# NON-INTERCONNECTED ISLANDS SYSTEM & MARKET OPERATOR

# Project Implementation of the Athens Central Energy Control Center (ECC) and the Local ECC for the Electrical Power System in Rhodes

# TECHNICAL AND FUNCTIONAL REQUIREMENTS

# PART E: DELIVERABLES

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# Contents

## List of Acronyms

| | |
|---|---|
| **DB** | Database |
| **DC** | Data Concentrator |
| **DBMS** | Database Management System |
| **DTS** | Dispatchers Training Simulator |
| **DW** | Data Warehouse |
| **ECC** | Energy Control Center |
| **EMS** | Energy Management System |
| **ETL** | Extraction Transformation & Loading |
| **HIS** | Historical Information System |
| **HMI** | Human Machine Interface |
| **HW** | Hardware |
| **IT** | Information Technology |
| **LDAP** | Lightweight Directory Access Protocol |
| **LTO** | Linear Tape-Open |
| **MIS** | Management Information System |
| **MMS** | Market Management System |
| **NII** | Non-Interconnected Islands |
| **NII SMO** | Non-Interconnected Islands System and Market Operator |
| **RAC** | Real Application Cluster |
| **RTU** | Remote Terminal Unit |
| **RES** | Renewable Energy Sources |
| **SSL** | Secure Sockets Layer |
| **SSO** | Single Sign On |
| **SW** | Software |
| **TFD** | Time-Frequency Device |

# 1 Introduction

This Part of the Technical Tender lists the Deliverables of the Project for the implementation of the Central Energy Control Center (ECC) in Athens and the Local ECC in Rhodes.

Section 2 presents general requirements for the Project Deliverables.

Section 3 lists the Energy Management System (EMS) Deliverables.

Section 4 lists the Market Management System (MMS) Deliverables.

Section 5 lists the Corporate Systems (DW/MIS and Helpdesk) Deliverables.

# 2      General Requirements

In this section, general requirements are listed on the deliverables of the Project. The section is organized as follows:

- NII IT Infrastructure Deliverables and Services (Section 2.1);

- NII IT Systems (Section 2.2);

- General Hardware Requirements (Section 2.3);

- General Software Requirements (Section 2.4);

- Hardware Technical Requirements (Section 2.5);

- Third-party Software Technical Requirements (Section 2.6);

- Services (Section 2.7);

- General Training Requirements (Section 2.8);

- General Documentation Requirements (Section 2.9).

## 2.1      NII IT Infrastructure Deliverables and Services

The Contractor shall deliver the NII IT Systems fully integrated to the NII SMO infrustructure and in full operation. The NII IT Systems for the Energy Control Centers (ECCs) should meet the NII SMO technical requirements set forth in the Technical and Functional Requirements of the Project.

All hardware, software, design documents, networking, configuration, customization, security setting and procedures for operation, backup maintenance and troubleshooting, security and restoration policies, documentation and training material will be deliverables as part of this Project.

All services needed for the project detailed design, project implementation, modeling and configuration, testing, roll out, migration and for the systems to go live as well as warranty and maintenance will be provided by the Contractor.

It is noted that the following systems are not part of this Tender:

- The telecommunication backbone for interconnecting the Control Centers (Central ECC in Athens and Local ECC in Rhodes);

- The supply of telecommunication lines required for the implementation of the telecommunication network by the contractor for the interconnection of the Local ECC with Island substations, Power Stations, and RES.

- The Market Settlements Systems.

The NII SMO telecommunication backbone (10Mbps based on rough estimates that is subject to change to 100Mbps, or higher, to meet future expansion requirements will be provided by the NII SMO.

## 2.2   NII IT Systems

The NII IT Systems that will be procured are:

- Energy Management System (EMS) (refer to Section 3 for EMS Deliverables);
- Market Management System (MMS) (refer to Section 4 for MMS Deliverables);
- Corporate Systems (refer to Section 5 for Corporate Systems Deliverables) as follows:
    - DW/MIS (Section 5.1);
    - Helpdesk (Section 5.2).

The new infrastructure provided by the Contractor should be fully integrated with the existing NII SMO infrastructure. It is presented in the respective Sections of this Part of the Technical and Functional Requirements.

It is emphasized that the Contractor should not only deliver the minimum infrastructure referred to the respective Sections of this document, but is also obligated to provide in addition any other infrastructure (hardware and software) required for the NII SMO IT Systems operation, according to the Technical and Functional Requirements of the Project.

In case the infrastructure decided upon during the Detailed Design or the Testing Phases of the Project needs to be upgraded due to capacity or performance problems, the Contractor should provide the upgraded infrastructure without any additional cost for the NII SMO.

All the equipment provided should be sufficient to meet the minimum Technical and Functional Requirements of the Project. In case an application or a service does not operate or perform within the specified limits due to hardware limitations, the Contractor should add more resources to the equipment or replace the equipment with one of a higher capacity, without any cost for the NII SMO.

Special attention shall be paid to the **expandability** and **modularity** of the system. The system should be capable of effectively managing additional NII data required to support the future NII expansion of the electrical network of the NII. It should also be able to support additional functions and equipment to cope with the evolution of the market operation.

Consequently, and as a result of these expansion requirements, only open architecture NII IT Systems will be accepted.

The use of the hardware and software should be according to the licencing policy of the respective companies that own the intellectual property. The number of licenses that should be provided, should cover, at a minimum, the NII IT Systems usage by the NII SMO users as mentioned in the Technical and Functional Requirements.

## 2.3 General Hardware Requirements

The hardware (HW) equipment including servers, networking and peripheral equipment should support the following requirements:

- They should be the newest production series at delivery time;

- They must be equipped with the latest system software version available during the installation time;

- The supplied equipment software shall provide all required functions for operation, maintenance, test and diagnostic;

- All parts must be assembled from the manufacturer;

- The manufacturer name must be clearly visible on the equipment;

- International standards shall be applied for hardware in order to allow equipment expansion at a later date and to reduce dependencies on a single manufacturer;

- All system relevant software functions shall be based on open architecture standards;

- The performance requirements for the equipment depend on the functions to be performed and on the amount of data to be processed. In order to cope with future system performance requirements and extensions, sufficient performance margin shall be available;

- The equipment must comply with the international standards of environmental protection, energy consumption and electromagnetic emission;

- The equipment should be covered by warranty for the entire period of the contract (implementation, warranty and maintenance period);

- The equipment Manufacturer or Contractor must have presence in Greece throughout the implementation warranty and maintenance period and should be capable to operate a support center (24x7);

- All servers should be of 64-bit architecture;

- All hardware should be delivered with its latest standard software and software updates and should include upgrades to the latest updates and patches. The update services must be an official product of the respective manufacturer.

## 2.4 General Software Requirements

The operating system will be either Microsoft Windows Server 64-bit 2012, downgraded to 2008R2 64-bit) or LINUX 64-bit.

All Databases should be relational Oracle 11g or newer and where there is a DB cluster it will be based on the Oracle RAC (Real Application Cluster).

The Contractor should provide all licences including the 3rd party ones that should permit the execution of the NII SMO tasks with the NII IT Systems.

The Contractor's applications should be the latest and the most robust version. Similarly, the 3rd party software should be the latest and the most robust version.

The Contactor applications should fully meet NII IT Sustems Technical and Functional Requirements.

All 3rd party software provided by the Contractor should include maintenance and upgrade services. The update services must be an official product of the respective manufacturer.

## 2.5 Hardware Technical Requirements

The minimum requirements for each main category of the hardware products should meet the minimum specifications listed below for the following:

- Hardware (Section 2.5.1);
- Disk Storage Array (Section 2.5.2);
- Tape Library Storage Systems (Section 2.5.3);
- Ethernet Switch (Section 2.5.4);
- FC Switch (Section 2.5.5);
- Operator and Maintenance Consoles (Section 2.5.6);
- Printers (Section 2.5.7);
- Rack Cabinets (Section 2.5.88);
- Cabling - Labeling (Section 2.5.99);

### 2.5.1 Hardware

#### 2.5.1.1 Servers

The Servers should be assembled in the factory of the company that produces them and carry the brand name of the product while the installations of the Operating Systems and 3rd party software will be completed at the Contractor premises or at NII SMO sites. The servers will include server management tools but also should be integrated in the NMS software solution. All servers should be delivered with all the necessary software tools, utilities and the manuals and the respective certificates.

The number of CPUs, hard disk capacity and memory installed should be defined by the Contractor in order to meet the NII Functional and Technical requirements as well as the availability and performance ones.

3rd party software for the zip function and anti-virus will be installed on the servers.

### 2.5.1.2    CPU

- Number of supported CPUs for each server: minimum 2.
- Cores: minimum 8.
- Cache memory (L3) : ≥ 12 MB for each CPU.
- Number of installed CPUs for each server should be defined by the contractor to meet the performance of each application.
- 64bit addressability support.
- Multithreading support.
- SPECint_rate_base2006   ≥ 512
- SPECfp_rate_base2006    ≥ 420

### 2.5.1.3    Memory

- Supported Memory for each server: minimum 128GB.
- Advanced ECC.
- Installed memory for each server.

### 2.5.1.4    HDD

- Number of supported HDDs for each server: minimum 4.
- Hot-Stand-by
- SSD or SAS: minimum 15000 rpm
- HDD capacity: minimum 300GB.
- Installed HDDs for each server.

### 2.5.1.5    Network

- Network Gigabit Ethernet ports: ≥ 2.
- Independent LAN port for remote management: ≥ 1.
- HBA FC 8Gbps       ≥ 1
- Ports per HBA       ≥ 2

### 2.5.1.6    System Disks-Controllers

- System Disk-Controller for supported Raid levels 0, 1, and 5.

### 2.5.1.7 I/O Interfaces

- Serial port for each server RS-232 9-pin: ≥ 1.
- Number of PCI slots for each server: minimum 6.
- DVD-RW

### 2.5.1.8 Host Bus Adapter (FC)

- Number of HBA's: minimum 2 (for each HIS server and wherever else is needed).
- Minimum 4 Gb/s channel.

### 2.5.1.9 Power Supply

- Number of supported PSU's for each server: minimum 2
- Hot-Stand-by
- Installed PSU's for each server: 2

### 2.5.1.10 Fans

Number of installed Fans for each server: 4.

### 2.5.2 Disk Storage Array

The Disk Storage Array should meet the following specifications:

- No Single Point of Failure Configuration;
- Redundant enclosures;
- Support of protocols iSCSI, NFS, CIFS;
- iSCSI 10 Gbps ports ≥ 2
- iSCSI 1 Gbps ports ≥ 2
- FC technology with minimum 8Gbps Fiber Channel (FC) ≥ 2;
- Storage tiering support
- Redundant power supplies;
- Redundant Fans;
- Dual Raid Controller, redundant, hot-pluggable, active-active, 1GB memory;
- Raid Level of 0, 1,1+0, 5, 6, 10 or equal
- Thin provisioning support;
- Number of Host Interfaces: minimum 8;
- Hot Stand-by technology of HDDs with automatic rebuild after a drive failure;
- SAS ornearline SAS and SSD support ;

- Hot-pluggable hard drives;

- Installed storage capacity of minimum 20TB Storage must be scalable and expandable to support of minimum 60 TB (raw);

- Online capacity expansion;

- Online volume / LUN expansion;

- Expandability on fiber channel ports;

- Integrated configuration, diagnostic and management tools with graphic interface;

- The storage array and storage switches shall be installed in a rack.

### 2.5.3 Tape Library Storage System

This section refers only to the local ECC site in Rhodes.

A Tape Library Storage System for backups, restoring, archiving and retrieving data will be provided by the Contractor for automatic daily backups. Backups will be configured by the Contractor according to the backup policy that will be communicated by the NII SMO. The Tape Library Storage System will be offered with the following specifications:

- Minimum cartridge slots: 48;

- Two LTO5 drives (Linear Tape-Open) or LTO6 alternatively;

- FC Interface;

- Min 6 GB/sec FC interface for interconnection;

- Minimum Cartridge Magazines 4 with 12 cartridge each;

- Buffer size 256MB;

- Cleaning cartridge;

- Transfer Rate real capacity / capacity with data compression: 1500 / 3000 TB;

- Compressed (assuming 2:1), Native: 72 / 144 TB;

- Backup Management Software for the automated backup/archiving process, installed in the server;

- Backup /restore of databases and archiving / retrieving historical data;

- Barcode reader;

- It will be installed in a rack.


### 2.5.4 Ethernet Switch (Data Center Switches)

This section refers only to the local ECC site in Rhodes.

The number of ports of the Ethernet switches should be defined by the Contractor in order to meet the functional and technical requirements and performance.

Two types of switches should be provided depending upon their specific use:

### 2.5.4.1 For the NII IT LAN, Ethernet Switches Equipment with Gigabit Connectivity.

- Layer 2 Switches;
- 48ports autosensing 10/100/1000 Mb/s;
- 4 uplinks ports 1000 Mb/s (SFP);
- Minimum flash memory 64MB;
- Minimum DRAM memory 128MB;
- Management Ethernet port 10/100;
- USB port;
- Management console port RJ-45;
- Half and Full Duplex port operation (802.3x);
- Minimum number of VLANs is 100;
- Dynamic creation of VLANs;
- VLAN Trunking/tagging (802.1q);
- Spanning-tree (802.1d);
- SNMPv3;
- RMON;
- L2 trace route;
- Command Line interface and Telnet;
- TFTP;
- NTP;
- LEDs for port status;
- Password protected;
- TACACS+ and RADIUS;
- Authentication via MAC address;
- Web authentication (SSL);
- ACL;
- DHCP;
- They will be installed in a rack.

### 2.5.4.2 For the Management LAN, Ethernet Switches equipment with Gigabit connectivity.

Each server will be connected to the management LAN using the remote management port.

- Layer 2 Switches;
- 24 ports autosensing 100/1000/10000 Mb/s;
- 4 uplinks ports 1000 Mb/s (SFP);
- Minimum flash memory 64MB;
- Minimum DRAM memory 128MB;
- Management Ethernet port 10/100;
- USB port;
- Management console port RJ-45;
- Half and Full Duplex port operation (802.3x);
- Minimum number of VLANs is 100;
- Dynamic creation of VLANs;
- VLAN Trunking/tagging (802.1q);
- Spanning-tree (802.1d);
- SNMPv3;
- RMON;
- L2 trace route;
- Command Line interface and Telnet;
- TFTP;
- NTP;
- LEDs for port status;
- Password protected;
- TACACS+ and RADIUS;
- Authentication via MAC address;
- Web authentication (SSL);
- ACL;
- DHCP;
- They will be installed in a rack.

### 2.5.5 FC Switch

This section refers only to the local ECC site in Rhodes.

Fiber Channel switches should be redundant.

- Layer 24 ports;
- Full-duplex;
- Autosensing ports 1/2/4/8 Gbps interfaces;
- 8 SFPs minimum of 4Gtb/s;
- Scalable;
- Unicast & Broadcast;
- Zoning;
- Trunking;
- SSH, Telnet, SNMPv3, Radius, SSL;
- 10/100 Ethernet port RJ45;
- USB port;
- Serial port;
- Diagnostics;
- Web GUI;
- Tools.

### 2.5.6 Operator and Maintenance Consoles

The Workstations are going to be used as Operator consoles, and Maintenance consoles. All types of consoles will have the same characteristics which are described below:

- Two supported slots for CPUs;
- 1 CPU Intel Xeon installed with minimum: 4 cores, 2.0 GHz, 8MB;
- 2 supported slots for Disks with RAID supported;
- 1 Disk installed with minimum: 300 GB SATA 7,2 k rpm;
- Minimum Memory 4GB;
- 2 ports 10/100/1000Mbit/s Ethernet;
- Graphic card for supporting four (4) monitor screens;
- Minimum 2 PCI Express 3x16, 1 x PCI Express 2x4;
- 1 DVD-RW;
- 1 optical mouse;

- 1 keyboard;

- 1 External loudspeakers;

- 3rd party software of Antivirus and zip;

- Microsoft Windows 8.1 64bit or any latest version (downgraded to Windows 7);

- Monitor 24-inch LED.

The operator consoles will be provided with three (3) Monitors connected to every operator console. The maintenance consoles will be provided with two (2) Monitors.

### 2.5.7 Printers

### 2.5.7.1 LaserJet B/W

- Black & white laser printer (size A4);

- Automatic duplex print;

- Minimum 64 MB RAM;

- 1 Ethernet port of 10/100Mbps;

- Minimum resolution 1200x1200 dpi;

- Minimum speed print 25 pages per minute;

- Windows or Linux compatible depending on the EMS/MMS platform.

### 2.5.7.2 LaserJet Color

- A4 Color Laser printer;

- Automatic duplex printing;

- Minimum 256 MB RAM;

- 1 Ethernet port of 10/100Mbps;

- resolution 2400x600 dpi;

- Minimum speed print 20 pages per minute;

- Windows or Linux compatible depending on the EMS/MMS platform.

### 2.5.7.3 Printer (logger)

- 1 Dot Matrix printer (A4/A3 page format);

- 1 standard parallel interface;

- Minimum print speed up to 450 characters per second;

- Windows or Linux compatible depending on the EMS/MMS platform.

### 2.5.8 Rack Cabinet

The rack cabinet must be the APC AR3300 NetShelter SX 42U 600mm Wide x 1200mm Deep Enclosure with Sides Black

### 2.5.9 Cable – Labeling

- All the appropriate cabling (power, network etc) shall be provided and installed by the Contractor;

- All cabling and interconnections between the different subsystems should be implemented in a very professional way, preferably at the server's manufacturing installations or certified workshop by the manufacturer, with the appropriate drawing and labels;

- All cabling should be properly labeled and special attention should be paid for the simplicity and minimum time to replace any failure component;

- Cat6 cables.

## 2.6 Third-party Software Technical Requirements

It is noted that Oracle DB and Operating Systems are considered as standard products and are not included in this document.

Third-party software technical requirements refer at the minimum to the following:

- Network Management System (Section **Error! Reference source not found.**);

- Backup Software (Section 2.6.1);

- Antivirus (Section **Error! Reference source not found.**).

### 2.6.1 Backup Software

#### 2.6.1.1 General

The backup software should provide:

- Backup and recovery solution for the OS physical environment but also for applications;

- On-line backup without having down time;

- Administrative console. Graphical User Interface (GUI) for management, monitoring etc.;

- Installation, configuration, policies and testing (backup-restore);

- Corresponding Licenses for all EMS/MMS servers.

### 2.6.1.2 Overview of Backup Policy

This policy defines a backup policy for the EMS/MMS servers which are expected to have their data backed up. It is designed to protect data, to be sure they are not lost, and can be recovered in the event of an equipment failure, intentional destruction of data, or disaster.

It is a suggested policy, agreed upon between the NII SMO and the Contractor, and should be subject to change upon recommendations. After the Contractor hands in the backup policy, this will be reviewed and approved by the NII SMO personnel.

### 2.6.1.3 Frequency and Timing of Backups

- A back up of data is taken every business working day (Monday to Friday). If for maintenance reasons, backups are not performed, they shall be done on Saturday or Sunday;

- Monthly Backups;

- Full or incremental;

- The backup is scheduled to run automatically.

### 2.6.1.4 Data Backed Up

Data to be backed up include the following information:

- Operating Systems installed on mirror local disks once a month;

- Infrastructure of applications installed on a second pair of local disks;

- Data of the Databases.

### 2.6.1.5 Backup Sequence

- Changing tapes;

- Storing the backup tapes;

- Checking the backup has been successful;

- Managing a backup failure;

- Maintaining the backup log.

### 2.6.1.6 Managing Backup Failure

In the event of an unsuccessful backup, the Contractor should provide the capabity so that the NII SMO personnel can:

- Note any messages / information on the server monitor;

- Record the failure in the backup log and any actions taken as a result;

- Clean the tape drive using the manufacturer's recommended cleaning cartridge;

- Check the age of the tape used. Destroy tape and replace if near or over its age limit;
- If the backup fails repeatedly, it may be necessary to perform a manual backup. This takes time, and must be performed when all users are logged out.

### 2.6.1.7    Tape Drive Cleaning

Tape drives shall be cleaned weekly and the cleaning tape shall be changed monthly.

### 2.6.1.8    Validation of Backup Tapes

A backup tape is validated every 3 months. As part of this process the capability will be provided to ensure that data can be fully restored from the tape.

### 2.6.1.9    Management of Tapes

Tapes are clearly labeled with a number or day of the week and used in strict rotation to ensure even wear and immediate identification of any problems with a specific tape. An example of a typical backup cycle is the following:

- All data are backed up to tape on a daily basis overnight Monday to Friday;
- A cycle of four complete weeks tapes is used in rotation;
- Each month one tape is removed from the cycle and kept for 12 months.

### 2.6.1.10    Storage of Backup Tapes

A full backup should always be kept in a secure fireproof location off-site.

### 2.6.1.11    Age of Tapes

The date each tape was put into service shall be recorded on the tape. Tapes that have been used longer than 24 months shall be discarded and replaced with new tapes according to the manufacturer's recommendations. Also, tapes must be replaced at the first sign of deterioration.

### 2.6.1.12    Backup Log

A daily backup log book is issued to keep a report of backups, their status and which tapes are used. Also it should include information about housekeeping of the backup system. These logs are stored in a specified location.

## 2.7    Services

The NII IT Systems project implementation includes all services for the detailed design, installation, modeling, customization, configuration, connection to the existing NII SMO infrastructure, put the system in operation, testing (in factory and on site), temporary acceptance, put system in full production, warranty according to maintenance requirements, final acceptance and maintenance. During the warranty

period, the Contractor should provide the services that refer to the maintenance requirements.

Additional special services that are needed and are referred to at the respective sub-systems should be provided by the Contractor.

It is empasized that any additional service that is needed to meet the Technical and Functional Requirements for the implementation of the NII IT Systems, and is not specifically mentioned in this document, should be provided by the Contractor at no additional cost for the NII SMO.

## 2.8 General Training Requirements

The Contractor should provide training courses in accordance with the requirements of this Section.

Training should be provided to the NII SMO experts to transfer the knowledge needed in order to be able to model and configure, maintain and troubleshoot, modify and expand, and operate the NII IT Systems and all applications.

Special training for the system operators should be provided in order to be able to use all systems with all respective applications.

Both types of training should cover the theory of design and operation, use, maintenance, and installation of upgrades or new releases.

Moreover, the Contractor should provide training on all 3rd party software products used by the NII IT systems (such as DBs, Application Server, Development tools, etc.) by deploying personnel of the software supplier whenever possible.

The Contractor offered training program will be finalized and agreed upon by the NII SMO during the Detailed Design Phase of the Project.

For each course, detailed learning objectives must be developed and specified, based on the course objective. The detailed learning objectives must state what the trainee should be able to achieve as a result of the training. When detailed learning objectives have been defined, the contents of the training must be designed to provide the learning experience which will enable the trainees to achieve the learning objectives.

The training Program shall contain Course Descriptions covering both class room and on-the-job training, and shall contain at least the following:

- The course name (and number if applicable);
- State whether this is a baseline/off-the-shelf versus customized course;
- A brief description of the course;
- Course learning objectives;

- "Self tests" (with references to appropriate sections where answers can be found) to determine entering and exiting course proficiency levels;

- A description of the intended audience for the course (target group);

- A description of the relationship of the course to others in the training plan;

- The duration of the course;

- The location of the course, whether at the NII SMO's facility or the Contractor's or Subcontractor's training center;

- In the case of training presented at a NII SMO's facility, an identification of required support material (e.g., audio-visual equipment, system workstations and software, laboratory equipment, etc.) should be provided;

- A breakdown of the course schedule, identifying classroom, laboratory, and hands-on periods;

- A list of the training materials to be supplied;

- A list of reference material to be used in the course;

- A list of any prerequisite training or experience expected of the students;

- Any special training equipment and licenses for software training tools required for the training setup (to be provided by the Contractor at no additional cost to the NII SMO);

- At the NII SMO's request, the Contractor shall provide a description of all courses offered by the Contractor and its Subcontractors.

The Contractor may choose to delegate the responsibility for preparing and conducting training courses between his own site and home office staff; training specialists; sub contractors, and original equipment manufacturers as appropriate. However, the overall responsibility for the training remains with the Contractor and the training organization and the quality assurance procedures must reflect this requirement.

As a minimum, the training staff must have the following qualifications:

- Experience in training of staff with background comparable to that of the NII SMO trainees;

- Basic understanding of learning and motivation theory and practice;

- Experience in preparation of instruction materials and manuals;

- Adequate communication skills;

- Education and work experience relevant to the subjects covered by the training in question.

Course instructors shall have demonstrated technical competence in the subject and shall have had previous instructing experience.

The NII SMO prefers instructors who specialize in course presentation, but may accept hardware or software developers to present courses. It is the obligation of the Contractor to provide the highest possible technical standard in relation to the course objectives.

Trainee performance shall be measured through tests designed for that purpose, and administered during, or at the end of a course. It shall also be measured through the trainer's assessment of each trainee, based on relevant exercises carried out during the training.

The Contractor must propose a system for assessing and testing trainee performance in relation to the training objectives, including documentation of this requirement. Moreover, each Course Description shall include a specific description of the assessment and test procedures proposed for that particular course.

A trainee will be considered to have passed a given course if a minimum of 80% of the test items have been successfully completed, and the number and range of test items must be such as to make this criterion meaningful. A certificate will be awarded to each trainee having passed a given course.

The Contractor is considered to have fulfilled his training obligations when all training has been conducted and a minimum of 90% of all possible certificates have been awarded.

Contractor should provide appropriate Training Manuals for each course.

The Trainer Manual shall contain at least the following:

- Course Description;
- Course Programme;
- Lesson Plans;
- Lesson title;
- Lesson objectives;
- Duration;
- Teaching method(s);
- Trainer(s);
- Reading materials and handouts;
- List of facilities and equipment required;
- Exercises to be carried out;
- Trainee assessments/tests.

The training manuals shall be amended by the Contractor according to any revisions of the training, so that they reflect the training actually carried out. After completion of the traning, the Trainer Manuals will be handed over to the NII SMO to support the NII SMO's training activities in the future.

## 2.9    General Documentation Requirements

### 2.9.1    General

The Contractor must produce technical manuals for the operation and maintenance of systems delivered under the contract. The Contractor shall use in the Training Manuals the operation and maintenance manuals which will be later included in the final operation and maintenance manuals. This requirement will secure that trainees are familiarized with these manuals as early as possible.

All the documentation shall be in the English language unless specifically required to be in Greek in other parts of the Tender Documents. The possibility that the Contractor provides the documentation also in Greek, in addition to the English version, will be discussed with HEDNO during Contract Negotiations.

In what follows, documentation requirements are listed for:

- Systems (Section 2.9.2);
- Operating Manuals and Handbooks (Section 2.9.3);
- Hardware (Section 2.9.4);
- Software (Section 2.9.5).

### 2.9.2    Systems Documentation

The documentation of individual systems and the integrated system shall cover at least all of the following areas:

- Detailed Design: Detailed Design Documentation includes a detailed reference on the algorithms used in the EMS and MMS systems, for the various EMS and MMS functions;
- Installation;
- Hardware: From system level up to component level, logic & physical modules, technical specifications, operation & administration guides etc.;
- Software: Detailed functionality descriptions, user and administration guides, roadmaps etc.;
- Operation & Maintenance: Detailed procedures for the daily operation, administration, backup, restore, first level maintenance procedures etc.

The following basic principles shall be fulfilled by the documentation to be supplied to the NII SMO:

- Documentation shall always be updated and a formal procedure shall be established for updating existing documentation;
- Each category of documents shall have a unique identification, according to use, for easy access;

- Documentation shall be fully indexed for fast reference and be in simple form for easy following through;

- All documents shall be supplied in at least four (4) copies;

- All documentation including its version history shall be available through a web-based project/document repository. At the end of the project this document repository should be migrated and become available;

- Documents submitted by the Contractor, including those provided by subcontractors, will not be accepted unless they include evidence that they have been verified by the Contractor.

The following documentation shall be provided for each of the systems that will be delivered:

- **System Configuration:** This documentation shall provide the procedures required to change the configuration (both hardware and software) and the operating features of all subsystems.

- **Alarms and Statistics:** This documentation shall provide detailed explanation of alarms and statistics.

- **Reference Manuals:** This documentation shall provide detailed explanation and procedures for all the functions to be used by System Administrators and Programmers. It shall also contain procedures for troubleshooting faulty units (hardware and software), fault locating and fault remedying as well as recovery procedures for recovering after System breakdown or failure.

- **User Manuals:** This documentation shall provide information for users and supervisors, describing in general all common interfaces (screens) and applications which they will be using.

- **System Specific Documents**: This documentation shall include system configuration data and records, etc., necessary for the proper installation, testing, operation and maintenance of the system.

- **System Customization**: All details of customization and interfacing techniques shall be fully documented so as to enable future modifications, expansions and/or upgrades of the System.

- **Installation Procedures:** This documentation shall include all the installation procedures providing a series of comprehensive guidelines on the sequence and methodology for all aspects of hardware and software installation activity.

- **Test Procedures:** This documentation should include test procedures to be followed during the commissioning of the System.

### 2.9.3 Operating Manuals and Handbooks

#### 2.9.3.1 Dispatcher's Manuals

The Dispatcher's Manual for each Control Centre shall handle at least the following subjects:

- System configuration

- System functions

- Reference between functions and system modules

- General principles are to be explained in the Overview to the operations manual.

- User's handbook

- Overview to operations

- The manual for each Control Centre shall explain the following matters:

- Usage of man/machine equipment including window handling, zooming, panning decluttering, cursor/function key usage.

- Types and characteristics of pictures including call-up procedures.

- Pointing out objects for operations, e.g., tagging, overriding, all kind of manual data entries.

- Procedures in fault situations,

- Meaning of different colours in symbols and numbers,

- User's handbook,

- The User's Handbook for each Control Centre shall be written in a way that it is easy to find advice in daily operational problems. It shall cover the following subjects:

  o Operating with all applicable applications.

  o Detection and isolation of problems. System messages concerning anomalies and invalid requests shall be listed in easily understood text together with suggested appropriate remedial actions.

#### 2.9.3.2 System Operator's Handbook

The Contractor shall prepare for each Control Centre a System Operator's Handbook which shall act as a summary for at least the following instructions or descriptions:

- System start up;

- Different operation modes of the system;

- Planned switch-over;

- Software summary and basic instructions;

- User instructions for each peripheral;

- List of error messages;

- Troubleshooting instructions to be used in conjunction with system dumps, error and abort messages;

- Database configuration and generation.

These manuals are deemed to be used by the system maintenance staff as a quick reference handbook.

### 2.9.3.3 Database, Display and Report Generation and Maintenance Manuals

Database Display and Report generation and Maintenance Manuals for each Control Centre shall include the following subjects:

- Description of different kind of data.

- Attributes of each data type.

### 2.9.4 Hardware Documentation

System design hardware documents needed for planning and coordination of the overall project shall be prepared in the system design stage. This documentation includes:

- General configurations for each system and subsystem illustrating relationships between major components and accessories.

- Functional block diagrams and descriptions for each system level.

- Room and equipment layouts.

### 2.9.4.1 Detailed Hardware Documents

These documents include:

- Assembly drawings and instructions.

- All cabinets, consoles, etc, and their sub-units shall be provided with assembly drawings, including the cases of identical equipment.

- Equipment, such as computers, VDUs, printers, etc., shall be provided with assembly drawings attached to their maintenance manuals.

- If the Contractor has delivered a standard documentation set, e.g.. for cabinets, they shall be referred to in the assembly drawings. In this case, the assembly drawings can be more schematic, and thus the most essential items, such as identification of the assembled parts, can be clearly indicated in the drawings.

- Attached to standard documentation there shall be instructions for assembly and disassembly of the equipment so that maintenance work, replacements, etc., can be carried out effectively.

### 2.9.4.2 Cabling and Wiring Diagrams

From the maintenance point of view cabling and wiring diagrams are of great importance. Thus clearness and logical organisation of this documentation is emphasised.

### 2.9.4.3 Interconnection Cabling Diagrams

These diagrams show the interconnections between different cabinets and units. On the diagrams, there shall be indicated identification and types of the cables, special precautions with regards to earthing, to cable routes, etc.

Diagrams shall be organised according to the use of the cables so that e.g., power supply cabling shall be presented on a separate diagram from the instrumentation cabling.

### 2.9.4.4 Wiring Diagrams

All inter-unit wiring in cabinets and racks shall be shown on wiring diagrams. Fixed wiring, such as busses of racks, shall be attached to maintenance manuals.

Cabinets, units, cables, connectors, etc., shall be marked using the same labels as used in the documentation.

### 2.9.4.5 Functional Descriptions

This information shall include a condensed description of how the equipment operates, and a block diagram illustrating the configuration. The operational sequence of major assemblies shall be described and illustrated by functional block diagrams.

### 2.9.4.6 Hardware Maintenance Manuals

Hardware maintenance shall mainly be based on the use of the Contractor's or a Vendor's standard maintenance manuals. Due to different kinds of maintenance there shall be several procedures presented in these manuals.

The hardware maintenance manuals to be provided shall make references to appropriate diagnostics routines and programs, if applicable, and published separately.

**Preventive Maintenance Instructions**

These instructions shall include all applicable visual examinations, hardware testing, diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the system. Instructions on how to load and use any test and diagnostic programs, and any special or standard test equipment shall be an integral part of these procedures.

**Corrective Maintenance Instructions**

These instructions shall include guides for locating malfunctions down to the module replacement level. Adequate details for quick and efficient localization of the cause of the malfunction shall be given. Particularly explicit fault finding procedures shall be presented and explained in the document. The probable source(s) of trouble, cause, the symptoms and instructions for remedying the malfunction shall be clearly stated. The use of any applicable on-line test and diagnostic programs or any special test equipment shall be explained.

The corrective maintenance instructions shall also include explanations for the repair, adjustment, or replacement of all items, including printed circuit boards.

Schematic diagrams of electrical, mechanical, and electronic circuits, component layouts, photographs and sectional views giving details to mechanical assemblies shall be provided as necessary to repair or replace equipment. For mechanical items requiring field repair, information on tolerances, clearances, wear limits and maximum bolt-down torques shall be supplied.

Information on the loading and use of special off-line diagnostic programs, tools and test equipment, as well as any cautions or warnings which must be observed to protect personnel or equipment (e.g. CMOS handling) shall be included.

### 2.9.5 Software Documentation

System design software documents should include for each system (e.g., the control system) the following:

- Block diagrams illustrating the information flow between the identifiable parts of the system in any configuration, e.g., database update, restart of components.

- Software interfaces and interactions between different modules.

- Flowchart illustrating the running sequence of the programs and their relationships.

- Description for each individual program module to illustrate program operations and features.

- Memory allocation (main/secondary memory resident programs and data) and file definitions combined with performance and capacity calculations.

### 2.9.5.1 Detailed Software Documents

The detailed software documents shall include for each software module or program:

- Detailed flowchart combined with functional description and execution criteria;

- Internal data tables;

- External data and module references;

- Description of programming techniques;

- Special considerations on language, timing etc.;

- Testing methods;

- Source language listings of each program module.

### 2.9.5.2 Software Manuals

The software manuals shall cover all functional areas. Indicatively, these areas include the:

- Operating system manual;

- Utility programs manual;

- Diagnostic and testing programs manual;

- System software manual.

If hardware manuals are needed together with software manuals, clear references shall be made to corresponding items in both manuals.

# 3 EMS Deliverables

## 3.1 General

One (1) Local Control Center in Rhodes, equipped with Energy Management Systems in a main/backup configuration, including the required RTUs, and DC – TFD Systems and Display Wall, should be delivered in full operation.

The Contractor should provide all hardware, software and services needed for the secure operation of the EMS applications.

In what follows the main deliverables are listed:

- EMS Hardware Deliverables (Section 3.2);
- EMS Software Deliverables / Licenses (Section 3.3);
- EMS Additional Services (Section 3.4);
- EMS Training (Section 3.5);
- EMS Documentation (Section 3.6).

## 3.2 EMS Hardware Deliverables

The EMS hardware deliverables consist of the hardware, servers, workstations networking/security (switches/routers/firewalls) and archiving equipment, and the printers (laser printers black and white and colour), loggers and the display wall for the Local ECC.

Hardware should be in full compliance to the requirements that have been set in Section 2.5 of this document.

### 3.2.1 Central ECC (Athens)

The Central ECC in Athens will basically have a monitoring role with respect to the NII system operation; hence only remote displays will be installed in the Central ECC (not actual production EMS systems).

A Development System shall be provided for the Central ECC, consisted of a stand-alone fully configured EMS program development environment with the DTS software also installed to facilitate testing. The development system shall not be redundant.

### 3.2.2 Local ECC (Rhodes)

The EMS in the Local ECC should include the appropriate fully redundant IT System integrated to the NII SMO infrastructure and able to host and operate all EMS applications for the NII.

The Main and Backup EMS should operate as complementary systems for the NII (only one should be active at a specific point in time while the other should be in monitor status). They should be always updated with the status of the electrical system and synchronized to each other in order to be ready to change their operational status when needed.

A separate infrastructure should be provided to host and operate Dispatcher Training Simulator (DTS).

### 3.2.3 RTUs

The Supplier shall deliver RTUs to the nominated address as indicated in the schedules. Delivery costs will be included in the tender. Full street address will be detailed at time of placing an order. Deliveries may only be made after agreement with HEDNO, to ensure staff are available to receive the Goods.

All goods shall be suitably packed to prevent damage during loading, unloading and transport. Equipment subject to damage due to vibration shall be removed & packed separately for transport.

Each RTU and associated equipment shall be labeled with its associated site.

In total, 7 RTUs will be delivered in Rhodes. The minimum technical specifications of the RTUs are presented in Part B - EMS of the Technical Tender Technical and Functional Requirements.

### 3.2.4 Data Concentrators - Time-Frequency Devices

The DC – TFD infrastructure is installed in the NII and mainly consists of redundant DC and TFD equipment. DC equipment and TFD infrastructure should be provided for the ECC in Rhodes. The minimum technical specifications of the DC and TFDs are presented in Part B - EMS of the Technical Tender Technical and Functional Requirements. Note, a central GPS system will be installed in Athens for the synchronization with the local ECC.

### 3.2.5 Display Wall

The Contractor should deliver the Display Wall at the Local ECC in Rhodes. The minimum technical specifications of the Display Wall are presented in Part B - EMS of the Technical Tender Technical and Functional Requirements.

## 3.3 EMS Software Deliverables / Licences

### 3.3.1 Central ECC (Athens)

The Central ECC in Athens should include software, hosted to respective hardware infrastructure, properly configured for monitoring the operation of the NII.

### 3.3.2 Local ECC (Rhodes)

The EMS in Local ECC should include at minimum the following software hosted to respective hardware properly modeled and configured for the operation of the NII:

- Firewall, Anti-Virus and Encryption Software;
- Archiving Software;
- Administration Software;
- HMI Software;
- DB and Global Database System;
- SCADA software;
- ICCP Software for communication with the external systems;
- Historical Aplication Software (HIS);
- State Estimator;
- Power Flow;
- Optimal Power Flow;
- Contingency Analysis;
- Short Circuit Analysis;
- Outage Scheduler;
- Automatic Voltage Control;
- Load Shedding;
- Automatic Generation Control with market extension and RES curtailment capabilities;
- Inter-site communication software (vendor specific or ICCP);
- Network management;
- Display Wall Control Software.

Moreover the Dispatcher Training Simulator (DTS) software should be provided.

### 3.3.3 RTUs

The RTUs should include at a minimum the software, properly configured, to ensure operation according to the Technical and Functional Requirements.

### 3.3.4 DC – TFD

The DC - TFD should include at a minimum the software, hosted to the respective IT infrastructure, properly modeled and configured for the communication with the Local ECC (where installed) and for the data exchange with the NII Electrical System.

### 3.3.5 Display Wall

The Contractor should deliver at a minimum Display Wall Control Software.

### 3.3.6 Licences

The Contractor should provide all licences, including the 3rd party software, for 10 users expected to use the EMS.

## 3.4 EMS Additional Services

### 3.4.1 EMS Modeling and Customization

The EMS should be modeled and customized to reflect the NII status at the end of the trial operation.

### 3.4.2 Data Migration

The migration of the existing data provided by the NII SMO, to the new EMS shall be carried out by the Contractor.

## 3.5 EMS Training

The Contractor should provide Training services covering all aspects of the EMS setup, operation, fine-tuning, administration and maintenance.

A minimum 30 days of training services for EMS should be provided. Training should be in full compliance to the requirements that have been set forth in Section 2.8 of this document.

Operator training shall have to take place in at least 2 groups at different periods of time to have sufficient personnel at the existing Control Centres for around the clock operation duty.

To gain substantial and in-depth knowledge and experience in power system control by utilizing the new EMS system as well as for the Corporate Services systems, a mixture of theoretical classroom training and practical hand-on exercises are recommended. The operational staff shall also be involved in control system design, implementation and testing as this is important for the acceptance of the system by the operators. Practical hands-on participation during the commissioning and testing of the new EMS shall also improve the confidence in the control system and provide additional practice in its utilization.

Apart from network operators, the NII SMO's management and personnel in the operational planning and operation evaluation shall receive introductory training. The training courses that are required at a minimum are presented in the following sub-sections.

Training for EMS system hardware maintenance personnel shall be held at the manufacturer's place and in Greece. The maintenance personnel shall actively participate in installation, commissioning and acceptance testing of all equipment.

Aim of all hardware training is to enable the NII SMO's personnel to conduct regular preventive maintenance, troubleshooting and repair on a module replacement basis. The trainees shall attend a series of theoretic courses in which they shall receive basic knowledge and skills to maintain all type of equipment/modules, use of test equipment and diagnostic software. Courses at the manufacturers place shall also include practical exercises.

### 3.5.1 Introduction of Operation Personnel and Management

This course shall provide basic knowledge on the SCADA/EMS upgrading and expansion and the control system itself. It shall be held in Greece immediately after installation of the control system and shall be held in the form of instructor directed lessons and demonstrations.

Main subjects of the training shall include:

- Project scope and schedule;
- Basic hardware and software configuration;
- Basic process control functions;
- Basic MMI functions;
- Process information and their basic processing;
- Historical data storage, presentation and report generation;
- Functions for planning, Network Calculations and Security Assessment, Load Frequency Control, Power System Economic Optimization and disturbance analysis.

### 3.5.2 Training for Control System Handling

The course shall enable operators to handle and use the control system by deploying practical exercises. It shall be held after the introduction course prior to the commissioning and testing of the system. The practical exercises shall be supported by theoretical instructions.

Main subjects of the training shall include:

- Use of operator consoles;
- Login and assignment procedures;

- Menu handling and display selection;

- Principles of display design;

- Dialog procedures;

- Control system monitoring;

- Switch/fail over procedures between redundant equipment at one CC (internal redundancy) and between the different CC sites (multi site configuration).

- Usage of Generation and Transmission specific Software module as:
  - State Estimator;
  - Dispatchers Power Flow;
  - Optimal Power Flow;
  - Short Circuit Analysis;
  - Outage Scheduler;
  - Contingency Analysis;
  - Automatic Voltage Control;
  - Load Shedding;
  - Load Frequency Control with Automatic Generation Control and Interchange Scheduling, Reserve Monitor.

- Interface to the RTD application (in the MMS platform) and processing of RTD information;

- Reporting and Analysis.

### 3.5.3    Training for Web-based Remote Terminal Users

The course shall enable users of Web-based Remote Terminals to handle their Remote Terminals by deploying practical exercises. It shall be held after commissioning and testing of the SCADA/EMS System. The practical exercises shall be supported by theoretical instructions.

Main subjects of the training shall be:

- Usage of remote terminals;

- Login and assignment procedures;

- Menu handling and display selection;

- Principles of display design;

- Workflow and information flow between SCADA/EMS System and remote terminals;

- Dialog procedures;

- Control system monitoring.

### 3.5.4      Training for EMS Software and Database Maintenance

Due to high complexity of EMS and DTS systems, software maintenance is increasingly important. During the lifetime of the system, functions have to be amended and new functions have to be added. On the other hand, the EMS and DTS system has permanently to be adapted to the evolving generation and transmission system.

The NII SMO's personnel must be able to conduct these adaptation activities themselves to keep the system alive at all times.

The trainees shall attend a series of theoretical courses in which they shall receive basic knowledge and skills to maintain the EMS and DTS system and the use of test equipment and diagnostic software.

Main subjects of the training shall include:

- Database design, engineering and maintenance of all kinds of objects;

- Parameterization data types for all functions specified e.g. alarm and measurement processing, calculations, interlockings, dynamic network coloring etc.;

- Design, engineering and maintenance of graphic displays;

- Design, engineering and maintenance report generation.

- Configuration, database maintenance and tuning of all SCADA/EMS/DTS specific software provided under the contract such as:

    o Operating software;

    o MMI software;

    o SCADA application software;

    o EMS Network Application software;

    o EMS Generation Control Application software;

    o Dispatcher Training Simulator.

In the phase of setting up the new system, the trainees shall:

- Participate in data migration from the existing Control System to the new system provided under the Contract;

- Actively participate during installation, commissioning and testing in Greece including instructor lessons;

- Actively participate in system factory tests and site tests including validation of data and point-to-point tests.

### 3.5.5 Training for Control Centre Hardware/Administrators

This training shall provide the maintenance personnel with in-depth knowledge about the control system design, hardware configuration, individual servers, operator workstations and peripherals.

Aim of the training program outlined below is to enable NII SMO personnel to perform regular tasks of system administrators including troubleshooting and repair utilizing diagnostic software to be provided under the contract.

Main subjects of the training shall include:

- Control system configuration;

- Operating software;

- Functional and physical description of equipment and modules;

- Basic components of control systems as processor, memory, I/O units, graphic adapters LAN and communication controllers, etc.;

- Peripherals (printers, hardcopy, tape units, terminal servers, large screen projection etc.);

- Installation procedures;

- Hardware and software tools for fault diagnosis;

- Equipment/module replacement procedures;

- Equipment/module restart procedures;

- System administration including:

  o Start-up and shut down;

  o Back-up and restoration procedures;

  o Fail-over and switch-over between redundant components, and;

  o System security management including access security, firewall settings, assignment of functions and authorities etc.

In addition to the training courses, system administrators shall also actively participate in system factory tests and in the installation, commissioning and acceptance testing on site.

### 3.5.6 Training for SCADA System Maintenance

The training shall give SCADA maintenance personnel in depth knowledge about design, functions and maintenance procedures for the Data Concentrators and RTUs. The NII SMO personnel shall also be able to configure, modify and expand the SCADA system (Data Concentrators and RTUs) by additional modules and extend/modify DC/RTU parameters.

Main subjects of the training shall include:

- Data acquisition principles;

- DaCon/RTU design (hard- and software) and functions;

- Basic communication principles for SCADA/EMS System utilizing Standard Communication Protocols such as IEC 60870-5-101, IEC 60870-5-104, ICCP, DNP 3.0, Modbus;

- Principles of modern IP-based Communication Networks including LAN, WAN, Routers, Firewalls;

- Functional and physical description of equipment and modules;

- Database Setup / Download, extension and modifications;

- Installation procedures;

- Diagnostic tools and procedures for the overall Communication servers, DaCons/RTU and individual modules;

- Preventive and corrective maintenance procedures for DaCons/RTU and individual modules;

- Equipment/module replacement procedures;

- Equipment/module restart procedures.

Active participation of NII SMO experts during installation, commissioning and testing of the new SCADA system is required.

Moreover System administration subjects shall include also the following:

- Periodic EMS maintenance procedures;

- Start-up and shut down;

- Back-up and restoration procedures;

- Fail-over and switch-over between redundant components, and;

- System security management including access security, firewall settings, assignment of functions and authorities etc.

**RTU Training of HEDNO's Maintainers**

HEDNO will require training of SCADA System maintainers in the operation and maintenance of RTUs. This shall be required normally for any new RTU products, but may be required for familiarity training as part of a refresher course for both new and existing personnel.

The courses shall cover aspects of the RTU design sufficient for the maintainers to maintain the RTU over its design life. Contents shall include:

- RTU operation and data communications protocols;

- Diagnostic tools provided with the RTU and test equipment to fault find an RTU;

- Failure modes;

- Configuration of the RTU.

HEDNO will take up training on the RTUs offered. The supplier shall include with its offer the following:

- Lists of standard RTU courses offered and the cost per attendee or per course, detailing minimum and maximum number of attendees.

## 3.6 EMS Documentation

The Contractor should deliver detailed documentation covering all the following:

- Aspects of the EMS setup, operation, modeling, configuration, fine-tuning, administration and maintenance;

- Procedures for EMS start-up and shutdown, backup and restoration procedures and fail-over and switch-over between redundant components and/or different locations.

In addition to the above, documentation associated with the RTU equipment comprises the (RTU) supplier's standard manuals and customised drawings for each RTU.

**Manuals**

The Supplier shall supply descriptive manuals for design, configuration, installation, commissioning and maintenance purposes. These shall be the Supplier's standard documentation, modified if necessary for HEDNO's purposes. Quantities shall be specified with each order.

**Drawings**

It is preferred that drawings of input/output circuits be provided be in "pro forma" form, such that they may be easily understood by field staff from a master set, rather than having multiple sets of drawings. Separate spreadsheets may be provided to contain additional information.

All drawings shall be produced using the latest version of Autocad or Microstation and the supplier shall allow 10 working days for review and approval by HEDNO. All drawings shall be provided in electronic form. All drawings shall be fully version controlled. Two sets are required.

Drawings as follows shall be submitted for the approval of HEDNO, for each RTU to be manufactured:

- Inspection & Test Plans;

- Cubicle or gear plate General Arrangements showing RTU layout;

- Dimensioned cubicle and/or gear plate drawings;

- Bill of Material for each cubicle/gear plate set identifying all parts;

- Power Distribution Schematic Diagrams for each RTU;

- Schematic Diagrams for Inputs and Outputs for each RTU (preferably using pro forma principles);

- Calculations for RTU and I/O power consumption: An Excel spreadsheet shall be provided that calculates the maximum power consumption of the RTU. Inputs shall be the numbers and types of I/O and communications cards. The calculations shall compute the power at the primary voltage level into the RTU allowing for any power conversion efficiencies.

All the above documentation should be in full compliance with the requirements that have been set forth in the Section 2.9 of this document.

# 4 MMS Deliverables

## 4.1 General

The MMS should be provided, installed and fully integrated with the existing SMO infrastructure in the Central Control Center in Athens and the Local Control Center in Rhodes.

In addition to the production MMS System, a Development and Testing MMS System should be provided for Athens. There will be no development system in Rhodes.

In what follows the main deliverables are listed:

- MMS Hardware Deliverables (Section 4.2);
- MMS Software Deliverables / Licenses (Section 4.3);
- MMS Additional Services (Section 4.4);
- MMS Training (Section 4.5);
- MMS Documentation (Section 4.6).

## 4.2 MMS Hardware Deliverables

MMS hardware deliverables include the hardware, servers, workstations and networking/security (switches/routers/firewalls), archiving equipment, security (antivirus) and the printers, laser printers (black and white and colour) loggers required to host and operate the applications of the MMS, as well as the other applications and utilities needed for communication with the other systems etc.

It consists at a minimum of:

- Web servers;
- Archiving/backup Servers;
- RTD Market servers;
- RDAS Market servers;
- DS Market servers;
- Load and RES Forecast servers;
- LDAP/SSO servers;
- Load balancing;
- Database RAC Servers;
- MMS Firewall/routers/switches;
- MMS Development and Test System.

The above provide more a functional decomposition than an actual servers' configuration. The MMS platform will be hosted in two main servers: an applications server, and a database server. The same physical servers can host EMS applications and databases.

Contractor should size the hardware to meet operational and performance times specified in the Technical and Functional Requirements of this Project. Hardware should be in full compliance to the requirements that have been set forth in Section 2.5 of this document.

## 4.3    MMS Software Deliverables/Licences

The MMS should include at a minimum the following software hosted in the respective hardware properly modeled and configured for the market operation of the NII:

The MMS main applications are:

- Common Services:
  - MMS User Interface;
  - Validation System;
  - Market Publishing System;
  - Market Reporting System;
  - Market Communications System.

- Applications:
  - Master File;
  - Rolling Day-Ahead Scheduling;
  - Dispatch Scheduling;
  - Cost-based Real-Time Dispatch;
  - Real Time Data Recording and Logging System.

In addition to the above, Load and RES Forecasting Applications will be fully integrated with the MMS platform.

It is noted that only one dispatch system (RTD Application) is foreseen in the project, which is part of the MMS, and which passes the information to the EMS for the implementation of the AGC.

The above software should be also provided and installed at the MMS Development and testing MMS System.

The Contractor should provide all licences including the 3rd party software for 10 users expected to use the MMS.

## 4.4 MMS Additional Services

### 4.4.1 MMS Customization to Latest Market Rules

The MMS and settlement system should be customized according to the latest Market Rules finalized during the Detailed Design Phase of the Project and updated accordingly, where necessary, before the Trial Operation Phase of the Project.

### 4.4.2 Data Migration from the Existing Market Operation and Settlement Systems

The migration of the existing data of the Market and Settlements activities, provided by the NII SMO, to the new system shall be carried out by the Contractor.

## 4.5 MMS Training

The Contractor should provide training to give NII SMO's personnel (Managers, System Operators and Maintenance and Support team) the necessary knowledge and skills for the operation, extensison and maintenance of the MMS.

A minimum 50 days of training services for the MMS should be provided.

The details of the training subjects and duration of the training courses will be defined in the Detailed Design.

Training should be in full compliance to the requirements that have been set in the Section 2.8 of this document.

NII SMO reserves the right to reallocate hours between the subjects, as well as to customize the schedule in order to match training needs and personnel schedule / availability. The NII SMO also reserves the right to increase the training days for particular subjects, in cases where the training days/hours will not be judged sufficient. The Contractor should provide training services covering all aspects of the MMS and settlement setup, operation, fine-tuning, administration and maintenance.

The training courses related to the MMS shall cover at the minimum the following subjects:

- Basic and advanced MMS Business knowledge;
- Database Building and Display Development;
- Data Engineering Workshops;
- MMS Programming Languages;
- Programming in the MMS Environment;
- MMS Communications Software;
- MMS System Administration;
- MMS Application Software;

- Hardware Training;

- Hardware Maintenance Training.

Moreover additional training to the Market and Settlement Operators should be provided.

The objective of these courses is to provide the necessary information to Market and Settlement Operators, in order to be able to operate the system.

Apart from the training courses mentioned above, the Contractor shall perform on the job training during all project phases, especially for database population, system handling and operation.

## 4.6    MMS Documentation

The Contractor should deliver detailed documentation covering all:

- Aspects of the MMS setup, operation, modeling, configuration, fine-tuning, administration and maintenance;

- Procedures for the MMS start-up and shut down, back-up and restoration procedures and fail-over and switch-over between redundant components.

The above documentation should be in full compliance with the requirements that have been set forth in Section 2.9 of this document.

# 5 Corporate Systems Deliverables

This Section includes the main Deliverables for the Corporate Systems are as follows:

- DW/MIS Deliverables (Section 5.1);

- Helpdesk Deliverables (Section 5.2).

## 5.1 DW/MIS Deliverables

### 5.1.1 General

The DW/MIS should be installed and be fully integrated with the existing NII SMO infrastructure in the Central Control Center in Athens.

Data from the Central Control Center, as well as from the Local Control Center of Rhodes shall be stored in the DW.

In what follows, the main DW/MIS deliverables of the as listed:

- DWMIS Hardware Deliverables (Section 5.1.2);

- DW/MIS Software Deliverables / Licenses (Section 5.1.3);

- DW/MIS Additional Services (Section 5.1.4);

- DW/MIS Training (Section 5.1.5);

- DW/MIS Documentation (Section 5.1.6).

### 5.1.2 DW/MIS Hardware Deliverables

DW/MIS hardware deliverables include the hardware, servers, workstations and networking/security (switches/routers/firewalls), archiving equipment, the printers, laser printers (black and white and colour) loggers required to host and operate the applications of the DW System as well as other applications and utilities needed for communication with other systems etc.

It consists at a minimum of:

- Web servers;

- Database server RAC Servers;

- Application Servers;

- Archiving/backup Servers;

- LDAP/SSP servers;

- Load balancing;

- Firewall/routers/Switches.

The above provide more of a functional decomposition than an actual servers' configuration.

The Contractor should size the hardware to meet operational and performance times specified in the Technical and Functional Requirements of this Project. The hardware should be in full compliance with the requirements that have been set in Section 2.5 of this document.

### 5.1.3 DW/MIS Software Deliverables/Licences

The DW should include at a minimum the following software hosted to the respective hardware properly modelled and configured for the NII SMO operations.

Main DW/MIS main applications are:

- Database Management System (DBMS);
- Authentication;
- Extraction Transformation & Loading (ETL);
- Reporting and Presentation;
- Data mining;
- Data analysis;
- Graphics;
- MIS and Business Inteligence,

The above software should also be provided and installed to the DW/MIS System.

The Contractor should provide all licences including the 3rd party software for 5 users expected to use the DW/MIS.

### 5.1.4 DW/MIS Additional Services

The migration of the existing data from former systems, provided by the NII SMO to the new system shall be carried out by the Contractor.

### 5.1.5 DW/MIS Training

The Contractor should provide Training services covering all aspects of the Corporate DW/MIS setup, operation, fine-tuning, administration and maintenance in full compliance with the requirements that have been set in Section 2.8 of this document.

The trainining should include:

- DW/MIS user training for end-users;
- DW/MIS analysis for power-users;
- DW/MIS administration & first line support training for administrators.

### 5.1.6 DW/MIS Documentation

The Contractor should deliver detailed documentation covering all aspects of the Corporate DW/MIS solution setup, operation, fine-tuning, administration and maintenance in full compliance with the requirements that have been set in Section 2.9 of this document.

DW/MIS design documents should be delivered to the NII SMO for:

- Mapping of data sources;

- DW Database;

- Flows;

- ETL;

- Applications;

- Reporting.

## 5.2 Helpdesk Deliverables

### 5.2.1 General

The Helpdesk should be installed and be fully integrated with the existing NII SMO infrastructure in the Central ECC in Athens.

Helpdesk will serve the Central Control Center, as well as the Local ECC of Rhodes. It will also serve the needs of the 32 NII in the future.

In what follows, the main Helpdesk deliverables of the as listed:

- Helpdesk Hardware Deliverables (Section 5.2.2);

- Helpdesk Software Deliverables / Licenses (Section 5.2.3);

- Helpdesk Additional Services (Section 5.2.4);

- Helpdesk Training (Section 5.2.5);

- Helpdesk Documentation (Section 5.2.6).

### 5.2.2 Helpdesk Hardware Deliverables

Helpdesk hardware deliverables include the hardware, servers, workstations and networking/security (switches/routers/firewalls), archiving equipment, the printers, laser printers (black and white and colour) loggers required to host and operate the applications of the Helpdesk System as well as the other applications and utilities needed for communication with the other systems, protection and security, archiving etc.

It consists at a minimum of:

- Web servers;

- Database server RAC Servers;

- Application Servers;

- Archiving/backup Servers;

- LDAP/SSP servers;

- Load balancing;

- Firewall/routers/switches.

The above provide more of a functional decomposition than an actual servers' configuration.

The Contractor should size the hardware to meet operational and performance times specified in the Technical and Functional Requirements of the Project. The hardware should be in full compliance with the requirements that have been set in Section 2.5 of this document.

### 5.2.3      Helpdesk Software Deliverables/Licences

The required deliverable is the Helpdesk application software with the appropriate licenses, installed and configured properly to meet the business goals of the NII SMO.

The Contractor should provide all licences including the 3rd party software for 25 users expected to use Helpdesk.

### 5.2.4      Helpdesk Additional Services

The migration of the existing data from former systems, provided by the NII SMO to the new system, if required, shall be carried out by the Contractor.

### 5.2.5      Helpdesk Training

The Contractor should provide Training services covering all aspects of the Helpdesk setup, operation, fine-tuning, administration and maintenance in full compliance with the requirements that have been set in Section 2.8 of this document.

The training should include:

- Helpdesk user training;
- Helpdesk analysis for power-users;
- Helpdesk administration & first line support training for administrators.

### 5.2.6      Helpdesk Documentation

The Contractor should deliver detailed documentation covering all aspects of the Helpdesk solution setup, operation, fine-tuning, administration and maintenance in full compliance with the requirements that have been set in Section 2.9 of this document.

# 6 Telecommunications Requirements

## 6.1 General

The telecommunications network required for the operation of the Central ECC in Athens and the Local ECC in Rhodes, will consist of the following networks:

a) The Backbone Network, which will include the interconnection between the local ECC and the central ECC. The Central ECC will be spatially located in two places, the premises of HEDNO's InformationTechnology and Telecommunications Department, where the core ICT and Corporate systems infrastructure will be hosted, and the premises of Islands Network Operation Department, where the operation department will be hosted. This network will be fully implemented by HEDNO.

b) The Local ECC Network which will involve the telecommunications interconnection of the Local ECC with the Substations and Plants and the telecommunications interconnections inside the Local ECC, between the core ICT and Corporate systems infrastructure with the respective operation department of the Local ECC. This network shall be implemented by the Contractor while the leasing of the required lines will be provided by HEDNO or the independent producers. The connection of the Local ECC network with the Substations and Plants shall be based on the implementation of an IP Virtual Private Network (VPN) to be developed by the Contractor and shall incorporate the best security practices for the interconnection through internet (Data Concentrator). The IP VPN shall be implemented through the Internet connections provided. The interconnection of the Data Concentrator with the core ICT and Corporate systems infrastructure of the Local ECC shall be implemented through a secure way with the use of suitable network equipment (Firewall – Routers). The configuration shall be carried out by the Contractor in cooperation with HEDNO.

## 6.2 Detailed Description

### 6.2.1 Architecture

HEDNO will provide two Metro Ethernet Interfaces (main and backup) to the Local ECC in Rhodes for the interconnection with the Backbone Network and the Central ECC in Athens in a high availability configuration implemented by the Contractor. HEDNO will also provide two telecommunication lines (main and backup) offering symmetrical telecommunications connection with Dedicated Internet Access for the interconnection of Substations and Plants through secure VPN interconnections in a high availability configuration as well, implemented by the Contractor.

For the implementation of Rhodes' Network, the Contractor has to:

a)      Install two routers and two firewalls in the Local ECC in high redundancy-availability formation, as described in the "Equipment Requirements" section and carry out the interconnections of this equipment with the telecommunications lines provided by HEDNO. The firewalls shall act as Data Concentrators at which the VPNs for the interconnection of the Local ECC with the Substations and Plants shall terminate. They shall also carry out basic routing operations. The main routers shall manage the secure Metro Ethernet interconnections with the Backbone Network and the Central ECC in Athens, shall apply Security techniques to control the access to the core ICT and Corporate systems infrastructure of the Local  ECC by the respective operation department of the Local  ECC and shall control the secure access by the Data Concentrator to the core ICT and Corporate systems infrastructure of the Local ECC.

b)      Install routers in every Substation and Plant as described in the "Equipment Requirements" section for their interconnection with the Local ECC. The interconnection shall be carried out through secure VPN connections.

c)      Program and configure the routers in every Substation and Plant for the implementation of the required VPNs. The Contractor shall implement the secure VPN connections of the Local ECC (through the firewall) with the Substations and Plants in cooperation and with the agreement of HEDNO.

d)      Supply the necessary passive equipment for the installation of the network equipment and the required interconnections (e.g. racks, structured cabling, patch panels) without any additional charge.

Rhodes' network will use the Local ECC as a central point and shall be interconnected with seven (7) Substations and Plants, five (5) Wind Parks and ten (10) Photovoltaic parks.

For all the aforementioned points, a main and a backup telecommunications line is suggested for the interconnection with the Local ECC through secure VPN connections. Depending on the availability requirements , ADSL or VDSL technology is suggested as the main telecommunication line, and a backup line over cellular network with GPRS, EDGE, preferably 3G or 4G technologies, depending on the availability as well. In case no telecom lines are available for the main or redundant line, alternate technologies should be examined (such as microwave links, satellite connection). Especially for the Photovoltaic parks there shall be no backup network and the main network will preferably use mobile telephony technology (GPRS or EDGE or preferably 3G or 4G).

The Contractor shall install and configure routers, as specified in "Equipment requirements" section, in all the aforementioned points. The Contractor shall also implement secure VPN connections of every point with the Local ECC (through the firewall), as well as the automatic switch from the main to the backup line in case of unavailability of the main line.

## 6.2.2    Network Devices – Infrastructure Management Platform

The core ICT and Corporate systems infrastructure of the Local ECC in Rhodes and the Central ECC in Athens, as well as the telecommunications interconnections with the Substations and the Plants, the interconnections with the respective operation sections (Athens, Rhodes) and the Backbone Network will be monitored by a network management and monitoring system.

This system shall monitor servers, peripheral devices (such as disk storage arrays) and computer terminals, network devices (switch, router, and firewall) and infrastructure, databases and applications, in order to assure timely fault detection and alarming.  The network operators shall be able to define rules, actions and alarms concerning faults or other issues.

The system shall include:

• 	Fault management

• 	Configuration management

• 	Performance monitoring

• 	Accounting management

• 	Security management

And also offer:

• 	Monitoring of performance, use of resources and statistical data for all the managed network connections and devices. This information will be provided through screens, periodic and ad hoc reporting.

• 	Graphic visualization of the network connections of the telecommunication lines and the state of devices, servers and other elements managed by the network management and monitoring system.

• 	Alarm notifications in case of predetermined fault conditions or resource usage problems with the possibility to carry precautionary actions for the aversion of faults.

• 	Logs collection and analysis from all involved devices.

• 	Diagnostic tools for fault detection.

• 	Data collection and processing capability (logs, network traffic, etc.) related to security and fault notification facilities.

Regarding the Network Devices – Infrastructure Management and Monitoring system, the Contractor has enable monitoring of all involved devices in the project, the applications, the services which run in the core ICT and Corporate systems infrastructure of the Local ECC and the Central ECC infrastructures, the telecommunications interconnections/lines and any other parameter that is important in order to define the required software licensing. The Network Devices –

Infrastructure Management system will collect and process logs from the managed devices. HEDNO shall have full access to all the log files in real time.

HEDNO shall also be notified directly and in real time, for every security-related event that is detected by the Contractor. These events / logs shall remain online for a three month period and archived for a six month period. During all this period this data has to be available to HEDNO. The Contractor will collect the events from all the devices involved.

The Contractor shall train HEDNO's personnel regarding the use of the platform, which is collecting, processing and monitoring network devices' logs and the status of network devices, firewalls, servers and the core ICT and Corporate systems infrastructure of the Central and Local ECCs. The training for the use of the platform includes security events according to an analytical training schedule and program submitted to HEDNO by the Contractor.

Certain capabilities of the platform include:

•       Protocol application for the detection of devices connected to the network (Local and Central ECC) (such as ping, LLDP, ARP, BGP, OSPF, route table lookup, SNMP)

•       Centralized devices event / logs monitoring for the detection of events related to the operation and status of the devices (health monitoring).

•       Monitoring and alert mechanism for the availability of the network, the devices and the ICT and Corporate systems of the Central ECC in Athens and the Local ECC in Rhodes.

•       Extra Functionalities in order to identify the network users, the applications' types executed, the bandwidth used (NETFLOW or functionally equivalent)

•       Capability to centrally manage and visualize the status of the infrastructure – devices of the whole network with dashboards

The Contractor is obliged to ensure the compatibility of the network devices management platform with all the other network equipment and devices and provide every possible network access to the platform by the managed equipment in its entirety, for the collection of data, measurements, and logs.

### 6.2.3      Security Characteristics of the Telecommunication Network

The Contractor is responsible to configure the high availability firewall cluster of the Local ECC, as well as the routers in the Substations and Plants, for the implementation of VPN connections in order to establish the secure connections of the Local ECC in Rhodes with the Substations and the Plants, through the Data Concentrator.

For the secure connections encryption techniques will be applied with IPsec tunneling based on DES / 3DES / AES standards. The Contractor shall implement the secure connections in co-operation and with the agreement of HEDNO. For the

implementation of the encryption techniques, the Contractor is obliged to ensure the support of the encryption technique on each router which is installed in Substations and Plants (based on the "Equipment Specifications" section) and in the central location (Data Concentrator) for the high availability firewall cluster infrastructure of the Local ECC in Rhodes.

Especially, for the high availability firewall cluster of the Local ECC in Rhodes, the Contractor shall undertake the termination of VPN secure connections with the Substations and Plants, through a symmetrical high-speed telecom line that HEDNO will provide (DIA type). In addition, the high-availability firewall cluster of the ECC of Rhodes will take over the routing of the data from secure connections with the Substations and Plants to the ICT & Corporate systems, through secured access zones (DMZ) and an intermediate cluster of high availability central routers of the ECC of Rhodes.

The installation, configuration, operation and maintenance of the high availability firewall cluster of the Local ECC shall take place in co-operation and with the agreement of HEDNO. HEDNO must be formally notified for any changes or modifications of the operating parameters of the high availability firewall cluster of the ECC of Rhodes. The Contractor must ensure, through the Network and Infrastructure Management Platform, the immediate notification of HEDNO via alerts or any means of user notification, for any form of configuration modification, logs for security incidents and operating condition collected for the high availability firewall cluster and the central routers cluster of the Local ECC.

HEDNO will provide two Metro Ethernet Interfaces (main and backup) for the interconnection of the Local ECC in Rhodes with the BackBone Network and the Central ECC in Athens. The Contractor must  provide and implement a high availability network solution to ensure secure connection between the Central ECC in Athens and the Local ECC in Rhodes and must properly configure the equipment for an automatic switchover mechanism from the main to the backup circuit in the event of the master line unavailability.

The installation, configuration and implementation of security techniques, access and control policies in the core ICT & Corporate systems infrastructures of the Central ECC in Athens and the Local ECC in Rhodes, access control of the respective operation sections in the Central ECC  and the Local ECC, as well as the implementation of an automatic switching mechanism (in case of master telecom line failure to ensure High-Availability) are implemented by the Contractor in co-operation and with the agreement of HEDNO.

### 6.2.4    Technical Support

The Contractor is obliged to provide maintenance and technical support for the telecommunication equipment provided, throughout the duration of the contract. Maintenance shall be carried out by the Contractor's qualified staff. During the

maintenance, the Contractor shall fix or replace the hardware and software or those parts which are considered defective, as long as they have an impact on the required High Availability of the system. Defects of hardware and software that do not have a direct impact on the High Availability of the system will be repaired as soon as possible. The Contractor is obliged to provide a study to identify the devices (network, core ICT, etc) that have a direct impact on the required High-Availability.

Maintenance services should also include the following:

• Upgrades and installation of upgrades to the software products provided with a corresponding extension of the warranty period

• Installation and implementation of patches/fixes

• 24x7 phone support for troubleshooting both for hardware and software

• Remote monitoring capability. Remote event logging and troubleshooting via remote secure connection provided by HEDNO

• Support by providing access to the support line (by telephone or e-mail)

During the implementation period, collaboration between the Contractor and HEDNO is necessary for the formulation of a step-by-step strategic plan towards addressing the case of a telecommunications failure from the Telecommunication Provider's side.

## 6.3 Equipment Specifications

### 6.3.1 Local ECC In Rhodes Firewalls (2 Items)

• Hardware physical devices

• Ability to be installed on a rack

• Should be able to operate in Active/Standby and Active/Active with a second Firewall

• Backup power (Hot Swap)

• SNMP support

• Should have at least 4 Gigabit Ethernet interfaces

• Memory >= 4 GB

• Stateful– Inspection architecture

• IPv4 and IPv6 support

• Transparent operation ability (L2 firewall)

• Support for static or dynamic routing with static routes, REP, OSPF or BGP protocol

- LACP support

- Ability to interface the firewall with Active Directory, LDAP

- Access Control Rules support

  o    Inbound and outbound traffic control

  o    Rules per subnet

  o    Rules per user

  o    Grouping rules

  o    Enable or disable rules

- Support for integrated Intrusion Detection and Intrusion Prevention to prevent threat (both known and unknown threats / unknown exploitation tools)

- Support for SCADA signatures

- Ability to create a different IPS policy for different traffic between different source/destination

- IPS signatures should be renewed regularly and automatically, with the manufacturer's security equipment provisioned, in order to effectively protect against new threats.

- Ability to collaborate with other network devices for more effective protection, collaboration through open APIs with third-party applications such as vulnerability management systems, security information and event management (SIEM) applications

- Network Access Control (NAC)

- Maintain a real-time list of all hosts, applications, connections and users

- Support for Threat Correlation with user, device, service and application

- Ability to Point-Point and Remote Access VPN (or functionally equivalent) connection with Client software

- Data encryption support using Triple-DES (168-bit) and AES (128, 192 and 256-bit) algorithms

- Ability to be centrally managed by Graphical User Interface (GUI) and Command Line Interface (CLI)

- Ability to support a reporting mechanism at user, app, ips events level

- The management application must support accounts depending on the role of the administrator

- The Graphical User Interface (GUI) shall be immediately informed about the operating status of the individual functions and processes

### 6.3.2    Local ECC In Rhodes Routers (2 Items)

• Ability to be installed on a rack

• Should be able to operate in Active/Standby and Active/Active with a second Firewall

• Backup power (Hot Swap)

• WAN bandwidth router performance with both routing, Firewall, QoS, and IPSec enabled IMIX (average packet size of about 360 Bytes) : >= 25 Mbps

• Offered memory DRAM (MB) : >=512

• AC supply, 220V

• Support for automatic identification of other similar routers or switches in the network topology

• IEEE 802.1q VLANs & trunking support

• PPP, Multilink PPP support

• RIP, RIPv.2

• OSPF

• BGP v4

• IPv6 and IPv4

• IPv6 Static Routing and IPv6 Multicast

• DHCP Server, DHCP Client/Proxy Client, DHCP Relay

• Support for the use of access control and routing filters at the discretion of the system administrator [packet filter based on recipient and sender IP addresses, protocols used (UDP, TCP, ICMP, etc.) and protocol numbers]

• MAC address based filtering support

•  RADIUS and / or TACACS + or operational equivalents

• Network Address Translation (NAT) support

• Support for built-in stateful Firewall features

• Support for IPS functionality without adding additional hardware

• Support for Internet Key Exchange Security Protocol

• Support for IPSEC DES and 3DES, AES encryption

• Dynamic Multipoint VPN Support (DMVPN), Group Encrypted Transport (GETVPN) or Functionally Equivalent

• Support of Queuing techniques

• Support for the setting of an independent routing policy for policy routing

- IEEE 802.1p suport

- SNMP support

- Telnet support, TFTP, NTP support or SNTP

- Local management support via Command Line Interface

- Device management support via Web GUI

- At least four (4) Gigabit Ethernet (10/100/1000 Mbps autosensing) ports

- At least two (2) universal USB ports

- IEC 60950-1, EN 300-386

- EN 61000

- EN 55024

- EN50082-1

### 6.3.3 Routers Of Substations & Plants (22 Items)

- Support for GPRS, EDGE, 3G, 4G technology

- At least four (4) LAN Fast Ethernet (10/100 Mbps) autosensing ports

- An ADSL2 + port

- Automatic transition support between Primary and Backup WAN Link

- Dual SIM support

- Firmware upgrade support from a remote location

- Removable antenna

- The appropriate antennas should be offered

- Support for built-in stateful Firewall features

- Support for IPSEC, 3DES and AES encryption

- Ability to be installed on a rack

- Telnet support

- SNMP support

- DRAM Memory Available> = 512 MB

- At least one (1) USB port

- IEEE 802.1q VLANs and 802.1q VLAN trunking support

- PPP support

- IPv6 and IPv4

- Support the use of Access Control Lists (ACLs) based on sender and receiver IP addresses, protocols used (UDP, TCP, ICMP, etc.) and protocol numbers.

- MAC address based filtering support

- Support for the use of filters to prevent spoofing and DoS (Denial Of Service) attacks and actions

- Network Address Translation (NAT) support

- QoS support

- SNMP support

- UL 60950-1, EN 60950-1, IEC 60950-1

- 47 CFR, Part 15, EN 300-386, EN 61000

- EN55022, CISPR22

- EN 301 908-1, EN 301 908-2

### 6.3.4     LAN Switches (2 Items)

- Ability to be installed on a rack

- Switching speed >= 12 Gbps

- Total packet switching speed >= 6 Mpps

- Supporting memory DRAM >=128 MB

- Ethernet: IEEE 802.3, 10BaseT, Fast Ethernet: IEEE 802.3u, 100BaseTX

- Gigabit Ethernet: IEEE 802.3ab 1000BaseT, IEEE 802.3z 1000Base-X (SX, LX/LH)

- At least twenty-four (24) Switched Ethernet ports 10/100, operating speed (10 or 100 Mbps) to be automatically selected.

- At least two (2) Gigabit combo ports to connect to another switch (uplinks). The ports support the 1000BaseT, 1000BaseSX and 1000BaseLX / LH protocols, with simple inverter change, if necessary.

- An asynchronous RJ-45 console for out-of-band management (Configuration & Management) via terminal.

- Full Duplex support for Ethernet and Fast Ethernet (IEEE 802.3x). Half or Full Duplex mode should be selected automatically.

- Support for VLANs

- IEEE 802.1d spanning-tree protocol support

- IEEE 802.1s support

- Support for broadcast and multicast storm control per port, so problematic computers can not affect network operation.

- Support for creating policers targeting rate limiting based on source and destination  IP / MAC address, and source and destination TCP / UDP port.

- SNMP support

- Telnet protocol support

- TFTP for data transfer support

- Network Time Protocol (NTP) support for precise and consistent timing

- Local management support via Command Line Interface.

- TACACS + or equivalent functionality and RADIUS user authentication for switch access

- 802.1x support for user authentication

- Multi-level security support for local access

- Support for controlling and restricting packet traffic by creating and using Acess Lists (ACLs) per port based on source and destination MAC and IP address, as well as level 4 (TCP / UDP port) information.

- Port configuration support to remove the MAC address of stations that are inactive after some time

- Ability to update network administrators from the switch when a user connects or leaves the network

- Support for port configuration to allow access only to specific workstations according to their MAC address

- UL 60950, EN 60950, IEC 60950, CE marking

- EN 55024 (CISPR24), EN 55022 Class A (CISPR 22)