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CONTENTS

Page

1. INTRODUCTION 4

2. SUPPORTING CLAUSES 4

2.1 SCOPE 4
2.1.1 Purpose 4
2.1.2 Applicability 4
2.2 NORMATIVE/INFORMATIVE REFERENCES 5
2.2.1 Normative 5
2.3 DEFINITIONS 6
2.3.1 Disclosure Classification 8
2.4 ABBREVIATIONS 8

3. SYSTEM REQUIREMENTS 9

3.1 INTERFACE REQUIREMENTS 12
3.1.1 Generator Bay Metering 12
3.1.2 HV Yard Metering 13
3.1.3 Extraneous Supplies 13
3.1.4 Communication with Metering Devices 13
3.1.5 Pulse Interface 14
3.1.6 UPI Requirements 15
3.1.7 Pulse Characteristics 15
3.1.8 Time Synchronisation 15
3.1.9 EMDAS Connections 16
3.1.9.1 EMDAS Data Server 16
3.1.9.2 Electrical Operating Workstation (EOW) 17
3.1.9.3 Interface Architecture 17
3.1.9.4 System Usage 18
3.1.9.5 Remote Access to EMDAS 18
3.2 OPERATING MODES 19
3.3 SYSTEM RELIABILITY 19
3.3.1 Fault diagnostics 20
3.3.2 Common Mode Failure 20
3.3.3 Secure Power Supplies 20
3.4 SOFTWARE REQUIREMENTS 20
3.4.1 Relational Database (RDB) 20
3.4.2 Configuration Software 21
3.4.3 UPI Resolution 22
3.4.4 Alarms and Reminders 22
3.5 VISUAL ENERGY REPORTING 22
3.6 EMDAS USER ACCESS 23
3.6.1 Phoenix and GPSS Interfaces 24
3.6.2 Manual Data Entry 24
3.7 SUMMARY OF EMDAS REPORTING REQUIREMENTS 25
3.7.1 Utilisation Reporting 25
3.7.2 Efficiency Reporting 25
3.7.3 General Reports 25
3.8 DOCUMENTATION 26

4. AUTHORISATION 27

5. REVISIONS 28

6. DEVELOPMENT TEAM 28

7. ACKNOWLEDGEMENTS 29

APPENDIX A: TYPICAL GENERATION HOURLY ENERGY REPORT FORMAT 30

FIGURES

Figure 1: Conceptual Metering and EMDAS Layout 10
Figure 2: EMDAS and Eskom IT Interfaces 11

TABLES

Table 1: Operating Modes 19
Table 2: Table Key for Report Abbreviations 30

1. INTRODUCTION

This document is a functional specification for a standardised dedicated stand-alone Energy Management and Data Acquisition System (EMDAS), to be installed at all Eskom's generating plants, so that accurate, reliable and auditable metering data can be provided to the power station and Eskom as a whole for a range of purposes.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

The purpose of this document is to cover the architectural requirements of the Generation energy metering system including the reporting system known as EMDAS. It further covers the detailed functionality of the EMDAS itself, ensuring that energy data is processed accurately and reliably, to comply with regulatory requirements.

The data that is captured and stored by the EMDAS will be available for the following purposes:

- Reporting of active energy generated for environmental tax levy payments to SARS,
- Confirmation of payment amounts for energy consumed by the Power Station for operational requirements, as well as for energy generated and sent out to Transmission/Distribution,
- Provision of energy data for Plant Performance management, operational purposes and economic evaluation of Power Station generators, unit transformers and auxiliaries,
- Quarterly reporting of energy generated to NERSA.

The design includes the appropriate communication protocols required to integrate with the Eskom LAN interfaces.

2.1.2 Applicability

This document shall apply to all existing and future electrical generating plant throughout Eskom Holdings Limited Divisions, including but not limited to:

- Fossil-fuelled plant (coal, gas),
- Hydro and Nuclear plant,
- Renewables plant (CSP, PV, Wind, and Geothermal).

2.2 NORMATIVE/INFORMATIVE REFERENCES

The following documents contain provisions that constitute requirements of this document. At the time of publication the documents indicated were valid. These documents are subject to revision and users are responsible to ensure that the most recent edition of the documents listed below are used/referenced. Where specified values differ the most stringent specification will apply.

2.2.1 Normative

These documents are indispensable for the application of this document, and must be used in conjunction with this document.

[1] Customs and Excise Act No 91 of 1964.

[2] 240-128353314: Drawing numbering system Standard

[3] IEC 60027-1: Letter Symbols to be used in Electrical Technology.

[4] ISO 9001 Quality Management Systems.

[5] NRS 002:2000: Graphical Symbols for Electrical Diagram.

[6] NRS 028:2013: Crimped Cable Lugs and Ferrules for Copper and Aluminium Conductors.

[7] OHSA no 85 of 1993: Electrical Installation Regulations under Occupational Health and Safety.

[8] SANS 474:2009 (NRS 057:2009): Code of Practice for Electricity Metering.

[9] SANS 1091:2013: National Colour Standard.

[10] SANS 10142-1: The wiring for premises Part 1: Low-voltage installations.

[11] SANS 60044: Instrument Transformers.

[12] SANS 60529: Degrees of Protection Provided by Enclosures (IP Code).

[13] SANS 61000-6-2: Electromagnetic compatibility (EMC) Part 6-2: Generic standards - Immunity for industrial environments.

[14] SANS 61000-6-4: Electromagnetic compatibility (EMC) Part 6-4: Generic standards - Emission standard for industrial environments.

[15] SANS 61000-6-5: Electromagnetic compatibility (EMC) Part 6-5: Generic standards - Immunity for power station and substation environments.

[16] South African Grid Code.

[17] 240-51999977: Specification For Digital Transducer Based Measurement System For Electrical Quantities.

[18] 240-55410927: Cyber Security Standard for Operational Technology.

[19] 240-56358929: Electronic Protection and Fault Monitoring Equipment for Power Systems Standard.

[20] 240-56359083: Requirements for Measurement and Metering Systems for All Eskom Power Stations in Generation Standard.

[21] 240-71469670: Terminology Relating to the Direction of Power Flow.

2.3 DEFINITIONS

Definition	Description
Audit	The process of inspecting the procedures, facilities and other relevant items to confirm compliance with requirements laid down in SANS474 (NRS057).
Archived Data	Data from the operational metering database that was saved/stored on a storage medium, for example compact discs.
Back-up Meter	An additional meter (of the same or of a different type/manufacturer and same accuracy class and functionality) installed on the same primary plant as the main meter for the purpose of storing back-up data in the event of failure of the main meter.
Channel	An input or a register for raw data that corresponds to a specific meter.
Check Metering	A dual redundant metering system (a completely separate installation) that has two dedicated CT cores but may have only one dedicated VT winding.
Data	The information that is contained in electronic format.
Data Acquisition	Signal translation and storage, not data logging as such.
Energy Management Data Acquisition System (EMDAS)	Front-end data acquisition equipment where signal translation takes place via pulse counting or directly interfacing with the metering system via communication port/s, which includes the necessary computer interfaces/switches to the Eskom LAN network.
Eskom IT infrastructure	Eskom internal network also known as the intranet, publicly accessible by any host connected to the LAN.
Estimation	The process whereby values are inserted into the set of energy usage data for a customer and where such data is not available through mal-operation of equipment or failure to retrieve it within a specified performance period or when metering is deliberately not reading at every billing interval.
Extraneous supplies	Energy taken from the generation process and used for purposes other than auxiliary power.
Four-Quadrant metering	A metering system that is capable of determining the direction of active and reactive energy transfer and measuring these quantities as per the geometrical representation as per standards IEC 60375 and 32-326.

Definition	Description
Generator transformer	The step up transformer that connects the generator to the transmission system.
Generating unit	The generator, generator transformer and unit transformers.
Intermediate Distribution Frame	The hardwire interface point or frames between the HV-Yard and the Generation power station.
Main and Check metering	A dedicated metering system with two active energy and reactive energy meters fed from two dedicated CT cores and at least one dedicated VT winding/s (Note: recording equipment is also duplicated).
Main and Back-up metering	A dedicated metering system with two active energy and reactive energy meters of the same or of a different type/manufacturer with similar functionality and class accuracy fed from one dedicated CT core and one dedicated VT winding (Note: recording equipment is also duplicated).
Metering device	A device that is capable of calculating, storing and displaying active and/or reactive energy values and real-time information.
Metering	Means energy quantities such as active and reactive energy, kWh and kvarh.
Metering information	Data (unprocessed information), processed information and stored information that relate to metering equipment at the metering point or the point of supply. Includes the following: Configuration data relates to the device itself, Status data relates to the condition of the metering device and Metering data refers to the measured energy values, etc.
Pulse	A wave that departs from an initial level for a limited duration of time and ultimately returns to the original level.
Raw data	Any unprocessed information that is received directly from a metering installation and or metering device.
Specification	The document/s forming part of the contract in which are described the methods of executing the various items of work to be done, and the nature and quality of the materials to be supplied, which may include drawings and technical schedules, as well as samples and patterns.
Unit	Boiler, Turbine, generator, cooling system, precipitator and including all auxiliary plant and systems associated with the unit. (Note: for non-fossil stations, this may differ).
Unit Pulse Index	The energy quantity assigned to each meter pulse. For active energy, this is expressed in either kWh or MWh. In the case of reactive energy, this is expressed in kvarh or Mvarh.
Unit transformer	The step down transformer that connects the export system to the unit boards.
Verification	The execution of specified tests to measure the ability of a process to meet specified criteria.
Weighted pulse	The energy quantity assigned to each meter pulse (see Unit Pulse Index).

2.3.1 Disclosure Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
C/B	Check/Backup
CSP	Concentrated Solar Power
DMZ	De-Militarised Zone
EMDAS	Energy Management Data Acquisition System
EOD	Electrical Operating Desk
EOW	Electrical Operating Workstation
FTP	File Transfer Protocol
GPS	Global Positioning System
GPSS	Generation Power Sales System
HMI	Human Machine Interface
HV	High Voltage
I/O	Input/Output
IDF	Intermediate Distribution Frame
kvarh	Kilovar hour
kWh	Kilowatt hour
LAN	Local Area Network
LDAP	Lightweight Directory Access Protocol
LV	Low Voltage
M	Main
MDMS	Meter Data Management System
ms	millisecond
MV	Medium Voltage
Mvarh	Megavar hour
MW	Megawatt
MWh	Megawatt hour
n	Numerical index
NERSA	National Energy Regulator of South Africa
ODBC	Open Database Connectivity
OHSA	Occupational Health and Safety Act
pu	per unit

Abbreviation	Description
PV	Photovoltaic
RDB	Relational Data Base
SANS	South African National Standard
SARS	South African Revenue Service
SCO	Synchronous Condenser Operation
SCP	Secure Copy Protocol
SFTP	Secure File Transfer Protocol
STEP	Station Thermal Efficiency Program
TCP/IP	Transmission Control Protocol over Internet Protocol
UPI	Unit Pulse Index
UTM	Unified Threat Management
W_P +	Active energy exported
W_P -	Active energy imported
W_{Q1}	Reactive energy exported (lagging)
W_{Q2}	Reactive energy exported (leading)
W_{Q3}	Reactive energy imported (lagging)
W_{Q4}	Reactive energy imported (leading)

3. SYSTEM REQUIREMENTS

a. The EMDAS shall be a dynamic system, accurately counting all incoming signals from metering devices and allowing for full mathematical manipulation of the data, such as summation, subtraction, multiplication and square root extraction. This capability shall allow for the calculation of energy produced/consumed at various points that are not metered directly. Such calculations shall be carried out continuously and presented as a real-time output to the system HMI.

b. The EMDAS shall include a hardware front-end, a relational database system, a secure EMDAS data server with a web interface, which will act as a data repository. There shall be a dedicated application running on the EMDAS data server that receives data from user-defined metering points, compiles the data into a CSV file and sends this file on an hourly basis from the EMDAS data server in the secure DMZ to a predefined address on the Eskom LAN. For this purpose, both FTP and SFTP functionality shall be provided as a minimum, with preference given to SFTP. Full access to this relational database system shall be available to authorised users in the DMZ via the Eskom LAN, on a Read Only basis, by way of a web interface on the EMDAS data server.

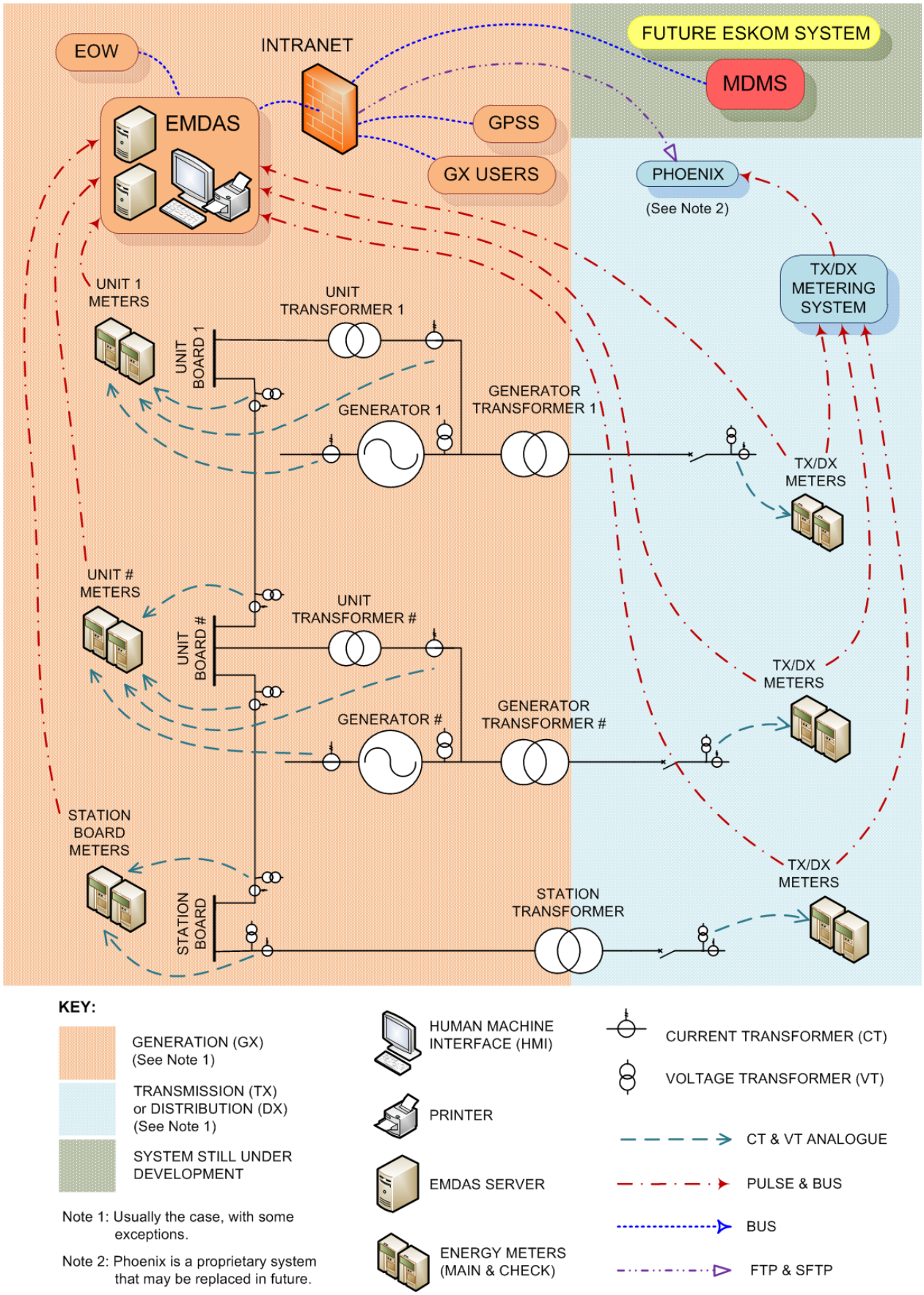

Figure 1: Conceptual Metering and EMDAS Layout

c. Details of individual EMDAS installations may vary, based on the unique characteristics at particular sites. A conceptual drawing of how a generic EMDAS would fit into a larger power system is shown in Figure 1, highlighting the energy metering information required for the accounting of energy produced and consumed in the generation process.

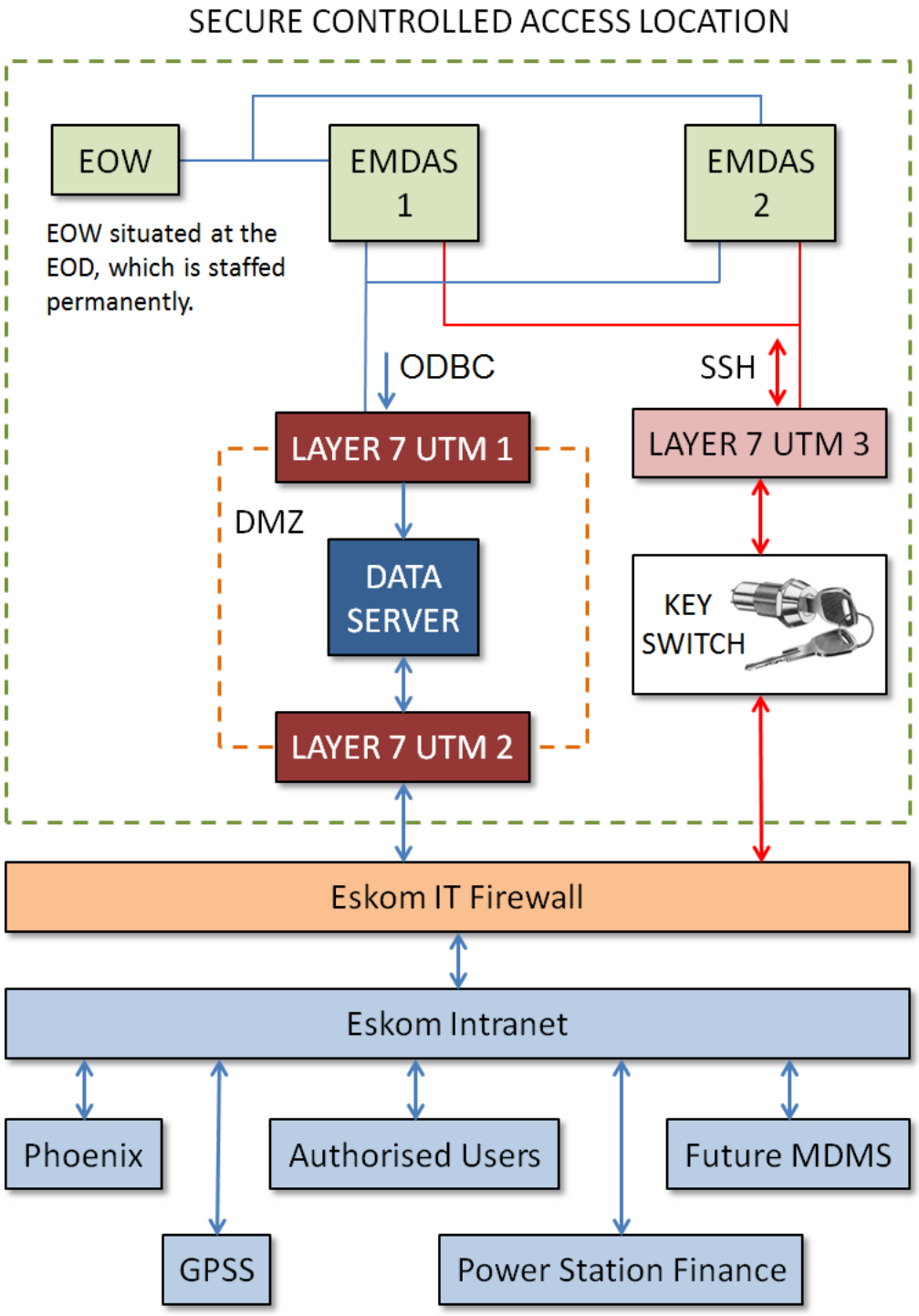

Figure 2: EMDAS and Eskom IT Interfaces

3.1 INTERFACE REQUIREMENTS

With reference to Figures 1 and 2, the following interfaces with the EMDAS shall be provided:

a. From energy meters via pulse and bus.
b. To energy meters for meter clock synchronisation, using NTP and/or SNTP.
c. From Electrical Operating Workstation (EOW) to EMDAS 1 and EMDAS 2, with EOW not connected to any other systems.
d. Raw data transfer from EMDAS 1 and EMDAS 2 to EMDAS data server in DMZ.
e. To Eskom LAN from the EMDAS data server in secure DMZ using FTP or SFTP.
f. From dedicated GPS clock source for time synchronisation, using NTP and/or SNTP.
g. From station GPS clock source for time synchronisation, using NTP and/or SNTP.

Note: The latest stable version of OpenSSL shall be employed where required, with Version 1.0.1g. as a minimum.

3.1.1 Generator Bay Metering

a. EMDAS shall allow for the full accounting of gross energy generated (exported), net energy (sent out), energy imported (received) and consumption by auxiliaries on a unitised basis.
b. EMDAS shall accommodate all modes of operation metered at unit level (e.g. Gen mode, Pump mode, SCO mode, Standstill mode).
c. Metering is installed at the generator star point and at unit transformer/s on the primary side. Metering is also installed at the supply point for any other load connected to the generator bus bars, provided the load is larger than 0.2% of the generator output rating. Metering is also installed on the inter-connections between units and station board supplies, and on primary and secondary sides of the station transformer/s. This energy information shall be dynamically displayed on the secure side of the DMZ via the EOW.
d. All the energy information shall be backed up in the EMDAS archive, with the method of archiving will be dependent on the supplier’s design.
e. The system shall have the capability of generating energy reports for the power station information management system via the EMDAS data server in the secure DMZ to the Eskom LAN. These reports shall be generated using the web interface.
f. The EMDAS EOW shall be used for local printing and producing reports on demand.
g. The EMDAS EOW shall provide the functionality to manually input information into GPSS via EMDAS when required.

h. The hourly energy report required by systems such as GPSS and Phoenix shall be sent automatically from the EMDAS data server in the secure DMZ to the Eskom LAN.

3.1.2 HV Yard Metering

a. Individual values of active and reactive energy are required from the generator interface with the HV Yard for each of the generators connected at the point of delivery with Transmission (or in some cases Distribution). The design shall be such that all operating modes of the generator are suitably metered and differentiated so that no ambiguity exists in evaluating the data. The metering installation is configured to output all active and reactive four-quadrant energy quantities as pulses and/or data bus from a main and check metering system.

b. The point of delivery is the HV bushings of the generator transformer and the point of metering is before the HV breaker. These values are available from the HV yard and interfacing to the EMDAS front-end is via pulses on UVG cables from the HV yard IDF and via a suitable bus communication system.

c. Metering information from the station transformer/s HV side, as well as Totalised Station Output is also provided to Generation from the HV Yard via the same transfer methods. In all these cases, any HV yard interfaces shall comply with the South African Grid Code. All these signals shall be catered for in EMDAS.

3.1.3 Extraneous Supplies

a. An extraneous supply refers to energy taken from the generation process and used for purposes other than auxiliary power for energy generation. All extraneous installations are treated as tariff points and shall be metered as per SANS474 (NRS057) requirements, with metering data captured by EMDAS.

b. Appropriate units need to be accommodated by EMDAS in each case, which could be in either kWh and kvarh or MWh and Mvarh.

3.1.4 Communication with Metering Devices

a. The acquisition of data from metering devices in the field by EMDAS shall be achieved by means of weighted pulse transmission and by direct communication with the metering device, via a bus type interface.

b. When weighted pulse transmission is used, it is not possible to have an exact duplication of the pulse and cumulative registers. In such cases, the pulse data and cumulative register reading from the metering device shall correlate to within one pulse over the integration period.

c. When direct communication with the metering device via bus is used, the energy quantities represented by the meter register values shall be read and stored by EMDAS. The cumulative register data shall be used to calculate the interval value, which shall be stored in an interval table. In addition to this, the cumulative register data shall be stored in its own table for meter tracking reasons and to allow for manual cross-checking if required.

d. The bus communication method shall either be open source or licensed to Eskom. For systems implemented on the Microsoft platform, the accompanying source code shall be required, in order that any meters added to the system at a future date can be interfaced to the EMDAS. For systems implemented on the Linux platform, with Debian being the preferred distribution, accompanying source code in at least C and/or Python shall be required. The source code shall be tested by Eskom.

e. RS485 serial and Ethernet TCP/IP have been earmarked as the preferred methods of connecting to meters in the field. The EMDAS design shall allow for the use of both communication mediums simultaneously. The choice of which type of communication shall be determined by the meters in the plant and it is not expected that individual meters will support both. The possible exception to this will be meters required to be accessed both by EMDAS and Transmission/Distribution energy metering systems.

f. Modbus and DLMS COSEM shall be included as a minimum for communication between EMDAS and meters in the field.

3.1.5 Pulse Interface

a. Meter output pulses shall be read directly into the EMDAS front-end. This front-end shall comprise of a suitable hardwire interface and pulse counters, with both of these forming part of EMDAS. Pulse counting shall meet the pulse definition requirements and the energy representation of the pulses shall be stored in an appropriate database by means of ODBC.

b. In order to accurately detect, count and process the meter pulses, either counter modules or high speed I/O modules shall be used. The pulse counter modules shall be capable of detecting pulses at a minimum rate of 5 per second, and totalise the pulses for up to 60 minutes for each channel.

c. For pulse counting, the EMDAS shall distinguish between inactive/faulty meters and errors due to deviation or inaccuracy. Failed or inactive meters shall be detected and alarms shall be issued to the EOW and via one-directional email from the EMDAS data server.

d. Both the main and check/back-up meter pulses are used for calculation purposes. The energy values from the main and check/back-up meters shall be compared continuously and the difference alarmed if it exceeds twice the meter class accuracy.

3.1.6 UPI Requirements

a. When weighted pulses are used, these shall be captured by EMDAS, counted, processed using the correct Unit Per Impulse (UPI) value, with the resultant energy value stored in the database per integration period.

b. The following fundamental principles shall be taken into account when counting pulses:

- Pulse duration or length,
- Pulse rate (load-dependent),
- Resolution required for accuracy purposes.

c. When parity checking is required, suitable pulse-counting verification shall be implemented.

3.1.7 Pulse Characteristics

a. The pulse shall be detected on the rising edge, achieved by using a normally open contact and a fixed time period of typically 80ms.

b. Where a change-over type relay is used, for parity checking purposes, the normally closed contact shall not be used for counting because of delays in closing and opening, which can cause large time deviations and give incorrect count values.

c. The weighted pulses shall be captured as raw data in real time and processed in a specific format to obtain the required information for immediate evaluation of energy utilisation. In order to alleviate the use and control of meter constants, the raw data shall be configured as primary values. In addition, no compensating calculations shall be configured in the meter.

The pulse produced by the energy meter shall be no shorter than 80ms and at a rate of less than or equal to 5 pulses per second, resulting in a Mark/Space ratio of 1:1.5 (typically 80:120ms). The pulse rate is such that the resolution is at least half the meter accuracy class at full load.

d. The acquisition and accumulation of pulses shall be continuous and acquisition for each input or channel shall start from zero after every integration period.

3.1.8 Time Synchronisation

a. The EMDAS system shall accept timing inputs for synchronisation (via NTP and/or SNTP) and shall allow regular synchronisation with a dedicated GPS master clock, ensuring that the difference in time between its internal clock and the external source never exceeds one second.

b. Each EMDAS server shall include one GPS time source, which shall identify itself. The GPS shall synchronise via NTP and/or SNTP.

c. The EMDAS data server will be periodically synchronised via secure side to EMDAS 1 and EMDAS 2, which themselves will be linked to dedicated GPS clocks.

d. Each server shall also use the station clock and any other available time sources with proven reliability. The time synchronisation mechanism shall allow for time cross-checking and automatic switching of time sources for the sake of redundancy. In the event that the available time sources fail or be judged as faulty, each EMDAS shall have the capability of independently switching over to an internal free-running clock, refusing requests to synchronise with other servers. Such a condition shall be treated as serious, for which an alarm requiring manual intervention shall be raised.

e. A manual time correction facility shall be available, should time correction be required.

f. Where meters are equipped with internal clocks and a suitable interface is present, these clocks shall be synchronised, checked and logged by EMDAS.

3.1.9 EMDAS Connections

3.1.9.1 EMDAS Data Server

a. With reference to Figure 2, an EMDAS data server within a secure DMZ shall be employed to provide controlled EMDAS data access to authorised users on the Eskom LAN, supporting a minimum of ten simultaneous remote connections.

b. The function of the EMDAS data server shall be as follows:

- To mirror the data on EMDAS 1 and EMDAS 2 within a Relational Data Base (RDB), with duplication being handled via an ODBC connection.
- Provide automated hourly reports to Phoenix and GPSS,
- To provide access to the mirrored data to authorised users throughout Eskom, in the form of user-defined customised reports,
- To send out one-directional emails to a specific address, via the Eskom SMTP system, to report on any system irregularities.
- To prevent direct access to EMDAS 1 and EMDAS 2 via the Layer 7 UTM 1 device.

c. Technical specifications shall include the following as a minimum:

- Ethernet ports for connection to Layer 7 UTM 1 and Layer 7 UTM 2,
- Support for Intel and/or AMD architecture,
- Controlled access to USB inputs and DVD drive once installed.

d. In some instances, the new EMDAS will coexist alongside an older EMDAS that is still sending out hourly CSV files to Phoenix, and it may be the case that such a situation exists until such time as the new EMDAS is fully commissioned for all units.

   Furthermore, it is important to note that:

   - Phoenix can only receive one file per power station, due to Phoenix system limitations and auditing requirements,
   - The hourly CSV file needs to include station totals.

   Therefore, in order to fulfil these requirements, the new EMDAS shall have the capability to receive an old CSV file (originally sent to Phoenix by the old EMDAS) back from Phoenix on an hourly basis. The new EMDAS shall also have the ability to analyse and extract the relevant energy data from the old CSV file, combine this with energy data from units connected to the new EMDAS, recompile this data into the new file format and send it back to Phoenix.

   This functionality shall be implemented within the EMDAS data server, in such a way that no risk is posed to EMDAS 1 and EMDAS 2.

3.1.9.2 Electrical Operating Workstation (EOW)

a. Energy metering data shall be made available to the power station operating and maintenance staff via an Electrical Operating Workstation (EOW), which will be a dedicated workstation situated at the EOD, not connected to any other systems other than EDMAS 1 and EMDAS 2.

b. The EOW shall comprise of a tower, a flat-screen monitor, a keyboard and a mouse. The tower shall be secured in a locked enclosure to prevent access to USB ports and CD/DVD drives.

c. A printer shall also be provided at the EOW to allow for the printing of reports.

d. The EOW shall provide a summary of real-time energy values from EMDAS 1 and EMDAS 2.

e. The EOW shall allow for manual entries to be made into EMDAS 1 and EMDAS 2, as described in Section 3.6.2.

3.1.9.3 Interface Architecture

Figure 2 shows the conceptual interface architecture, with everything inside the larger dotted-line box falling within the boundaries of EMDAS. In order to cater for the requirements of Eskom at large, a number of access and functionality requirements shall be catered for by Eskom IT infrastructure. These shall be as follows:

a. EMDAS data server within the DMZ shall initiate FTP/SFTP and SCP transmission to the Phoenix and GPSS systems.

b. EMDAS data server within the DMZ shall transmit and receive session via Relational Data Base (RDB) specific protocol with the GPSS system.

c. For authorised users on the Eskom LAN, data stored in the EMDAS data server RDB shall be queried via HTML over HTTP. This shall be Read Only access from the RDB's point of view.

d. Key-switch enabled remote access shall be required via the Layer 7 UTM 3 device to EMDAS 1 and EMDAS 2 directly, for providing administrative engineering assistance to power station staff when required.

NOTE: All traffic passing through the Eskom IT firewall to and from the EMDAS key-switch route shall be monitored by Eskom IT System Security, to ensure that any unauthorised access is detected.

3.1.9.4 System Usage

a. With reference to Figure 2, under normal operating conditions all traffic shall be routed via the DMZ, configured to provide the requirements listed in 3.1.10.2, points a) to d).

b. Authentication shall be done against the Eskom LDAP (Lightweight Directory Access Protocol) while user privileges should be stored within a user rights table in the EMDAS RDB stored on the EMDAS data server.

c. The third and final level of security is the database management engine itself, which due to its nature should only be accessible from the local console.

3.1.9.5 Remote Access to EMDAS

a. With reference to Figure 2, should any issues arise with EMDAS 1 and/or EMDAS 2 that cannot be addressed locally, it shall be possible for an EMDAS administrator to log in remotely, via the Engineering Key Switch.

b. The key to the Engineering Key Switch shall be kept in a secure and controlled location at the EOD and shall only be made available to operational staff or EMDAS administrators. The key shall allow remote access via the Layer 7 UTM 3 device, from the Eskom intranet.

3.2 OPERATING MODES

Different modes of unit generator operation are possible and EMDAS shall accommodate the tracking of the four modes shown in Table 1.

a. Generating, Pumping and SCO modes are direct signals from the energy meters.

b. Standstill mode is a conditional logic within EMDAS, so that energy values are correctly stored. This logic is as follows:

When energy inputs from generator meters are all zero, then energy metered on related unit transformer/s must be recorded as standstill mode energy.

Table 1: Operating Modes

Mode	Possible Condition
Generating	• Generator is generating, with active energy (Mwh) exported and reactive energy (Mvarh) exported. • Generator is generating, with active energy (Mwh) exported and reactive energy (Mvarh) imported.
Pumping	• Generator is motoring, with active energy (Mwh) imported and reactive energy (Mvarh) exported. • Generator is motoring, with active energy (Mwh) imported and reactive energy (Mvarh) imported.
Synchronous Condenser Operation (SCO)	• Generator is spinning, with negligible active energy (Mwh) imported and reactive energy (Mvarh) exported. • Generator is spinning, with negligible energy (Mwh) imported and reactive energy (Mvarh) imported.
Standstill (back-energized)	• Generator is at standstill (or on barring), where only auxiliary plant is running, with active energy (Mwh) imported and reactive energy (Mvarh) imported.

3.3 SYSTEM RELIABILITY

a. EMDAS shall be fully redundant from a hardware I/O level up to EMDAS 1 and EMDAS 2. Two identical systems shall be provided, with both systems having identical inputs and outputs (excluding the Key Switch, Layer 7 UTM devices, EMDAS data server and DMZ).

b. Transfer from EMDAS 1 to EMDAS 2 and vice versa shall not cause an interruption of availability nor result in inaccurate data processing. Reliability, availability and maintainability are of critical importance in the system design. Refer to Section 3.3.2.b. for further details.

3.3.1 Fault diagnostics

a. Fault diagnostic routines shall be included for both EMDAS servers. The interpretation of alarms shall be clear and understandable, so that site maintenance personnel are able to do speedy and effective fault finding.

b. EMDAS hardware alarms shall be incorporated into the system as well (e.g. power supply fail, CPU failure, communication module failure, GPS failure etc), to allow for total user supervision of the system.

c. All alarms shall be relayed to the EMDAS database. In the event that one EMDAS server is unable to raise such alarms due to catastrophic failure, the second EMDAS server shall raise the relevant alarms, alerting operators of the failure.

3.3.2 Common Mode Failure

a. Where possible, the system design shall eliminate common mode failure, with the failure of any single device or module not resulting in a system malfunction at any given time.

b. The system shall have no less than 99.95% availability, which equates to 4 hours per annum. Techniques and interventions used to achieve this performance shall be clearly stated by the Supplier.

3.3.3 Secure Power Supplies

a. Eskom shall provide secure redundant supplies to EMDAS from a 230V ±10% AC circuit.

b. Power requirements shall be specified by the EMDAS supplier so that the secure supply circuits can be sized correctly.

c. Cabling from the point of supply shall be provided by the EMDAS supplier.

d. In the event that the supplies from Eskom fail, EMDAS as a whole shall be capable of sustaining itself for a period of 4 hours under full load conditions. This supply shall be dual redundant and sized according to the system, with appropriate alarms raised as per Section 3.4.4.

e. In the event of a loss of supply to EMDAS 1 only, automatic changeover to EMDAS 2 shall take place, and vice versa.

f. EMDAS 1, EMDAS 2 and the EMDAS data server shall have dual internal power supplies.

3.4 SOFTWARE REQUIREMENTS

3.4.1 Relational Database (RDB)

a. EMDAS software shall allow for all raw metering data to be time-stamped, stored and archived in an EMDAS RDB, together with the data for each integration period (per hour or user-definable).

b. The system shall be capable of storing 36 months of raw data locally on EMDAS 1, EMDAS 2 and the EMDAS Data Server.

c. All archived data for the life of the power station shall be available on request, with a suitable method provided for achieving this.

d. The database shall accommodate a minimum of ten simultaneous users via the EMDAS data server interface.

e. Energy data shall be stored in at least two independent tables. The first table will store data at a fixed interval of 1 hour at the end of each hour and with a time accuracy of better than 1 pu of the 0.2 accuracy class. The second table should be a user-adjustable time interval which should allow for data storage down to 1 minute intervals.

f. All intervals selected shall be fully divisible into 60 minutes (e.g. 7 minute intervals should not be permitted).

g. ODBC shall be employed for connecting to the RDB, which will be supplied with sufficient connectivity licenses to ensure unhindered operation.

h. The database shall maintain backup files of the configuration information and of the metering value. This function, together with an automated disaster recovery procedure, shall be integrated within the software.

i. It shall be possible to store these backup files on an appropriate reliable external medium.

3.4.2 Configuration Software

a. All configuration software for the EMDAS system shall be supplied, documented comprehensively, with all the features and functions as stated in this document.

b. Included in the documentation shall be a list of possible problems and how to solve them.

c. Software shall be kept as simple as possible and designed specifically to enable personnel to reliably operate it with minimum training. Where possible, the software shall be menu-driven.

d. All licenses required for the EMDAS system shall be provided, including all standard software and application licenses.

e. All upgrades of software and the associated licenses throughout the life of the system shall be catered for.

f. A list of acceptable and compatible EMDAS hardware shall be provided for any software package offered.

g. Future revisions of software shall be supplied and submitted in accordance with the Eskom standard 34-387.

h. Eskom shall be supplied with a fully functional ODBC driver with all relevant licenses to ensure that all connectivity requirements can be met.

3.4.3 UPI Resolution

a. A UPI (Units per Impulse) value shall be allocated by the user to each channel.

b. The value shall be of the format NNNN.NNN and the default value shall be 0001.000

3.4.4 Alarms and Reminders

a. In order to ensure satisfactory maintenance and swift resolution of system malfunctions, EMDAS shall be able to raise alarms and issue periodic reminders, customisable by those with administrator rights.

b. The status of EMDAS, including alarms and reminders, shall be viewable both locally and via the EMDAS data server to the Eskom LAN.

c. EMDAS data server shall be capable of sending out one-directional emails to a specific address, to report on any system irregularities.

3.5 VISUAL ENERGY REPORTING

a. Energy metering data shall be made available to the power station operating and maintenance staff via the EOW.

b. Operator screens and/or reports shall be user-definable and have the facility for selecting and viewing the metering period as hourly, daily, weekly, monthly or between any two user-defined dates and times.

c. A facility shall be available for producing summaries for each metering point of the following quantities for both Import and Export for the selected period:

- Gross active and reactive energy production/consumption, for each unit,
- Total Gross active and reactive energy production/consumption for the station.

d. The facility shall be provided to compare any channel and differences greater than a user defined percentage value (format NN.NN%) shall be flagged on the reports and displays as soon as the data is available.

e. Printable reports shall be available for the following from EMDAS 1 and EMDAS 2 Engineering Station, as well as from the EOW:

- Current hour (dynamic per integration period),
- Last hour (historical per integration period),

- Current hour daily (dynamic per integration period),
- Last day hourly (historical per integration period),
- Quarterly Energy generated report.

f. The visual report data for kWh and kvarh shall be dynamic and user-definable for current hour and daily hour including historical data from the archive.

g. The visual reports shall be available locally to authorised personnel via the EOW, as well as via any machine that has access to the Eskom LAN, in which case the data will come from the EMDAS data server situated in the secure DMZ.

h. A local printer shall be available at the EOW in the event that an operator needs to print out reports. Such reports shall allow for a user-defined rounding factor, with the default set to 3 decimal places while employing a MWh or Mvarh scale.

i. All data shall be summated then rounded for reports such as day totals.

3.6 EMDAS USER ACCESS

a. EMDAS metering data is confidential and the access thereof shall be controlled and password protected.

b. Data storage shall be such that any access to the data is recorded, with this record being available on request.

c. Security measures, such as an hierarchical password system shall prevent the configuration information of the database from being changed by unauthorised personnel.

d. The integrity and consistency of the EMDAS data is critical and shall require strict governance of the database in order to track any undesirable activity. The Supplier shall provide documentation on how this will be achieved.

e. A complete audit trail shall exist for all data gathering, validation and processing functions, as well as when manual entries are done. This audit trail shall apply to all archived data for the Life of Plant.

f. In correcting any working data i.e. reports, the original data shall be protected from being changed. In cases where data needs to be changed, both original and modified data shall be archived. Data estimation shall be required where raw meter data is not available.

g. Further details related to manual entries are covered in Section 3.6.2.

3.6.1 Phoenix and GPSS Interfaces

Phoenix is an application used for the reporting of generated hourly values and hourly sent out energy values. It runs on a client/server architecture situated at Simmerpan, serving clients throughout Transmission. At present, Phoenix supplies GPSS with metering data as required.

a. An independent application shall be provided for transferring hourly data to systems such as Phoenix and GPSS as per the example format in Appendix B.

b. Generator energy data shall be configured in a specified text format within the EMDAS data server and made available using FTP/SFTP to Phoenix and any other users that may require data in the same format via the Eskom LAN.

c. The file format is specified in the following document:

   "INTERFACE SPECIFICATION: Phoenix Interface for Power Stations EMDAS for <POWER STATION NAME> Version 1.2 Generic".

   The latest version of this document shall be used and the file format shall be user-configurable to accommodate future requirements.

d. Sending of the text file shall be automated, which shall occur as soon as possible after the hour with a user-definable time setting. If the first attempt fails, it shall be reattempted with a user definable interval and retry limit.

e. EMDAS data server within the DMZ shall be capable of transmitting and receiving a session via Relational Data Base (RDB) specific protocol with the GPSS system.

3.6.2 Manual Data Entry

At present, the Generation Power Sales System (GPSS) is running on a client/server architecture with the server situated at Megawatt Park. The information is used to reconcile Generation offers, events, hourly sent out values and key performance indicators.

Currently, any manual data entries are done directly into the GPSS database, which is accessed by GPSS client software at each power station. This is not ideal, as the system does not allow for station data that is modified in GPSS to be reflected back to the station EMDAS, which leads to discrepancies between EMDAS and GPSS.

a. Manually-entered data shall be entered via the EOW into EMDAS 1 and EMDAS 2, not directly into GPSS, so as to ensure data integrity, traceability and consistency between EMDAS and GPSS.

b. Manual entries via EOW shall be carried out according to an authorisation process, with EMDAS recording both the automatic and manually-entered values. Manual data forwarded on to GPSS shall replace any existing data sent through previously.

c. Locally produced reports shall indicate any instances of manually-entered data, via a suitable method such as colour coding.

d. In all cases where data is corrected or altered, a journal shall be automatically generated and archived with the following as a minimum:

- Operator ID.
- Date of correction/alteration.
- Time of correction/alteration.
- Reasons for correction/alteration.
- Identification of the demand periods of data corrected/altered.
- All supporting calculations.

3.7 SUMMARY OF EMDAS REPORTING REQUIREMENTS

3.7.1 Utilisation Reporting

Local utilisation reports shall be made available for:

a. 24 hour, 7 day, 30 day, 365 day moving window reports, as of time of query,

b. Any user selectable period.

c. Utilisation expressed as a percentage of rated machine capability per generator.

3.7.2 Efficiency Reporting

Efficiency reporting for Generation shall be available for:

a. 24 hour, 7 day, 30 day, 365 day moving window reports, as of time of query,

b. Any user selectable period.

c. Efficiency expressed as a percentage per generator, calculated as the sum of all auxiliary load divided by generated power.

3.7.3 General Reports

General EMDAS reports shall be as per the example formats included in Appendices B and C for:

a. Last hour, last day, last month,

b. Any user selectable period.

3.8 DOCUMENTATION

a. Full documentation shall be supplied in both digital and paper mediums for each site. This documentation shall cover each component of the system, including a comprehensive description of all features and functions of the EMDAS. Digital documentation must be searchable.

b. Front-end configuration settings and drawings shall be provided, as well as any information related to customised configuration.

c. Step-by-step guides to the basic tasks that may need to be performed by an operator shall be provided in the form of a stand-alone document.

d. Hard copies are to be stored in a convenient location, with soft copies available via Help menus within the system.

e. A list of possible problems and how to go about solving them must also be included in the documentation.

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5. REVISIONS

Date	Rev.	Compiler	Remarks
January 2010	0	J Strydom	To determine the requirements for a Generation Metering Data Management System.
March 2013	1	R Brayshaw	Updated to TDAC template and changed document number from 36-469 to 240-62581162. Published TDAC 16 July 2013.
June 2014	2	R Brayshaw	Specification revised by SCOT Metering work group to address standards, regulatory requirements and comments from power station personnel. Final Rev 2 Document for Authorisation and Publication.
January 2015	3	R Brayshaw	Changes and corrections to paragraph numbering (see 3.1.1, 3.1.4, 3.1.7, 3.4.3, 3.4.4, 3.6.1). Final Rev 3 Document for Authorisation and Publication.
December 2019	3.1	M. Lentsoane	Standard validity extension to 2024 updates complete
December 2019	4	M. Lentsoane	Final Rev 4 Document for Authorisation and Publication

6. DEVELOPMENT TEAM

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APPENDIX A: TYPICAL GENERATION HOURLY ENERGY REPORT FORMAT

Note: Report format shall be user-configurable, to cater for individual site requirements.

Table 2: Table Key for Report Abbreviations

Abbreviation	Description
*	Unit number
C/B	Check/Backup
n	Variable index
M	Main
W_P +	Active energy exported
W_P -	Active energy imported
W_{Q1}	Reactive energy exported (lagging)
W_{Q2}	Reactive energy exported (leading)
W_{Q3}	Reactive energy imported (lagging)
W_{Q4}	Reactive energy imported (leading)

SITE: POWER STATION NAME
HOURLY ENERGY REPORT
DATE:
TIME:

GENERATORS (Gx)	Unit 1	Unit *
Gross Gen W_P+ M	xxx.xxx	xxx.xxx
Gross Gen W_P+ C/B	xxx.xxx	xxx.xxx
Gross Gen W_P- M	xxx.xxx	xxx.xxx
Gross Gen W_P- C/B	xxx.xxx	xxx.xxx
Gross Gen W_{Q1} M	xxx.xxx	xxx.xxx
Gross Gen W_{Q1} C/B	xxx.xxx	xxx.xxx
Gross Gen W_{Q2} M	xxx.xxx	xxx.xxx
Gross Gen W_{Q2} C/B	xxx.xxx	xxx.xxx
Gross Gen W_{Q3} M	xxx.xxx	xxx.xxx
Gross Gen W_{Q3} C/B	xxx.xxx	xxx.xxx
Gross Gen W_{Q4} M	xxx.xxx	xxx.xxx
Gross Gen W_{Q4} C/B	xxx.xxx	xxx.xxx

GENERATOR TRANSFORMERS (HV Side, calculated by Gx)	Unit 1	Unit *
Gen Calc W_P+ M	xxx.xxx	xxx.xxx
Gen Calc W_P+ C/B	xxx.xxx	xxx.xxx
Gen Calc W_P- M	xxx.xxx	xxx.xxx
Gen Calc W_P- C/B	xxx.xxx	xxx.xxx
Gen Calc W_{Q1} M	xxx.xxx	xxx.xxx
Gen Calc W_{Q1} C/B	xxx.xxx	xxx.xxx

Gen Calc W_{Q2} M	xxx.xxx	xxx.xxx
Gen Calc W_{Q2} C/B	xxx.xxx	xxx.xxx
Gen Calc W_{Q3} M	xxx.xxx	xxx.xxx
Gen Calc W_{Q3} C/B	xxx.xxx	xxx.xxx
Gen Calc W_{Q4} M	xxx.xxx	xxx.xxx
Gen Calc W_{Q4} C/B	xxx.xxx	xxx.xxx
GENERATOR TRANSFORMERS (HV Side, metered by Tx/Dx)	Unit 1	Unit *
Gen Sent Out W_P+ M	xxx.xxx	xxx.xxx
Gen Sent Out W_P+ C/B	xxx.xxx	xxx.xxx
Gen Sent Out W_P- M	xxx.xxx	xxx.xxx
Gen Sent Out W_P- C/B	xxx.xxx	xxx.xxx
Gen Sent Out W_{Q1} M	xxx.xxx	xxx.xxx
Gen Sent Out W_{Q1} C/B	xxx.xxx	xxx.xxx
Gen Sent Out W_{Q2} M	xxx.xxx	xxx.xxx
Gen Sent Out W_{Q2} C/B	xxx.xxx	xxx.xxx
Gen Sent Out W_{Q3} M	xxx.xxx	xxx.xxx
Gen Sent Out W_{Q3} C/B	xxx.xxx	xxx.xxx
Gen Sent Out W_{Q4} M	xxx.xxx	xxx.xxx
Gen Sent Out W_{Q4} C/B	xxx.xxx	xxx.xxx
GENERATOR TRANSFORMERS (Calculated by Gx)	Trfr 1	Trfr *
Gen Trfr Losses W_P-	xx.xxx	xx.xxx
Gen Trfr Losses W_{Q2}	xx.xxx	xx.xxx
Gen Trfr Losses W_{Q3}	xx.xxx	xx.xxx
UNIT TRANSFORMER 1 (Gx)	Unit 1	Unit *
Unit Trfr W_P- M	xxx.xxx	xxx.xxx
Unit Trfr W_P- C/B	xxx.xxx	xxx.xxx
Unit Trfr W_{Q2} M	xxx.xxx	xxx.xxx
Unit Trfr W_{Q2} C/B	xxx.xxx	xxx.xxx
Unit Trfr W_{Q3} M	xxx.xxx	xxx.xxx
Unit Trfr W_{Q3} C/B	xxx.xxx	xxx.xxx
UNIT TRANSFORMER * (Gx)	Unit 1	Unit *
Unit Trfr W_P- M	xxx.xxx	xxx.xxx
Unit Trfr W_P- CH/B	xxx.xxx	xxx.xxx
Unit Trfr W_{Q2} M	xxx.xxx	xxx.xxx
Unit Trfr W_{Q2} C/B	xxx.xxx	xxx.xxx
Unit Trfr W_{Q3} M	xxx.xxx	xxx.xxx
Unit Trfr W_{Q3} C/B	xxx.xxx	xxx.xxx

STATION TRANSFORMERS (HV Side)	Trfr 1	Trfr *
Stn Trfr W_P+ M	xxx.xxx	xxx.xxx
Stn Trfr W_P+ C/B	xxx.xxx	xxx.xxx
Stn Trfr W_P- M	xxx.xxx	xxx.xxx
Stn Trfr W_P- C/B	xxx.xxx	xxx.xxx
Stn Trfr W_{Q1} M	xxx.xxx	xxx.xxx
Stn Trfr W_{Q1} C/B	xxx.xxx	xxx.xxx
Stn Trfr W_{Q2} M	xxx.xxx	xxx.xxx
Stn Trfr W_{Q2} C/B	xxx.xxx	xxx.xxx
Stn Trfr W_{Q3} M	xxx.xxx	xxx.xxx
Stn Trfr W_{Q3} C/B	xxx.xxx	xxx.xxx
Stn Trfr W_{Q4} M	xxx.xxx	xxx.xxx
Stn Trfr W_{Q4} C/B	xxx.xxx	xxx.xxx

LOOP SUPPLIES (Gx)	Loop 1	Loop *
Unit *n* to Loop W_P+	xx.xxx	xx.xxx
Unit *n* to Loop W_P-	xx.xxx	xx.xxx
Unit *n* to Loop W_{Q1}	xx.xxx	xx.xxx
Unit *n* to Loop W_{Q2}	xx.xxx	xx.xxx
Unit *n* to Loop W_{Q3}	xx.xxx	xx.xxx
Unit *n* to Loop W_{Q4}	xx.xxx	xx.xxx

STATION BOARD INCOMERS (Gx)	Trfr 1	Trfr *
Stn Brd *n* from Stn Trfr * W_P- M	xxx.xxx	xxx.xxx
Stn Brd *n* from Stn Trfr * W_P- C/B	xxx.xxx	xxx.xxx
Stn Brd *n* from Stn Trfr * W_{Q2} M	xxx.xxx	xxx.xxx
Stn Brd *n* from Stn Trfr * W_{Q2} C/B	xxx.xxx	xxx.xxx
Stn Brd *n* from Stn Trfr * W_{Q3} M	xxx.xxx	xxx.xxx
Stn Brd *n* from Stn Trfr * W_{Q3} C/B	xxx.xxx	xxx.xxx

STATION BOARD FEEDERS (Gx)	Unit 1	Unit *
Stn Brd *n* to Unit Brd * W_P+	xxx.xxx	xxx.xxx
Stn Brd *n* to Unit Brd * W_P-	xxx.xxx	xxx.xxx
Stn Brd *n* to Unit Brd * W_{Q1}	xxx.xxx	xxx.xxx
Stn Brd *n* to Unit Brd * W_{Q2}	xxx.xxx	xxx.xxx
Stn Brd *n* to Unit Brd * W_{Q3}	xxx.xxx	xxx.xxx
Stn Brd *n* to Unit Brd * W_{Q4}	xxx.xxx	xxx.xxx

GENERATOR EXCITATION TRANSFORMERS (Gx)	Unit 1	Unit *
Gen Exc Trfr W_P-	xxx.xxx	xxx.xxx
Gen Exc Trfr W_{Q3}	xxx.xxx	xxx.xxx

DIESEL GENERATORS (Gx)	Unit 1	Unit *
Diesel Gen W_P+	xx.xxx	xx.xxx
Diesel Gen W_{Q1}	xx.xxx	xx.xxx
Diesel Gen W_{Q4}	xx.xxx	xx.xxx

EXTRANEOUS SUPPLY SIGNALS (Gx)	Supply 1	Supply *
Ext Supply W_P+	xx.xxx	xx.xxx
Ext Supply W_{Q1}	xx.xxx	xx.xxx
Ext Supply W_{Q4}	xx.xxx	xx.xxx

TOTALS	Total
Total Stn Trfrs W_P-	xxx.xxx
Total Unit Trfr W_P-	xxxx.xxx
Total Unit Trfr W_{Q2}	xxxx.xxx
Total Unit Trfr W_{Q3}	xxxx.xxx
Total Stn Aux Consum W_P-	xxx.xxx
Total Stn Aux Consum W_{Q2}	xxx.xxx
Total Stn Aux Consum W_{Q3}	xxx.xxx
Total Gross Gen W_P+	xxxx.xxx
Total Gross Gen W_{Q1}	xxxx.xxx
Total Gross Gen W_{Q4}	xxxx.xxx
Total Gen Sent Out W_P+	xxxx.xxx
Total Gen Sent Out W_P-	xxxx.xxx
Total Gen Sent Out W_{Q1}	xxxx.xxx
Total Gen Sent Out W_{Q2}	xxxx.xxx
Total Gen Sent Out W_{Q3}	xxxx.xxx
Total Gen Sent Out W_{Q4}	xxxx.xxx