 <p>ATTIKO METRO S.A.</p>	<p align="center">“DESIGN, PROCUREMENT, INSTALLATION AND COMMISSIONING OF TELECOMMUNICATIONS, LOW VOLTAGE AND CONTROL SYSTEMS IN THE THESSALONIKI METRO EXTENSION TO KALAMARIA”</p> <p align="center">DESIGN, PERFORMANCE, MATERIALS AND WORKMANSHIP SPECIFICATION FOR POWER REMOTE CONTROL SYSTEM (PRCS)</p>	<p align="center">RFP-380/20</p>
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Spec. Code	Specification Description
<p align="center">K_LV_DP015460</p>	<p align="center">DESIGN, PERFORMANCE, MATERIALS AND WORKMANSHIP SPECIFICATION OF POWER REMOTE CONTROL SYSTEM (PRCS)</p>




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1 GENERAL

- 1.1 This Specification will cover the principles and essential requirements for the design, supply, factory testing, shipment, delivery on-site, installation, site testing, commissioning, spare parts, special tools, training, technical support and corrective maintenance in the guarantee period for the Power Remote Control System (PRCS) of Thessaloniki Metro, which shall be extended from the “25th March” crossover to “Micra” Forestation, so as to cover the extension to Kalamaria [five (5) new stations]. This system shall be implemented in cooperation with the main contractor of the Kalamaria extension, who installs the power supply electrical systems themselves on the expansion, as well as in cooperation with the contractor of the Base Project of the Thessaloniki Metro, who installs the central PRCS systems in the OCC and the ECR, with which the PRCS system of the extension will be functionally interfaced.
- 1.2 Both the PRCS central system in the Operation Control Center (OCC) and the emergency control room (ECR) shall be required to be properly upgraded / expanded / modified in terms of hardware and software to serve the needs of the extension to Kalamaria. The existing central systems are installed in the Pylea Depot, while the remaining associated systems shall be installed in the new peripheral stations, crossovers, shafts and wherever else it is required.
- 1.3 The PRCS system is based on a fully redundant network of centralised computer system of high reliability and availability made up of industrial grade PC. The system provides control and monitoring capabilities for the various power supply systems and other electrical installations of the Thessaloniki Metro system. The system is of high-speed, continuous operation and scanning and shall be used in combination with the systems installed in all peripheral stations. It is pointed out the ECR, which incorporates the auxiliary central PRCS system, is installed in a room other than the OCC room, but also in Pylea Depot.
- 1.4 Under normal operation conditions, the Power Controller shall execute the control and monitoring functions from the OCC by means of the central computer system (FEP-TCI servers), and by means of four workstations equipped with 21” display units, keyboard and mouse. In addition, there shall be an industrial type PC with keyboard and mouse, which controls three 46” display units for reasons of better monitoring.
- 1.5 The ECR which will be activated in case of failure or shutdown of the OCC, is equipped with three workstation with a 21" screen, keyboard and mouse and three 46" screens, as well as with an additional industrial type PC type with keyboard and mouse that controls and manages the three 46" screens. The workstations as well as the 46" screens control and management computer communicate directly with the two central servers (FEP-TCI).

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- 1.6 The main operation of the PRCS system shall include for the extension project, but not limited, the remote control and monitoring of PPC (DEDDHE) circuit-breakers, load break switches, DC-supply track circuit-breakers, isolating switches, transformers, rectifiers, circuit-breakers and disconnecting switches, battery chargers, analogue measurements and calculated values, alarm signals and indications etc. The PRCS system must also feature data storage facilities and fault diagnostic software.
- 1.7 The PRCS system shall ensure that the large amount of the data received from the various power supply systems and other electrical installations at the peripheral stations shall be forwarded in real-time. This also applies to the PRCS system for the extension to Kalamaria. The memory capacity of the existing central system and the capabilities of the data transmission network is sufficient enough for the performed tasks required by the PRCS system, including the extension to Kalamaria.
- 1.8 The Contractor shall provide and/or modify the systems and equipment (both software and hardware) described in this Specification. The Contractor shall also provide the systems, equipment and functions not described or explicitly specified in this Specification, but which are required for the safe and reliable operation of the PRCS system on the Metro extension to Kalamaria.
- 1.9 The Contractor shall be also responsible to deliver a unified and functional PRCS system for the Base Project and the extension, regardless whether some or all the necessary details related to system or sub-system components have been included in this Specification or not.
- 1.10 The information presented in this Specification may not cover all the design criteria in details, such as, communication protocol, WAN/LAN network, software development, hardware / software integration, interface requirements, graphic displays etc. All information related to the existing system shall be made available to the Contractor upon his request to AM. The Contractor shall be responsible to the needed details in order to implement the system’s extension as required.

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2 REMOTE CONTROL AND MONITORING OF SYSTEMS AND ELECTRICAL INSTALLATIONS

2.1 The PRCS system (see schematic diagram below) shall control and monitor, but not limited to them, the following systems and electrical installations on the Line including the extension to Kalamaria, as mentioned below:

- a) PPC (DEDDHE) Circuit-breakers.
- b) 20kV MV Power Supply Distribution System.
- c) Power Distribution Transformers at the Stations.
- d) Measurement, supervision and analysis of energy quality (consumed).
- e) Stray currents in stations, in the tunnel and in the Depots.
- f) Differential protection and pilot line of the 20kV MV network.
- g) 750V DC Traction Power System (Transformer, Rectifier, DC Switchboard, auxiliary Transformer, short-circuiting devices etc.).
- h) 400/230V AC Low Voltage Power Supply Distribution Systems.
- i) Power factor correction System.
- j) Auxiliary Power Supply Systems (Batteries and Chargers).
- k) Traction Circuit Removal (TCR) System.
- l) Short-circuit devices (VLDs).
- m) The distribution switchboards of the Signaling and Telecommunication Systems.
- n) General Release (GR) and emergency Systems.
- o) Inter-tripping and Pilot-Line Systems.
- p) Other Station and Tunnel Installations.
- q) Items to become necessary as a result of the DFD phase.
- r) Traction Circuit Removal systems in emergencies.

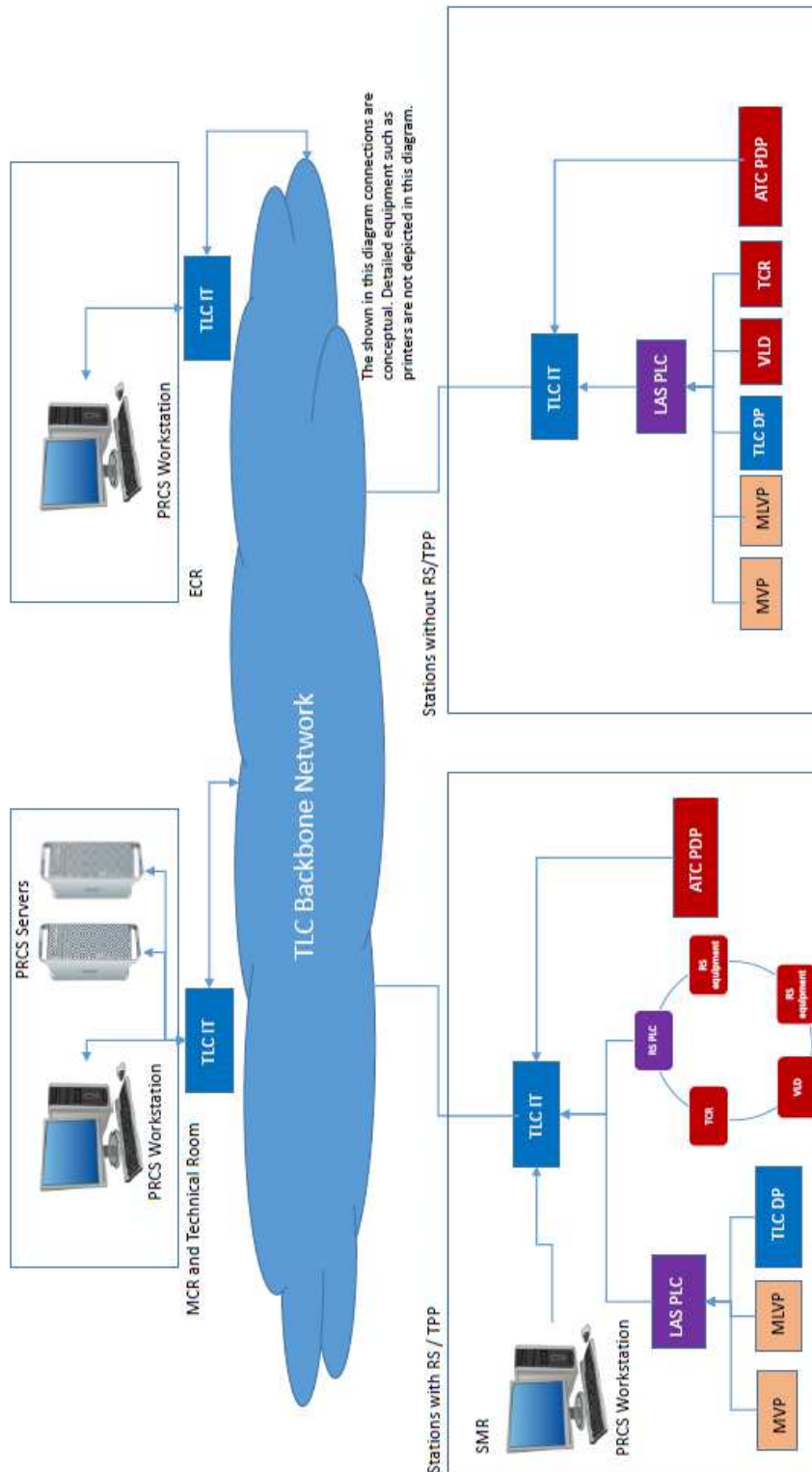



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SCHEMATIC DIAGRAM OF PRCS SYSTEM



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3 SYSTEM’S CAPACITY AND REDUNDANCY

- 3.1 The PRCS system as extended to cover the extension to Kalamaria, shall cover its normal functions related to the extension and the existing line, including the Depot, with redundancies at a minimum of 15% for each location (OCC, ECR, and associated new stations in the periphery) in hardware-software. Provisions shall be made for future incorporation of possible extensions. The exact number of the data points for the equipment in LAS, RS and MVP substations, tunnel recesses on the Line and wherever else required, shall be determined by the Contractor during the DFD phase.
- 3.2 The Contractor is obliged to prepare and submit to AM detailed information related to the control, monitoring and operation for all power supply systems and other electrical installations, which shall be remotely controlled and monitored by the PRCS system.
- 3.3. The main contractor of the Extension to Kalamaria has equipped the entire principle and secondary equipment of the stations with devices ready to be connected with the PRCS system.

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4 SPACE REQUIREMENTS FOR EQUIPMENT IN OCC AND ECR

- 4.1 The system shall terminate in OCC at Pylea Depot, where the Power Controller desks and the central computer system, four workstations and the Power Supply Mimic Panel comprised of three 46” screens and an industrial type PC serving as an Overview Server Manager of the three screens shall be installed. The ECR shall be equipped with three workstation with three 46” screens and an industrial type PC serving as an Overview Server Manager of the three screens. The spaces reserved for the above purposes are sufficient to accommodate the equipment, which shall be installed in order to fully serve the new extension to Kalamaria.
- 4.2 The OCC is equipped with a PC with a terminal screen (workstation directly linked with the LAN network) and a printer for covering maintenance / evaluation and other distributed functionalities of the PRCS. This system shall also incorporate the new stations of the extension to Kalamaria. The proposed system shall be submitted to AM for review and approval with all technical information concerning the hardware and software (similar to the respective soft/hardware of the central system).
- 4.3 The Contractor must investigate and ensure that sufficient space is available in the OCC and ECR to accommodate all new equipment to handle the immediate requirements of the extension to Kalamaria, as well of potential future extensions (e.g. to the airport). Otherwise, the Contractor shall advise AM and propose the optimum solution to tackle this problem.

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5 SYSTEM'S CONFIGURATION IN OCC/ECR AND PERIPHERAL STATIONS

- 5.1 The modifications / upgrades of the PRCS system in OCC, ECR and the relevant peripheral stations shall be subject to review and approval by AM. The system shall always guarantee operational efficiency, availability, reliability, expandability and compatibility for all required facilities, exactly as determined in detail in the various related parts of this Specification. The Contractor shall provide a complete reliability/availability analysis of the final PRCS system. This analysis shall be based on a calculation method.
- 5.2 The design of the PRCS system shall provide for various levels of means for addressing the possible cases of damages or failures regarding the equipment in OCC, ECR and related peripheral stations. In no case, a single fault, failures or damages in any of the sub-systems shall cause suspension in the operation of the entire PRCS system. The pertinent design shall be based on a calculation method and shall be subject to AM's review and approval. Any reference by AM to “system” shall always be regarded by the Contractor as including both hardware and the respective software.
- 5.3 The design of the PRCS system shall provide for various levels of addressing the possible cases of damages or failures regarding the equipment in OCC, ECR and related peripheral stations. In no case, a single fault, failures or damages in any of the sub-systems shall cause suspension in the operation of the entire PRCS system
- 5.4 The critical and/or sensitive equipment in the OCC, the ECR and the peripheral stations shall be installed in pairs. The Contractor shall inform AM about the equipment, so as to receive its approval after AM's review.
- 5.5 The critical and/or sensitive sub-systems in the OCC, the ECR and the peripheral stations shall be connected via redundant pairs to a 3rd sub-system in the form of a stand-by inactive redundancy. The Contractor shall inform AM about the specific sub-systems, so as to receive their approval after AM's review.
- 5.6 Other less critical sub-systems in the OCC, ECR and the peripheral stations shall be either in pairs, as regards operation, or with one active stand-by 1 in N after agreement with AM. The Contractor shall inform AM about the specific sub-systems, so as to receive their approval after AM's review.
- 5.7 The Contractor shall submit a schematic layout of the PRCS system in OCC and the peripheral stations, to demonstrate compliance with the aforementioned requirements and this Specification.

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6 OPERATING SYSTEM AND APPLICATIONS SOFTWARE

- 6.1 The Contractor will keep the existing operating system used by the PRCS system to the extension of the line. If any modifications to the operating Metro network are required, the Contractor shall be solely responsible for modifying or replacing, if necessary, the operating system (on account of the extension) and informing AM accordingly.
- 6.2 The operating system shall be based on a windows environment (of MS Windows type). The operating system shall be supported for a minimum period of 15 years after the Project's commissioning.
- 6.3 The applications software shall be user-friendly, flexible, customized to support its indented operation and shall support the functions of the Power Controller by means of an ergonomically designed user interface for future system's extensions. The operations shall be executed with the mouse or keyboards, in view of facilitating the system functions. It's the Contractor's responsibility to incorporate all new information in the applications software and/or required modifications. The new and modified data shall be subject to AM's review and approval.
- 6.4 The Contractor shall introduce the data processing framework, as well as the quantities of the customized data (new and old) of the proposed PRCS system for the Metro extension to Kalamaria. It shall be possible to increase the relevant quantities in the future.
- 6.5 The Contractor shall submit for AM's review and approval the documentation to demonstrate that the proposed operating system and applications software for the PRCS of the Metro extension to Kalamaria have been approved by recognized Metro or Railway authorities and have a proven record of operation in identical or similar equipment worldwide.

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7 EQUIPMENT IN OCC AND ECR

7.1 The PRCS equipment (hardware) of the workstation in the in OCC has been designed for high availability and full redundancy with a dual PC system (central – auxiliary station), comprising four workstations with industrial type PC, terminal screens and sufficient memory capacity.


7.2 The central computer system shall have the capability to operate under full workload, without reducing to the least its required performance upon incorporation of the extension to Kalamaria.

7.3 The OCC is equipped with workstations for the PRCS, which function as a “Man Machine Interface” (MMI), capable of remotely controlling and monitoring the various power supply systems and other electrical installations. The workstations in the OCC for the Power Controller(s) are consisting of the following items:

- a) Four (4) industrial grade PC's (19" racks) of high performance for control and display, automated functions, communication etc. The industrial PC's shall always guarantee reliable operation and high capability even in harsh environment and provide monitoring functions of their components.
- b) Four (4) high resolution LCD technology terminal color display units (21-inches), low power consumption, multi-level power management, low-radiation, immune to electromagnetic fields, integrated loud-speakers etc.
- c) Keyboards and mice of the latest technology for all PC's.
- d) Three (3) 46" display units.
- e) One PC connected to the central servers, which control the three (3) 46" screens.
- f) The PRCS printers in OCC are of general purposes, high speed, high quality, heavy-duty type and advanced technology. In the OCC there are one (1) printer of 136 columns for printing the alarms, two (2) black & white laser printers of the same type (protocol and event), one placed in the maintenance area and one (1) color laser printer for hardcopies. The printers are required for logging and printing the alarms, events, reports etc., as well as for the system's administration. The printers shall be appropriate for use in a Control Centre environment and shall be of high standards.

The ECR shall be equipped with the following items:

- a) Three (3) industrial grade PC's (19" racks) of high performance for control and display, automated functions, communication etc. The industrial PC's shall always guarantee reliable operation and high capability even in harsh environment and provide monitoring functions of their components.

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- b) Three (3) high resolution LCD technology terminal color display units (21-inches), low power consumption, multi-level power management, low-radiation, immune to electromagnetic fields, integrated loud-speakers etc.
- c) Keyboards and mouses of the latest technology for all PC's.
- d) Three 46" display units.
- e) One PC connected to the central servers, which control the three 46" screens.
- f) One (1) black & white laser printer.

7.4 The Base Project contractor has installed redundant communication systems and transmission networks in the OCC, ECR and the respective technical equipment rooms. The Contractor shall submit to AM for review and approval the detailed layout as required to support the extension to Kalamaria.


7.5 The capability must be provided to AM for immediate technical support by the system manufacturer, which shall be available via dedicated lines for direct connection to the PRCS system. The Contractor shall foresee all necessary protection and security schemes (passwords, firewall etc.), while the remote maintenance / technical support shall be provided in communication with the Operations Company and the OCC.

7.6 It is the responsibility of the Contractor of this Contract to verify the sufficient memory capacity of the central computers and workstations.


The Contractor shall propose the hardware and software that have been approved and operate properly and satisfactorily in identical or similar applications, as verified by recognized Metro or Railway Authorities. The Contractor, together with his offer, shall also submit a list of other projects to which identical or similar hardware has been provided by the proposed manufacturer / supplier. The Contractor shall guarantee the availability of spare parts for printers etc., as well as the technical support of the system for a minimum period of 15 years after the commissioning of the Project. The central computer system shall be capable of operating under full load without losing the required performance even to the minimum.

7.7 The layout of the entire equipment and/or modifications to the already existing equipment in OCC/ ECR and the technical equipment room (for maintenance and evaluation reasons) shall be subject to AM's review and approval. The Contractor shall prepare and submit to AM for review and approval General Layout Drawings.

7.8 The overall equipment to be supplied by the Contractor for the expansion of the PRCS shall carry, as a minimum, the manufacture's name and the year of manufacturing. The Contractor shall provide designation labels for all equipment and cable connections, which shall be subject to AM's review and approval.


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- 7.9 Communications and data collection system (FEP-TCI) in the OCC and the ECR.
- 7.9.1 The data collection / transmission and communication system (FEP-TCI) serves as the main interface between the central computer system and the processing units incorporating changeover and general update facilities. It consists of industrial type Servers (FEP-TCI) in hot stand-by. The incoming process data shall be collected there from all Remote Terminal Units (RTU's) at the peripheral stations and shall be converted for further processing in the central computer system. The ECR shall be connected to the two abovementioned servers. The Contractor will present in detail the modifications or upgrades to the FEP-TCI system (hardware and software) for review and approval by AM.
- 7.9.2 The FEP- TCI system shall be fully redundant for continuous operation and high availability. The Contractor is responsible to investigate the sufficient capacity of the existing FEP-TCI system to incorporate new data from the new installations and to support the upgraded function, which shall be subject to review and approval by AM.
- 7.9.3 The FEP-TCI system is the interface with the transmission system, which shall be used by the PRCS for data transmission / reception from/to the OCC and ECR and from/to the RTUs at the peripheral stations.
- 7.9.4 The central equipment of the PRCS system (FEP-TCI system) shall provide information regarding the presence of 750V DC voltage at the third rail, to inform the traffic control system to be installed in the OCC and ECR.
- 7.9.5 The hardware and software that will be provided for the extension to Kalamaria shall be of advanced technology and available for use at the time of the factory tests. The spare parts for the hardware shall be available for a period of at least 15 years after the commissioning of the Kalamaria extension project.

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8 RECONFIGURATION OF THE 20 kV NETWORK

- 8.1 The reconfiguration of the 20kV network shall be managed by the main servers of the PRCS in the OCC by transmitting the appropriate commands to the PLCs of the RTUs of the Stations and the Depot in case of a cable error or loss of voltage. The new stations of the Kalamaria extension shall be interfaced with the existing 20kV network resetting system. The Contractor shall communicate with the main contractor to ensure that this interface is ensured both in terms of hardware and software, with any items in addition to the items of the existing Base Project, constituting scopes of this Contract (see also par. 13.3)
- 8.2 The hardware and software supplied for the extension to Kalamaria shall be of the latest technology, and shall be available for use at the time of the factory acceptance tests. The replacement parts for all hardware shall be available for a minimum of 15 years after commissioning of the Thessaloniki Metro extension.

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9 NEW EQUIPMENT IN THE OCC

- 9.1 The Contractor shall supply one additional 46” screen of a technology similar to that of the existing screens in the OCC. This screen will be installed at a location already foreseen by the Base Project, adjacent to the existing screens. The Contractor is responsible for creating a new HMI that shall now be displayed on four 46” screens, including the extension to Kalamaria, as a single unified network. Similarly, an additional 46” screen of a technology similar to that of the existing screens in the ECR, as well. The Contractor shall have to create a new HMI in the ECR as well, including the extension to Kalamaria, as a single unified network. Both additional screens shall be compatible with the PC that controls them.
- 9.2 In order to cover the need of the PRCS system in the OCC, the Contractor shall supply new general purpose network printers, additional to the existing printers. The new printers shall be of high-speed, high-quality, heavy-duty and advanced technology. Specifically, the Contractor will provide in the OCC two black & white laser (2) printers of the same type (protocol printer and event printer) and one (1) laser printer for the of color printouts. Printers are required in order to record and print alarms, events, reports and also to manage the system. The printers will be suitable for use in a control center environment and will be of high standards. The Contractor shall pay special attention to the noise levels generated by the printers. The type of printers to be used for the needs of the PRCS system in OCC and in the technical equipment room (e.g. matrix type, color laser printer etc.) shall be subject to AM’s review and approval.
- 9.3 The installation of all new equipment or any changes to the already installed equipment shall take place in a way that minimizes the disruption in the operating Metro network. It is the Contractor’s responsibility to provide all the necessary modifications (in hardware and software) to the existing equipment in the OCC and the ECR (e.g. FEP-TCI system, workstations, Mimic Power Supply Panel, i.e. 46 " screens etc.), springing from the extension of the line. The Contractor shall be responsible for the work, the supply of all materials and upgraded drawings, which are subject to AM’s review and approval. The Contractor shall ensure that during the works for installation or modification, there are no conflicts with other Project disciplines regarding connections and interfaces.

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10 COMMUNICATION SYSTEM

10.1 Communication circuits Cabling

10.1.1 The central system of the PRCS shall be connected to the OCC and ECR and the local RTUs via two pairs of fiber optics, each one connected to the existing fiber optic cables ring, to be installed in the framework of the main contractor’s contract, and shall be terminated in each station, at the respective distribution panel. In the framework of the Contract, the Contractor shall perform all works (welding or bonding, local extensions, terminations, measurements etc.) that may be required in the respective fiber optics, in order to implement the topology of the double optic ring in the entire central and peripheral fiber optics network of Thessaloniki Metro.

The exact technical solution shall be finalized in the DFD assuring, thus, safe operation and maximizing the system performance.

10.1.2 The Contractor shall provide dual circuits for communication lines along the two independent and different cable routings in order to interconnect the OCC, the ECR and the relevant peripheral stations. This connection shall be realized using fiber optic cables. More details are provided in the Performance Specification for Telecommunications.


10.1.3 Each terminal RTU at the peripheral station shall be equipped with dual CPUs in hot stand-by mode, and dual communication cards and shall be connected to dual communication / link lines via the optical fibre rings of the data transmission network (along two independent and different routings). In case a communication line or a CPU cannot operate correctly, the RTU cubicle must be designed in such a way that it shall be possible for the one cable to transfer its function to the “healthy” one or the function to be transferred to the other CPU and the overall operation of the RTU shall continue smoothly, while an alarm signal shall be transmitted and simultaneously displayed in OCC and ECR.

10.1.4 The Contractor shall also specify the cables and main lines of communication for data transmission. The Contractor’s design shall aim at limiting induced voltages at the 750V DC conductor rail, the 20kV power distribution cables and the LV power distribution cables, which shall be routed parallel (this shall be implemented according to national and international standards to be required by AM).

10.1.5 For more details and requirements, see also the Performance Specification for Telecommunications and Low Voltages.

10.2 Data Transmission System

10.2.1 The Contractor is required to propose the type of the data transmission system for the extension to Kalamaria, along with the type of equipment in order to trace, locate and rectify the faults and/or alarms. The Contractor is also required to state the scheme of error detection and correction (troubleshooting) that is to be used, which shall be subject to AM’s review and approval.

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10.2.2 The proposed system must minimize the influences from interferences, which are generated by local increases of the earth’s potential due to the short-circuits of the power supply systems and/or the transitory phenomena in the batteries or battery charger units.

10.3 Communications Protocol

10.3.1 The Contractor is required to provide the communication protocol design among OCC, ECR and peripheral stations and depot, according to IEC 60870-5-104, 61850, DNP3, Modbus TCP/IP, OPC etc or equivalent standard. The current communication protocol is Modbus TCP/IP. This design shall cover at least the following criteria:

- a) Maximization of the efficiency of the communication channel.
- b) Transfer of the entire data volume required from/to the existing stations, as well as from/to the new stations.
- c) Data transmission speeds, aiming at satisfying the system’s respond requirements, both generally and on-a-per-case basis, as this speed is defined in the pertinent paragraphs of the Performance Specification.
- d) Minimization of the communication errors and assuring the correctness and completeness of the transmitted information data.
- e) Open protocol with the ability to communicate with industrial control systems and systems for the control of power substations manufactured by acknowledged firms.

The Contractor shall provide detailed technical documentation that demonstrates the minimum requirements (not limited to them) mentioned above and which shall be subject to review and approval by AM.

10.3.2 The Contractor shall provide in full details the “handshaking” sequence for the following (as a minimum):


- a) Control of all types of switchgears.
- b) Response to any change of the digital input status at the peripheral stations.
- c) Periodical updating of all static digital status.
- d) Updating of all analogue information from the peripheral stations.

The Contractor shall provide detailed technical documentation that demonstrates coverage of the above requirements, which shall be subject to review and approval by AM.


10.4 Protection against overvoltage

The personnel and the equipment must be protected against excessive voltages, which are induced in the lines and against direct contact with excessive voltages. The Contractor is required to state the protection concept and design, which shall be reviewed and approved by AM.


10.5 Remote Terminal Units (RTU) in the Peripheral Stations

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- 10.5.1 The operation and purpose of the Remote Terminal Units (RTU's) at the peripheral stations is to remotely control/test and monitor directly the equipment of the various power supply systems and other electrical installations. All connections with electrical equipment of the facilities shall be hardwired and shall be fed by the RTUs, terminating within the RTUs cubicles.
- 10.5.2 The RTU's cubicles at the peripheral stations shall be equipped (among other devices) with the appropriate input/output modules (digital and/or analogue) for the execution of the required functions (process, control, monitor etc.).
- 10.5.3 All input modules within the RTU's cubicles at the peripheral stations shall collect and store information independently and be available for retrieval during the scanning cycle.
- 10.5.4 All input modules within the RTU's cubicles at the peripheral stations shall be updated on a continuous basis.
- 10.5.5 The RTU's cubicles shall be designed in such a way that an extension of the installation to cover future needs shall not present any difficulty to add the necessary elements (hardware and software) and shall minimise the future interruptions of the Metro system operation. This requirement is also necessary for maintenance purposes.
- 10.5.6 The major functions and operations to be performed by the RTU's cubicles at the peripheral stations shall be, but not limited, the following:
- a. Continuously and automatically cycle scanning of the whole digital status of the various electrical installations in technical rooms and immediately recording of any change in OCC and/or ECR.
 - b. Execution of the remote controls and performing tests in RTU's cubicles at the peripheral stations.
 - c. Perform the analogue / digital conversions for the analogue signals and transmission of the information in a digital form in OCC and/or ECR.
 - d. Pre-process of the collected data from RTU's cubicles at the peripheral stations, before any transmission to the OCC and/or ECR.
 - e. Execution of all required polynomial time controls.
 - f. Periodical overview of the system's status, stored in the OCC and/or ECR.
- 10.5.7 The industrial Programmable Logic Controllers (PLC's) installed within the RTU's cubicles shall have the following characteristics, as a minimum:
- a) Self-monitoring to any faults in the system.
 - b) Troubleshooting for maintenance items.
 - c) Detecting absence of voltage and restoring it.
 - d) Ensuring a fail-safe system.
 - e) Clock of the exact time periodically checked from OCC / testing.
 - f) Time synchronization with the rest of the system.
 - g) Locating faults.


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- 10.5.8 Dual communication / link lines shall connect each terminal RTU at the peripheral station. In case a communication line cannot operate correctly, the RTU cubicle must be designed in such a way that it shall be possible for the one cable to transfer its function to the “healthy” one and the overall operation of the RTU shall continue smoothly. An alarm signal shall be transmitted and simultaneously displayed in OCC and ECR.
- 10.5.9 The Contractor shall provide means to interface each RTU in each peripheral station to connect the maintenance equipment or any other portable equipment for RTU testing and control purposes. The Contractor shall provide to AM a portable programming device with all necessary software.
- 10.5.10 The RTU’s cubicles at the peripheral stations, which shall be based on industrial Programmable Logic Controllers (PLC’s), must be provided, as minimum, with the following:
- a) The program for storage in the memory must be of the non-volatile type.
 - b) The available memory capacity must have a 30% redundancy for future extension.
 - c) Software description, specifications and installation method for the software for the RTU’s cubicles at the peripheral stations.
- 10.5.11 The firmware of the equipment within the RTU’s cubicles shall be identical and exchangeable in the new RTU’s cubicles at the peripheral stations.
- 10.5.12 The Contractor is obligated to provide detailed technical description of all equipment (hardware) and software, which are related with the Programmable Logic Controllers (PLC’s) and shall be installed within the RTU’s cubicles at the peripheral stations.
- 10.5.13 During the reactivation of any RTU cubicle of a peripheral station (which was previously switch-off), the time required for the exchange of information between OCC and/or ECR, must be less than ten (10) seconds.
- 10.5.14 The proposed hardware and software for the RTU’s cubicles at the peripheral stations supplied for the Kalamaria extension Project shall be the latest series and advanced technology available for use at the time of the factory tests. The replacement parts for all hardware and software shall be available for a minimum of fifteen (15) years after commissioning of the Thessaloniki Metro Extension.

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11 NEW EQUIPMENT FOR RTUs

The installation of all new equipment or any changes to the already installed equipment shall take place in a way that minimizes the disruption in the operating Metro network. It is the responsibility of the Contractor to provide all necessary modifications (in hardware and software) to the existing RTU equipment in the LAS and RS of the 25th March Station and in the 25th of March crossover, as required so as to serve the needs of the extension to Kalamaria, the reconfiguration of the Medium Voltage - 20 kV power supply in case of loss of the permanent supply, for the 750 V DC Traction Equipment and for the Power Distribution. The Contractor shall be responsible for the work, the supply of all materials and upgraded drawings for reviews and approval by AM. The Contractor shall ensure that during the works for installation or modification, there are no conflicts with the foreseen operation, the connections and interfaces with the existing Power Supply systems of the Base Project and the extension which are installed by the main contractor.

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12 SYSTEM INTEGRITY

The integrity of the PRCS system shall cover, as a minimum, the following requirements:

12.1 Failures of RTU's cubicles at the Peripheral Stations

12.1.1 The defective operation of one or more RTU's cubicles at the peripheral stations shall not prevent the remainder of the PRCS system to operate properly, independently, reliably and continuously. Furthermore, an alarm signal must be transmitted to OCC/ECR, which shall indicate that one or more defective RTUs are to be found at some location.

12.2 Verification of the Status

The PRCS system in OCC and ECR shall verify prior to any commands for operation will be carried out, the acceptable condition of all types of switchgears and other electrical installations. The verifications shall be made in the OCC and ECR, as well as at the RTUs in the peripheral stations. This action shall nullify the possibility for activating a switchgear of any power supply system, which must not be activated. The scanning cycle of the RTU's cubicles will ensure always the actual status of all types of switchgears and other electrical installations. The design of the system must be such that any failure condition in one part shall not create undesirable disturbances in the remaining equipment of the respective circuit. The Contractor shall provide detailed technical information, which shall be subject to review and approval by AM.

12.3 Reverse Status Verification

12.3.1 The actual status of all types of switchgears shall be transmitted in two statements.

12.3.2 The alarms signals, faults etc. shall be checked via the inverse status.


12.3.3 The reverse condition shall be tested in all cases. An error in the tests for the reverse condition shall produce an alarm signal, which shall be transmitted to OCC and ECR.

12.4 Safety against Electromagnetic Interferences for the PRCS

The offered systems shall work satisfactorily and shall be able to withstand the following (but not limited) electrical disturbances:

- a) Lighting circuits.
- b) Surges, switching spikes and fluctuations.
- c) Traction power supply switching spikes and fluctuations.
- d) 20kV power supply switching spikes and fluctuations.
- e) Excessive electromagnetic connections from relays, transformers etc.
- f) Lightning.

All designs, materials and equipment shall continue to work correctly and safely in the presence of Electro-magnetic fields (EMI) generated by other

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equipment. The Contractor must identify the specific (EMI) sources and to provide adequate screening or other remedial measures.

12.5 Doubling equipment and subsystems (see section 15.6)

12.6 Failure of the Communication Lines

12.6.1 The communication lines between OCC, ECR and RTU's cubicles at the peripheral stations shall be double (in pairs - two independent and separate runs of cables) in accordance with Section 10 of this Specification. Any failure of one communication / data transmission line shall not result in loss of memory and information. Switching to the alternative communication / data transmission line shall be automatic.

12.6.2 The alarm signals, which indicate the faults in the communication / data transmission lines, shall be recorded by the PRCS system. All information and operations shall continue in the alternative communication / data transmission line.


12.6.3 Under normal and regular operation conditions, the PRCS system shall transfer all communication with the RTU's cubicles at the peripheral stations from one communication / data transmission line to the other through switching - periodically - to secure the integrity of both connections of communication from OCC/ECR to the RTU's cubicles. All switching actions in the communication / data transmission lines shall be reported and recorded in OCC and ECR. Any switching error shall be reported and recorded in OCC and ECR.

12.7 Failures to the Power Supply at OCC and ECR

12.7.1 In order to avoid any damage to the main power supply to the PRCS system in the OCC and ECR, a stand-by power supply shall be provided (for more details, see the relevant paragraphs later in this Specification). Any switching to the auxiliary power supply shall not trigger any loss in the software or data stored in the memory. Any changes / modifications to the normal power supply shall be monitored and recorded in the OCC and ECR and shall be always accompanied by an audible alarm.


12.7.2 In case of failure or malfunction of the central remote control system and / or total failure of the transmission / communication lines, all central terminal screens shall continue to display the conditions prior to the failure or malfunction. Furthermore, it shall be clearly indicated that the information displayed in OCC and ECR is "frozen". After the rectification of the failure or malfunction, the PRCS system in OCC and/or ECR shall update automatically all controlled and monitoring points, alarm signals, analogue measurements and calculated values etc. and afterwards shall continue to operate as usual.

12.7.3 The entire process of the start-up of the PRCS system (reboot or automatic restart after power failure) shall be less than five (5) minutes. The time for the automatic switching from the central computer to the stand-by computer shall not exceed ten (10) seconds. However, the

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actual equipment status of all power supply networks shall be presented on the Power Supply Mimic Panel (and VCP panel), independently from the display on the central computer system, due to hardwiring via the FEP-TCI system. In case the Power Controller carries out a manual switching, the entire process shall take less than one (1) second.

- 12.7.4 Due to critical situations (especially for the automatic reconfiguration of the LAS network of the medium voltage loop), the automatic changeover process of the FEP-TCI system in OCC (in case of failure of one FEP-TCI) shall take within less than one (1) second.
- 12.7.5 The reboot time for the FEP-TCI system including the actual equipment status of all power supply networks on the Power Supply Mimic Panel (46" screens) in OCC and ECR shall be accomplished in less than ten (10) seconds, after rebooting. Therefore the complete status on the PRCS system shall be available in OCC and ECR in less than ten (10) seconds.

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13 KEY FUNCTIONS AND CAPABILITIES OF PRCS SYSTEM IN OCC AND ECR

The key functions of the PRCS system in OCC and ECR shall be, as a minimum, the following:

13.1 Data transmittal and reception to / from the Equipment at the Peripheral Stations (via the RTU's).

13.1.1 The PRCS system shall continuously scan all RTU's cubicles at the peripheral stations, in accordance with a predetermined procedure, which shall be subject to AM's review and approval. The analogue data (measured and calculated values etc.) from the RTU's cubicles at the peripheral stations shall be collected and transmitted digitally to OCC and ECR.

13.1.2 The Contractor shall state the transmission protocol between OCC and RTU's cubicles at the peripheral stations.

13.1.3 The data, which return to OCC and/or ECR, shall be stored in the memory of the FEP-TCI central computer system for processing and logging purposes. All indications and tests of all types of switchgears in technical rooms shall be transmitted as related to two conditions, whose reverse status shall be verified in each case.

13.2 Remote Control of the Equipment


13.2.1 The remote control (or testing) and remote monitoring of the equipment of the various power supply systems and other electrical installations shall be done exclusively and solely through the RTU's cubicles at the peripheral stations.

13.2.2 For safety reasons, prior to the activation of any type of switchgear at the peripheral stations, all commands (for control operation and tests purposes) shall pass through software and hardware verifications. The regular process of selection, verification by the user and execution shall be performed for all equipment at the peripheral stations.

13.3 Control Sequence Functions and Automations

Within the framework of the proposed PRCS system for the extension to Kalamaria, the Contractor shall provide various control sequence functions and automations, as per the requirements. The main contractor of the Kalamaria extension shall provide the procedure for automatic reconfiguration of the 20kV network in the LASs for the new extension to Kalamaria, after an internal or external fault in the Medium Voltage power supply network. More information is available in the MV Power Supply Specification of the main contractor of the Kalamaria extension, as well as in section 8 of this specification.


13.4 Data processing

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- 13.4.1 The following processing, as minimum, shall be performed on the data collected by the RTU’s cubicles at the peripheral stations:
- a) Changes in the reporting and analysis conditions.
 - b) Escalation and control of the analogue thresholds.
 - c) Recording of analogue value etc.
 - d) Completion of switching and tripping operations of all types of switchgears and alarm signals.
 - e) Real-time display / reporting of the system’s conditions.
 - f) Recording of system control, operation and failures.
 - g) Verification of the integrity of the system’s hardware and software.
 - h) Preparation of daily, weekly and monthly reports by the maintenance / evaluation computer system as well, in the technical equipment room.
 - i) The system-stored data and the customized database shall be available to be exported by the Power Controller in a form suitable for analysis by using the latest version of commonly available applications (e.g. Excel, Word, Access etc.).

13.5 Processing of the Power Controller Commands


- 13.5.1 The Power Controller shall communicate with the PRCS system through the mouse and data input via the keyboards of the central computer system. Prior to login in the central computer system, a password must be transmitted using a pre-selected security code. In case the Power Controller leaves his workstation, a simple process shall be foreseen to give the logout signal. The details about login/out the PRCS system from the central computer system shall be always recorded in the event logs.
- 13.5.2 The Contractor shall specify not only the access rights, but also, the control functions that can be accessed, not only by the Power Controller, but also by other authorized users. The access rights shall be granted individually by the system’s administrator and shall be basically linked with the Power Controller. The system administrator shall assign the passwords, user’s initials and any other access rights for each authorized user.
- 13.5.3 Any user shall have access to the corresponding functions by entering his name and corresponding password, when logging into the system. Login and logout for the system’s operation shall be possible at any time during the 24/7 operation of the PRCS system. All actions carried out by the users shall be entered in the log (e.g. login, control etc.). At any particular time, only one user shall be permitted to log into the central terminal unit. When a new user logs in, the previously logged-in user shall be logged out.
- 13.5.4 The PRCS system provides several levels of authorization related to the fields of responsibilities and related actions. All related details concerning

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the aforementioned authorization levels shall be available from the main contractor of the Kalamaria extension.

13.6 Conditions in Real-Time

- 13.6.1 The system’s conditions shall be displayed in real time on the terminal screens of the central computer system and shall be also printed by the associated printers in OCC or ECR. The information shall consist (as minimum) of “on/off” status of all types of switchgears, faults, alarm signals, events, mode of operation, analogue measurements and calculated values such as A, kV, V DC, kVA, MW, kWh etc. from all the electrical installations. The fault indications and alarm signals shall be necessarily accompanied by distinct audible signals for acknowledgement. For the sake of easy visual recognition by the Power Controller, all information related to the each alarm signal shall be in a flashing condition.
- 13.6.2 The flashing condition shall return to a stable one with a different color, after acknowledgement from the central terminal screens of the Power Controller and to stable condition on the Power Supply VCPs in OCC and ECR.
- 13.6.3 The central computer system shall be able to use the editor to provide a number of pages on the terminal screens in order to cover the successive demands of the Power Controller. Each screen page shall include a mixture of permanent information (static data) and dynamic data of the system. The dynamic data shall be at least, as minimum, alarm signals, conditions of all switchgears, analogue measurements, calculated values, track voltage presence, time and date etc.
- 13.6.4 The Contractor shall introduce picture diagrams on the central terminal screens that shall be created to fulfill AM’s requirements for the control and monitoring functions of the various power supply systems and other electrical installations. Overview diagrams for Rectifier Substations (RS), Medium Voltage Power Substations (MVP), Lighting and Auxiliary power Substations (LAS), traction diagrams, other networks, electrical equipment and systems etc. shall be either generated or modified (the existing ones) by the Contractor and shall be reviewed and approved by AM.
- 13.6.5 The rows of all reports (e.g. in the alarm panel etc.) on the terminal screens of the central computer system shall include the alarm signals or events. The alarm panel shall be resizable. The Power Controller shall be in a position to change the height of the displayed window and consequently the number of the appearing alarm or event rows.
- 13.6.6 The Contractor shall submit, for AM’s review and approval, a color photographic sample for each category of the terminal screens, which shall be included in his offer, from identical or similar PRCS systems designed by him and approved by recognized Metro or Railway Authorities worldwide.

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13.7 Regular Event Log


- 13.7.1 Any report on the terminal screen shall be output at the event Logs. An option shall be provided to allow the Power Controller to select printer, where the reports of the terminal screens shall be printed. The Power Controller command for printouts of the requested reports shall be aborted, if the Power Controller does not execute the printing command in a certain frame time. The condition of the printers and their availability shall be monitored continuously by the Power Remote Control System.
- 13.7.2 The system shall provide the possibility for regular recordings of the selected screen pages. The frequency of the recordings and the selected screen pages shall be regulated by the mouse and/or the keyboards of the central workstations.
- 13.7.3 The recording intervals shall be determined by the Contractor and shall be approved by AM. The protocol printer shall operate on a 24/7 basis providing printouts of all the commands, status changes of all types of switchgears, alarms, events, analogue values etc.

13.8 Requirements of the Event Log

- 13.8.1 Any central workstation can be used to issue a print command for any condition. For this function, the mouse or the keyboards and the printers shall be used. It shall also be possible for the Power Controller to request for any printout of the reports appeared on the terminal screens by means of the mouse or the keyboard.
- 13.8.2 The system shall provide the possibility to transfer the complete content of the terminal screens to the hard-discs archive for printouts and afterwards to the event log.
- 13.8.3 The event log, which shall be saved and retrieved under a specific name, shall be created “on-line” by the Power Controller or the system’s administrator by using the editor. The Contractor shall specify the log functions, which shall be subject to review and approval by AM. Additional functions, as required, shall be provided by the system.

13.9 Event Log

- At least the following information shall be logged onto the event log according to their sequence:
- a) All control functions.
 - b) All changes in the condition of the alarm signals.
 - c) All changes in the analogue values.
 - d) All changes or modifications in the system’s parameters.
- 13.9.1 Events (change of status) shall be recorded on the precise date and time they took place (0,5% of a second). The Contractor shall pay special attention to the time the event was recorded. The event log time shall be

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the real time when the event occurred and the same shall be valid for the respective recordings at the printers.

- 13.9.2 The events and alarms shall be chronologically classified and afterwards the central control system shall evaluate the chronological order. The actions of the Power Controller shall not delay the indication of the system status in real time. The evaluation shall be carried out by the central system in background mode. The Power Controller shall be notified when the evaluation is completed. This evaluation can be displayed or printed (if requested by the Power Controller).


13.10 Summary of the Alarm Signals

A dynamic list of the alarm signal condition at all workstations shall be available. The conditions shall be shown on the terminal screens of the central computer system or shall be printed in the hardcopy printer and shall be shown in the event log. The Contractor shall provide also the option to produce printouts from the maintenance printer located in the technical equipment room.


13.11 Preparation of the Daily / Weekly / Monthly Reports

- 13.11.1 All information, as reported by the event log, shall be stored on the hard-disc and shall be available for the preparation of the reports. The reports shall be executed either by the central computer system or the maintenance computer system located in the technical equipment room. The Power Controller shall execute at any time the activation of the preparation of reports. The printer in the OCC/ECR or the printer located in the technical room shall produce the relevant printout.
- 13.11.2 The typical daily reports shall comprise all information and shall be recorded in various categories. The Contractor shall determine these categories in his offer. All these categories shall be printed at the discretion of the Power Controller. The Contractor shall provide the relevant information, which shall be subject to review and approval by AM.
- 13.11.3 The system shall provide daily, weekly and monthly reports. Their format and the structure shall be subject to review and approval by AM.
- 13.11.4 The capacity of the archive buffer for such database shall be able to store, at least, 20000 recordings of all alarm signals and history events occurred in an archive covering as a minimum 30 days. Alarm signals shall be activated in case the size of the archive buffer is not sufficient for the alarm entries. The activation level of the alarm signals on the central terminal screens is required, when more than 80% of the useful memory capacity has been filled. Moreover, the PRCS system shall provide an alarm buffer for up to 200, at least, alarm entries on-line into the alarm table, which shall be sorted according to the priority of its alarm class. The relevant documentation shall be subject to review and approval by AM.

13.12 Energy Quality Metering and Monitoring

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The PRCS system shall be upgraded / expanded / modified so as to monitor the active and reactive energy consumption and the maximum power demand at the MVP/LAS substations and RSs throughout the extension of the line to Kalamaria. It shall also monitor the quality of the supply voltage in respect to other critical factors, for example, harmonics content etc. The measured values shall be transmitted to the central computer in OCC and ECR for display, recording and further processing. For additional information please refer to the Medium Voltage Power Supply Specification of the main contractor of the extension, which will be available.

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14 INTERFACES OF PRCS SYSTEM IN OCC


14.1 Power Supply Mimic Board (VCP)

14.1.1 A Power Supply Mimic Board is provided for the existing line and the Depot. It is installed in the OCC and the ECR at Pylea Depot. The Mimic board consists of three 46” screens and is specifically installed on the Power Controller’s workstation. Yet one similar 46” screen shall be installed to cover the extension needs.


14.1.2 The following information, but not limited, shall be displayed on the these 46” screens for the existing operating segments, as well as for the extension to Kalamaria, from 25 March station to Micra forestation, including Pylea Depot:

1. Upper portion, for the 20kV Medium Voltage Distribution System of the Line (including the extension to Kalamaria) and Pylea Depot.
 - a) Conditions of all circuit breakers of PPC (DEDDHE).
 - b) Conditions of all 20kV circuit breakers in MVP substations and in LAS.
 - c) Voltage indicators of PPC (DEDDHE) circuit breakers.
 - d) Voltage indicators of 400V AC power supply to the main Low Voltage Switchboards at the LAS stations.
2. Middle portion for the 750V DC Traction Power Supply System:
 - a) Conditions of all 20kV all power supply sources from PPC (DEDDHE) circuit breakers in the Traction Substations (RS).
 - b) Conditions of all 20kV circuit breakers in the Traction Substations.
 - c) Conditions of all DC power supply circuit breakers, traction breakers and remote controlled switches.
 - d) Conditions of all DC switchgear in the Depot.
 - e) Voltage indicators of PPC (DEDDHE) circuit breakers and 750V DC circuit breakers.
 - f) General alarm indication (RTU fault) of all traction substations.
 - g) Status of the Traction Circuit Removal (TCR) system of all Traction Substations.
 - h) Status of the “emergency” General Release (GR) system of the Traction Substations.

14.1.3 All AC and DC circuit breakers on the Power Supply Mimic Board shall have a different illuminated indication for “open” and “closed” position. A change in the condition of the circuit breakers or any switching element, which is not received, shall be displayed by a stable indication in yellow color.


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- 14.1.4 The condition of the electrical equipment on the Mimic Board shall be automatically updated. The updating time for the invariable conditions shall not exceed 15 seconds.
- 14.1.5 In case of failure or damage in the control central system and / or total failure of the transmission line or the communication system, all indications on the Mimic Board shall continue to show the conditions just prior to the failure. After the system’s restoration, all remote control and monitoring equipment as well as all indications shall be updated automatically on the Mimic Board and afterwards shall continue its regular operation.
- 14.1.6 The texts shall be in Greek language. The Contractor shall use different colors for the various voltage levels e.g. 20kV, 750V DC, 400V AC etc. The color, height and width of the fonts and numerical characters, as well as of the various symbols shall be in compliance with current fonts of the Mimic Board.
- 14.1.7 The Contractor shall offer a full description of the Power Supply Mimic Board with dimensions on scale related to the extension to Kalamaria, as displayed in the 46” screens. He shall also submit the diagrams to be projected on the Mimic Board for AM’s review and approval, as well as color photographs of similar Mimic Boards recently submitted in the framework of other contracts.
- 14.1.8 The installation of the entire new equipment or any modifications to the existing Power Supply Mimic Board shall take place in a manner minimizing disruptions to the Metro system operation.
- 14.1.9 The Contractor shall be responsible for the cabling, codification and routing of all connections from the central equipment room to the two Mimic Boards in the OCC (Power Supply and Traffic Mimic Boards), as well as in the ECR, to the extent required in the framework of the extension to Kalamaria.
- 14.2 Traffic Visual Control Panel (VCP) for Train Circulation**
- The central equipment of the PRCS system (FEP-TCI system) shall provide information regarding the presence of 750V DC voltage to be projected on the Traffic Visual Control Panel installed in OCC and ECR (in front of Traffic Controllers workstations). The Contractor is obliged to incorporate the new information concerning the extension of the line, including the Depot, as well as to implement the said modifications.
- 14.3** The PRCS system shall be also interfaced with the TLC/ICCS, ATC (ATS) receiving all signals from the distribution switchboards of the aforesaid systems; it shall be also interfaced with the SMS and Time Server systems and the Contractor should respectively interface same with the extension of the PRCS system to Kalamaria.


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15 POWER CONTROLLER’S WORKSTATION


- 15.1 The workstations in OCC are provided for the permanent operation on 24-hours basis of the PRCS system by the Power Controller.
- 15.2 The design of the workstations is based on ergonomic principles, which are accepted by the industry and meet accepted medical standards in respect to preventing repetitive physical strains especially protecting the operator’s back and eyes. The same are valid for the ECR as well.
- 15.3 The information provided in the following paragraphs shall be the main functional requirements of the central terminal screens and the data input by the keyboards or mouse.
- 15.4 Any central terminal in OCC and/or ECR shall permit the remote control operations of any electrical installation by the Power Controller, in accordance with a detailed description, which shall be available to AM for review and approval after the signing of the Contract.
- 15.5 The remote control operations (via commands) shall be carried out by the mouse or data input via the keyboards of the central computer system. The functional sequence for the controls shall be the selection, control, execution and final configuration e. g.:
- a) Selection of the remotely controlled component by the mouse. A subsequent flashing condition of the selected component shall appear.
 - b) Verification that the proper component has been selected.
 - c) Display of the possible actions, which the Power Controller can execute (in the window menu).
 - d) Execution of the required command (by selection within the window menu).
 - e) Expected status of the component shall be flashing until acknowledgement command has arrived or has timed-out.
 - f) The final indication status shall confirm the correct execution of the command. The monitoring of the command execution shall conclude to the successful result of the control operation with a subsequent display of the component in the actual status (steady state) without alarm indication. In case there is an unsuccessful result of the control operation, the status display of the component shall change into the actual status and a respective message shall appear in the alarm list. The alarm indication of an unsuccessful control operation shall be configured for each electrical installation of the extension Project.
 - g) It shall be always ensured that the information displayed on the workstations or elsewhere in OCC, ECR (e.g. printers, Power Supply and Traffic VCPs, maintenance room etc.) shall be always consistent (correct information from the various electrical installations of the extension Project).

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- 15.6 A schematic diagram shall describe the above sequence to show the response time of the controls. AM shall be fully informed of the aforementioned sequence by the Contractor.
- 15.7 The control confirmation shall be configured separately for each individual network component of the extension project. The Contractor shall provide all required information for review and final approval by AM.
- 15.8 The central terminal screen shall schematically display the various power supply systems and other electrical installations. The components of the networks and other electrical installations and sub-systems shall be arranged in project diagrams, which shall have a physical interface with the actual process.
- 15.9 The current status of all types of switchgears, alarm signals, indications, analogue measurements and calculated values etc. shall be displayed on the central terminal and maintenance screens. The display shall be divided into screen pages, which shall be reviewed and approved by AM. The Contractor shall inform AM about the content of the new screen pages and/or other modified ones during the General Final Design of the extension project. AM shall review and approve all the central terminal screens (new and modified) of the PRCS system.
- 15.10 All measured values shall be displayed graphically by curves on the central computer. The Contractor shall determine the resolution of the curves. The Power Controller shall be able to select, print and store the curves in the computer system (in OCC, ECR or technical room). Saving shall be easily accomplished by the Power Controller for further processing.
- 15.11 The application software shall provide the option to the Power Controller to make modifications or corrections in the pages on the central terminal screens, when it is required. All software tools shall be made available to the Power Controller by the Contractor.
- 15.12 The alarm signals, which shall be accompanied by audible signals, shall be silenced by pressing a button of the keyboards of the central computer system or by the mouse.
- 15.13 The Power Controller shall be able to display easily the complete screen page, which is associated with the specific alarm signal, by using the mouse or the keyboards of the central computer system.
- 15.14 The non-audible signals shall be also displayed on the terminal screens. The alarm signals shall include, but not limited to, the following:
- a) Change of signal status.
 - b) Analogue thresholds of signal.
 - c) System errors.
- 15.15 The Contractor shall also adhere to the requirements of Section 13.6 herein.
- 15.16 The oldest not acknowledged signal shall be displayed in all screen pages, which are related to this signal.

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- 15.17 The main computer shall contain sufficient storage space with an additional 30% capacity including the output gateways.
- 15.18 The non-controlled status changes shall be displayed as flashing symbols. The symbols shall represent the affected equipment. The symbols shall be flashing, until the Power Controller shall acknowledge the condition. These conditions shall be recorded as alarm signals.
- 15.19 The transient status changes shall be processed in the same way as the regular changes. A flashing symbol shall represent the equipment unit and not its current status. The Power Controller shall recognize and “put-off” consequently the system’s exit from the transient alterations.
- 15.20 A status change due to a fault, which put an equipment unit in a transitional condition, shall be recorded. The symbol of the equipment unit shall be flashing until the condition is acknowledged.
- 15.21 The Contractor shall provide means to interface with the central computer or the FEP-TCI system to connect the maintenance control equipment or any other portable equipment for testing and control purposes. The Contractor shall provide to AM a portable programmable device with all necessary software.
- 15.22 The proposed PRCS system shall be continuously self-monitored.

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16 POWER CONTROLLER OPERATIONS AND INDICATION COMMANDS

16.1 General


The Power Controller shall regularly control and monitor the equipment of the various power supply systems and other electrical installations by messages and commands, which exchange information with the system’s application software. The messages shall be normally input via the dialogue system by means of the mouse and / or the keyboard in a windows environment. These messages shall be the following, not restrictively:

- a) Input messages.
- b) Output messages.
- c) On screen images, as chosen by the user
- d) Summary of alarm signals.
- e) Alarm lists.
- f) Checklists.
- g) Changes in the information reporting status.
- h) Reporting of alarm signals.
- i) System performance.
- j) Electrical measurements on the terminal screen.
- k) Control response.
- l) Reliability.

16.2 Input Commands

16.2.1 Input commands shall be available to the Power Controller and shall include, not restrictively, the following functions:

- a) Request for specific display by the user.
- b) Request for point alarm signals.
- c) Request for summary presentation of the alarm signal items.
- d) Request for summary presentation of all system alarm signals.
- e) Request for item control status.
- f) Selection of control.
- g) Control cancellation.
- h) Next page.
- i) Previous page.
- j) Clear screen.
- k) Alarm signal acknowledgement.
- l) Activation / deactivation of the transient alarm signals.
- m) “Open/close” approval.
- n) Priority to the Power Controller (line switching).

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- o) Switchgear status changes.
- p) Time setting.
- q) Preparation of the daily / weekly / monthly reports.
- r) Scheduled interruptions.
- s) Data definition.

16.2.2 It must be pointed out that these functions are those required for the daily operation of the PRCS system. Functions required for other purposes are described in other paragraphs of this Specification.

16.2.3 The Contractor shall submit to AM his proposed control schematic diagrams for the execution of the above-mentioned functions. AM shall review and approve the final description of the schematic diagrams for the control commands.

16.3 Exit Commands

16.3.1 The exit commands from the PRCS system given by the Power Controller or in response to a remote event shall include, not restrictively, those described in the following Sections 16.4 up to and including 16.11 herein.


16.4 Picture Diagrams on the Central Terminal Screens in OCC.

16.4.1 The Contractor shall create picture diagrams of the central terminal PRCS screens and maintenance terminals required for the extension to Kalamaria, which shall be subject to review and approval by AM. The picture diagrams shall present standardized variations of the system (conditions, analogue values etc.) in a stable frame. The picture diagrams shall be displayed on the central terminal screens or shall be printed. They shall be generated out of a total of graphic symbols, alphabetic and numerical characters, which shall be presented to AM in advance for review and approval. The process for the generation of the graphic symbols shall be submitted to AM for review and approval. Each picture diagram shall present information for one or more locations, data condition, regular event logs or representation diagrams. The switchgears shall be grouped according to their switching circuit topology and geographical location. Each picture diagram shall be updated spontaneously by the central computer system, whenever a change has been observed, and also at regular intervals.

16.4.2 The central system of the computer shall display in full configuration the various power supply systems and other electrical installations, which are arranged in up to four (4) terminal screens in the OCC and the ECR.

16.4.3 Any of the picture diagrams on the central terminal screens shall be printed to form an “Event Log at the Power Controller’s option”. The selection process shall be specified by the Contractor and shall be subject to AM’s review and approval.

16.5 Summary of the Alarm Signals

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16.5.1 A summary of the alarm signals shall be a dynamic condition of all positions and conditions of the alarm signals. It shall be displayed on the central terminal screens or be printed.

16.5.2 The summary of the alarms signals shall be in window-lists where the events shall be displayed chronologically in text form. The status of all alarm signals shall be updated automatically upon change in the signal status. The messages to appear in the list shall basically include the following information (as a minimum):

- Date
- Time
- Power Controller
- Network
- Equipment address
- Message text
- Status, value and cause
- Alarm priority, Alarm color
- Acknowledgement
- etc

16.5.3 The final structure shall be approved by AM. The system shall provide various types of lists, which shall be customizable on line to display the required information. Whenever a list is longer than the window of the terminal screen, then it shall be scrollable.

16.5.4 The coding and position designation of an unacknowledged signal shall be flashing, until the signal is acknowledged by the Power Controller.


16.5.5 The message “page overrun” shall be displayed when the list is longer than the screen length. AM shall review and approve the details during the design phase after the Contract signing.

16.6 Alarm Signals Status

16.6.1 The alarm signals status shall present all signals obtained from a selected location. Every status shall be recorded in time sequence and shall be presented in the alarm list on the central terminal screens and/or shall be printed. The structure of the alarm list shall be subject to AM’s review and approval. Significant information shall be presented according to the following (as minimum): date, time, location, type of equipment etc.

16.6.2 The presented conditions shall be updated immediately, as soon as new conditions appear in the PRCS central system.

16.7 Alarm Signals Reporting

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16.7.1 The signals shall be classified according to the categories mentioned here below:

- a) Installation signals.
- b) General signals.
- c) System's signals.
- d) Signals of faulty operation of the PLC's components and devices within the RTU's cubicles at the peripheral stations and equipment installed in OCC and/or ECR (e.g. workstations, FEP-TCI, UPS, VCPs for power supply etc.).

16.7.2 The installation signals shall cover any non-controlled condition of any installed unit at some location. The general signals shall cover the faults of the remotely controlled equipment.

16.7.3 Alarm signals reporting shall be the same for the general and installation signals and shall include an audible warning signal, a flashing signal on the terminal screen and shall be printed "on-line".

16.7.4 The system shall generate daily, weekly and monthly reports. This shall be carried out by the central computer system in OCC / ECR or the maintenance / evaluation system located in the technical equipment room.

16.8 Management of the Alarm Signals and Messages

16.8.1 For each alarm signal or message the alarm class parameters shall be defined. In addition, alarm classes shall be reserved and used for the system's internal faults, messages or indications. The alarm class shall indicate the alarm priority. A high alarm shall correspond to a high priority.

16.8.2 The alarms and messages shall be sorted in the alarm list in accordance with the alarm class. According to the alarm classes, the entered events shall process on the basis of the FIFO principle (First In / First Out).


16.8.3 The Contractor shall also provide different audible signal for each alarm class. The audible signals configuration shall be subject to review and approval by AM. The audible alarm signals shall be silenced from the PRCS system.

16.9 Alarm Signals Processing procedures

16.9.1 Each alarm shall be displayed in an alarm line in real-time in each process or any control activities currently executed by the Power Controller. The most recent alarm with the highest alarm class, which has not been acknowledged, shall be displayed in a flashing condition on the central terminal screens.

16.9.2 All alarms shall be acknowledged by actions of the Power Controller via the mouse or the keyboard.

16.9.3 Alarm signals shall be provided for every fault condition of the entire PRCS system installed in OCC and/or ECR and in the RTU cubicles. The audible alarm signals shall be silenced by the Power Controller via the PRCS system.

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16.9.4 Signals for error messages shall be generated in response to a faulty entry signal by the Power Controller. The signals shall be displayed on the terminal screens and shall be printed.

16.9.5 The final conditions of the process regarding the alarm signals shall be subject to AM's review and approval after the Contract signing.

16.10 PRCS System performance


16.10.1 The performance of the PRCS system shall correspond to a maximum possible number of peripheral stations all connected to the central equipment in OCC and ECR. The PRCS system performance degree shall be valid for the integrated PRCS system as well.

16.10.2 In the following paragraphs, the response times shall refer to the time from the moment of the event occurrence at the peripheral station, until the moment the information is displayed on the terminal screens of the Power Controller in OCC and ECR. This shall be under the assumption that the system is in a permanent condition, just prior to the display of the events.


16.11 System Response Times

16.11.1 The following response times for the controls and indications are required (as minimum):

- a) The command shall be transmitted to the selected control point in less than one (1) second from the activation of the execution command.
- b) The updating time of the analogue measurements and the non-variable digital condition on the central terminal screens shall not exceed ten (10) seconds. The Contractor shall ensure that the measurements updating is completed at least two (2) seconds prior to displaying on the central terminal screen.
- c) Checking of a selected point shall be completed in less than two (2) seconds after the activation of the selection command.
- d) The status indication of the selected check point shall be fed back in less than two (2) seconds after completion of the change at the peripheral station. The time period from the moment an execution command has been issued, until the moment that the pertinent change has been successfully completed and has been displayed shall be clearly indicated.
- e) The event log or the printer of the system printer shall print the integrated message of the alarm signal in less than five (5) seconds after the event was displayed.
- f) The updating time on the terminal screen for any system status change shall not be over two (2) seconds for a one single status change or up to fifteen (15) changes of the same work at the same peripheral station, except for the analogue measurements.

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- g) For the same event (or for up to fifteen (15) events in the same work) occurring at each peripheral station, the updating time for the first event shall not typically exceed two (2) seconds. Under the same circumstances, the updating for the most recent event shall not typically exceed ten (10) seconds.
- h) The overall accuracy of the offered analogue / digital conversion and digital transmission shall be better than $\pm 0.5\%$ of the complete scale. The screen accuracy will be better than 2% of the complete scale.
- 16.11.2 The control procedure shall be completed within less than four (4) seconds after the Power Controller has issued the execution command.
- 16.11.3 All indication for control items shall be updated within two (2) seconds. The alarm signal indications shall be displayed within two (2) seconds after the occurrence of the event.
- 16.11.4 The Contractor shall guarantee that the PRCS system shall not block due to non functionality of some selected item or due to the execution of a command by the Power Controller.
- 16.11.5 The Contractor shall declare the method to achieve the required time performance by the PRCS system. The response times shall be measured during the site tests after completion of all installations and /or modifications in the OCC and/or in the ECR and the peripheral stations.

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17 PRCS RELIABILITY / AVAILABILITY

17.1 The PRCS shall meet the following requirement:

- The Availability of the system shall not be less than 0.9999.
- The availability (A) is defined as:


$$A = \text{MTBF} / (\text{MTBF} + \text{MTTR}),$$

Where: MTBF = Mean Time Between Failures, and
MTTR = Mean Time To Recover.

The Contractor shall furnish AM the following information:


- Mean time between failures for one installation, which shall be considered as an integrated system.
- Mean time between failures of all individual parts of the installation.
- Availability of the entire installed system.
- Availability of all individual parts of the installed system.

17.2 The Contractor shall calculate and record all the “Mean Time Between Failures” (MTBF) and “Mean Time for Maintenance (MMT) values for all systems, sub-systems, individual equipment and devices of the completed PRCS system. The Contractor shall determine and verify the MTBF analysis for the final systems, together with the availability of all individual equipment (in OCC/ECR and the related peripheral stations). In general, the MTBF must not be less than 60.000 hours. The analysis shall be submitted to AM for review and approval.

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18 POWER SUPPLY FOR THE PRCS IN THE OCC AND THE ECR


- 18.1 The PRCS operates at a power supply of 400 / 230VAC, 50Hz and has a voltage fluctuations tolerance $\pm 10\%$ of its rated value / $\pm 15\%$ (for duration of 500ms) of the rated voltage and frequency fluctuations $\pm 2\%$, without any reduction in system efficiency.
- 18.2 The supply voltage of 400 / 230VAC, 50Hz is available from the main low voltage switchboard located in the Pylea Depot and is equipped with all the necessary equipment for control, coupling and protection.
- 18.2 The Contractor shall determine the respective nominal values and power requirements of the entire new equipment (if any) and/or modification to equipment to be installed in the OCC and ECR (e.g. power consumption in W, nominal load in kVA etc.).
- 18.3 Especially for the PRCS, the OCC and ECR have been designed to be equipped with a UPS system, with special provisions for suppression of impulse voltage, which is necessary for the protection of the equipment against failures of the main power supply network and other fluctuations. The PRCS system in the OCC and ECR shall be continuously supported by the UPS. This PRCS system shall not be affected by any power outages and shall be automatically reconfigured after restoration of the normal power supply. Subsequent changeover to the backup power supply shall not cause any loss to program elements and data stored in the computer memory. Under these conditions, no loss of memory will be caused to the computer during power outages. The auxiliary power supply consists of an uninterruptible power supply (UPS) unit with batteries and battery chargers and a manual by-pass switch. The Contractor is required to calculate the capacity of the UPS system for the additional equipment of the line extension to Kalamaria. The Contractor is required to submit these calculations, which shall be subject to review and approval by AM.

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19

TIME SOURCE


The PRCS system, at all integrity levels in OCC/ECR (e.g. workstations, computers, printers, storage facilities etc.) and the peripheral stations shall utilize the same time source. In case the central time source fails, each system shall be able to continue its operation based on its internal time source. After the re-establishment of the central time source, the synchronization of the various systems shall be performed automatically. The interruption of the time source and time deltas, after synchronization, shall be recorded.

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20 REQUIREMENTS OF THE REMOTE TERMINAL UNITS (RTU's)


The requirements for the Remote Terminal Units (RTU's) at the peripheral stations and the depots, as outlined in the following paragraphs, shall be considered by the Contractor as the minimum ones.

- 20.1 The RTU's cubicles for the PRCS system shall be located in the following technical rooms: Rectifier Substations (RS), Lighting & Auxiliary power Substations (LAS) and Medium Voltage Substations (MVP) on the Kalamaria extension. The Contractor shall determine the arrangement of the RTU's cubicles at the peripheral stations. The RTU's cubicles shall operate under a main supply voltage of 110V DC from the respective Battery Chargers, which shall be provided with special equipment for continuous charging.
- 20.2 All RTUs mentioned in this specification shall be accompanied by documentation demonstrating that they operate properly when executing similar functions.
- 20.3 The Contractor shall determine the respective nominal values and power requirements for the entire equipment to be installed in the RTUs at the peripheral stations (e.g. power consumption in W, nominal load in kVA etc.).
- 20.4 It is necessary to outline the interfaces of the RTU's cubicles with other installations. The Contractor shall provide specific information, which shall be properly co-ordinated among the various disciplines.
- 20.5 The RTU's cubicles shall be equipped with front door, key locks and removable transport fixings on the top. The front door shall be hinged on the right side and the opening angle shall be more than 90°.
- 20.6 The RTU's cubicles shall be made of folded sheet metal with a minimum thickness of 2.0mm, bolted or riveted to a steel structure frame to ensure that the cells are rigid. The steel structure frame assembly shall be welded, free from distortion and welding strain and sufficiently rigid to support equipment under normal and short-circuit conditions. The degree of protection shall be in accordance with IEC 529, IP 54 for all RTU's cubicles.
- 20.7 The RTU's cubicles shall be firmly fixed on the floor and shall be relatively light, but robust. Removable racks shall not be accepted. Maximum dimensions of the shipped sections shall be co-ordinated with the dimensions of the access hatches, corridors and doors to ensure movement without damage and difficulty.
- 20.8 The interior equipment of the RTU's cubicles shall be accessible from the front side for operation, inspection, controls and from the front and back side for connections and maintenance. The RTU's cubicles shall be equipped with an internal equipment mounting structure. The spare feeder circuit provisions within the RTU's cubicles for future loads shall be at least 20%.
- 20.9 If it's needed, due to excessive heat generation, the RTU's cubicles shall be ventilated through air inlets and outlets. The air inlets and outlets shall

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be equipped with easy maintainable washable dust filters. Use of fans for forced cooling shall not be permitted.

- 20.10 The RTU's cubicles shall have adequate provisions for the entry and termination of all associated power and control cables. The cable entry shall be from the bottom and cable inlets and outlets shall be sealed through "cable glands" in accordance with IEC standards to the specified IP protection.
- 20.11 Each RTU cubicle shall be equipped with a separate illumination neon tube type, with a door operated switch and separate fuse or miniature circuit breaker (mcb). The Contractor shall install internal general purpose sockets. Lighting panels shall not supply power and socket loads to the RTU's cubicles.
- 20.12 All installed equipment shall be dimensioned in accordance with the electromechanical systems regulations, as well as the safety regulations, referring to the latest European Standards. The robust construction of the RTU's cubicles and their integrated components shall operate under the project environmental conditions.
- 20.13 The Programmable Logic Controllers (PLC's) shall be electronic units of industrial type of the most recent series (in terms of hard/software), available for use at the time of the factory tests with Central Processor Unit (CPU), memory, Communication Processor (CP), power supply modules and modular I/O's modules etc. to facilitate the control and monitoring functionalities between OCC, ECR and various power supply systems as well as with other electrical installations. The configuration of the proposed industrial PLC's for the RTU's cubicles shall be state-of-the art technology and the latest production series (hardware and software). The Contractor shall also provide for AM's review and approval documentation that demonstrates that the proposed industrial PLC's has been approved by recognized Metro or Railway Authorities and proven to work satisfactory in similar projects worldwide. The Contractor shall follow the requirements derived from International Standards for proper installation and protection of these devices.
- 20.14 The transducer-equipment of the analogue cards within the RTU's cubicles shall require galvanic isolation. The corresponding transducers shall provide the analogue inputs. It's shall be the Contractor's responsibility to co-ordinate the design between the various equipment of all power systems (AC and DC) and PRCS system. The Contractor shall provide along with the details concerning the requirements of the transducers' outputs together with any special requirements for covering, isolation, insulation, protection etc. to ensure the continuous and satisfactory operation of the equipment. The range of the analogue input currents shall be:
- 0-10mA
 - 4-20mA
 - 10-50mA
 - 0-1V


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- 0-10V
- 0-5V


- 20.15 The Contractor shall be responsible for all input and output circuits. The input and output circuits shall have no direct electrical connection to the PLCs (industrial type) located inside the RTUs.
- 20.16 The Contractor shall anticipate any special provision required for the suppression of the impulse voltages, necessary for the protection of the equipment within the RTU's cubicles and shall ensure the specified operation.
- 20.17 The system shall distinguish all the fluctuations lasting more than 20ms and shall reject those lasting less than 2ms. Whenever the resistance between a pair of terminal inputs to the peripheral station RTU cubicle is higher than 10k Ω , the system shall consider the input status as “normally open”. Whenever the resistance is lower than 50 Ω the input status shall be considered “normally closed”. When the resistance is between 50 Ω and 10k Ω the condition shall be considered as invalid.
- 20.18 It is expected that the information exchanged between the control CPU and other CPU's shall mainly be the control commands, alarm signals, statuses of switchgears, indications, analogue values etc. The Contractor shall declare the protocol and the proposed procedure for the communication with the other CPU's. It's shall be also the Contractor's responsibility to check the distance in such cases prior to finalizing the design.
- 20.19 All hardware connections of the equipment at the peripheral stations to RTU's cubicles shall be placed with care and in good order in a form of twisted wires, along cable-ways or in cable trays. The cable conduits and the fused parts must not be at the edges of the RTU's cubicles, but shall be located in the center part of the RTU's cubicles.
- 20.20 The incoming / outgoing control and monitoring cables shall be isolated from the power cables, as required, to insure that, any interference does not affect their function. It shall be the Contractor's responsibility to avoid such interferences.
- 20.21 The assembly of the RTU cubicles shall include internal protective covers for all live parts in such a manner that they cannot unintentionally be touched.
- 20.22 The noise level from any normally operating equipment shall not exceed the desirable sound levels, as defined by any National or IEC Standards.
- 20.23 In all RTU cubicles, the protective devices within the assembly shall be so graded, that a short-circuit occurring in out-going branch circuit is cleared only by the switching device installed in the faulted branch circuit without affecting the other outgoing branch circuits or upstream protection switchgear, thus ensuring selectivity of the protective system.
- 20.24 In the RTU cubicles the Contractor shall install monitoring relays to provide suitable protection against insulation faults.

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- 20.25 The frames, sheet metal covers and RTU cubicles shall be properly treated and painted with coat thickness of 20 microns at least. The color of the cubicles shall be RAL 7032. The equipment support rails shall be made of galvanized or dichromated sheet metal.
- 20.26 All main loads shall be supplied with power through circuit breakers. The circuit breakers shall be capable of withstanding the short-circuit fault current level. All control and alarm relays shall have a varistor or R-C type surge suppression device across their coil.
- 20.27 The internal wiring shall be in accordance with the IEC 227. The outer sheath of the flexible rods and / or flexible cables shall be black. The phases shall be identified by rings or by heat marks, using the identification code and color specified under IEC 446. Cable terminations shall be done according to IEC 445. The minimum cross section shall be 2.5mm². The color coding system of the internal wiring within the RTU cubicles shall be subject to review and approval by AM.
- 20.28 The Contractor shall be responsible for the surge protection of the RTU cubicles by installing suitable surge arrestors.
- 20.29 The Contractor shall install selector switches, where required. These shall be round, with a diameter of a 22mm, with a label specifying their functions and their positions. The rated current of the contacts shall be 10A thermal.
- 20.30 The Contractor shall install status and alarm indication lights, where required. These shall be of the round flush type, with a diameter of 22mm and their colors shall be as follows:
- Red: "ON" or closed.
 - Green: "OFF" or open.
 - Yellow: Fault or Alarm.
- 20.31 The Contractor shall install push-buttons, where required. These shall be of the round flush type, with a diameter of 22mm. The rated current of the contacts shall be at least 10A thermal. The colors shall be as follows:
- Blue: lamp test or fault detection / acknowledge.
 - Black: for other functions.
- 20.32 All electrical components within the RTU cubicles shall be labelled clearly and indelibly, according to the respective wiring diagrams. Each item of equipment shall carry a label on its face, indicating its function and / or its electrical reference. These labels shall be made of damage resistant materials (such as dilophane) engraved and secured by rivets or screws.
- 20.33 The normal operating labels shall be white with black letters. The danger or warning labels shall be white letters in a red background. The identification labels of the terminal blocks shall be mounted onto the head of the terminal blocks.
- 20.34 Each RTU cubicle shall carry a label on its face, indicating its name and location as approved by AM. Additionally, each RTU cubicle shall be fitted with an identification plate, indicating the name of the manufacturer, type,


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- year of manufacture, service voltage, short-circuit current, control and signalling voltage(s) and degree of protection.
- 20.35 The texts of the labels shall be submitted to AM for review and approval. They must appear in English and Greek language. The size of the labels and height of letters shall be sufficient to enable easy reading.
- 20.36 Each RTU shall be equipped with a document holder behind the front door for the documents' storage within the cubicle. The labelling of the documentation shall be according to IEC standard "Labelling of operation devices". Each RTU cubicle shall include a complete set of documentation. The labelling in the wiring diagrams, schematic diagrams and within the RTU cubicle shall be identical.
- 20.37 The identification codes for the power cables and bus bars shall be the following:
- Alternative Current (AC):
 - Phase 1 : L1
 - Phase 2 : L2
 - Phase 3 : L3
 - NEUTRAL: N
 - Earth : green/yellow (cultured throughout the length of cables and wiring)
 - Direct Current (DC): + 24V: L+, + 48V: L+, + 110V: L+ etc.
- 20.38 All RTU cubicles shall be equipped with a copper earth bar, on which the earth connections shall be made. An appropriate means of connection to the main earthing loop shall be provided. The earth bar shall be of sufficient size to safely carry the predicted earth short-circuit fault current.
- 20.39 For all doors or flaps carrying electrical components, a braid or a green/yellow wire, with a minimum cross-section of 2.5mm², must provide earth continuity.
- 20.40 Thermo-marking or rings shall identify the wiring. All connections shall be made with crimped terminal lugs or end pieces.
- 20.41 The cables within the RTU's cubicles shall be laid in cable channels with 20% spare capacity.
- 20.42 The electrical connection terminal blocks for auxiliary voltage and controls shall be separated from the 420 / 240V AC terminal blocks.

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21 MONITOR AND CONTROL SYSTEM (SCADA) – STATION MASTER ROOM (SMR)

This system, fully functional, shall be installed by the main contractor of the extension to Kalamaria. The Contractor shall ensure, in cooperation with the main contractor of the Kalamaria extension, the interface between the PRCS and the equipment to be installed in the Station Master Room (SMR), as regards the control points, signal transmission etc..

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22 STANDARDS

- 22.1. Relevant international standards are generally accepted, but for cases not covered by them, then the latest German Standards (DIN, EN, VDE), or British Standards (BS) or other National Standards shall be used in agreement with AM. The Contractor shall submit the standards for approval by AM. All international standards (IEC), European standards (EN) and CENELEC (HD) regarding the equipment and systems of this contract apply even if they do not exist as Greek Standards. Where there is a conflict between the standards and the Specifications, the Specifications shall prevail.
- 22.2. In case one of the standards is no longer valid, the Contractor shall submit to AM the current version of the standard for review and approval.

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23 DESIGNS – DOCUMENTATION


23.1 The Contractor shall prepare and submit documentation regarding the complete PRCS system. All documents and information submitted to AM shall be in accordance with the “Drawing Office, Structural Analysis of the Project Works and Codification Manual” (GS0100) of the General Specifications and the stipulations of this Specification.

The documentation shall be submitted to AM for review and approval, at the various defined stages. The quantity and format requirements of the documents, which shall be supplied by the Contractor in reproducible and electronic forms, shall be in accordance with the General Specifications, Article GS0200 and GS0100. Any AM's reference to "system" shall be considered to include both hardware and software. The documentation shall consist of the following (as a minimum) as described in the paragraphs here-below.

23.2 General Final Design (GFD)

23.2.1 The Contractor shall compile the technical offer prepare the General Final Design for the PRCS within the time frame stipulated in the contract documents, so as to fulfill the requirements regarding the design, installation, testing, operation, maintenance, certification, validation and training on the systems, sub-systems and components, as specified in the Contract. The Contractor shall supply the following as a minimum:

- Document Submittal Program, which shall identify each document, which is required to complete the Project, including a unique document number, title, purpose of the document and scheduled submittal date.
- Codification principles for all systems, sub-systems and components of the offered systems according “Equipment Codification” Manual.
- Interface Management Plan to identify and to manage the interfaces within the systems and interfaces with other systems and various installations and Works.
- Complement of all offered designs regarding the following (as a minimum):
 - a) Schematic configuration.
 - b) Logic diagrams and flow charts.
 - c) OCC layout.
 - d) ECR layout
 - e) Layout and arrangement of the workstations
 - f) Preliminary layout of technical rooms
 - g) Key Installation principles.

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h) Layout and arrangement of the equipment.

i) Main Equipment listing

j) Power demands and consumptions.

23.2.2 The General Final Design shall be subject to AM's review and approval.

23.3 Detailed Final Design (DFD)

23.3.1 The Contractor shall prepare the Detailed Final Design (DFD) for the PRCS system based on the approved GFD. The aim of the DFD is to enable each discipline to prepare its own design based on the approved GFD level design, as well as to determine all interfaces related to the operation.

The DFD for PRCS shall be provided by the Contractor so as to fulfill the requirements regarding the design, installation, testing, operation, maintenance, certification, validation and training on the systems, sub-systems and components, as specified in the Contract and according to the defined milestones.


At least the following documentation shall be provided at DFD stage to AM for review and approval within the defined deadlines:

General submittals:

- Project Quality Plan.
- Project Programme.
- Software Quality Assurance Plan.
- Software Development Plan.
- Software Development Programme.
- Software Management Plan.


Technical and functional designs:

- System design and functional analysis.
- Detailed schematic layout of equipment on a station / shaft level.
- Detailed schematic layout of equipment in the OCC.
- Description of Operator Workstations in the OCC.
- Detailed schematic layout of equipment in the ECR.
- Description of Operator Workstations in the ECR.

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- Layout drawings for PRCS equipment in technical rooms in stations, shafts, OCC and ECR, including cable routing.
- RAMS analysis.
- Detailed list of equipment.
- Hardware specifications.
- Software specification.
- Operation concept.
- Network and communication protocol.
- Lists of commands, indications, alarms etc.
- Calculations of power demands and consumptions.
- Layout of the screens, graphic symbols etc. of the workstations, maintenance stations, temporary screens and the power supply VCP screen.
- Definition of all interfaces between components and sub-systems and definition of all interfaces with other systems.
- Other documents, which are required for a full understanding of the systems and are needed to describe, identify and clarify various issues.

23.3.2 The Detailed Final Design shall be subject to AM’s review and approval.

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24 SOFTWARE REQUIREMENTS

No PLC software module shall be locked and it will be fully accessible via the manufacturer’s communication environment.

The PLC software (RTU etc.) shall be compiled in the language: IEC 61131-3 compliant programming in: Ladder Diagram (LD) and/or Function Block Diagram (FBD) and/or Sequential Function Chart (SFC).

The complete documentation of the PLC programs shall be provided in the form of the flowcharts as well as all accompanying documents in electronic form (symbol catalogue, sequential files, address catalogue, description address catalogue etc.).


Likewise, all software modules of the PRCS and the ECR (operating system, service pack, drivers, libraries, Run-time part & Development part of SCADA packages etc.) shall be delivered in CDs ready to be installed in accordance with the documented detailed and step-by-step installation procedure to a new hard drive (brand new hardware).

All help files and any accompanying manuals in electronic or printed form shall be at least in the English language.

All drivers, operating system and any peripheral program to be installed in the framework of the PRCS in the OCC and the ECR shall be at least in the English language.


In addition, the Contractor shall deliver all required licenses both for the PRCS operating system, as well as for any software program to be installed on the PRCS workstations (OCC/ECR).

All settings, parameters, fine tuning of the PRCS shall be described in detail in the Maintenance / User manuals.

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25 MANUALS

- 25.1 The Contractor shall supply all manuals in an approved format, before the commissioning of the appropriate equipment and completed systems. In case of modifications in any of the systems or addition of new equipment, the Contractor shall document the modifications and shall submit the necessary information for AM's review and approval. The Contractor shall revise any and/or all manuals, as required incorporating any necessary modifications or changes found during the installation or commissioning or interfacing with the existing Metro system in order to deliver the revised versions of the manuals to AM for review and final approval.
- 25.2 The manuals shall include sufficient information and details to enable efficient operation and maintenance for the service life of the supplied PRCS system.
- 25.3 It's also the Contractor's responsibility to enable AM personnel to extend, change and create new possibilities or to upgrade the system in-house, when it's required.
- 25.4 The Contractor shall provide all necessary information to locate failures and control, after any repair, all systems and sub-systems by using any special or standard tools as well as test equipment that shall be delivered by the Contractor and handed over to AM. The Contractor shall specify and provide in details the equipment for this purpose supported by suitable documentation to enable AM's maintenance personnel to carry out this work.
- 25.5 The Contractor shall supply sufficient staff, spare parts and testing facilities on-site to enable them to modify or repair any parts or entire systems in order to comply with the Specification for a period of 12 calendar months from the final setting the system into revenue operation. The Contractor shall provide a full fault analysis report of the equipment or system, which shall include, the type of faults found and the remedial action, which was taken to rectify each fault.
- 25.6 In particular, the maintenance manuals of the systems shall be fully integrated and shall provide step-by-step instructions on how to repair and replace all components of the PRCS system down to Lowest Level Replaceable Unit (LLRU). It shall be assumed that the AM maintenance personnel performing the work shall have familiarity with these systems, but shall not possess a detailed working knowledge. The LLRU shall be defined as any component within an assembly that is defined in the Original Equipment Manufacturer's Illustrated Parts Catalogue and/or is offered for sale by him. Any changes to the documentation needed as a result of service experience during the warranty period, shall be incorporated at no cost to AM. The maintenance manuals shall also identify all special or standard tools needed to perform the work required for the system.
- 25.7 The Contractor shall indicate the amount of necessary maintenance that is required to be carried out on the equipment and the entire PRCS system in order to keep it operating efficiently for the full service life of the

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equipment and entire system, in accordance with the General Specifications.

- 25.8 The maintenance of the PRCS system shall be classified into periods, which shall be defined by the Contractor. The maintenance activities shall be consisting, as minimum, of the following: preventive maintenance, inspection, annual overhaul on-site, checking of connections, main overhaul, replacement of worn parts etc.
- 25.9 Other maintenance activities to achieve fault-free operation and a minimum service life of 15 years shall be also provided by the Contractor, as required.
- 25.10 The manuals for the PRCS system shall include, not restrictively, the following:
- The “System Manuals” with comprehensive description of all systems’ principles in block diagram format.
 - The “Workshop Manuals” shall contain detailed wiring diagrams or any other necessary working document as well as original equipment manufacturers’ illustrated parts catalogue with their codes to enable the maintenance personnel to identify the faults.
 - The “Operating System Manuals” shall contain the user’s guide for each computer system or any other necessary document.
 - The “Software Manuals” shall be provided for each piece of equipment or systems, which contains software (firmware) programmable devices, describing all the necessary information. These manuals shall contain the application software (in source code and object code), all software principles, major functions, data structure, code listings adequately supplied with comments, communication protocols and operating instructions. All programs shall have comments on more than 70% of their lines and respective descriptions for their parts or sections.
 - The “Functional low Charts” shall incorporate all software modules of the system as well as logic diagrams to support these software modules.
 - The “Equipment Room Manuals” shall contain all wiring diagrams, equipment layout, terminal diagrams, cables’ lists & connections, lists of I/O’s etc. for the equipment located in each technical room.
 - The “Testing and Commissioning Manuals” shall provide all information including the test sheets for the required tests.
 - The “Training Schedules” shall provide all information regarding the required training for the system, as described in this Performance Specification.
 - The “Installation Manuals” shall provide all information regarding the required installation activities for all components and entire system.

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- The “Operation and Maintenance Manuals” shall provide sufficient information to enable Operations staff to operate the systems and convey sufficient information on equipment diagnostics so that this will enable the maintenance staff to carry out detailed faults identification and proceed to the required corrective actions.
- The “As-Built” Drawings shall consist of the detailed wiring diagrams, cables’ lists and connection diagrams, telegram assignments lists, software applications, program listings and any other necessary working drawings.

- 25.11 One (1) set of documents is required in OCC, the ECR and each peripheral station in order to provide the required information for the operation and maintenance personnel to repair and/or maintain the equipment and systems on-site. The Contractor shall develop a list of documentation that shall be provided at each peripheral station, the OCC and the ECR room.
- 25.12 Exporting the entire application (configuration, data points, data points views displayed in the screens etc.) to an editable file in EXCEL format, rendering possible its comparison to previous versions of the application.


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26 TESTING AND COMMISSIONING

- 26.1 The testing and commissioning for the Power Remote Control System shall be performed in accordance with the General Specification. The Contractor shall perform the required tests in order to verify the correct function and safety of each part of the specific systems as well as for the entire PRCS system.
- 26.2 The Contractor shall not offer any individual equipment, module, component, system or sub-system for inspection or factory tests (witnessed by AM), which has not previously been inspected or pre-tested and is known to be operated properly and satisfactory.
- 26.3 All tests shall demonstrate that the equipment and systems meet with the specified requirements and functionalities. The Contractor shall provide fully detailed inspection and test plans for the PRCS system, which shall be submitted to AM for review and approval, prior to the commencement of the subject testing phase.
- 26.4 The SAT and SIT test schedules and procedures shall be produced in close co-operation and co-ordination with the various power supply systems and other electrical installations and shall be submitted to AM for review and approval.

26.5 Factory Acceptance Tests (FAT)

- 26.5.1 The FAT of the Power Remote Control System shall be carried out in the manufacturer’s premises before the delivery on-site. The tests shall demonstrate that PRCS system (hardware and software) meet the requirements of the Performance Specifications.
- 26.5.2 The Contractor shall conduct factory routine and type tests at the site of its industrial construction. The FAT procedure for both systems shall be reviewed and approved by AM before the testing phase commences.
- 26.5.3 Tests and Inspection of the RTUs
 - 26.5.3.1 The Contractor shall perform visual, mechanical, electrical and functional tests during the manufacturing process of the RTUs, in order to prove the specified performance and the quality of the work. All data-points (e.g. commands, indications, analogue values etc.) for each RTU shall be tested at the factory before released by AM for their transportation on-site. Any interface between the CPU of the RTU cubicle and any other CPUs or any Programmable Logic Controller (PLC), which receive or transmit information to the RTU cubicle, shall be connected and tested during the FAT. The Contractor shall provide a detailed factory test procedure for AM’s review and approval describing all the test activities to be performed.
 - 26.5.3.2 If new equipment is installed on the existing RTUs belonging to functional parts of the Metro, the Contractor shall be responsible to prepare a testing procedure (to be reviewed and approved by AM), which shall incorporate visual inspection of the entire new equipment, in order to confirm the

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specified performance during the manufacturing period, as well as the quality of the work.

26.5.4 Power Supply VCP

A visual inspection is required during the installation procedure in order to confirm the specified performance and quality of the installation works of the new 46” screen of the Power Supply VCP. The Contractor shall submit to AM for review and approval a testing procedure.

26.5.5 PRCS system – Central Equipment

26.5.5.1 The Contractor shall demonstrate to AM all the required modifications (at all levels) of the application software, new or modified data points, display diagrams, graphical displays etc. of the central computer system including new equipment (e.g. printers etc.). The purpose of this is to test the quality of work and the general behavior of the upgraded PRCS system and to demonstrate that all the specified requirements have been implemented in the system. The Contractor shall carry out tests of the various functions and automations of the control sequence as required. The Contractor will prepare a factory testing procedure for the central computer system to be submitted to the AM for review and approval.


26.5.5.2 The Contractor shall perform visual, mechanical, electrical and functional tests during the manufacturing process of the maintenance / assessment in order to prove the performance, as specified and quality of the work. The Contractor shall provide a factory test procedure for AM’s review and approval describing all test activities for hardware and software to be performed.

26.5.5.3 If new equipment is installed on the existing FEP-TCI system because of the new extension, the Contractor shall be responsible to prepare a testing procedure (to be reviewed and approved by AM), which shall incorporate visual inspection of the entire new equipment, in order to confirm the specified performance during the manufacturing period, as well as the quality of the work.

26.5.5.4 In order to install the PRCS system to the extension project, the results of the FAT tests must be successful. Any unresolved or pending issues shall be noted in the FAT test reports and shall be resolved before the equipment is dispatched on site the Project. Any equipment or systems or sub-systems with unresolved or pending issues shall not be dispatched on site the project unless AM’s approval has been received in advance.

26.6 Stand Alone Tests (SAT)

26.6.1 After the onsite installation and connections of the PRCS, the SAT tests in each location shall be performed according to the schedule, which shall be reviewed and approved by AM. The tests shall verify that all equipment and systems are supplied and installed according to the Specifications and the contractual requirements and are ready for SIT testing.

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- 26.6.2 The SAT tests shall verify, as a minimum, the following:
- Correct installation of the PRCS system with the various power supply systems and other electrical installations.
 - Verification that all data-points (e.g. commands, indications, alarms, analogue values etc.) of the various power supply systems and other electrical installations are properly and correctly connected to the RTU's cubicles. The tests shall be exhaustive to demonstrate that the PRCS meets the specified functionalities and requirements.

26.7 System Integration Tests (SIT)

26.7.1 The SIT shall be conducted after the successful execution of the SAT in all locations of integrated systems, including not only the extension to Kalamaria, but also the interfaces with the existing Metro network.


26.7.2 These tests shall demonstrate that all PRCS equipment and systems supplied under the Contract are fully integrated, correctly displayed at the peripheral stations and the OCC/ECR, communicate correctly to / and from OCC/ECR, as integrated systems and satisfy the functional and performance requirements of the Specification, when they're operated in the intended and predictable manner. The Contractor shall also test the various control sequence functions and automations, as required (e. g. automatic reconfiguration of the Medium Voltage network etc.).

26.7.3 The Contractor shall also take into account other important requirements and details concerning the testing and commissioning of the PRCS system, which are detailed in section 16 of this document.

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27 SPARE PARTS

- 27.1 For all hardware and software supplied as part of the works, the Contractor shall supply sufficient spare parts for at least three (3) years of normal operation and the replacement parts shall be available for a service lifetime of, at least, fifteen (15) years, after the commissioning of the extension project.
- 27.2 In accordance with the General Specifications, the Contractor shall provide parts lists and spare parts lists. The list of spare parts shall be divided into two lists, one describing the capital spare parts and one describing the non-capital consumable spare parts. Every attempt shall be made to provide at least two sources for spare parts or components and both sources shall be quoted.
- 27.3 The list of spare parts shall be subject to review and approval by AM, which shall be the consignee of all delivered spare parts. The Contractor has the obligation to replace with new spares every spare part used during the three (3) years warranty period.
- 27.4 The Contractor shall include in his list of spare parts the re-ordering time and shall undertake the obligation ensure the availability of spare parts or acceptable replacements for the minimum service life of the PRCS system, fifteen (15) years.
- 27.5 The Contractor shall submit to AM a parts list, including a list of all major parts of the PRCS system that he shall install. The parts list shall be submitted together with the list of spare parts.
- 27.6 The following spare parts, as minimum, shall be provided by the Contractor:
- Two (2) PLCs (CPU), two (2) power supply units for the PLCs, two (2) digital I/O cards, two (2) A/I analog cards, two (2) communication cards, all of the above for RTU units.
 - Five percent (5%) of all installed parts micro-materials for the PRCS system, such as terminal blocks, switches, indication bulbs, lighting fixtures / push buttons within the RTUs, 110V / 48V transformers etc.

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28 SPECIAL TOOLS AND TEST EQUIPMENT

- 28.1 The Contractor shall provide a list of all special tools and test equipment necessary for preventive maintenance and fault repair of all equipment regarding the PRCS system. The type and quantity of the special tools and test equipment to be supplied shall be sufficient to ensure the efficient operation of the PRCS system. Where the equipment is not considered to be economically maintainable by AM’s personnel (e.g. computer processors etc.), the Contractor shall specify those available maintenance facilities for this equipment in the Thessaloniki area. If such installations do not exist in Thessaloniki, the Contractor shall propose how such equipment shall be maintained.
- 28.2 The list of special tools and test equipment shall contain the following:
- A serial number for the purpose of identification.
 - A detailed description of the special tools / test equipment and related documentation.
 - The recommended quantity.
- 28.3 Special attention shall be paid for the PRCS system regarding the provision of portable special tools (e.g. programming devices for OCC and peripheral stations etc.) and test equipment and the appropriate software, to the extent required in order to set or to modify, for example, the system’s parameters etc. This equipment shall be capable of being used during service without affecting the safety related nature of the circuits or equipment.
- 28.4 One (1) industrial grade portable programming device (laptop) shall be provided to support maintenance activities, which shall have all necessary software for the PRCS, as well as all other special tools and keys required for the maintenance of the new equipment.

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29 TRAINING


- 29.1 The training shall be conducted in accordance with the General Specifications – article GS0410. The training activities shall be of sufficient size, content and scope to enable the training of engineers, technicians and specialist artisans to ensure the opening of the extension to Kalamaria and the continuous efficient operation of the Metro network.
- 29.2 The scope of the training shall include, not restrictively, the training of the AM Engineers and maintenance and operations staff of the Thessaloniki Metro Operation entity / company to ensure full familiarity with the design, maintenance, operation and the methods / principles to develop skills for future modifications / upgrading and extensions of the systems (in OCC, ECR and peripheral stations).
- 29.3 The Contractor shall provide training facilities in the area of Thessaloniki and shall communicate with AM and/or the Metro Operation agency / company to utilize available training facilities in Pylea Depot, as well as on site the project if necessary. The Contractor shall submit a detailed description of the courses to be reviewed and approved by AM. Furthermore the number of classes for each series of educational lessons shall be agreed with AM. The Contractor shall also supply operational and maintenance instructions and documentation, which shall be approved by AM. The training documentation shall be based on use of the approved by AM Operation and Maintenance Manuals and other required information from the extension Project such as wiring diagrams, telegram assignments lists, operating systems, software applications and manuals etc.
- 29.4 Prior to the courses the Contractor shall submit a training schedule for AM’s review and approval. The training courses shall include classroom lectures with site visits and instructions to demonstrate and explain the equipment and systems as well as training with the software packages.
- 29.5 All the materials that shall be used for the training shall be reviewed and approved by AM at least one (1) month before the training commences.
- 29.6 Only trainers having knowledge and practical experience of the equipment and systems shall carry out the training. Their trainers’ CVs shall be provided for AM’s approval. Specialist engineers shall supplement the training courses, where it is required.
- 29.7 The following training shall be also conducted for the PRCS system:
- Training to provide AM’s staff a complete understanding of the operating system, application software and tools of verification and maintenance.
 - Training to permit AM’s engineering staff to add / delete / modify items in the system, if systems expansions are required.
- 29.8 Upon completion of the training, the trainers shall assess each trainee’s understanding and competence to perform the operations and maintenance activities for which the training has been provided.

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LANGUAGE

The PRCS system in OCC / ECR (at all integrity levels) shall support the Greek and English languages for all “Man Machine Interface” (MMI) workstations. Independent on-line switching languages shall be performed by the PRCS operator, regardless of the language in other consoles. This shall permit operation by operators using different languages. The scope of the Contractor’s supply shall include appropriate and convenient tools and related training to allow AM to modify any Greek and English texts of the MMI.

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31 ENVIRONMENTAL CONDITIONS

- 31.1 The complete PRCS system in OCC/ECR, shall be able to perform all applicable operations and automation functions (in a 24-hours basis) between the range of environmental conditions per described in paragraph 8.2.1 of the Environment Impact Assessment Study, which are attached to the tender documents, without using air-conditioning or heating equipment.
- 31.2 The Contractor shall ensure that the offered equipment and systems shall not be adversely affected by any changes in the environmental conditions caused by the local heat emissions of other equipment in the OCC/ECR and the peripheral stations.

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32 DOCUMENTATION OF PROPOSED PRCS SYSTEM

32.1 At the beginning of the design submittal procedure for the PRCS, the Contractor shall also provide documentation for AM’s approval that demonstrates that the proposed PRCS system has been installed in identical or similar form at specific Metro systems or Railway Systems worldwide and proven to work satisfactory.

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33 CONTRACTOR’S RESPONSIBILITY AND EQUIPMENT SUITABILITY

- 33.1 Any approvals granted by AM regarding the designs and the execution of the works do not release the Contractor from any responsibilities assumed upon Contract signing.
- 33.2 The Contractor shall demonstrate that the offered systems and equipment to be supplied under this Contract shall be of the most recent technology, proven and reliable, as per the recent international standards and suitable for Metro or Railway systems.