 m.

The numerical relays at the S/S are fitted with two serial ports for reasons of interfacing and specifically with: (1). One serial port suitable for connection to a PC. An operator program, running under WINDOWS is available to enable user-friendly parameter setting, analysis of fault data and records and commissioning either locally or remotely.

(2). One serial port suitable for system interface. (fiber optic) shall be available for connection to a digital computerized substation control system. The communication protocol for this case is as per IEC 61850.

- d) The necessary and suitable office PCs at the masterstation. in order the S/W to run.
- e) Time synchronizing devices (GPS clock and antennas) shall be provided if necessary. At substations where GPS receivers are foreseen, these may be used for synchronization, following the practice and know-how of the bidder.
- f) Communication: For communication/connection between the various IEDs and substation HDPCs/Gateways the bidder will offer the necessary equipment. For communication of the corporate S/S-telecom-terminal and the central evaluation station at Athens (Ag. Stefanos), the existing telecommunication corporate infrastructure shall be utilized (e.g. dial - up, Digital Subscriber Lines (DSL), Ethernet, etc).

At PDCAS's disposal one VPN port at the control room of each S/S to connect the output of the Gateways and then the communication will be implemented via the corporate VPN telephone network.

At the main building with the S/S control of each S/S an Ethernet/LAN exist, where the HDPCs/Gateways can be connected. The communication of the S/Ss with the master station at the central building of Agios Stefanos is made with WAN networks, which realize the Corporate Telecommunication Network (TCP/IP). The bidders must declare the minimum needed bandwidth (rate of data transmission) for the exchange of data between HDPCs/Gateways and masterstation.

At the Data Centre of Ag. Stefanos Ethernet LAN exists with available ports for the connection of the Masterstation. The system will be installed at protected zones firewall so that the controlled access to them will be assured.

- g) For relays which do not support setting on rear port, terminal servers shall be used, to access the front port from remote, if this is considered necessary by the bidder for its application.
- h) The communication between local substation equipment (numerical relays) and the gateways/corporate telecom terminal shall be implemented by the bidder according to the existing equipment and site conditions.
- i) Prices for goods necessary for the setting into operation of present application, that are not included in the commercial list of present inquiry, may be included in the cost of the «S/S equipment», item Gateways/HDPCs.
- j) Services: Beside the installation, commissioning and testing of the equipment and the overall system, the bidder shall specify the main requirements of the future substation control and protection systems to ensure their integration into the Protection Data Collection and Analysis System.

- k) The operational structure of the overall application is set up in the following text. Bidder can perform any equivalent architecture, with the precondition that it is safe, reliable, user friendly, fast, convenient and that it includes at least the here described features and capabilities.

The "List of the Goods and Services" of PDCAS is included in present inquiry's documents. Please see reference Doc 4.1. at chapter 4 [references].

### 2.1 Master Station Equipment

The following Table shows an overview on the masterstation equipment to be provided under the project as a minimum:

Table 2: Minimum PDCAS Masterstation configuration

Main users at Ag. Stefanos-Krioneri (PCs are also included in present scope of supply) (*)	2
Network Accessed S/W Running System (Hard Disc or other media)	# (**)
Backup and medium term archive (data for 5 weeks)	# (**)
LAN HUB/Switch	# (**)

(\*) Users shall have via internet access to the S/W. Therefore the one of two of them may be located at other place of Athens area, upon selection of the user.

(\*\*) Quantities indicated in the above table with "#" are not explicitly pre-described but depend on the solution offered by the respective bidders and its usually available and existing equipment in order to fulfil the specific requirements stipulated within present technical specifications and considering the already available corporate equipment. Bidders are requested to clearly indicate and describe the offered quantities and configuration in their bid.

Redundancy at present application is wished but it is not meant by a duplication of physical devices. It is meant mainly operational redundancy, wherever it is possible. So concerning communication, databases e.a. components included in PDCAS will foresee in a S/W manner for assuring redundancy. The bidder can indicate / propose for a potentially future upgrade of the system for fully redundancy. With its offered equipment the bidder can foresee interface terminal for future connection of redundant devices, which are not included for the present at this scope of supply.

Peripherals such as GPS clocks (SCADA - GPS receiver can be used for synchronization) etc . If not synchronized by local GPS receivers at the substations, the PDCAS equipment shall allow for synchronization of the substation equipment by the central system.

The communication equipment shall allow simultaneous communication with the different type of IEDs at the substations.

Initially the license will be for 2 users, but it will be considered that in the future it must be possible to expand the licenses for other regional responsible business units. One license/user will be located at Ag. Stefanos' System Protection Section, the second one may be either at same location or at a remote place in Athens area, IPTO business unit, accessed via internet, at the IPTO's choice.. Each of the client/users shall have PCs to support the application, which are not included in present scope of supply.

The additional remote users' location shall be responsible IPTO units' premises (indicative proposal: the regional headquarters corresponding to the key-substations) and all –except masterstation- client users shall be assigned to functionalities related to the

distinct roles and responsibilities via passwords and priorities. IPTO shall have the possibility to manage the information in future in central and / or in regional (peripheral) level. The system must have the tools for sorting and/or addressing data according to the geographical location of the substations.

The Masterstation equipment shall be powered from the 230 VAC Uninterruptable Power Supply at the IPTO premises at Ag. Stefanos. A loss of AC power to the Masterstation shall not result in any loss of a system parameter and configuration.

## 2.2 System Functions

The S/W shall be composed of a group of essential applications (tools) that, when considered together, shall provide a complete system for collection, storage and evaluation of the comprehensive files/data available from today's IEDs at the substation level.

### 2.2.1 Data Analysis and Evaluation

Disturbance / protection data analysis and evaluation is the primary task of the Masterstation. The analogue and event data shall be displayed graphically both on the screen and on the printer with the user having control over the displays.

Once a fault record is stored within the Masterstation the following display and analysis facilities shall be provided at least but not restricted to:

- Each analogue channel and each group of events shall be capable of being displayed / amplified individually or together with other selected channels.
- The display's time base shall be capable of being modified.
- The instantaneous primary values of current, voltage, time shall be capable of being displayed at a moveable cursor position.
- The identification of the substation and circuit (feeder etc), the fault reference number, the trigger data, time and source, identification of individual analogue and event channels and amplitude scale shall all be capable of being displayed.
- Any chart / diagram embedded in a relay must be capable for display.
- Any display on the screen shall be capable of being printed out.
- Representation of the fault locus in the R-X plane in primary ohms
- Calculation of the distance to the fault (Fault Location) – Fault location tool
- Presentation of historical / statistical data shall be possible.
- Vector presentation values and phase angle in graphical form.
- ONLINE help text function etc.

### 2.2.2 Device Manager

The device manager, as the automatic data collection application, shall be able to handle a vast range of different data types such as but not limited to: disturbance records, event records, relay data, fault location data.

Other data such as SCADA data, email, fax, text, spreadsheet, graphic data, SMS is useful to be supported by the system, but it is not obligatory.

The device manager shall provide a library of communication protocols for communication between the various types of IEDs and master stations as per the list provided in Doc 4.4.

Nevertheless the processors must be selected and the library of the S/W developer must assure a bigger variety of protocols, in case the user wishes to connect other

IEDs in existing S/W. Indicatively the following protocols could be expected –but not foreseen in the quotation, besides the necessary acc. to Doc. 4.4.; IEC 650870-5-101/104, FTP, TCP/IP,, Profibus FMS Slave, DNP, TASE2, CIM, etc. Bidders shall inform with their offer the additional protocols supported by the proposed system.

As it is mentioned at § 2.4 there are basically three types of protection data records: faults (transient data records), trends (steady state RMS data records) and events (relay targets and alarms data records). The user wants to have in its central station all of them available and for elaboration by the specialized PDCAS S/W.

The S/W shall be designed to run periodically from the unmanned HDPC / Gateways in the substation and/or from the office (the masterstations). It shall provide for the extraction of the latest fault information and the processing of available measurements. Any critical information (e.g. circuit breaker tripping) captured shall be automatically transferred upon detection, in clear way (i.e. giving the main target as well). The user can select and assign the events he needs to be alarmed for him; e.g. a protection expert may need to know only the automatic tripping of a relay, an operation expert any tripping of any c.b., a maintenance expert the accumulated tripping of a breaker etc.

The S/W can establish links with related devices over the various types of available dial up and network circuits such as Gateways, communication processors, telephone switchers, data concentrators, Ethernet networks, local SCADA / DSCS, and so on, as specifically is mentioned at the appropriate place at present text. Once connected, the program shall poll the devices for their latest information.

The capability for searching according various criteria shall be provided. Such criteria shall be the circuit breaker identity number, the relay model, the date, etc.

The device manager shall provide daily reports on communication integrity, and for security purposes it shall foresee a relevant safe method of passwords' management.

Everything either S/W or H/W that is necessary for the communication of the tie-lines-PDCAS with the relays must be developed and delivered by the contractor. For eventual relays that are not numerical though they are digital (previous generation) and if they shall not have been replaced with modern/numerical ones till the time of realization optional interfaces must be offered for their connection at the PDCAS and it will be at the choice of the user to include or not these equipment at the PDCAS.

### 2.2.3 System and File Manager

A file manager shall be provided that it is specialized in dealing with files from IEDs. These devices produce large numbers of files that have complex inter relationships and varying naming conventions (many events can be in one file, or one event can be in multiple files etc).

The file manager shall support the format specified in the IEEE-PES-PSRC report "File Naming Convention for Time Sequence Data" and similar newer appropriate ones.

The software shall be launched from the PDCAS network described in this project (masterstation). The program can be installed on a shared network drive(s) –according to the bidders' practice- where multiple users can execute concurrently from their own HMIs. The authorized users at IPTO premises shall be able to use the program provided that the proper read/write access levels are assigned to each user.

Users on the network can use available S/W tools to browse the various types of deposited formats or they can use S/W to manage and display the formats from a common Interface. System security and confidentiality by using passwords shall be assured.

The collected information shall be processed and the resulting information shall be saved to a shared folder on the company network. Immediate and secure access to the deposited information shall be available to all responsible users on the company network. The stored files are considered legal records and are always maintained in their original proprietary form.

The bidder shall indicate the rates and maximum volumes of the data that can be transferred within the PDCAS according to the offered equipment.

#### 2.2.4 Fault Statistics

The evaluation of the automatic operation of the circuit breakers and the protection is also very important for both, the dispatcher and the protection engineer.

A powerful fault agent shall be foreseen. The event and fault reports being issued / produced in an automated manner by PDCAS, shall create for the user reports or Tables for statistical purposes.

### 2.3 Human Machine Interface requirements

The HMI shall be a high-resolution graphics interface for display and analysis of digital fault records. More specifically the waveforms of VA, VB, VC, V0, V2 and IA, IB, IC, I0, as peak values and as RMS calibrated values, in single phase and phase-to-phase quantities, as well as the respective phasor diagrams at selected by the cursor time instant will be at least illustrated.

The HMI shall allow for display and analysis standard and proprietary formats (ex. given SIEMENS-DIGSI, SEL, ABB, ALSTOM, GE etc, at least the ones foreseen for the very IEDs installed at the 17 feeders of present application) for transient and time sequence data. The IEEE Standard P37.111, 1999 COMTRADE format and a number of known derivatives must be supported. Bidders shall inform a list of formats with their offer that – beside the COMTRADE format – are supported.

Users on the tie-lines-PDCAS shall be provided with software tools to browse the various types of deposited formats or they can use S/W to manage and display the formats from a common interface. In these menus information such as : Substation, device, fault date, fault time, save date, save time, driver, filename, file type, file size, etc shall be made available and updated.

The HMI shall provide advanced analysis features for showing fault and disturbance plots, phasor diagrams, event sequences, etc. Bidders shall, with their offer, inform the different types of diagrams that can be displayed and shall provide sample displays.

The display and analysis software of the masterstation shall indicatively provide following features:

- It shall be capable of displaying on an UXGA screen all analogue waveforms and digital signals.

- It shall be capable of loading a complete or partial fault record. Several screens of data shall be held in memory at the same time so that scrolling through screens will be very fast.
- The user shall have the capability of starting with any channel of a fault record and at any point on a waveform.
- User-selectable amplitude, time bases, and waveform placement shall be possible. In addition, capability to place multiple waveforms on the same axis or inserting or deleting waveforms shall be required.
- Amplitude scaling of any analogue input trace up to full screen shall be required for ease in viewing.
- The placement of the cursor shall automatically give values in either PEAK or RMS as selected by the user. Multiple cursors shall be required to read the difference in time and the difference in amplitude of waveforms.
- The Masterstation shall identify each channel of a respective IED. It shall be capable of labelling each plotted output with the relevant information of the substation, feeder, date, time of trigger.
- The Masterstation shall allow the selection of a screen area for exporting to other S/W applications (e.g. word processor, drawing program).
- The Masterstation shall offer the possibility to display the digital event information contained in a record as a time tagged listing of the signal transitions (sequence of Event Recorder type listing). This listing shall be available for display or printing. Events shall be time tagged with appropriate precision.

## 2.4 Types of Information

Basically there are three types of protection data records: faults (transient data records), trends (steady state RMS data records with frequency relevant to such application) and events (relay targets and alarms data records). The System shall integrate and manage data according to the international practice of such applications. Bidders shall provide a list of data that will be included in all PDCAS components of their offered system. IPTO will declare the allocation and the identification of the data during the detailed design phase (customization) of the system.

IEDs' information have to be retained at the substation HDPC/Gateway, but only until the Masterstation collects them. They may be retained for hours or days, if the Masterstation is having troubles accessing them; consequently some data-memory at the substation level is necessary.

Examples of waveform data shall include: Oscillographic data (analogue & digital traces, angles, magnitudes, harmonics, status), Periodic Load Data (amps, volts, watts, vars).

Examples of critical reliability information shall include:

- Fault summaries (type, location, duration, magnitude, targets)
- Event Sequences (alarms, triggers, breaker operations)
- Planning Reports (total in/out, peaks, imbalances, efficiencies)
- Integrity Checks (connections, communications, storage)

Parts or all of these waveform data will be managed by PDCAS, as it is described in other chapters of present specifications. The bidders should size their devices and S/W to support certain needs concerning data of such in-the-state-of-art applications of electric utilities and submit with its offer examples of presentations. IPTO shall select and clarify the data and its standardization during the detailed design stage; but the system must be flexible for future modifications according the needs of the user.

## 2.5 Drivers for the IEDs

The bidder shall provide drivers for working with the relays of the feeders selected in the preceded Scope of Supply of the present. The price of the quotation will refer only the needed drivers for the installed numerical relays.

Nevertheless an extensive library of drivers for working with various types of IEDs and remote access connections including indicatively to following, shall be considered by the bidder as much as possible, after discussions with the user, and scoping the compatibility of the application with possible future integrating of other IEDs, instead of the very relays being installed at the 17 feeders of present application.

The manufacturers of distance protection equipment generally installed at the Greek Transmission System (only for information purposes and for eventual future expansion) are (in alphabetical order): ABB, ALSTOM, General Electric, Schweitzer, Siemens, VA-TECH, ZIV. For information purposes a list of Protection Relays and other IEDs installed in the «key-substations» is shown in referred file Doc 4.4.

Bidder can indicate financial conditions for the availability of other drivers at the disposal of the user, i.e. for drivers for modern relays of the makers included at the a.m. Table, and not being included at the list of the relays of tie-lines-PDCAS project.

In the event that any additional drivers and features are requested in the future, then the bidder shall develop such drivers and features and bill at rates that are mutually agreed upon.

It is possible in the future additional safety copies of the data at other (corporate) media to be needed (such as tapes etc). The equipment to be quoted will foresee the future implementation of this and the suggested methodology will be declared.

## 2.6 Substation Equipment and Communications

The communication set-up is briefly illustrated at Doc. 4.3. The communication of the IEDs with masterstation will be made through the internet corporate security network. This network and appropriate terminals/nodes at each S/S shall be provided by IPTO, meeting the needs of the tie-lines-PDCAS's supplier.

At all substations, with the eventually and appropriately applied telecommunication method, IEDs shall be polled periodically from the masterstation for their latest information (poll hourly / daily and/or upon request) according the international practice of such applications.

At substations where local data collection systems e.g. Digital Substation Control Systems (DSCSs) are available, it is preferable the IEDs to be polled through the existing LAN interface, independently of the DSCS. It is required to install a dedicated PDCAS-gateway connected to the LAN of the DSCS in order to access the IEDs of the bays (feeders), without any involvement of the existing local DSCS or SCADA. This is due to better reliability, overall security, systems independency etc. If the proposal by the bidder, according to its experience, is different but assuring same security and reliability, this could be an alternatively proposal and it is in the discrete choice of the user to make its selection.

At all substations Heavy Duty Industrial Type PCs / Gateways will be installed for following purposes: S/W running, files' storage, retrieval the data from the IEDs locally at the substation level. Purpose is –in case of failure of communication with masterstation, to have the data / files available locally, for separate local retrieval. These

Heavy Duty Industrial Type PCs / Gateways shall then communicate with the master-station through the IPTO infrastructure.

The Heavy Duty Industrial Type PCs/Gateways shall be of state-of-the-art design and shall satisfy following requirements:

- At each S/S the necessary set of HDPC/Gateways will be installed.
- Each PCs/Gateway shall be suitable for continuous operation in harsh environments and shall be compliant to IEC 60255 protective relay standards and shall withstand electrical surges, fast transient and extreme temperature.
- It shall be capable to operate on a wide range of power supply voltages and shall be connected to the safe power supply available at the substations.
- It shall be of modular design for easy expansion / connection of local IEDs. They shall have the necessary number of Ethernet ports and shall provide sufficient ports for connection of the local IEDs so that they can support present project, the seamless connection of the «optional equipment» and the future connection of additional Gateways, for the future expansion of this operation, i.e. the integration of additional compatible IEDs.
- It shall provide for a high availability and shall have no moving parts. Self diagnostic and watchdog facilities shall be implemented to detect and alarm malfunctions and failures.
- The HDPC/Gateways shall have a log-on system secured with passwords which shall be user configurable.
- Configuration of the local I/Os, processing functions and messages shall be possible through a simple GUI interface either locally or from the Masterstation. The local GUI consisting of keyboard, mouse and monitor will be provided by the user; they will be commercial type and they will follow the specifications of the bidder.
- The HDPCs/Gateways shall store all settings and configuration allowing for recovery after prolonged loss of power.
- The HDPC/ Gateways support all communication standards mentioned elsewhere in present text (e.g. paragraph 2.2.2).
- The necessary number of Gateways per substation will be provided for the communication and storage to be assured, with the foreseen capability for potential adding in the future of additional Gateways (out of present scope of supply) for additional feeders. No redundant devices are foreseen.
- Gateways will be designed in order to support the function of any devices that are considered as optional scope of supply. These cases are relays of older generation (those will be replaced with numerical compatible ones in the future), relays that are not distance relays (one case: line differential relay) and the specific feeder of the HVDC link Greece-Italy, where its integration have to be implemented via the control system of the Station. In case IPTO decide the implementation of the «optional» tasks, these Gateways will cover this need from the beginning.

## 2.7 Tests, commissioning and setting into operation

FAT: All relevant IEC / IEEE / EN foreseen tests shall be executed and the bidder shall declare its appropriate practice (Standards followed during FAT tests etc). Bidders shall inform their quality assurance procedures.

Installation and setting into operation will be implemented by the contractor i.e. by locally present staff of it or under its responsibility (via a reliable partnership). Specific items are mentioned for quoting at other (commercial) issues of this inquiry.

The Bidder shall test the tie-lines-PDCAS System and shall demonstrate its performance. The tests shall include communication with IEDs, the completeness of the data necessary for analysing the events, the collaboration of users' stations, the flexibility and expandability, the multifunction and the multitask functionality, etc.

SAT: The bidder shall inform the test which have been executed in similar projects for both H/W and S/W deliverables and the tests scheduled to be performed under the Inquiry in order to assure the specified functionality of the entire tie-lines-PDCAS system and it's interoperability with the complete IEIS system. Bidders shall further inform the Standards applied for the Tests.

Any peripherals, such PCs, tablets, printers, screens that are necessary for the operation of the system but are not included in the scope of supply, since they are considered as standard available by the company (user), shall be available during the tests, as well as any other apparatus necessary for the testing of the equipment.

## 2.8 Training, Support and Upgrades (maintenance services)

The bidder shall fully train the users of the PDCAS for a sufficient and reasonable time period assuring the absolute and trouble-free setting into operation of the PDCAS system, with all its functions, tools and features being described so far.

The deliverables shall include the license to use the S/W along with copies of the executable and the manuals in a number of copies as it is foreseen generally at the contract issues about the documentation to be delivered by the contractor.

For the duration of present project, the bidder's personnel will be authorized to access and work with the specified types of IEDs, their manuals, formats or any other documentation that is related to the project scope, and will treat with them in a confidential manner. In any case prior advice of IPTO and its written permission is necessary.

The bidder shall provide the user with a qualified development and technical support team. The team will answer questions about operating the program and shall provide training, installation instructions, quick start manuals, technical drawings, and/or any other type of documentation that is essential for the operation of the PDCAS.

For protocols / Standards foreseen and embedded in the relays, the documentation exclusively for them will be provided by the user free at the disposal of the bidder / contractor -as the user is the owner of the System and of the relays too-. Any additional documentation needed for the operation of the PDCAS shall be given by the contractor.

Upgrades that may be developed shall be made available electronically via a protected web site. The frequency of upgrades shall be informed by the bidder. Upgrading and generally annual maintenance cost and expert disposal for trouble shooting shall be given by the bidder.

### 3 Acronyms

CIM	Common Information Model for Electrical Networks
COMTRADE	Common Format for Transient Data Exchange
DSCS	Digital Substation Control System
EMS	Energy Management System
FAT	Factory acceptance tests
F/W	Firmware (S/W for IEDs)
GPS	Global Positioning System
GUI	Graphical User Interface
HDPC	Heavy Duty Industrial Type Local Process Unit with display and programming capabilities (like PC but dedicated for the tools of this application)
HIS	Historical Information System
H/W	Hard Ware
HUB	A networking device that allows one to connect multiple PCs
IPTO	Independent Power Transmission System Operator
HVC	High Voltage Centres, Substations (Greek abbrev. KYT)
GIS	Geographical Information System
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device (digital relay)
IEEE	International Electrical Electronic Engineers
I/O	Inputs / Outputs
LAN	Local Area Network
OS	Operating System
PDCAS	Protection Data Collection and Analysis System
PES	Power Engineering Society
PSRC	Power Systems Relay Committee
SAT	Site Acceptance Tests
SCADA	Supervisory Control and Data Acquisition
S/W	Software
TASE2	Telecontrol Application Service Element, SCADA Protocol
TSO	Transmission System Operator
UXGA	Ultra Extended Graphics Array
UI	User Interface
XML	Extensible Mark-up Language

### 4 References to Related Documents to this Specifications

Doc 4.1: List of Devices being in «PDCAS-tie-lines» connected (20150922-List-of devices.doc)

Doc 4.2: Map of Greek Transmission System w. PDCAS physical location (<http://www.admie.gr/...../20140414MAPofPDCAS2.pdf>)

Doc 4.3: PDCAS\_Configuration : main communications (indicative) ([http://www.admie.gr/.../ Visio-2015-09-23-PDCASconfiguration1.pdf](http://www.admie.gr/.../Visio-2015-09-23-PDCASconfiguration1.pdf) )

Doc 4.4: List\_of\_IEDs\_Protocols\_at\_PDCAS\_related\_substations (for information) [http://www.admie.gr/TIE-LINES-ONLY-PROTECTIONS-400-KV\(23-09-2015\).pdf](http://www.admie.gr/TIE-LINES-ONLY-PROTECTIONS-400-KV(23-09-2015).pdf)