Eskom	Standard	Technology

Title: **SUBSTATION GATEWAY AND STATION RTU/IED STANDARD SPECIFICATION FOR EHV SUBSTATIONS**

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Compiled by	Approved by	Authorized by
M Sukhnandan.	I. Naicker.	
Marlini Sukhnandan	**Ian Naicker**	**Richard McCurrach**
PTM&C – Control & Automation	**Chief Engineer: PTM&C - Control & Automation**	**Senior Manager PTM&C**
Date: 9 December 2014	Date: 9 December 2014	Date: 9/12/2014

Supported by SCOT/SC

M Sukhnandan.

Marlini Sukhnandan

Telecontrol and SCADA SC Chairperson

Date: 9 December 2014

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SCOT Study Committee Number/Name: **Telecontrol & SCADA SC and Protection & Automation SC**

Content

Figures

Tables

1. Introduction

This document specifies the technical requirements of a substation gateway and substation Remote Terminal Unit (RTU) for application in Transmission EHV substations.

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

This standard specification details Eskom Transmission Group's Substation Control System (SCS) requirements for equipment that will find application in the following scenario:

a) New EHV substations / Full Refurbishments

In such instances, the *Purchaser* shall consider the installation of equipment that meets it's functional and interface requirements as specified in this document, conforms to industry standards and is economically feasible.

This enquiry shall therefore consider items such as cost effectiveness; functionality offered; modular 'off the-shelf'; tried and tested solutions; coexistence with the current substation control system components; system design; development/engineering; testing at workshop and on site; delivery; upgradeability; maintainability; and local support of the range of Control equipment to be installed at specific sites.

The range of Telecontrol equipment to be supplied shall be comprised of the following:

a) Gateway

b) Station RTU/IEDs.

c) PC-based applications for diagnostic purposes

d) PC-based applications for RTU engineering purposes

e) PC-based applications for post fault analysis purposes

2.1.2 Applicability

This standard specification shall apply throughout Eskom Transmission.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

2.2.1.1 International Documents

Document number	Document title	Preparer/author
[1] IEC 60068-2-30	Environmental testing - Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	IEC
[2] IEC 60255-5	Electrical relays. Insulation coordination for measuring relays and protection ...	IEC
[3] IEC 60529	Degrees of Protection Provided by Enclosures (IP code)	IEC
[4] IEC60255-25	Electrical relays - Part 25: Electromagnetic emission tests for measuring relays and protection equipment	IEC

Document number	Document title	Preparer/author
[5] IEC60255-26	Electrical relays - Part 26: Electromagnetic compatibility requirements for measuring relays and protection equipment	IEC
[6] IEC60255-22-2	Measuring relays and protection equipment – Part 22-2: Electrical disturbance tests - Electrostatic discharge tests	IEC
[7] IEC60255-22-3	Measuring relays and protection equipment – Part 22-3: Electrical disturbance tests – Radiated electromagnetic field immunity	IEC
[8] IEC60255-22-4	Measuring relays and protection equipment – Part 22-4: Electrical disturbance tests - Electrical fast transient/burst immunity test	IEC
[9] IEC60255-22-5	Measuring relays and protection equipment – Part 22-5: Electrical disturbance tests - Surge immunity test	IEC
[10] IEC60255-22-6	Electrical disturbance tests for measuring relays and protection equipment – Immunity to conducted disturbances induced by radio frequency fields	IEC
[11] IEC60255-22-7	Electrical disturbance tests for measuring relays and protection equipment – Power frequency immunity tests	IEC
[12] IEEE Std C37.1	IEEE Standard Definition, Specification and Analysis of Systems used for Supervisory Control, Data Acquisition, and Automatic Control	IEEE
[13] IEEE Std C37.90.1	Standard Surge Withstand Capability (SWC) tests for protective relays and relay systems ...	IEEE
[14] IEC60870-2 Part 1	Telecontrol equipment and systems – Operating Conditions	IEC

2.2.1.2 South African National Documents

Document number	Document title	Preparer/author
[15] SABS ISO 9001	Code of practice for quality management systems	SABS/ISO

2.2.1.3 Eskom Divisional Documents

Document number	Document title	Preparer/author
[16] 240-55410927	Cyber security standard for operational technology	J H Botha
[17] 240-61478967	Eskom Master Device IEC60870-5-101 Implementation standard	D Gojela
[18] 240-61478980	Eskom Slave Device IEC60870-5-101 Implementation standard	D Gojela
[19] 240-68235024	Eskom IEC61850 Station Bus Interoperability Test Standard	M Sukhnandan
[20] 240-68107841	Eskom IEC61850 Standard Requirements for PICS, PIXIT and TICS	M Sukhnandan
[21] 240-60725641	Specification for Standard 19 inch Equipment Cabinet	K Naicker
[22] 240-64038621	Remote Devices Communication Standard for Data Retrieval and Remote Access	T Hyman
[23] 474-313	Transmission Secondary Plant Technology Development	N Luthuli
[24] 240-70412755	Substation Control and Automation HMI Standard Specification for EHV Substations	M Shangase

2.2.1.4 Protocols

Document number	Document title	Preparer/author	Revision or date of issue
[25] IEC 60870-5-1	Telecontrol equipment and systems, Part 5: Transmission protocols - Section 1: Transmission frame formats	IEC	First Edition 1990-02
[26] IEC 60870-5-3	Telecontrol equipment and systems, Part 5: Transmission protocols – Section 3: General structure of application data	IEC	First Edition 1992-09
[27] IEC 60870-5-101	Telecontrol equipment and systems, Part 5-101: Transmission protocols -Companion standard for basic telecontrol tasks	IEC	Second Edition 2003-02
[28] IEC 60870-5-104	Transmission Protocols, Network access for IEC 60870-5-101 using standard transport profiles.	IEC	Latest
[29] IEC 61131-3	Programmable controllers – Part 3: Programming languages	IEC	2003
[30] IEC61850	Communication networks and systems in substations [All parts]	IEC	2002-2005

2.2.2 Informative

Document number	Document title	Preparer/author	Revision or date of issue
[31] 32-9	Definition of Eskom documents	Eskom Document Centre	Latest
[32] 32-644	Eskom documentation management standard	Eskom Document Centre	Latest
[33] 474-65	Operating manual of the Steering Committee of Technologies (SCOT)	Vinod Singh	Latest

2.3 Definitions

2.3.1 General

Definition	Description
IED	Intelligent Electronic device. Generic name given to all microprocessor-based substation secondary devices, e.g. relays and tariff meters.
Purchaser	Eskom Holdings SOC Limited.
RS232	An Electronic Industries Association (EIA) standard for the interfacing between Data Communications Equipment (DCE) and Data Terminal Equipment (DTE). It defines the electrical characteristics of the signals from such devices.
RS422	An EIA recommended standard to extend the RS232 50 ft limit to 1 200 m and is electrically compatible with the CCITT V.11 standard.
Substation Control System (SCS)	Defined as an integrated and coordinated system that performs the tasks of Supervisory Control and Data Acquisition (SCADA), substation automation and offers a single point of control and alarm annunciation (Human–Machine Interface (HMI)) to the substation operator.
X.21	A Consultative Committee on International Telegraphing and Telephony (CCITT) standard that defines the connections of terminals to modems.
X.25	A CCITT standard that defines the interface between Data Terminal Equipment (DTE) and data circuit terminating equipment (DTE) for workstations operating in a packet switch mode across public data networks.

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
A/D	Analogue to Digital
AC	Alternating Current
ARC	Automatic Reclose Control
ASDU	Application Service Data Unit
BCD	Binary Coded Decimal
bit/s	bits per second
BLC	Bay Level Controller
BME	Bandwidth Management Equipment
BNC	Bayonet Neill–Concelman
CAP	Committee for Accepted Products
CCITT	Consultative Committee on International Telegraphing and Telephony
CD	Compact Disc
CI	Communications Interface
CML	Control and Monitoring Logic
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
DA	Distribution Automation
DBMS	Database Management System

Abbreviation	Description
DC	Direct Current
DCD	Data Carrier Detect
DCE	Data Communications Equipment
DCE	Data Communications Equipment
DDS	Detailed Design Specification
DO	Digital Output
DRTU	Distribution Remote Terminal Unit
DSP	Digital Signal Processing
DTE	Data Terminal Equipment
Dx	Distribution
EIA	Electronic Industries Association
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ERTU	Enhanced Remote Terminal Unit or Data Concentrator
Estel	Eskom's standard telecontrol protocol (currently implemented)
FAT	Factory Acceptance Test/Testing
FOC	Fibre-optic Cable
FSK	Frequency Shift Keyed
GM	General Manager
GPRS	General Packet Radio Service
GPS	Global Positioning System
HMI	Human–Machine Interface
I/O	Input/Output
IDC	Insulation Displacement Connection
IDF	Intermediate Distribution Frame
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IP	Internet Protocol
ISO	International Standards Organization
kVAh	Kilovolt Ampere Hours
kVAr	Kilovolt Ampere Reactive
LAN	Local Area Network
LAP	List of Accepted Products
LED	Light-emitting Diode
n/a	not applicable
NTP	Network Time Protocol
PC	Personal Computer
PCB	Printed Circuit Board
PID	Protocol Implementation Document
PLC	Power Line Carrier
PPS	Portable Plant Simulator
PRP	Parallel Redundancy Protocol

Abbreviation	Description
PSTN	Public Switched Telephone Network
PTM&C	Protection, Telecoms, Metering and Control
RF	Radio Frequency
rms	root mean square
ROM	Read-only Memory
RTC	Real-time Clock
RTS	Request to Send
RTU	Remote Terminal Unit
SABS	South African Bureau of Standards
SAT	Site Acceptance Test
SC	Serial Cable
SCADA	Supervisory Control and Data Acquisition
SCS	Substation Control System
SER	Sequence of Events Recorder
SNTP	Simple Network Time Protocol
SOE	Sequence of Events
TCP	Transmission Control Protocol
UHF	Ultra High Frequency
VF	Voice Frequency

2.5 Roles and responsibilities

N/A

2.6 Process for monitoring

N/A

2.7 Related/supporting documents

N/A

3. Requirements

3.1 Project Phases

3.1.1 General

The Project shall be executed according to a defined project schedule made up of five phases. These phases are governed by the procedures defined under Transmission Secondary Plant Technology Development [23].

3.1.2 Phase 1 – Functional Design Specification (FDS)

a) Phase 1 consists of the production of a Functional Specification, a System Design Report and Protocol Implementation Description.

b) It is the intention of Phase 1 to document the proposed design and protocol description to form the baseline for the following phases.

c) The deliverables for Phase 1 are:

1) Functional Specification, which details the *Purchaser's* requirements in context of the *Supplier's* product.

2) Systems Design Report.

3) Protocol Implementation Description for each protocol (IEC 60870-5-101, and IEC61850).

4) Updated Project Programme.

3.1.3 Phase 2 – Detailed Design Specification (DDS)

a) Phase 2 consists of the production of a Detailed Design Specification (DDS) for both hardware and software components of the system, and specifies the procedures for testing.

b) The deliverables for Phase 2 are:

1) DDS.

2) Factory Acceptance Test (FAT) Procedure document.

3) Site Acceptance Test (SAT) Procedure document.

3.1.4 Phase 3 – Development, System Integration and FAT

a) Phase 3 will commence on completion of Phase 2.

b) Phase 3 consists of the procurement of hardware required for testing, any required development and supply of software as well as all training associated with the system.

c) The *Supplier* shall perform a pre-FAT according to the accepted Factory Acceptance Test (FAT) Procedure.

d) A completed pre-FAT report incorporating all the pre-FAT results shall be provided to the *Purchaser* at least 4 weeks prior to the commencement of the FAT

e) The FAT shall only commence once the *Purchaser* has approved this pre-FAT report and results.

f) The deliverables for Phase 3 are:

1) Prototype equipment.

2) A signed-off pre-FAT report with results from the *Supplier*

3) A signed-off FAT report indicating accepted completion of FAT.

3.1.5 Phase 4 – Delivery, Installation, Testing and Commissioning

a) Phase 4 will commence on completion of Phase 3.

b) Phase 4 comprises delivery of hardware, software, documentation and manuals to site, installation (assisted by the *Purchaser*) in conjunction with training. Thereafter, the system will be commissioned.

c) The deliverables for Phase 4 are:

1) Equipment delivery and installation.

2) System documentation in triplicate hardcopy and electronic format.

3) On-site training.

4) Commissioned system.

3.1.6 Phase 5 – Site Acceptance Test

a) Phase 5 consists of conducting tests according to the SAT Procedure document.

b) The deliverables for Phase 5 are:

1) A signed-off SAT report indicating accepted completion of SAT.

2) Updated documentation.

3) A Handover Certificate.

3.2 Substation Control System Specification

3.2.1 Transmission installed substation control system description

a) Currently, the Transmission Substation Control System (SCS) is based both on legacy architecture as well as a more modern arrangement. The legacy SCS architecture is based on functionally distributed RTUs that are serially connected to ERTUs (via the Estel protocol), which provides the central points of data and communication coordination. The newer modern architecture also has limited distributed RTUs. These RTUs communicate via IEC61850 over an IP connection to the Gateway which also provides the central points of data and communication coordination.

b) The interface of the legacy SCS with the protection schemes is achieved by having an RTU 'embedded' in each scheme, as a dedicated BLC. The link between the BLC and protection scheme is a hardwired, discrete interface. In the legacy architecture, the BLC serially connects to the legacy ERTU via the Eskom Standard Telecontrol protocol (Estel). In the modern architecture, however, this link between the BLC and Gateway is via IEC61850.

c) The current datalink from the legacy ERTUs to the stand-alone Human–Machine Interface (HMI) utilises the Estel protocol while the current datalink to external Supervisory Control And Data Acquisition (SCADA) master stations is based on the IEC 60870-5-101 protocols.

d) In the Transmission SCS, the Station RTU/IED is a stand-alone RTU device and shall interface to plant via an IDF. The Station RTU/IEDs/BLCs monitor and report the status of inputs to assigned ERTUs/Gateway and also execute plant output controls as instructed by assigned masters. The BLC, via its hardwired interface, captures and stores alarms, status indications and events from the protection scheme and reports changes to the assigned ERTU(s)/Gateway. It also receives control messages from the master via the ERTU(s)/Gateway to execute controls (e.g. open/close circuit-breaker) by sending the appropriate control signal to the protection scheme.

e) The ERTUs/Gateway perform the task of a 'smart' RTU in the SCS data acquisition environment by maintaining a database containing the current state of all Station RTU/IED/BLC inputs as well as collating all information received from the RTUs. The ERTUs/Gateway also provides the communications link to and from the external HMI and master stations.

f) The key to the success of this architecture is the communications link between the various components that constitutes the SCS architecture. At the 'lowest' level, discrete I/Os from primary plant, via transducers, either directly or via an Intermediate Distribution Frame (IDF) are interfaced to the protection, metering and RTU devices. Also between the protection schemes and the BLCs (RTUs), discrete I/O is used for interfacing.

g) In the legacy architecture, the Estel protocol forms the communications link between the ERTUs and BLCs/Station RTU/IEDs as well as the link to the external HMIs, whereas in the modern arrangement this is achieved via IEC61850. Between remote master stations and the substation ERTUs/Gateways, the protocols supported are Estel and IEC 60870-5-101.

3.2.2 Transmission - System Architecture

a) The philosophy for the SCS is to be based on non-proprietary system architecture, at the substation level, that provides the *Purchaser* with the infrastructure to monitor and control the Transmission Network from remote master stations, as well as for a local point of control (HMI) at the individual substations. Figure 1 depicts the *Purchaser's* existing legacy and modern architecture. Figure 2 illustrates the current station level SCS architecture; and Figure 1 provides an indication of the future SCS architecture requirements.

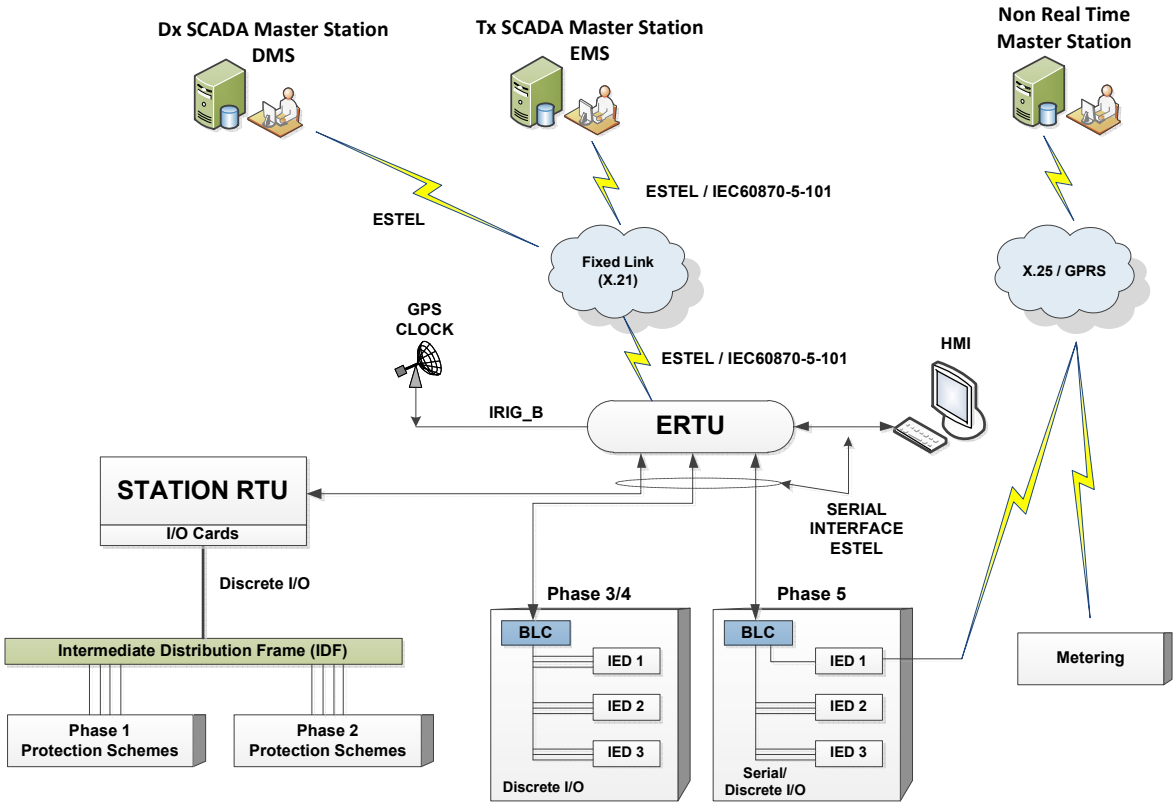

Figure 1: Transmission current substation control system legacy architecture

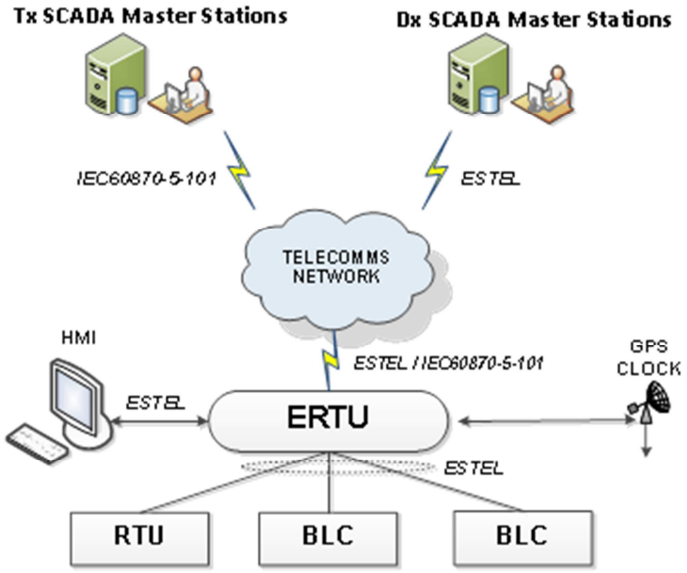

Figure 2: Transmission current station level substation control system legacy architecture

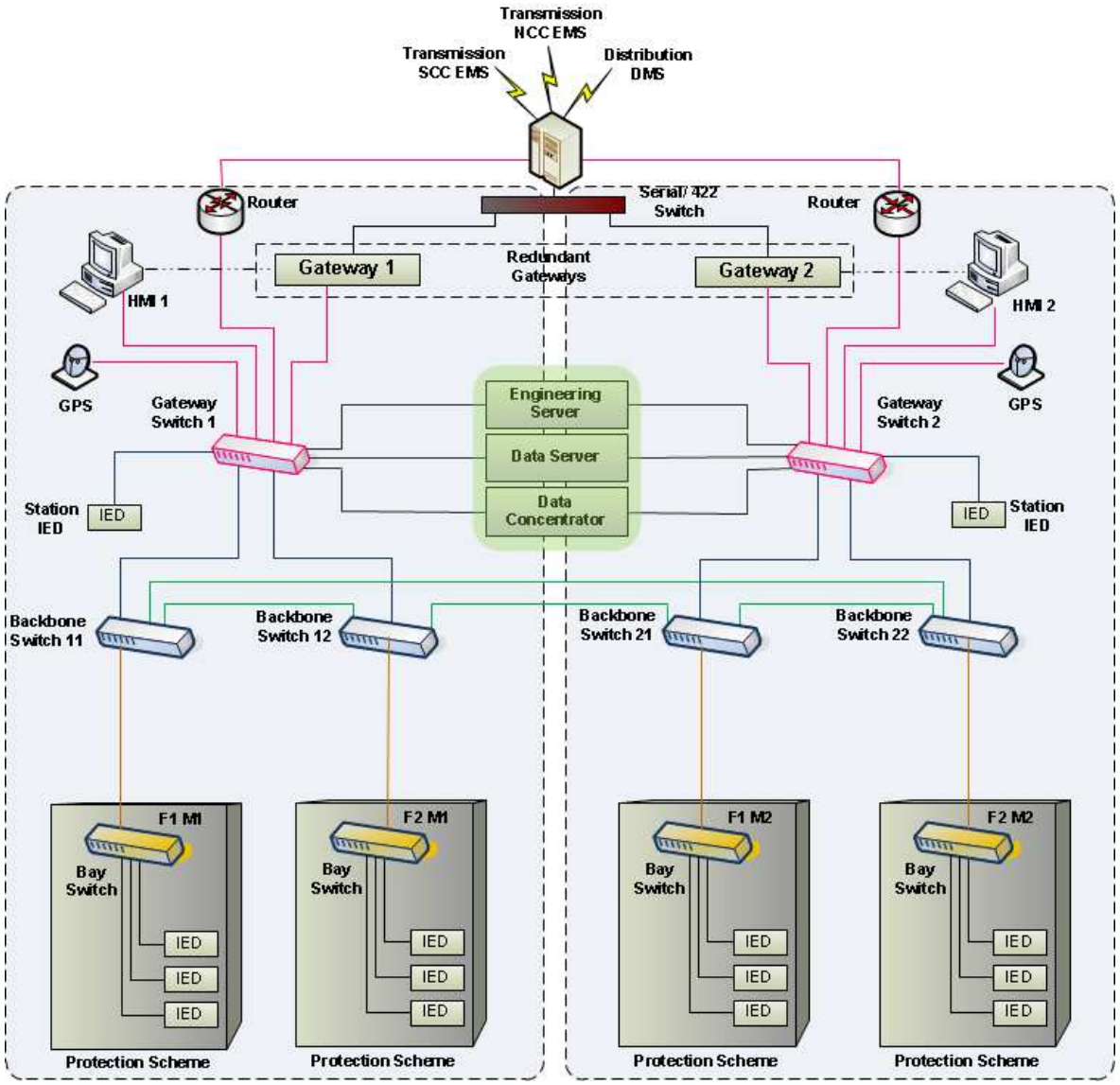

Figure 3: Transmission future segregated control and protection architecture

3.2.3 Transmission System Description and Requirements

The modules as well as their interfaces are described in detail to ensure that the *Supplier* provides solutions that accomplish the *Purchaser's* SCS requirements adequately.

3.2.3.1 Telecommunications Interface

a) A fundamental requirement of the *Purchaser's* Telecontrol system is for remote access to substation information from one or more than one master station.

b) The telecommunications interface between remote master stations and the SCS shall be accomplished by the use of an RS422/RS485/X.21 interface to the Bandwidth Management Equipment (BME) or Power Line Carrier (PLC) and an ethernet interface for Internet Protocol (IP) telecommunication links. The BME and PLC equipment are not included in the scope of this specification.

3.2.3.2 Gateway – Telecommunications Interface

a) The interface between the Telecommunications infrastructure and the Gateway shall be via point-to-multipoint serial RS422/X.21, supporting the IEC 60870-5-101 serial protocols and via a IP connection supporting IP-based SCADA protocols such as:

1) IEC61850 (optional)

2) IEC 60870-5-104 (optional)

3.2.3.3 Gateway to SCADA master station interface

a) The Gateway shall communicate with at least 10 master stations.

b) The Gateway shall provide a facility for master stations to communicate with all IEDs within the substation.

c) Remote master stations shall access the Gateway via multi-dropped serial link using the IEC 60870-5-101 protocol. The functional profile for the basic telecontrol tasks in the IEC60870-5-101 protocol that are used in the TEMSE Energy Management System is presented in [17].

d) Remote master stations shall also be capable of accessing the Gateway via an IP link using IP-based SCADA protocols as per 3.2.3.2.

3.2.3.4 Gateway to GPS receiver interface

a) The Gateway shall provide an interface to a substation master clock (Global Positioning System (GPS)) supporting the following protocols / standards:

i. IRIG-B amplitude-modulated with IEEE 1344 compliance

ii. IRIG-B unmodulated with IEEE 1344 compliance

iii. IRIG-B Manchester coded modulation with IEEE 1344 compliance

iv. Network Time Protocol (NTP)

v. Simple Network Time Protocol (SNTP)

vi. Precision Time Protocol

b) In the event of there not being a master clock in the substation, the Gateway shall synchronize its clock with that of the remote SCADA master station via the Eskom-approved SCADA protocol in use at that site.

3.2.3.5 Gateway – external Human Machine Interface

a) The Gateway shall be configurable to multiple HMI systems.

b) Communication with the HMI shall be via a multi-dropped serial link implementing the IEC 60870-5-101 (slave) protocol.

c) Communication with the HMI shall be via a Transmission Control Protocol (TCP)/IP supporting the IEC61850 (server) protocol.

3.2.3.6 Gateway to station remote terminal unit/IED

a) Each Gateway in the system shall have the capability to interface to a minimum of 5 Station RTU/IEDs.

b) Communication between the Gateways and the new Station RTU/IED shall be via the IEC61850 protocol.

3.2.3.7 Gateway to intelligent electronic device interface

a) Each Gateway in the system shall have the capability to interface to a minimum of 100 IEDs.

b) Communication between the Gateways and the new IEDs shall be via the IEC61850 protocol.

3.2.3.8 Gateway to Gateway (Legacy)

a) The Gateway shall provide the capability to interface to other legacy Gateways in the substation via the IEC60870-5-101 (Master) protocol.

b) The Gateway shall provide the capability to interface to other legacy Gateways in the substation via the IEC61850 protocol.

3.2.3.9 Gateway – general functionality

a) The Gateway shall maintain a database containing the current state of all RTUs and IEDs that are connected to it.

b) The Gateway shall collate all information received and, if required, it shall transmit this information to:

   1) Remote SCADA master stations.

   2) External HMI Clients.

c) The Gateway shall also process limit checking, disabling of reporting and manual overrides on plant inputs.

d) All oscillating status and analogue points shall be detected, reported and suppressed.

e) After a user-defined delay, the point shall be reactivated and tested. If the points continue to oscillate, they shall again be suppressed and reported.

3.2.3.10 Gateway – Control Handover functionality

a) The Gateway shall provide the facility to ensure proper handover of control functionality between the remote control centres and substation HMI. The control handover functionality required is detailed in the points below.

b) Figure 4 presents a pictorial representation of the control handover functionality required by the *Purchaser*.

1) The Engineering Assistant (EA) or on-site operator sends a control from the substation HMI to the Gateway initiating the control handover process.

2) The Gateway shall set a “Handover Bit” indicating that the Substation HMI has control on this particular bay which will therefore block controls from any other master stations i.e National Control Centre (NCC), Regional Control Centre (RCC) and other substation HMIs.

3) The Gateway shall send this “Handover Bit” status to the Master Stations other substation HMIs.

4) If the National Control Centre (NCC) or Regional Control Centre (RCC) requires control of this bay while the EA still has control authority, a double control (double command) shall be sent to the Gateway to reset the “handover bits” of **ALL** bays to thus allow controls from NCC or RCC.

   If the Control Handover has not been reset by the master station and the EA wants to hand over control back to the other master stations, the EA shall send a control from the HMI to the Gateway to hand back control. The Gateway shall then reset the “Handover Bit” of the particular Bay.

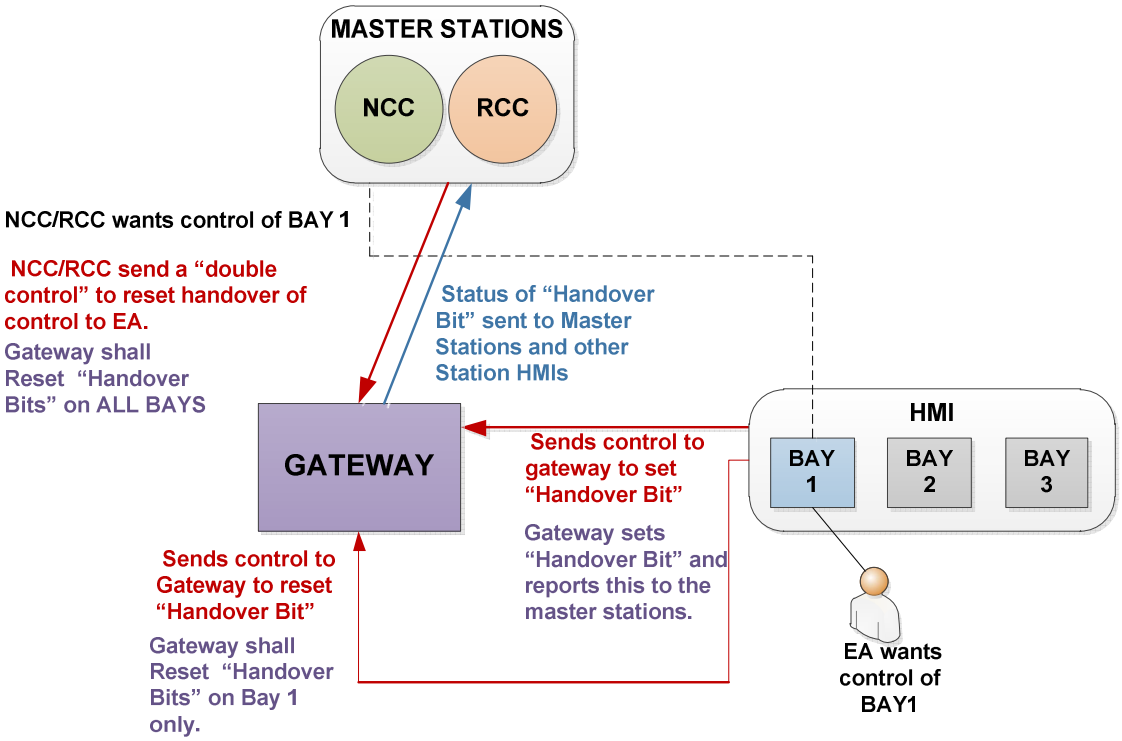

Figure 4: Control Handover Functionality

3.2.3.11 Gateway – Interlocking functionality

a) The Gateway shall provide the functionality for configuration and application of station and bay interlocking rules / equations. Bay level interlocking rules may also be applied at bay level IEDs.

b) There shall be no interlocking applied on all breaker “Open” / “Trip” controls.

c) There shall be interlocking applied on all breaker “Close” controls.

d) There shall be interlocking applied on the opening and closing of isolators and earth switches.

e) In the event that Gateway detects that a proposed control action is invalid, based on the interlocking rules, the control shall be blocked and a violation indication shall be sent to the master station attempting the control. This indication shall be a double bit indication. It is preferred that the interlocking rule which was violated shall also be sent to the relevant master station.

f) It is preferred that this interlock violation indication be reported via a bitstring of 32 bits message.

g) The user can acknowledge the message which shall remove the popup window. Once the reason for the violation has been corrected the user should be able to execute the supervisory control.

h) In order cater for situations when the interlock at the station/bay needs to be overridden by a remote control centre, an “override control” shall be sent from the control centre to the Gateway

i) The Gateway shall provide and host and a double bit “interlock override indication”.

j) When “interlock state” is overridden, double bit state 01, the interlock text “Interlocks Overridden” shall be shown in green, on all station one-line displays both locally and remotely.

k) When “interlock state” is not overridden i.e. active, double bit state 10, the interlock text “Interlocks Active” shall be shown in red, on all station one-line displays both locally and remotely.

l) In the event that interlock state is set to “overridden”, all supervisory controls for the entire substation shall be executed irrespective of how many interlock violations are detected.

m) The “interlock override” state shall remain active for a predefined configurable time period (range from 1min – 60mins).

n) The override timer shall be reset for the configurable time period each time a new control action is initiated as long as it takes place within the predefined configurable time period.

o) If the interlock timer times out the “interlock override indication” double bit points shall be reset and all displays shall be updated accordingly

p) Whenever the substation “interlock override” control is activated, the time and the identity of the originating source shall be logged.

q) The time at which the “interlock override” state transitions from “Interlock Overidden” to “Interlock Active” shall be logged.

r) All control actions shall be logged.

s) The Gateway shall support the facility to manually apply/force binary states so as to ensure the interlocking rules will be valid.

t) The Gateway shall support the addition of portable/working earth indications (which are usually handressed on the HMI) to be used in the interlocking rules.

u) The Gateway shall support the functionality of sending back an interlock violation indication in the event that the remote master stations attempts to perform any controls to an interlocked device.

v) Interlocking rules shall be applied via a .xml file input and the same principle shall apply for both Station and Bay level interlocks.

Figure 5 below provides a pictorial representation of the *Purchaser's* interlocking functionality.

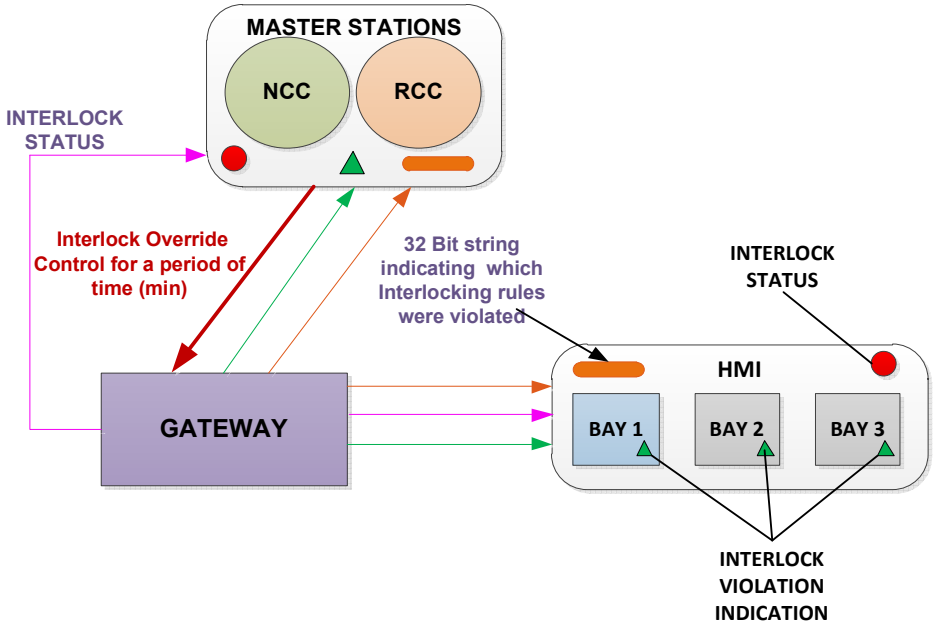

Figure 5: Interlocking Functionality

3.2.3.12 Gateway – Automated Operating Sequences Functionality

a) The Gateway shall provide the functionality for configuring safe automated operating scenarios. An example of a typical operating exercise which shall be automated is the transfer of a feeder from one busbar to another in a dual busbar architecture.

3.2.3.13 Gateway – System Redundancy

a) The Gateway shall support a redundancy architecture whereby there is a main/master gateway and standby gateway.

b) The *Supplier* shall provide details on how IP addresses and RTU addresses on both the Main Gateway and Standby Gateway is implemented to ensure seamless switch over.

c) In the event of failure of the main/master Gateway, the system shall automatically swap over to the standby Gateway. The *Supplier* shall provide details on how this is implemented.

d) This redundancy mode shall allow seamless connection to the Master Stations in the event of a swap over from the main gateway to the standby gateway. *Supplier* shall provide details on how this is achieved in their products

e) The both gateways' databases should be synchronised at all times. The *Supplier* shall provide details on how this is implemented and achieved.

3.2.3.14 Gateway – "Test Mode" functionality

a) The Gateway shall support a "Test Mode" scenario that shall enable the Purchaser to completely test one half of the segregated control system (Main 1 system or Main 2 system) in isolation to the fully operational other half of the system.

b) The status of this "Test Mode" shall be reported to all Master Stations.

c) Figure 6 below presents the required functionality of the "Test Mode".

d) It shall be possible to place half of the segregated system in "Test Mode" via a test switch/button. The Supplier shall provide full details on how this is functionality shall be achieved.

e) Once the Gateway is in "Test Mode" it shall:

   i. "Separate"/disassociate from the other gateway i.e. exits out of hot standby/redundancy mode.

   ii. Not allow controls from all remote master stations. It shall also block controls from the local HMI connected to the operational half of the system.

   iii. Allow full SCADA functionality from the HMI connected to the half of the system in Test Mode.

   iv. Allow the HMI on the test half of the system to only send controls to that half of the system in "Test Mode".

f) The Gateway on the operational half of the system shall allow full SCADA functionality supervisory and control from all remote master stations including the HMI connected to the operational half of the system.

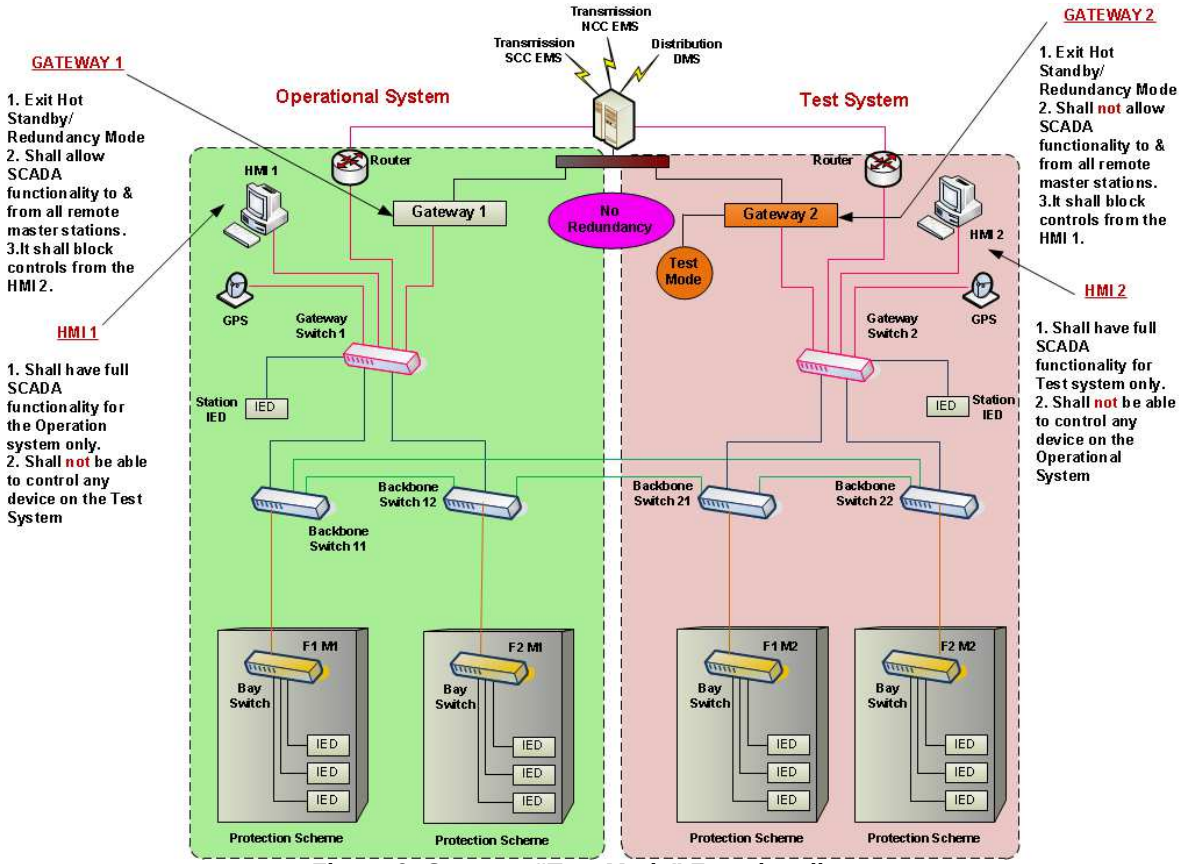

Figure 6: Gateway "Test Mode" Functionality

3.2.3.15 Gateway – control functionality

a) The Gateway shall provide a facility to receive commands from either the remote master stations or external HMI Clients to control plant outputs.

b) The control shall be sent immediately to the RTU/IED.

3.2.3.16 Station remote terminal unit/IED – general functionality

a) The new Station RTU/IEDs shall monitor and report the status of inputs to assigned Gateways, and shall execute plant output controls as instructed by assigned masters.

3.2.3.17 Station remote terminal unit Time Synchronisation interface

a) The Station RTU/IED shall provide an interface to a substation time server supporting the following protocols / standards:

i. Network Time Protocol (NTP)

ii. Simple Network Time Protocol (SNTP)

iii. Precision Time Protocol

3.2.3.18 Station remote terminal unit – plant interfaces

a) The Station RTU/IED is a stand-alone device and shall interface to plant/secondary plant schemes via an IDF.

3.2.3.19 Station remote terminal unit – control functionality

a) Every plant output mapped into the Station RTU/IED database shall have at least three (3) possible masters to which it can be assigned.

b) The Station RTU/IED shall provide a facility to receive commands from the substation gateway to control plant outputs.

c) The control shall be sent immediately to the IED.

3.2.3.20 General system requirements

1) From a system perspective, consideration shall be given to ‘tried and tested off-the-shelf’ solutions/equipment.

2) The life expectancy of the new equipment shall be > 10 years. *Supplier* shall state the life expectancy of products offered.

3.3 Communications

3.3.1 Introduction

a) This section shall provide the necessary information required by *Supplier's* to enable their equipment to communicate with the existing Telecontrol Network.

3.3.2 General communications requirements

a) The communications system of all substation control equipment provided shall be modular and flexible with regard to functional configuration.

b) It shall only be necessary to install those communications subsystems which are required for the specific application of the substation control equipment.

c) The functioning or performance of the substation control equipment provided or user application programs shall not be compromised by any communication activity and vice versa.

d) The communication protocol and physical interface is presented in Table 1 for both higher and lower-order processes. Higher-order processes are processes which act as a master to the Gateway, whilst lower-order processes are those to which the Gateway act as a master.

e) Adherence to the Communications Interface (CI) functionality shall enable the interconnectivity, interoperability and interchangeability of multiple suppliers' equipment/modules in the telecontrol environment.

3.3.3 Communications interface

3.3.3.1 General requirements

a) The Communications Interface (CI) shall handle communications to all processes by implementing the relevant protocols and physical interfaces as presented in Table 1.

b) Any changes to the CI shall not affect the applications that use the interface, i.e. the CI function shall not be 'embedded' within any specific application.

c) The CI shall at all times be able to function within a 'multi-drop' communications line environment.

d) The CI shall interface to a variety of telecommunications media. These shall include:

   1) Microwave radio.

   2) Power Line Carrier systems.

   3) IP Networks.

3.3.3.2 Protocol requirements

a) General

   1) The *Supplier* shall implement all the specified protocols as described in the relevant protocol definition documentation, on all equipment provided (Gateway and Station RTU/IED).

   2) The services offered by each layer and the manner in which these services are specified, shall be adhered to in the protocol implementation of the equipment.

   3) The *Supplier* shall provide all relevant information on their implementation, clearly defining what services and functions contained in the subset are not supported.

4) The IEC 60870-5-101 (Slave) protocol implementation on Gateway shall be tested against the existing SCADA master stations to ensure interoperability/compatibility. It shall comply with Eskom's Slave IEC60870-5-101 Implementation standard [17].

5) The IEC 60870-5-101 (Master) protocol implementation on Gateway shall be tested against the existing legacy Gateways to ensure interoperability/compatibility. It shall comply with Eskom's Master IEC60870-5-101 Implementation standard [18].

6) The IEC61850 protocol implementation on Gateway and Station RTU/IED shall be tested against the existing IEC61850 IEDs, HMIs and Test sets to ensure interoperability/compatibility. It shall with Eskom's IEC61850 Interoperability Standard – 240-68235024 [19]. It shall comply with Eskom's PICs and TICs Implementation Standard – 240 - 68107841[20].

b) Specification requirements: In terms of the IEC61850 requirements, the *Supplier* shall provide the following:

1) Compliance with IEC61850: The *Supplier* shall provide an IEC61850 compliance test certificate, obtained from an approved IEC certified test facility/organization, for each component provided that supports the IEC61850 protocol.

2) Protocol Implementation Document (PIC, PIXIT and TIC): The *Supplier* shall provide the relevant documents that describes the detail implementation of the IEC61850 protocol in terms of meeting the functional and system requirements.

3) Model Implementation Conformance document (MICs): The *Supplier* shall provide a MIC that describes the detail implementation of the IEC61850 protocol in terms of meeting the functional and system requirements.

4) Configuration, diagnostic and simulation capabilities: The *Supplier* shall provide a detailed description of all configuration, diagnostic and simulation capabilities offered by the system, as well as any other relevant information pertaining to this requirement.

5) Architecture and performance: The *Supplier* shall provide a description of the IEC61850 architecture, performance and *Supplier*-specific implementations/messages.

c) Gateway to Master Station protocols: The Gateway shall support the following Master-to-Gateway protocols:

1) IEC 60870-5-101:

i. The Gateway shall comply with the Eskom IEC60870-5-101 (Slave) specifications as stipulated in [17].

ii. The *Supplier* shall provide all details of its IEC 60870-5-101 implementation. All features supported shall be clearly stated.

iii. Proof of Independent testing and verification of the protocol functionality shall be provided.

2) IEC61850 – station to control centre:

i. The *Supplier* shall provide all details of its IEC61850 Station to Control Centre protocol implementation. All features supported shall be clearly stated.

ii. Proof of Independent testing and verification of the protocol functionality shall be provided.

d) Gateway to IED protocols: The Gateway shall support the following protocols:

1) The Gateway shall support the IEC61850 Client Implementation.

2) The Gateway shall support the IEC61850 Server implementation (for communication to substation HMIs).

3) Preference shall be given to those *Suppliers* that support of GOOSE Subscription and Publishing.

4) The *Supplier* shall provide all implementation details relating to this protocol. All features supported shall be clearly stated. All features not supported shall be clearly stated.

5) Proof of Independent testing and verification of the protocol functionality shall be provided.

e) Gateway to Station RTU/IED protocols

1) The Station RTU/IED shall support the IEC61850 Server implementation.

3.3.3.3 Physical layer requirements

a) Operation of communication ports

1) All communication ports for the Gateway and Station RTU/IED shall be capable of operating independently at different baud rates with different protocols simultaneously.

2) All ports shall be individually configurable. The *Supplier* shall state all related configuration parameters in the offer.

3) The data rate for each serial communication port on the Gateway and Station RTU/IED shall as a minimum be configurable between 1 200 bit/s and 19 200 bit/s.

4) Each Ethernet port shall support a minimum data rate of 100 Mbit/s.

5) It is preferred that each port provides a protocol emulation capability, which is independent of the functioning of the other ports.

6) The Station RTU/IED shall have as a minimum the following simultaneous communications interfaces:

(a) One diagnostic and configuration port. It is preferred that this be an Ethernet port.

(b) Two communication ports, each configurable as either a master station or a slave interface.

7) The Gateway shall have as a minimum the following simultaneous communications interfaces:

(a) One diagnostic and configuration port. It is preferred that this be an Ethernet port.

(b) Ten communication ports, each configurable as either a master station or a slave interface.

8) For the Gateway, it is preferred that the IED communication ports be located on separate modules.

9) For the Gateway, it shall be possible to expand the number of IED ports and/or master ports by, for example, adding additional Processor/Communications modules.

10) The *Supplier* shall specify the maximum number and type of communications ports possible.

b) Communication standards. As a minimum, the Gateway and where applicable the Station IED/RTU shall implement the following CCITT/ISO standards:

1) EIA RS232C: (a) Functional – V24 (EIA RS232C). (b) Electrical – V28 (EIA RS232C). (c) Connection- ISO 2110 [9 pins] (EIA RS232C).

2) EIA RS422: (a) Functional – V24 (EIA RS449). (b) Electrical – V11 (EIA RS422A). Connection – ISO 4902 [15 pins] (EIA RS449). In the event that the Gateway does not support and on-board 15 pin port, the *Supplier* shall then provide a 15 pin, RS422 interface to the telecommunications equipment.

3) EIA RS485 (4 wire): (a) Connection – Screw Terminals (minimum 2 kV Isolation).

c) Gateway to Station RTU/IED

1) The Gateway CI can interface to multiple Station RTU/IEDs.

2) It is preferred that there is no logical limit on the number of RTUs to which the Gateway may interface. However, for purposes of sizing the number of communications ports, the Gateway shall cater for a minimum of 5 communications ports.

3) It shall be possible to implement these communications links over Fibre-optic Cables (FOCs) due to the high levels of Electromagnetic Interference (EMI) in the substation environment.

4) The protocols that this interface shall support are indicated in Table 1.

d) Gateway to GPS receiver interface

1) The Gateway shall interface to a substation master clock (GPS).

2) The Gateway shall support the following communication ports:

i. BNC.

ii. Fibre Optic (ST connectors preferred)

iii. Serial (RS485)

iv. Ethernet (Copper and FOC)

3) The protocols that this interface shall support are indicated in Table 1.

e) Gateway to IEDs

1) The Gateway CI shall interface to multiple IEDs.

2) It is preferred that there is no logical limit on the number of IEDs to which the Gateway may interface. However, for purposes of sizing, the number of communications ports, the Gateway shall cater for a minimum of 100 IEDs.

3) It shall be possible to implement these communications links over FOCs due to the high levels of EMI in the substation environment.

4) The protocols that this interface shall support are indicated in Table 1.

f) Gateway to external HMI

1) The Gateway CI shall provide an interface to the external HMIs. The Gateway shall provide a minimum of two HMI communications ports.

2) The communications between the Gateway and the HMI shall be supported by an RS232/RS422/RS485 serial link as well as an Ethernet LAN.

3) The protocols that this interface shall support are indicated in Table 1.

g) Gateway to SCADA master station communications

1) Considering the Gateway to be Data Terminal Equipment (DTE), any Data Communications Equipment (DCE) (modems, radios, etc.) shall be physically separable from the DTE to allow Eskom to supply or select the appropriate DCE.

2) The DCE shall be powered by the Gateway.

3) The Gateway shall support the following Master communications interfaces:

   a) EIA-422(RS422).

   b) EIA-485 (4 wire)

   c) EIA-232(RS232)/EIA-423(RS423) three-wire operation.

   d) EIA-232(RS232) with full telephone modem signalling.

   e) Ethernet interface (Copper and Fibre).

4) The CI shall be required to interface to multiple SCADA master stations.

5) It is preferred that there be no limit on the number of logical master stations, which can interface to the Gateway or Station RTU/IED. However, for purposes of sizing the number of communications ports, the Gateway and Station RTU/IED shall both cater for a minimum of 10 physical master stations.

h) Station RTU/IED to Time Synchronisation Server

1) The Station RTU/IED shall interface to a substation time server.

2) The Station RTU/IED shall support an Ethernet interface (Copper and FOC)

3) The protocols that this interface shall support are indicated in Table 1.

Table 1: Summary of physical layer and protocol requirements

Interface	Protocol	Physical link
Gateway to Tx/Dx SCADA Master Station	IEC 60870-5-101 (Slave), IEC61850	RS232, RS422/X.21, RS485 (4wire), PLC, Ethernet – ST/LC connectors
Gateway to Gateway (Legacy)	IEC60870-5-101 (Master), IEC61850,	Serial, Ethernet (FOC, Copper) – ST/LC connectors
Gateway to Station RTU/IED	IEC61850 (Client)	Ethernet (FOC, Copper) – ST/LC connectors
Gateway to IEDs (SCADA)	IEC61850 (Client)	Ethernet (FOC) ST/LC connectors
Gateway to IEDs (Time Synchronisation)	SNTP (Server)	Ethernet (FOC) ST/LC connectors
Gateway to GPS Receiver	IRIGB, IRIGB (unmodulated), NTP, SNTP (Client), PTP	BNC, Fibre Optic, Serial, Ethernet (FOC, Copper) – ST/LC connectors
Gateway to External HMI	IEC60870-5-101 (Slave), IEC61850 (Server)	Serial, Ethernet (FOC, Copper) – ST/LC connectors
Gateway to LAN Equipment	SNMP Client	Ethernet (FOC, Copper) – ST/LC connectors
Station RTU/IED to Gateway	IEC61850 (Server)	Ethernet (FOC, Copper) – ST/LC connectors

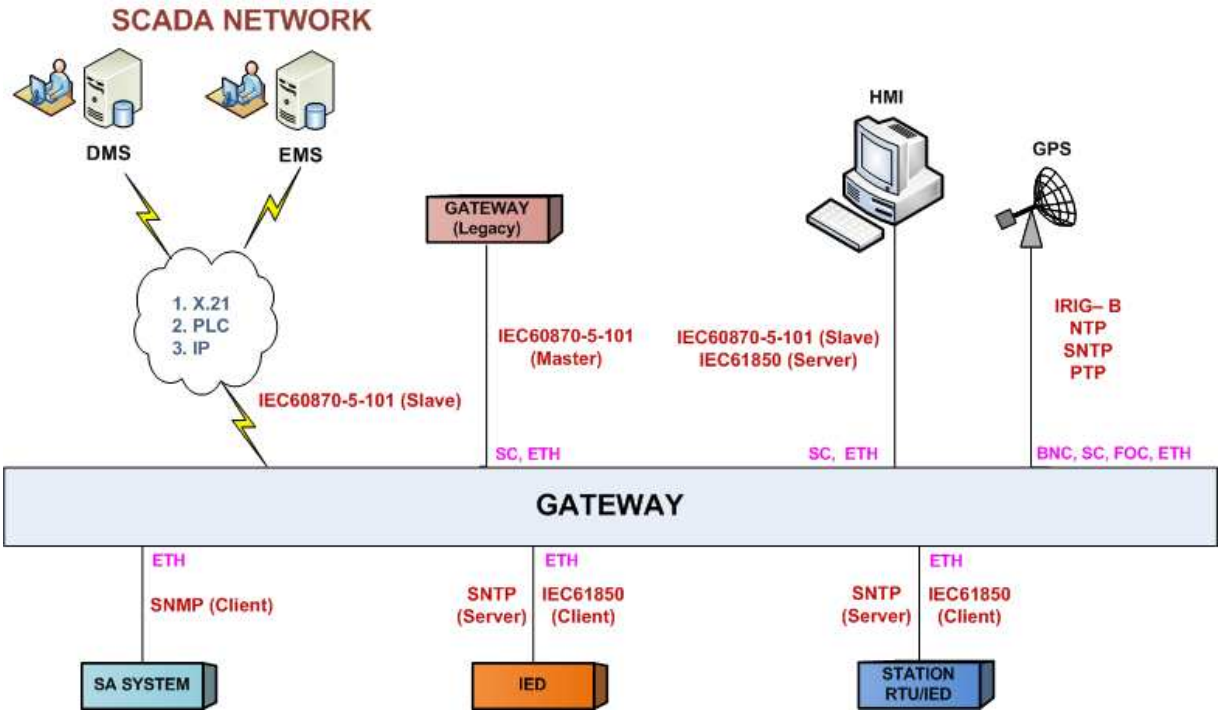

Figure 7: Gateway Protocol and Interface Requirements

3.4 Control and monitoring logic

3.4.1 General requirements

a) The Control and Monitoring Logic (CML) functionality shall maximize on the data acquisition capability of the RTUs to provide for the coordinated real time control and monitoring of substation primary plant/equipment.

b) The following CML functions are required at present:

1) Monitoring of substation plant and equipment.

2) Management of substation operation.

3) Management of the integrity of substation supply.

4) Ensuring the integrity of the SCS and related systems.

3.4.2 Monitoring of substation plant and equipment

3.4.2.1 Introduction

a) The Gateway and Station RTU/IED shall have the capability of monitoring plant and equipment on a real-time basis.

b) The Gateway shall ensure that all indications and analogues values shall by default originate from the protection Main1 system (M1), unless it is out of service or unavailable for whatever reason upon which the Main 2 system (M2) indications and analogues values shall become active.

c) In addition, the Gateway and Station RTU/IED shall have the capability of interfacing to protection relaying schemes.

3.4.2.2 Monitoring description

a) The Gateway and Station RTU/IED shall provide online monitoring of the status and operation of substation plant and equipment.

b) The data, which is captured by the Gateway and Station RTU/IEDs, shall be used to provide the basis for an online diagnostics and condition monitoring facility.

c) The data captured shall also be packaged by the CML function for transmission to the SCADA master station/s.

d) The Station RTU/IED shall provide a discrete/serial interface to some secondary plant equipment.

3.4.2.3 Monitoring requirements

a) General requirements. The Gateway and Station RTU/IED shall perform inter alia, the following monitoring functions:

1) Capture of status and measurand data.

2) Sequence of event data from protection schemes.

b) Digital alarms

1) Digital input ‘alarms’ shall be monitored and reported based on their individual or group priority.

2) The individual alarm priorities shall be software defined at both the individual and group level.

3) Each digital input shall be configurable to provide time stamping of status changes with an accuracy of 1 ms with respect to any other digital input in the same RTU.

4) The *Supplier* shall state the resolution of digital input time stamping in the offer.

c) Pseudo-variables

1) The logical grouping of inputs shall be unrestricted.

2) It shall be possible to assign some or all of these groups to logical pseudo-variables, which shall be processed as any other digital input.

3) Pseudo-variables shall be derived by means of Boolean operations performed on discrete digital inputs to provide a single output quantity.

d) Analogue windows

1) Software-configurable ‘moving window’ analogue monitoring techniques shall be applied to all analogue inputs and pseudo-analogue values. The ‘moving window’ concept implies that an analogue change shall not be reported or flagged as a change unless it exceeds a predefined ‘window’.

2) This ‘window’ consists of a configurable upper and lower limit around the current value of any analogue point.

3) The ‘window’ shall remain static and shall only move to the new analogue value once the change has been reported.

4) These thresholds shall be provided per individual analogue.

e) Analogue reporting. Analogue changes shall be reported under the following conditions:

1) When the analogue input exceeds the ‘window’.

2) When the analogue input exceeds a predefined upper maximum limit or lower minimum limits. These limits are defined as high, high-high, low and low-low values.

3) The reporting function shall feature hysteresis that inhibits repeated reporting of small changes around the thresholds. Figure 8 explains the desired functionality. The high analogue value is reported when the HIGH threshold is exceeded, i.e. at H1. It is only reported again when the value falls below HIGH – hysteresis, i.e. at H2. The low analogue value is reported if the value falls below the LOW threshold, i.e. at L1. The analogue value is only reported again when it rises above the LOW + hysteresis threshold, i.e. at L2.

4) It shall be possible to enable/disable the reporting of individual analogues.

5) Preference will be given to equipment that allows analogues to be configured to report on a periodic basis.

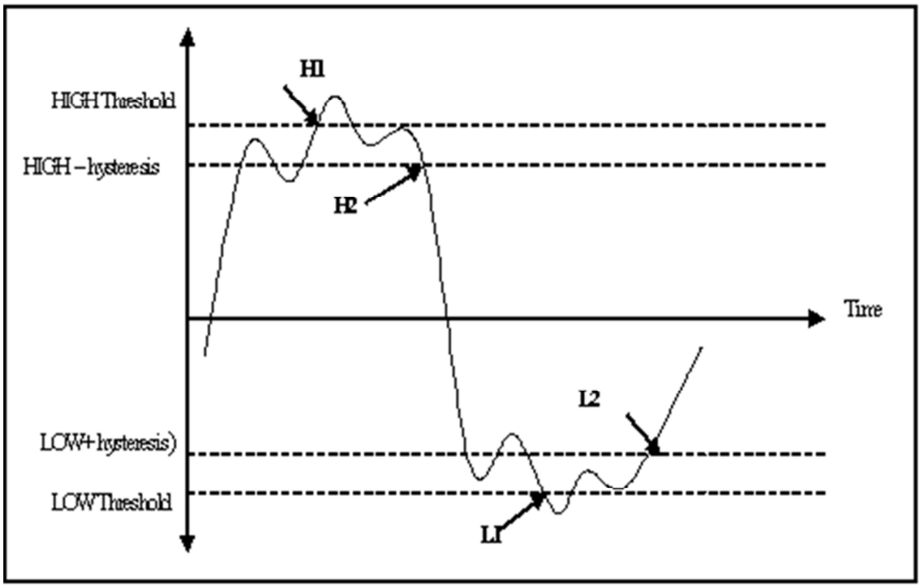

Figure 8: Analogue Threshold Reporting

b) Analogue time tagging

1) Analogues, which have exceeded the upper maximum or lower minimum limit, shall be time tagged and logged into the Sequence of Events (SOE) list described in 3.6.

2) Time tagging shall be a configurable function for all configured analogue inputs.

3.4.2.4 Monitoring physical implementation

a) The Gateway shall collate all the data received from the IEDs/Station RTU/IEDs to provide a centralized substation database.

b) The Station RTU/IED shall also collate all the data received from hardwired IEDs to provide this information to the Gateway.

c) The Gateway and Station RTU/IED shall coordinate time tagging on a substation basis, so that time-tagged information, which is passed to the SCADA master station, has a common reference within the context of the SCS.

3.4.3 Management of substation operation

3.4.3.1 Introduction

a) The Gateway shall provide a data collation facility for remote master station(s).

b) The Gateway shall also provide the SCADA master station with the ability to remotely control substation plant and equipment.

3.4.3.2 Substation operation description

a) The Gateway shall have the capability of operating substation plant under remote control of the SCADA master station(s).

b) The Gateway shall also operate substation plant under the direct control of the external HMIs in the context of the SCS.

c) The Gateway shall ensure that all controls for the protection system shall by default be sent to the Main1 system (M1), unless it is out of service or unavailable for whatever reason upon which the Main 2 system (M2) controls shall be utilised.

d) In addition, the Gateway shall provide a control path to the Station RTU/IED for the remote SCADA master stations.

e) The Gateway shall provide the ability to collate data for transmission to a remote SCADA master station.

3.4.3.3 Substation operation requirements

a) Data types/reporting

1) Prioritization and reporting of data shall be implemented with the view to optimizing system performance with respect to the available data communication rates.

2) In addition, any mechanism provided, shall enable the implementation of flow control under system surge conditions.

3) Real time CML data shall consist of: (a) Digital outputs. (b) Digital status points. (c) Accumulators. (d) Analogue measurands. (e) Analogue set points.

4) This data shall be captured according to the requirements defined in 3.4.2.3, ‘Monitoring Requirements’.

b) Priority queues

1) All real-time CML data shall be provided within the concept of priority queues.

2) On a master station demand basis, the contents of these queues shall be available for transmission.

3) The Gateway and Station RTU/IED shall provide a priority queue mechanism that conforms to the requirements of IEC 60870-5-101 and IEC61850 protocols.

4) The Gateway shall supply data to the queues on an exception basis. That is, only those items in the database that have changed since the last time the Gateway were polled.

5) When transmitting data to the master station, the following information shall be provided:

(a) The status of each queue.

(b) The priority of the data which is being transmitted.

c) Resynchronization of databases

1) The SCADA master station shall issue a command to ‘resynchronize databases’. This shall entail the Gateway transferring its entire state of database to the SCADA master station.

2) The Gateway to Station RTU/IED interaction shall be identical to the interaction between the SCADA master station and the Gateway (as described above).

d) Time synchronization – Gateway/Station RTU/IED clock accuracy

1) The time source in the Gateway/Station RTU/IED shall have an inherent accuracy of better than 250 ms during any 24 h period. This means that time lost or gained during a 24 h period shall not be > 250 ms.

2) The Gateway/Station RTU/IED shall be equipped with a battery backed-up Real-time Clock (RTC) with leap year support.

3) It shall be possible to set the clock via the configuration software connected locally to within 1 ms of the Personal Computer’s (PC’s) clock, as well as via the Telecontrol protocol from the master station.

4) The precision of the clock shall be 1 ms or better, i.e. CCYY/MM/DD hh:mm:ss.ttt.

5) The RTC battery shall provide at least 50 days of total standby time.

6) The battery should not need replacing more often than every 10 years under normal operating conditions.

e) Time synchronization – Gateway to SCADA master synchronization

1) Using IEC 60870-5-101 / IEC61850 it shall be possible to synchronize the time of the Gateway to the SCADA master station.

2) The *Supplier* shall provide details of time synchronization accuracies that can be achieved.

f) Time synchronization – Gateway to GPS receiver synchronization

1) The interface between a substation master clock (GPS receiver) and the Gateway shall as per the requirements mentioned in 3.3.3.3(d)

2) The IRIG-B interface shall be designated as the primary/master time source interface, and any Gateway synchronization messages from other hosts shall be ignored.

3) If there is communication port failure, the next designated time synchronisation host shall assume responsibility for the synchronization of the Gateway/Station RTU/IED.

4) The Gateway synchronization shall be done to an accuracy of better than or equal to 1 ms when referenced to the GPS receiver. An accuracy of 1 ms means the following: (a) Any two simultaneous events on the Gateway shall not have a difference exceeding 1 ms (plus or minus). (b) The absolute time of an event that occurs simultaneously on the GPS and Gateway should not be > 1 ms from the GPS referenced absolute time.

g) Time synchronization – Station RTU/IED or bay IEDs to Gateway for time synchronization

1) Using SNTP/NTP/PTP, it shall be possible to synchronize the time of any RTU/IEDs/Data Concentrators/Data Server to the Gateway to an accuracy of 1 ms.

h) Plant control – control of plant shall be initiated in the following ways:

1) From the remote SCADA master station to the Gateway. The Gateway in turn issues a control command to the Station RTU/IED/ or bay IED.

2) From the external HMI Clients to the Gateway

i) Control sequence: Master station to Gateway. A control sequence from a Master station to the Gateway, shall be performed as follows (after all control handover and interlocking rules have been passed):

1) Upon receipt of the ‘Select and Execute’ message, the Gateway shall select the appropriate control output relay. After checking that the correct relay has been selected, it shall execute the control by applying a voltage to the control output relay.

2) Upon successful operation of the output relay, the Gateway shall send an ‘Execute Confirm’ message to the master, in addition to the change of state message from the controlled device.

3) If the control operation failed, the Gateway shall send an ‘Execute Fail’ message to the SCADA master station, as applicable.

j) Substation operation physical implementation

1) Prioritization and reporting of data as described above shall be implemented at the Gateway.

2) The control function shall be implemented at the Gateway as described in i) above.

3.4.4 Management of the integrity of substation primary supply

3.4.4.1 Introduction

a) Integrity of substation primary supply relates to providing an electrical supply to customers which is free of:

1) Voltage dips or surges.

2) Supply interruptions.

3) Harmonics.

b) It also relates to restoring primary supply as quickly as possible once an interruption has occurred.

3.4.4.2 Management of substation primary supply description

a) The Gateway shall provide for the manual restoration of primary supply.

b) At this stage, it shall be possible to manually restore supply, i.e. under master station or operator control.

c) Depending on feasibility, some form of automatic voltage control shall be implemented.

3.4.4.3 Management of substation primary supply physical implementation

a) This function is to be implemented on the Gateway.

3.4.5 Gateway/Station RTU/IED Integrity

3.4.5.1 Introduction

a) The Gateway/Station RTU/IED is to be used for the operation of plant and equipment in substations.

b) It is essential that the integrity of the Gateway/Station RTU/IED be such that it shall at no time threaten human life or any plant and equipment.

3.4.5.2 Gateway/station remote terminal unit integrity description

a) The Gateway/Station RTU/IED integrity refers to the integrity of all software processes and hardware elements provided by the *Supplier*.

3.4.5.3 Gateway/station remote terminal unit integrity requirements

To enhance the functionality of the Gateway/Station RTU/IED the following criteria shall be provided for:

a) Watchdogs

1) The Gateway/Station RTU/IED shall provide hardware and software watchdogs that continuously monitor the hardware and software elements of these systems.

2) These watchdogs shall ensure safe operation of the Gateway/Station RTU/IED at all times. If the Gateway/Station RTU/IED should fail, it should fail to a ‘safe’ condition.

b) Error detection/correction

1) Adequate coding techniques for error detection shall be used to eliminate incorrect controls being carried out due to undetected errors in code/messages.

2) Adequate coding techniques for error detection shall also be used to eliminate incorrect indications and alarms being presented due to undetected errors in code/messages.

3) For remote control functions, it is required that the effectiveness of the coding system be such that the probability of an incorrect control command being performed is 10^{-10} or better.

4) For remote indication purposes, it is required that the effectiveness of the coding system be such that the probability of an incorrect status indication of alarm being presented to the operator is 10^{-7} or better.

5) The *Supplier* shall substantiate how these error rates are achieved, and shall clearly state the assumptions that have been made in determining compliance with the specified error rates.

c) Reliability/availability

1) The individual reliability of system components shall in no way cause the overall system availability at any one substation or site to drop below 99,98% per 1 000 h.

2) The *Supplier* shall substantiate how the availability specified in 1) is to be achieved, and shall clearly state the assumptions that have been made in determining compliance with the specified availability.

3) The *Supplier* shall clearly state the reliability of major system components in meeting the availability figure in 1). These system components shall be described in the proposal at the time of tendering.

4) It is a requirement that if 10% or more of the total number of each system component installed, fails during the warranty period, all such system components shall be replaced at the *Supplier's* expense and the warranty shall be extended for a further period under the same conditions.

3.4.5.4 Gateway/Station RTU/IED integrity physical implementation

a) The Gateway/Station RTU/IED shall both provide a relay contact, which is not part of the normal control output boards.

b) The relay contact shall be closed under normal operating conditions. When the Gateway/Station RTU/IED experiences a catastrophic failure, the Gateway/Station RTU/IED shall 'shut down' and the relay contact shall open. A catastrophic failure is defined as follows:

1) Any failure of a major system component.

2) Failure of system power supply.

3) Corruption of the configuration database.

4) Corruption of system or application software.

5) Failure of one or more control outputs, if control sensing is active.

c) The failure of a digital input or analogue input card is not classified as a catastrophic failure.

d) This relay shall be under direct control of the microprocessor unit on the RTU.

e) 'Shut down' is defined as follows: The Gateway/Station RTU/IED shall be provided with an automatic and orderly closing down of databases and processes on detection of a catastrophic failure.

f) The Gateway/Station RTU/IED shall have power-on sequencing, which shall occur automatically when power is restored to a unit after an outage.

g) This power-on sequencing shall include, inter alia, automatic resynchronization of Gateway/Station RTU/IED databases and a complete diagnostic check of both the Gateway/Station RTU/IED.

h) No data changes shall be reported to the master stations or the HMI Client/Server until the power-on sequence is complete.

3.5 Plant Interface

3.5.1 General requirements

a) The plant interface shall consist of the following:

1) Plant outputs.

2) Plant inputs.

b) The inputs and outputs to the RTU shall be designed to withstand the surge withstand capability tests as defined in the IEEE Std C37.90.1-1989 [13] without RTU damage, misoperation or data corruption.

c) It shall not be possible to fit an I/O module in an I/O slot or position where so doing will cause any damage or maloperation whatsoever.

d) It shall be possible to isolate/remove an I/O module for maintenance without having to power down the RTU or to take it offline.

e) Failure of any one I/O module shall not affect the performance of any of the other modules.

f) The RTU shall provide visible local diagnostic indications on all the modules.

g) Visual status indication of the I/O on each I/O module is preferred.

3.5.2 Plant outputs

3.5.2.1 Introduction

a) Plant outputs are also termed control outputs. These outputs are essentially relay outputs, which are directly activated by the Gateway/Station RTU/IED. This is the primary method for controlling substation plant and equipment.

3.5.2.2 Plant output requirements

a) The plant outputs shall consist of a normally open contact for each open or closed function. These contacts shall have a maximum switched voltage of U_{AC} 250 V/U_{DC} 50 V. The maximum switchable power of 100 V.A/60 W shall be required.

b) Each digital control output shall provide a voltage free (‘dry’) contact with the following minimum rating: 1 A, U_{DC} 110 V. The *Supplier* shall provide the ratings of the control relays on the modules that are offered.

c) Control output modules providing pulse-width output functionality shall be available whereby a normally open contact will close for a configured period.

d) The duration of the closing pulse per output relay shall be variable between 0,1 s and 10 s in 100 ms steps.

e) Control output modules that support pulse-width functionality shall offer the option to prohibit the simultaneous operation of pulsed output relays on a per module basis. The *Supplier* shall state all related configuration parameters in the offer.

f) Control output modules providing latching relay output functionality shall also be available.

g) In this configuration, it shall be possible to have more than one output relay active at a time.

h) The latched relay shall not be mechanically latched.

i) Preference will be given to systems which allow control output relays on the same Digital Output (DO) module to be individually configured as either pulse-width outputs or latched outputs. The requirement is to have, for example, on the same DO module, outputs 1, 2 and 4 configured as pulsed outputs, while outputs 3 and 5 are configured as latched.

j) All switching shall be carried out using a double pole switching method. This implies that a common relay shall switch the common supply rail at the same instant that a specific output relay is activated.

k) The combined operation of the output relay and the control common relay shall take place in the following modes:

   1) To switch through the U_{DC} 50 V equipment derived voltage.

   2) To switch an external voltage.

   3) To provide a 'dry' contact to an external user.

l) A U_{DC} 48 V output switching voltage shall be provided by the RTU. It shall also be possible to provide this voltage from an external source.

m) The 48 V switching supply shall be short-circuit protected.

n) The short-circuit protection should be self-healing once the short circuit is removed. The *Supplier* shall provide details of the short-circuit protection mechanism.

o) Control outputs shall use a local select-checkback-execute principle. On receipt of a control select and execute request from the Remote Master Station, the remote unit shall select and confirm, internal to the module, selection of the appropriate control output relay. Power shall only then be applied to the output relay to operate it.

p) Control outputs shall also support the direct operate principle.

q) After initiation of the control sequence, the sequence shall be terminated either:

   1) automatically 10 s after commencing the sequence; or

   2) after the successful execution of the sequence.

r) In the event of any failure, no erroneous control shall be executed.

s) Preference shall be given to an RTU system that checks control successes, and which can provide information on the source of control failures. The *Supplier* shall provide full details on such functionality if it is offered.

3.5.2.3 Number of relay outputs

a) The Station RTU/IED shall have a minimum of 8 output relays, each with one set of changeover contacts.

3.5.2.4 Plant output physical implementation

a) Plant outputs shall be implemented as relays on a separate I/O module that plugs into the Station RTU/IED rack.

b) These modules shall be separate from any Central Processing module or Communications module.

c) All I/O shall at least be opto-isolated and protected against surges. The *Supplier* shall provide full details.

3.5.3 Plant Inputs

3.5.3.1 Introduction

a) Plant inputs are the primary method of data acquisition for the Station RTU/IED

b) Plant inputs include digital inputs, analogue inputs and accumulator inputs.

c) Accumulator inputs are digital pulsed type inputs.

3.5.3.2 Plant input requirements

a) Digital inputs

1) Cables with lengths of up to 1 km are used for connecting digital inputs to the plant. It may be assumed that each 'potential free' contact in the plant is connected to a separate pair of wires. Regardless of any 'commoning' which results from the design of the digital input circuitry in a manufacturer's equipment, and with any combination of closed and open contacts (particularly all but one contact closed), it is required that an open contact be correctly detected as such. It may be assumed that the worst-case inter-core cable impedance is 1 MΩ.

2) A closed contact shall be detected when a condition of 0 Ω to 200 Ω exists in parallel with up to 4,0 µF at the input. The hysteresis values shall be provided by the *Supplier*.

3) The open contact shall be detected when a condition exists of 100 kΩ to 1 MΩ in parallel with up to 4,0 µF at the input. The hysteresis values shall be provided by the *Supplier*.

4) All breaker status and alarm inputs shall be derived from potential-free inputs provided by the *Purchaser*. The RTU shall provide a suitable wetting voltage for reading these contacts. *Supplier* shall provide information on this wetting voltage and how it is sourced.

5) All digital circuit inputs provided shall offer a noise immunity of U_{DC} 5 V and 10 V root mean square (rms) at 50 Hz applied transversely, and 100 V rms at 50 Hz applied longitudinally to earth.

6) Each input shall have a configurable contact closure delay, variable from 10 ms to 60 s.

7) The digital inputs shall be configurable as single-bit inputs, double-bit inputs, accumulator (counter) inputs and Binary Coded Decimal (BCD) inputs for Transformer Tap Position indicators. Normal double-bit states (i.e. 01 and 10) shall be reported immediately, while abnormal double-bit states (i.e. 00 and 11) should only be reported after the abnormal state has been sustained for a configurable period. Similarly, only stable BCD values shall be reported, i.e. invalid intermediate states should not be reported The *Supplier* shall state the related configuration parameters in the offer.

8) The ability to configure a processing delay per digital input is sought. This delay should be settable in 1 s steps from 0 to 255.

9) The status change should only be reported if the status change is sustained for the duration of the timer.

10) Delayed status changes shall be time-stamped with the time at the start of the delay and not the end of the delay. The *Supplier* shall state all related configuration parameters in the offer.

11) The Gateway/Station RTU/IED shall provide the ability to invert the logic status per digital input.

12) The Gateway/Station RTU/IED shall provide the ability to disable and enable the reporting of digital inputs on a per input basis.

13) Any digital input shall be configurable to enable the counting of digital status changes. Counter values shall be stored in non-volatile memory.

14) The reporting of counter values shall be configurable, i.e. on the transgression of a configurable value, or on the basis of a configurable freeze period. The *Supplier* shall state all related configuration parameters in the offer.

b) Accumulator inputs

1) Each accumulator input value shall be represented by a minimum of a 16 bit binary word.

2) All accumulator inputs shall accept input pulse rates of up to 20 pulses per second. Each accumulator shall be reset under three conditions: (a) Under remote control. (b) On a preset time. (c) After a given time period.

c) Analogue DC inputs

1) The accuracy of the Analogue to Digital (A/D) converter shall be sufficient to ensure that any specific analogue input shall have an accuracy ≤ 0,25% of the full-scale reading.

2) All transducers may be regarded as linear over the range ± 7,5 mA, which can be regarded as the full-scale working range of all analogue inputs.

3) The Analogue Input subsystem shall support the following input ranges: U_{DC} ±1 V, ± 10 mA and 4 mA to 20 mA.

4) The input circuitry shall not present more than 400 Ω load to the transducer.

5) Analogue input circuits shall be balanced, floating and isolated. The flying capacitor technique (or equivalent) shall be implemented to achieve the required level of isolation.

6) No potentiometers shall be used to scale any of the inputs. All input scaling shall be done via software configuration.

7) With U_{DC} 150 V or U_{AC} 100 V rms (50 Hz to 300 Hz) applied common mode to the analogue inputs, the A/D converter count shall not change by more than approximately two counts.

8) With U_{AC} 1,5 V (50 Hz and 1 MHz) applied differentially to the analogue inputs, the A/D converter count shall not change by more than approximately two counts.

9) Each analogue input shall be represented by a minimum of a 12 bit binary value.

d) Analogue AC inputs

The requirements for interfacing to analogue AC inputs are as follows:

1) Nominal input voltage U_{AC} 115 V.

2) Nominal input current 5 A.

3) It is preferred that the analogue AC input modules provide the option for Digital Signal Processing (DSP) functionality.

3.5.3.3 Plant input physical implementation

a) Digital inputs and accumulator inputs shall be implemented on a separate I/O module that plugs into the Station RTU/IED rack.

b) Analogue inputs shall be implemented on a separate I/O module that plugs into the Station RTU/IED rack.

c) These modules shall be separate from any Central Processing module or Communications module.

d) All I/O shall at least be opto-isolated and protected against surges. The *Supplier* shall provide full details.

3.5.4 Plant multi input/output modules

3.5.4.1 Introduction

a) Multi I/O modules shall comprise a combination of digital I/O and analogue I/O on a single module.

3.5.4.2 Plant multi input/output module requirements

a) The requirements, as specified in 3.5.2.2 and 3.5.3.2 for digital inputs/outputs and analogue inputs, shall apply equally to the Multi I/O module if applicable.

b) The *Supplier* is required to provide specifications on the various types of Multi I/O modules.

3.5.4.3 Plant multi input/output module physical implementation

a) The multi I/O module shall provide a combination of digital and analogue I/O on a separate module that plugs into the Station RTU/IED rack.

b) These modules shall be separate from any Central Processing module or Communications module

c) All I/O shall at least be opto-isolated and protected against surges. The *Supplier* shall provide full details.

3.5.5 System sizing

3.5.5.1 General requirements

a) The RTU/Gateway architecture shall be based on a modular concept, whereby the controller, I/O modules and communications modules shall be easily separable.

b) The platform shall provide for easy expandability and functional flexibility.

c) The system sizing provides an indication on the typical rack types and I/O counts that shall constitute the Gateway and Station RTU/IED system.

d) It shall be possible to add or remove different I/O modules and communications modules to achieve the desired functionality and sizing.

e) The Gateway/Station RTU/IED shall be able to operate in the absence of dedicated plant I/O modules, performing communications and deriving plant and equipment databases serially from IEDs.

f) It is preferred that the same I/O modules are usable for all the different RTU/Gateway system configurations. If this is not the case, then the *Supplier* shall provide full details with regard to the application limitations of the different modules offered.

g) The *Supplier* shall provide full sizing details of the modules offered and shall describe how the I/O requirements of in the applications as per Table 2 will be satisfied. Small module sizes may result in large physical RTU sizes, which are not favoured. A multi I/O module is preferred for smaller applications as a way of reducing costs.

3.5.5.2 Rack types

a) A single 19″ sub-rack with a preferred height of 4U (or less) shall be provided. The complete rack shall be mounted into a 19″ floor or wall-mount cabinet as a stand-alone unit.

b) A 19 inch signal termination sub-rack with KRONE modules with a preferred height of 4U (or less) shall be provided catering for a minimum of 64 I/O terminations.

3.5.5.3 Input/output sizing – Transmission

a) In Eskom Transmission (Tx) the typical I/O counts for large, medium and small Gateway and Station RTU/IED systems are as indicated in Table 2. The *Supplier* shall provide a typical cost schedule for the scenarios listed in Table 2 When specifying the cost, the *Supplier* shall provide information on unit cost and the number of I/O modules, Central Processing Unit (CPU) modules, communication modules, sub-racks or any other information deemed necessary by the *Supplier* to achieve these scenarios.

Table 2: Tx Substation Input/Output Sizing

Application	Description	I/O Configuration			
		DI	AI	DO	Counters
	Small	800	70	70	10
	Medium	2000	200	100	30
	Large	4500	400	250	60
	Station RTU (for all applications)	64	8	8	0

3.6 Sequence of events and remote terminal unit statistical information

3.6.1 Sequence of events

3.6.1.1 Introduction

a) Sequence of Event (SOE) information shall be required to analyse the cause of certain events. This is a specific requirement for determining the correct operation of protection relays.

b) The Gateway/Station RTU/IED shall log the events to an SOE list in its mass storage facility and shall report the events to the required host.

3.6.1.2 Sequence of events requirements

a) Each digital input shall have a character description within the Gateway/Station RTU/IED database.

b) The Gateway/Station RTU/IED shall produce a report detailing the chronological sequence of events for each operation of the primary plant. This shall apply to operations initiated by the following sources:

1) Protection relays.

2) Changes in primary plant, e.g. manual changes from protection panels.

3) HMI Client/Server.

4) Remote SCADA master stations.

c) The report shall be accessed from Gateway/Station RTU/IED (locally/remotely) in the following ways:

1) Serially.

2) Via Ethernet port.

3) Via hard copy to a printer.

d) SOE time tagging resolution

1) All digital input changes shall be time tagged, at the resolution of 1 ms, and logged.

2) This time tagging resolution shall allow for absolute discrimination between digital inputs.

e) Number of SOE digital inputs

1) The Gateway/Station RTU/IED shall cater for a minimum of 256 digital inputs at a time tagging resolution of 1 ms.

f) Events storage

1) The Gateway/Station RTU/IED shall record and store events in the sequence in which they were detected in the Gateway/Station RTU/IED.

2) The Gateway shall also store the events as they are reported from the various Station RTU/IED

g) Masking of events

1) The Gateway/Station RTU/IED shall have the facility to mask single events, a group of events or all events, and thus prevent the occurrence of a masked event from being logged into its SOE list.

2) The masking of an event shall be effected via configuration tool, or as a result of the protection panel being put ‘on test’.

3) The system shall be able to differentiate between ‘Main 1’ and ‘Main 2’ protection panels being put ‘on test’ and shall mask events accordingly.

h) Transient operation and contact debounce filters

1) The Gateway/Station RTU/IED shall have the facility to activate configurable, digital debounce filters to prevent spurious triggering of events.

2) The persistence time delays shall be selectable in 1 ms steps, from 1 ms to 255 ms.

i) Status inputs

1) It shall be possible to define a minimum of 20 grouped sequence of events.

2) If there is a change in state of any digital input, it is required to immediately record the group of status points in the SOE list.

3) The status points shall be time stamped with the time and date of the initiating event.

4) The occurrence of an initiating event shall inhibit the further recognition of any initiating events for a user defined time period. The time period shall range from 1 s to 30 s.

5) Upon completion of the time period, the recognition of initiating events shall be enabled.

6) The status data shall be transferred to the SOE list before being updated from the I/O cards. That is, if the initiating event also causes a 'status point' defined event to alter state at the plant level, the original state shall be entered in the SOE list, after which the changed state is entered in the SOE list.

j) SOE list structure. The SOE list shall include the following minimum fields of information:

1) Date : yy.mm.dd

2) Time: hh:mm:ss.000 (000=milliseconds)

3) State: e.g. 00, 01, 10, 11, 0, 1

4) State Description: e.g. In Transit, Open, Closed, Invalid, Normal, Alarm

5) Event classification fields: This is the type of event, e.g. Trip, Indication, Alarm, Status

6) Nature of event field: This is the point description, e.g. 400kV Matimba 1 Fdr 6 Breaker Status [this field shall accommodate 96 characters or more]

7) Source of event fields: This is the unique ID of the IED that generated the event, e.g. AA1C1F06A3

8) Bay ID field: This is the name of the Bay e.g. 400kV Matimba 1 Fdr 6

9) Station ID field: This is the name of the station, e.g. Medupi

10) User Configurable field: This is a field that can be setup by the user.

k) SOE data storage handling

1) The Gateway/Station RTU/IED SOE list storage shall be a circular buffer of non-volatile removable memory storage, with a capacity of 1 000 individual events.

2) The events shall be placed in the buffer as they occur, and also transferred to the Gateway as the Station RTU/IED is polled.

3) A facility to transfer complete files to the remote SCADA master station shall exist, as well as a facility to extract files serially from the storage device in the event of malfunction of the Gateway/Station RTU/IED.

l) SOE data retrieval. Data retrieval shall be defined for the Gateway/Station RTU/IED as follows:

1) Gateway/Station RTU/IED data shall be uploaded to a 'PC-based' HMI, HMI Client/Server data concentrator/server and remote SCADA master station from the Gateway/Station RTU/IED SOE list.

2) The portion of data required shall be specified by means of a start and end date and time.

3) Where the Gateway/Station RTU/IED is operational but cannot communicate with the SCADA master station and/or Gateway, data retrieval shall be effected by means of a portable PC via a dedicated serial interface to the mass storage facility.

3.6.2 Gateway/station remote terminal unit statistics

The Gateway/Station RTU/IED should provide non-volatile storage for each of the following values.

a) The Gateway/Station RTU/IED shall record the following communications statistics (i.e. counters) related to each communications port. The purpose of this requirement is to facilitate effective monitoring of the telecommunication performance:

1) Number of Gateway data messages transmitted to the Master Station.

2) Number of Gateway data messages received from the Master Station.

3) Number of Gateway data message retries to the Master Station.

4) Number of received messages with Cyclic Redundancy Check (CRC) errors.

5) Number of framing errors (preferred).

6) Number of collisions (preferred).

b) These counter values shall be available via the configuration port. It shall be possible to reset these counters locally and remotely. The *Supplier* shall provide all details with regard to these requirements.

c) The Gateway shall record the following control-related statistics related to each communications port. The purpose of this requirement is to facilitate the effective monitoring of the Control Success Rate.

1) Number of control messages received from the Master Station.

2) Number of controls successfully executed – where success is defined, as a minimum, as output contact closure or transmission of the control command to an IED. The preferred definition is current flow through the output contact or acknowledgement of the control message by the IED.

3) The counter values shall be available locally, as well as remotely via the SCADA protocol, and it shall be possible to reset these counters locally and remotely.

d) The Gateway shall provide the following event logs:

1) A transaction log, containing a brief description of all messages transmitted to and received from the Master.

2) A Gateway diagnostics log that records all internal status changes/failures, e.g. Gateway/Station RTU/IED start-up, watchdog timer timeouts, configuration changes, card failures and communications failures. The *Supplier* shall provide a list of all the internal conditions that are monitored and stored.

3) All events/messages/internal status changes of the above-mentioned logs shall be date and time-stamped accurate to 10 ms and shall be stored in the sequence in which they occurred.

4) It shall be possible to clear the logs locally as well as remotely.

3.7 Configuration, software and firmware requirements

3.7.1 Gateway/station remote terminal unit configuration – general requirements

a) All Gateway/Station RTU/IED configuration settings shall be stored in non-volatile memory. This includes any setting changes done remotely.

b) It shall be possible to upload the Gateway/Station RTU/IED's configuration parameters remotely as well as locally.

c) It shall also be possible to remotely configure Gateway/Station RTU/IED configuration parameters. Remote access philosophies shall comply with [16] 240-55410927 – Eskom Cyber Security Standard and [22] Remote Devices Communication Standard for Data Retrieval and Remote Access.

d) It should not be necessary to download the configuration parameters if the device is reset or restarted. The *Supplier* shall provide details on how remote uploading and downloading are achieved on the Gateway/Station RTU/IED that is offered.

e) New settings shall preferably take effect immediately without the need to restart the device. The *Supplier* shall supply details of how new settings take effect and any Gateway/Station RTU/IED unavailability that will result.

f) User programmability shall be provided, i.e. the user shall be able to program a specific user application, such as a Distribution Automation (DA) algorithm, in the Gateway/Station RTU/IED.

g) Support for open programming standards such as [29] IEC 61131-3 is preferred.

h) The *Supplier* shall supply details of the type of user programming application as well as the level of user programmability and the extent to which the I/O database can be accessed on the offered Gateway/Station RTU/IED.

i) The complete Gateway/Station RTU/IED configuration shall be stored in the Gateway/Station RTU/IED to allow complete reconfiguration using an uploaded copy of the Gateway/Station RTU/IED database. This also includes any user application programmes as referred to above.

3.7.2 Gateway/station remote terminal unit configuration software

a) The Gateway/Station RTU/IED system shall be supplied with PC-based configuration software that shall be compatible with a Microsoft Windows 7™, 64 bit operating system.

b) The *Supplier* shall also provide details of configuration software compatibility to any other operating systems.

c) The software shall have an auto-install feature whereby a set-up program will prompt for options and the software will automatically be extracted to the appropriate directories with program groups and icons created (for Windows™).

d) Software shall be user-friendly and menu-driven, and comprehensive help files should be provided. Only basic computer knowledge should be required to use the software interface.

e) The *Supplier* shall specify the minimum computer hardware requirements of the software that is offered.

f) It shall be possible to save and retrieve Gateway/Station RTU/IED configurations and application programs to/from disc.

g) All software supplied with the system shall be documented comprehensively, with all the features and functions discussed, including a set of examples as to how the Gateway/Station RTU/IED systems can be configured for different applications. Included in the documentation shall be a list of possible problems and instructions on how to solve them.

h) It is preferred that the software is free or included in the price of the Gateway/Station RTU/IED system. If not, the *Supplier* shall specify the price per licence or certain number of licences (e.g. 100 licences).

i) Eskom prefers to be given an Eskom-wide licence agreement for the configuration software. The *Supplier* shall supply all terms and conditions related to the distribution of the software in the offer.

j) The *Supplier* shall specify how version control of software will be handled over a period of at least 10 years.

k) The tender documentation shall provide a full disclosure of the costs of annual software updates for the 10-year period commencing in January of the year following the Enquiry issue, so as to meet the following requirements:

1) Support for a Microsoft Windows™ Operating System less than two years old.

2) Full backward compatibility of the latest Configuration software for all units less than 10 years old.

3.7.3 Gateway/station remote terminal unit firmware

a) Firmware shall be stored in non-volatile memory and shall be upgradeable by Eskom staff.

b) The *Supplier* shall provide a detailed firmware revision history every time a new release is made. Any modifications shall be clearly specified and the impact explained.

c) Any firmware bug fixes shall be made available free of charge within a period of eight weeks after the problem has been formally communicated to the *Supplier*.

d) Any bugs discovered in a firmware version used by Eskom, by either the *Supplier* or other customers, shall be brought to Eskom's immediate attention.

e) The *Supplier* shall specify how version control of firmware will be handled over a period of at least 10 years.

f) The tender documentation shall provide a full disclosure of the costs of annual firmware upgrades for the 10-year period commencing in January of the year following the Enquiry issue, so as to provide support for the latest applicable IEC Telecontrol protocol within two years of its official release.

3.8 System performance

3.8.1 General

a) It shall be the responsibility of the *Supplier* to provide all equipment required to measure system performance.

b) The *Supplier* shall meet the following system performance requirements.

3.8.2 Station remote terminal unit/IED performance requirements

3.8.2.1 General

a) Performance requirements are specified for the following Station RTU/IED configuration:

1) 8 double control outputs.

2) 64 digital inputs.

3) 8 analogue inputs.

4) All monitoring functions fully operational.

5) All control and data acquisition functions full operational.

b) The following Station RTU/IED test conditions shall apply:

1) When no changes occur at any of the above digital, analogue or accumulator inputs.

2) When a continuous change of state occurs simultaneously at 30% of the above digital and analogue inputs.

3) When a continuous change of state occurs simultaneously at 60% of the above digital and analogue inputs.

3.8.2.2 Station remote terminal unit/IED controls performance

a) The maximum time elapsed from receipt of the 'Select and Execute' message from either the legacy ERTU, Gateway or master stations to the point where the relevant output relay operates shall be designated T_e.

b) The *Supplier* shall specify T_e for the Station RTU/IED test conditions.

c) T_e shall not exceed 400 ms under any conditions.

d) The *Supplier* shall specify the methodology to measure and perform the above test.

3.8.2.3 Station remote terminal unit indications performance

a) The time elapsed from the change of state at a digital input to the point where the indication is entered into a priority queue is designated T_i.

b) The *Supplier* shall specify T_i for the Station RTU/IED test conditions.

c) T_i shall not exceed 400 ms under any conditions.

d) The *Supplier* shall specify the methodology to measure and perform the above test.

3.8.2.4 Station remote terminal unit communications performance

a) The Gateway or SCADA master station shall issue 'General Poll' messages to the Station RTU/IED.

b) If the Station RTU/IED has a change, it shall respond with a 'Change Message'.

c) The time elapsed from receipt of the 'General Poll' message to the point where the RTU responds with a 'Change Message', having retrieved a valid change from its queues, shall be designated T_{rgp}.

d) The *Supplier* shall specify T_{rgp} for the Station RTU/IED test conditions.

e) T_{rgp} shall not exceed 20 ms under any conditions.

f) The *Supplier* shall specify the methodology to measure and perform the above test.

g) This test shall be physically measured on the digital side of the modem (if it is used).

3.8.2.5 Station remote terminal unit processing capacity

a) The *Supplier* shall provide a measure for the maximum processing capacity of the Station RTU/IED. For the purposes of the following discussion, this measure shall be designated P_{rmax}.

b) The *Supplier* shall specify the processing capacity (in terms of a percentage P_{rmax}) used under the Station RTU/IED test conditions.

c) The Station RTU/IED shall have a minimum of 30% spare processing capacity under the above operating conditions (i.e. 0,7 P_{rmax}).

d) The *Supplier* shall specify the methodology to measure and perform the above tests.

3.8.3 Gateway performance requirements

3.8.3.1 General

a) Performance requirements are specified for the following Gateway configuration:

1) Gateway with at least 2 x HMIs fully operational.

2) All functions as specified in this enquiry document are fully operational.

3) The Gateway is connected to 2 Station RTU/IEDs configured as in 3.8.2.1 (i.e. maximum configuration) and 100 bay IEDs with the total number of points as shown in Table 2, "Large Application"

b) The following Gateway test conditions shall apply:

1) When no changes occur at any of the digital, analogue or accumulator inputs at any of the Station RTU/IEDs or Bay IEDs.

2) When a continuous change of state occurs simultaneously at 30% of the digital, analogue and accumulator inputs, at all of the Station RTU/IEDs and bay IEDs.

3) When a continuous change of state occurs simultaneously at 60% of the digital, analogue and accumulator inputs, at all of the Station RTU/IEDs and bay IEDs.

3.8.3.2 Gateway controls performance

a) The maximum time elapsed from receipt of the 'Select and Execute' message from the master stations (including HMIs) to the point where the relevant output relay at the Station RTU/IED operates shall be designated T_{ee}.

b) The *Supplier* shall specify T_{ee} for the Gateway test conditions.

c) T_{ee} shall not exceed 400 ms under any conditions. These time limits shall also apply when bay level interlocking and inter-bay interlocking are active.

d) The *Supplier* shall specify T_{ee} with no interlocking active and T_{ee} with interlocking fully configured.

e) The *Supplier* shall specify the methodology to measure and perform the above test.

3.8.3.3 Gateway indications performance

a) The time elapsed from the change of state at an Station RTU/IED digital to the point where the indication is entered into a priority queue in the Gateway is designated T_{ei}.

b) The *Supplier* shall specify T_{ei} for the Gateway test conditions.

c) T_{ei} shall not exceed 400 ms under any conditions. The *Supplier* shall specify the methodology to measure and perform the above test.

3.8.3.4 Gateway communications performance

a) The SCADA master station shall issue 'General Poll' to the Gateway. If the Gateway has a change, it shall respond with a 'Change Message'.

b) The time elapsed from receipt of the 'General Poll' message to the point where the Gateway responds with a 'Change Message', having retrieved a valid change from its queues, shall be designated T_{egp}.

c) The *Supplier* shall specify T_{egp} for the Gateway test conditions.

d) T_{egp} shall not exceed 20 ms under any conditions. The *Supplier* shall specify the methodology to measure and perform the above test. This test shall be specifically measured on the digital side of the modem (if it is used).

3.8.3.5 Gateway processing capacity

a) The *Supplier* shall provide a measure for the maximum processing capacity of the Gateway. For the purpose of the following discussion, this measure shall be designated P_{emax}.

b) The tender shall specify the processing capacity (in terms of a percentage of P_{emax}) used under the Gateway test conditions.

c) The Gateway shall have minimum of 30% spare processing capacity under the above operating conditions (i.e. 0,7 P_{emax}).

d) The *Supplier* shall specify the methodology to measure and perform the above tests.

3.9 Power supplies

3.9.1 General requirements

a) There shall be no equipment malfunction, damage or spurious event, under any of the following conditions:

   1) As a result of the loss or restoration of supply.

   2) As a result of an under-voltage or over-voltage condition.

   3) If either AC or DC supplies to the unit are switched off and on repeatedly at a random rate.

   4) Short interruptions on any of the power supply voltages for not longer than 20 ms occurring in a random sequence for a period of no longer than 20 s.

b) The power supplies shall be equipped with terminals for connecting the primary power cable and capable of accepting 6 mm^2 cable

c) The power supplies shall have the necessary current overload cut-outs and over-voltage limiting, with automatic reset on removal of the fault.

d) Each unit shall include a power supply-isolating switch (two pole preferred). Miniature circuit-breakers are preferred in place of fuses.

e) A Light-emitting Diode (LED) indication, with a check facility, shall be provided to indicate a supply healthy condition for all internal supply voltages. It is preferred that a contact be available to communicate power supply health remotely. The *Supplier* shall provide details of this feature.

f) The design shall allow for three isolated power sources, which shall supply the electronic logic circuitry, the output and the input circuitry.

g) In addition, the design shall provide a floating power supply regardless of any earthing which may exist on the DC supply rails.

h) If the Gateway or Station RTU/IED is supplied from a DC source, the noise measured across the power supply terminals of the equipment under test shall not be greater than 2 mV peak-to-peak or -58 dBV (0 dBV = 0,775 V) measured psophometrically.

i) The equipment derived supply voltage (output voltage) shall be a floating 48 V, 2 A, supply and shall energize the 48 V, 110 V, 220 V DC protection breaker control relays either via a 'potential' contact or 'dry' contract.

j) The power supply unit shall provide galvanic isolation between the primary supplies and the electronic circuitry.

k) The *Supplier* shall make provision for a power supply unit output for a radio operating at 1,5 V to 13,8 V DC and 4 A average current. These output terminals should be capable of accepting 2,5 mm^2 cable.

l) The *Supplier* shall provide details regarding RTU power consumption to enable Eskom to decide on a suitable power supply source. The maximum current drain per module (considering the inputs to be in a 'worst-case' configuration regarding power consumption) and any inrush current parameters shall be stated.

3.9.2 Power supply physical implementation

3.9.2.1 Gateway/Station RTU/IED power supply

a) The standard supply voltage options for the Gateway/Station RTU/IED unit shall be:

1) U_{DC} 48 V (voltage tolerance, as per Table 3)

2) U_{DC} 110 V (voltage tolerance, as per Table 3) (floating input).

3) U_{DC} 220 V (voltage tolerance, as per Table 3) (floating input).

4) U_{AC} 220 V at 50 Hz (voltage tolerance, as per Table 3).

Table 3: DC Supply Tolerances

Nominal supply voltage	48V	110V	220V
Nominal supply voltage	52,8 V	117 V	234 V
Equipment terminal voltage limits	43 V to 55 V	88 V to 132 V	176 V to 264 V
Connection to earth	Note 1	Note 1	Note 1
NOTE 1: Fully floating supply symmetrically balanced about earth with earth fault detection set to detect 10 mA current from either pole to earth. For the 48 V telecommunications supply, the positive is earthed.			

3.10 Enclosures and connectors

3.10.1 Equipment modules

a) All modules shall be clearly labelled and identified, thereby simplifying the fault finding, maintenance and replacement of units or modules within the equipment racks.

b) The design and construction of any part of the equipment shall be such that any component or module thereof may be easily removed for replacement or testing.

3.10.2 Equipment enclosures

a) The cabinets that house the 19″ equipment racks shall be floor-mounted units.

b) The *Supplier* should note that these cabinets, which will be mounted inside the substation control building, will be ventilated but may not have air conditioning.

c) The cabinets shall have upper and lower gland plates to allow top and bottom cable access. These gland plates shall be interchangeable and shall have holes drilled for 20 mm cable glands. Each hole shall be closed with a suitable, removable plastic or rubber cover.

d) Doors shall have top and bottom louvres, which shall be covered on the inside of the door with wire gauze. The doors shall be removable by lifting them off the hinges. The spindle of the bottom hinge shall be longer than the spindles of the middle and upper hinges to allow easy reinstallation of the door. The doors shall have dust-proof seals around the perimeter.

e) All cabinets offered shall conform to the Eskom Specification for Standard Equipment Cabinets [21]

f) All cabinets shall permit easy access to the cable looms and plant interface connectors

g) The RTU equipment and enclosure shall be suitably protected against corrosion, in accordance with [21]. Given that the equipment offered will be installed inside cabinets whose doors will normally be closed, the *Supplier* shall fully disclose all ventilation requirements, if any.

h) The following enclosure options shall be offered:

1) Option 1: Standard fixed frame cabinet with front and rear doors. These cabinets shall have front and rear access

- ✓ Width: 600 mm fixed frame cabinet.
- ✓ Depth: 600 mm not including doors.
- ✓ Height: 2 400 mm overall, including 100 mm plinth.

2) Option 2: Standard swing frame cabinet with front door only

- ✓ Width: 800 mm swing frame cabinet.
- ✓ Depth: 600 mm not including doors.
- ✓ Height: 2 400 mm overall, including 100 mm plinth.

3.10.3 Input/output connectors and terminating blocks

a) Each connector and terminating block shall be clearly marked using a unique identification method, which is in accordance with the identification shown on the circuit diagram and/or logic diagram.

b) A mechanism shall be provided to logically group and route all I/O functions to suitable high-density termination connectors.

c) All connectors used shall be terminated by the use of mass termination techniques.

d) In some applications, all plant-to-equipment connections shall be connected by use of cabling supplied by the *Supplier*.

e) The *Supplier* should note that installation of the RTU equipment will be done by the *Purchaser*. The *Purchaser* will supply and install all cabling that interfaces to the RTU system as dictated by the design.

f) The preferred termination method for all I/O cables onto the RTU system is via high-quality Insulation Displacement Connections, e.g. Krone Insulation Displacement Connection (IDC) modules. The *Supplier* shall specify the terminations offered.

g) The *Supplier* shall include the cost of all termination hardware required to terminate the Eskom cables (standard telephone cable – TPH*AX) to the RTU/I/O modules.

h) All analogue connectors that interface to transducer outputs shall permit the in-circuit measurement of current, without the disconnecting of any associated wiring.

i) It shall be possible to remove an I/O module without having to individually remove plant terminations.

3.11 Test equipment

3.11.1 *Purchaser's* test equipment

a) It shall be the responsibility of the *Supplier* to provide adequate test equipment and facilities to verify system functionality and performance. Full functionality on the available test equipment and test requirements shall be defined during Phase 1 of the contract.

3.11.2 *Supplier's* test equipment

a) The *Supplier* is required to clearly describe the functionality and purpose of all test equipment provided for the system. However, preference shall be given to systems that maximize on the utilization of the *Purchaser's* test equipment as opposed to systems that require dedicated proprietary-based test equipment.

b) Test equipment should not be regarded as an integral part of the RTU system and will be ordered separately by Eskom.

c) All applicable test equipment shall operate from a U_{AC} 240V 50 Hz supply, or directly from the unit under test.

3.11.3 Remote terminal unit test facilities

a) The RTU shall have clearly marked and easily accessible measuring and test points to aid fault finding.

b) The test points shall allow for the measurement of important voltages, currents, waveforms and signals.

c) Comprehensive fault finding procedures shall be provided as part of the maintenance manual.

3.12 Documentation

3.12.1 General

a) Documentation will be ordered by Eskom separately from the RTU equipment.

3.12.2 Drawings

a) Drawings shall be submitted in English and shall form an essential part of the contract.

b) Schematic diagrams shall be drawn and conform to the following layout:

1) The schematics shall have a logical data flow left to right, and top to bottom.

2) This implies that all inputs to the schematic are on the left-hand side of the page, and outputs on the right-hand side.

3) Inputs from and outputs to other schematic pages are to be referenced accordingly.

4) Logic symbols to be drawn such that inputs are on the left (or top) and outputs to the right (or bottom).

c) Duplicate copies of a schedule listing all drawings and circuit diagrams applicable to all equipment included in the contract, shall be supplied with or before the notification of readiness for acceptance testing.

d) As a minimum the following drawings should be provided by the *Supplier*/Tenderer:

1) Block schematic diagrams showing the functional arrangement of the equipment.

2) Detailed schematic diagrams.

3) Functional drawing showing the overall operation of the equipment.

4) Cabinet equipment layout.

5) Module sub-rack and cabinet wiring diagram, including functions and designations of the terminal blocks.

6) Details of terminals and terminal blocks.

7) Outline dimensions of cabinets and fixing details.

e) Detailed drawings of all equipment shall be supplied not later than the notification of the first item of equipment readiness for FAT.

f) The drawings shall not be submitted as separate drawings, but shall be incorporated in the instruction manuals. In addition, documents shall be available in electronic format e.g. CD ROM, for use in a document management system.

g) When changes to the equipment are envisaged, either by the *Supplier* or the *Purchaser*, during the contract period, the *Supplier* shall submit details of these changes in writing together with modified drawings for the *Purchaser's* approval, before proceeding with the implementation of these changes.

h) The *Supplier* shall comply with the *Purchaser's* drawing specifications for all necessary drawings.

3.12.3 Instruction manuals

a) Approximately 3 hard copies of the instruction manuals and related documentation shall be supplied, covering all equipment in the Contract, before the first items of equipment are dispatched to site.

b) Single sets of instruction manuals shall be made available as an option within the contract.

c) The instruction book shall only cover the equipment variant supplied to the *Purchaser*.

d) Typical circuit diagrams and descriptions are not acceptable in the instruction books.

e) The diagrams shall correspond in exact detail with the equipment delivered.

f) The instruction books shall have a hard-covered, ring file construction and they shall open flat at any page. Folders that do not comply with these requirements are not acceptable. Different sections of the handbooks shall be separated by means of thumb tab separators.

g) The instruction book shall contain a master key or block schematic, which shall clearly indicate the reference numbers of the individual detailed circuit diagrams against the appropriate blocks.

h) Block schematics of the complete equipment shall indicate clearly the interconnections between the various units. Wiring schematics with cable harnesses are not acceptable for this purpose.

i) The equipment handbooks shall basically consist of the following sections:

1) Index.

2) Electrical and Mechanical specifications and parameters of the equipment.

3) Basic description of the equipment and its operations.

4) Basic mechanical designs of the equipment and the cabinet and inter sub-rack wiring. Description, block schematic and wiring schematic of the complete equipment.

5) Sub-rack mechanical design and wiring.

6) Individual modules.

7) Description, Parts layout, Electrical Schematic and Parts List.

8) Installation, commissioning and maintenance procedures.

9) The individual module description shall contain a written description of the operation of the module; the module test and commissioning procedures where applicable; as well as the technical ratings of the unit. This shall be followed by the module schematic, the component layout and a component list giving the component values, rating, tolerance and manufacturer. The module schematic shall detail the nominal DC and AC voltages on the semiconductor devices. The functions of various input and output points shall be given on the schematic.

10) All handbook drawings and descriptions shall conform to the international A4 series (295 mm $\times$ 220 mm). Larger drawings that cannot be accommodated on this size of drawing shall be folded in a single plane, along the 220 mm axis of the standard A4 series. Handbook drawings, which must be unfolded in two directions, are not acceptable.

11) In the event of any changes being made to the equipment, as detailed in the Documentation Section (0), 3 sets of drawings and descriptions, if applicable, shall be provided to update the equipment handbooks.

3.13 Delivery of drawings, handbooks and test certificates

a) All drawings and handbooks shall be delivered to: The Manager, PTM&C Control and Automation, Group Technology, Eskom, PO Box 107, Germiston, 1400.

b) One copy of all routine test reports and one copy of the type test reports shall be sent to the address specified in (a) as well.

c) All correspondence relating to equipment supplied shall be headed with the Eskom National Contract number allocated by the *Purchaser*.

d) All technical inquiries shall be addressed to the PTM&C Manager at the address specified in a), and all commercial enquiries shall be addressed to The Procurement Advisor/Manager, Eskom, PO Box 1091, Johannesburg, 2000.

e) Drawing and instruction manuals form an essential part of the Contract. No payment shall be made for any equipment supplied as part of the Contract until all drawings and handbooks have been supplied in accordance with the requirements detailed in the Contract.

3.14 Training

a) The *Supplier* shall provide training courses conducted in South Africa.

b) The training shall be targeted at three different user groups, and shall therefore be divided into three categories:

1) System overview and operations guide: The system overview shall provide an overall understanding of the system and its capabilities and limitations. In addition, system configuration shall be covered in such a way that the user shall understand how to construct a system from the building blocks to meet his/her requirements.

2) System configuration and system maintenance training: This training would include computer system operation, hardware maintenance, computer supplier software and relevant operating system aspects.

3) Detailed system training on all hardware and software aspects: It is intended that any person attending this course shall be in a position to maintain the system down to PCB and/or component level.

c) All aspects of the training shall be supplemented with periods of practical training; this shall apply to all courses and shall be implemented where applicable.

d) All training shall be given directly through the medium of English.

e) The *Purchaser* shall give the *Supplier* at least one month prior notice before any training course is scheduled.

f) The *Supplier* shall provide the following information:

1) Location of training centre in South Africa.

2) Duration of training course(s).

3) Syllabus of training courses(s).

4) Entrance requirements (basic knowledge required) for trainees.

5) The preferred number of candidates per course.

g) The *Supplier's* quotation for training shall include the cost of tuition and documentation, but shall exclude all travelling and accommodation costs for the candidates, as these shall be provided by the *Purchaser*.

h) The *Supplier* shall quote separately as an option the cost of subsequent training courses during a period of 10 years from start of the supply contract.

3.15 Spares, maintenance and quality assurance

3.15.1 Spares

a) A detailed spares list shall be provided with its individual price schedule. This shall include items such as semiconductors, lamps and fuses. The component list shall include the component type, the component value, the type number and the manufacturer's component name.

b) A detailed and individually priced list of all fully assembled PCBs shall be provided.

c) A detailed and individually priced list of all test equipment shall be provided. This shall include extender cards, test plugs, diagnostic/monitoring cards and test sets.

d) A recommended spares holding list for the guarantee of 12 months, shall be provided.

e) Spares shall be packed in separate cases marked 'Spares'. Each spares item shall be clearly identified by means of a metal or plastic label, or indelible marking.

f) The availability of spares shall be guaranteed for a minimum period of 10 years from the date of latest delivery. If, during this 10-year period, the *Supplier* or one of its sub-suppliers intends to discontinue the manufacture of spares or replacement parts for the equipment, the *Supplier* shall forthwith give written notice to the *Purchaser* of such intention and offer the *Purchaser* the opportunity, which the *Purchaser* shall have the right to exercise within six months, of ordering at reasonable prices the quantities of spares or replacement parts as the *Purchaser* shall require.

g) Although Eskom will administer its own spares holding, the *Supplier* should be able to deliver any required spare part within a maximum of four weeks.

h) In the case where the *Supplier* operates and administers a spares holding (5% of delivered equipment), a faulty module exchange facility shall be made available, whereby Eskom may receive a functional module within 48 hours while a faulty module is being repaired. The original module sent in for repairs should be returned within three weeks (or less). The *Supplier* shall indicate what the additional cost would be for such a facility.

i) The delivery lead-time for required spares is four weeks (or less) from date of order.

3.15.2 Maintenance

a) The *Supplier* shall, for the duration of the contract, including the guarantee period, supply the necessary infrastructure in South Africa which shall provide the following services:

   1) A well-documented and controlled PCB repair service with a one-week turnaround time. A complete list of all PCBs and their repair cost shall be detailed within the enquiry document.

   2) A software maintenance service in the form of a maintenance contract.

   3) A systems level maintenance service.

   4) A list of support centres and facilities shall be submitted with the offer.

b) The *Purchaser* desires to be as self-sufficient as possible in both the first line (field) maintenance and system engineering aspects of the Gateway and Station RTU/IED System, to achieve maximum flexibility for system applications. Thus, the *Supplier* shall detail, via a proposal, the suggested approach to system engineering and first line (field) maintenance, with due consideration to the self-sufficiency requirements mentioned.

3.15.3 Quality assurance

a) The requirements of [15] SABS ISO 9001 (2000 version), are included as requirements of this specification.

b) The *Supplier* shall be responsible for the complete quality assurance requirements to be imposed on its subcontractors and suppliers of materials, in terms [15] SABS ISO 9001.

4. Testing and acceptance

4.1 Testing

a) After the *Supplier* has completed each module (object) during Phase 3 (Development, System Integration and FAT), the *Supplier* shall carry out system tests on that module at the *Supplier's* works.

b) The *Purchaser* may elect to witness such tests. These tests would constitute informal factory acceptance tests.

4.2 Factory acceptance test

a) The *Supplier* shall perform a pre-FAT according to the accepted Factory Acceptance Test (FAT) Procedure.

b) A completed pre-FAT report incorporating all the pre-fat results shall be provided to the *Purchaser* at least 4 weeks prior to the commencement of the FAT.

c) The FAT shall only commence once the *Purchaser* has approved this pre-FAT report and results. The *Purchaser* and the *Supplier* shall agree upon a date when formal FAT shall commence. The testing shall then be carried out in accordance with the FAT procedure.

d) In the event of any tests malfunctioning, the *Purchaser* may elect to restart the complete test procedure from the beginning.

e) The *Purchaser* shall also carry out an unstructured testing programme (Free-form Tests), at its discretion, on the *Supplier's* premises for a duration of two weeks. This two-week shall not include the time taken to repair any faults.

f) The *Supplier*, at no extra charge to the *Purchaser*, shall correct any errors detected.

g) After the *Purchaser* has satisfied itself that the system has passed the prescribed tests, the prototype units shall be officially handed over to the *Purchaser*.

4.3 Site acceptance test

a) After delivery of the production unit to a *Purchaser*-selected site, the *Supplier*, assisted by the *Purchaser*, shall install the equipment in a substation in accordance with the *Purchaser's* standards.

b) The *Purchaser* shall be informed in writing of the completion of the installation. Within a three-week period or less after completion of installation, the SAT shall commence.

c) These formal tests shall be defined in the SAT procedure. In the event of an error being detected, the *Purchaser* may elect to restart the SAT.

d) For a period of one month after the successful completion of the formal SAT, the equipment shall undergo random testing while being subjected to a soak test.

e) In the event of any non-conformance being detected, the *Supplier* shall be required to commence the correction of the errors within a 72 h period. Only on completion of the correction procedure, the one-month test and soak test period shall commence.

f) Depending on the nature of the fault, the *Purchaser* may at its sole discretion elect to restart the SAT. During this SAT, the *Supplier* shall make available at no extra charge to the *Purchaser*, the relevant hardware, software and/or system specialist.

4.4 General

a) All equipment shall be subjected to the *Supplier's* standard works test and inspection.

b) The equipment under test shall be switched on and allowed to soak (burn in) for 48 h before the type tests are started.

c) A representative single sample of all types of equipment supplied shall be subjected to type tests, which shall be continued for at least 10 h at the extreme conditions specified in 4.6 of this specification.

4.5 Witnessing of tests

a) The *Purchaser* reserves the right to appoint a representative to inspect the equipment at any stage of manufacture, or to be present at the specified tests.

b) The *Supplier* shall ascertain in writing whether inspection or witnessed tests, or both, are required.

c) The *Supplier* shall then give the *Purchaser* not less than seven working days' notice in the case of local manufacture, and 20 working days' notice in the case of foreign manufacture, of when the equipment shall be ready for inspection or the witnessing of tests.

4.6 Type tests

4.6.1 General

a) The *Supplier* shall provide all certificates and type test results.

4.6.2 Environmental and electrical classes

The environmental and electrical classes for the equipment type tests are specified in this clause.

a) Gateway and station remote terminal unit

   1) Temperature and Humidity: Class C [refer to [14] IEC60870-2, Part1, Table 1].

   2) Electrical

      i. The device shall operate within an electrical interference environment, where equipment is placed within high voltage switching compounds (132 kV or above) such that it is subject to high levels of radiated electrical interference, due to its physical placement or its direct connection to electrical plant.

      ii. The device shall not be affected by other device frequencies.

   3) Cyclic Temperature and Humidity ([1] IEC 60068-2-30) +25 °C and 95% relative humidity/55 °C and 95% relative humidity, 12 h + 12 h cycle).

   4) Altitude: The device shall operate within an altitude range between 0 – 2500m.

b) Enclosure protection: As per [3] IEC 60529 - Degrees of Protection Provided by Enclosures (IP code) the equipment enclosure should satisfy the IP51 rating which dictates protection from ingress of dust particles as well as dripping water.

c) The RTU equipment and panel shall be suitably protected against corrosion, in accordance with [21].

4.6.3 Dielectric withstand test (as per [2] IEC 60255-5)

a) No damage shall be caused to the equipment when the impulse voltage test is applied to the equipment in the following manner:

   1) Differentially to all analogue input and output terminals.

2) Differentially to all digital input terminals.

3) Differentially to power supply input terminals.

4) Differentially to communication line input and output terminals.

5) Between all control and digital output terminals commoned together and earth.

6) Between all measured input commoned together and earth.

7) Between all power supply input terminals commoned together and earth.

4.6.4 Insulation test (as per [2] IEC 60255-5)

a) For the purpose of this test, any surge diverters shall be removed.

b) As per [2] IEC 60255-5, a test voltage of U_{DC} 500 V shall be applied for at least 1 MIN to all circuits entering or leaving the equipment (excluding measurand outputs).

c) The test voltage shall be applied between each circuit and earth and between independent circuits, i.e. circuits not normally connected together.

d) The leakage resistance shall be > 20 MΩ.

e) A test voltage of U_{DC} 50 V shall then be applied between all input and output terminals (excluding measurand outputs) and earth, with any surge diverters previously removed having been replaced.

f) The leakage resistance during this test shall be > 100 MΩ.

g) Full details shall be provided of the standard equipment voltage withstand capabilities.

h) If special modifications are required to meet the requirements of [2] IEC 60255-5, these should be detailed and the cost of these modifications shall be quoted.

4.6.5 Electric impulse test (as per [2] IEC 60255-5)

a) No damage or maloperation should result when a 5 kV, 1,2/50 µs waveform (0,5 J) is applied to the equipment. The test should be conducted as per [2] IEC 60255-5.

4.6.6 Reflected noise

a) The equipment shall be checked for compliance with the reflected noise requirements as specified in Power Supplies Section 3.9. Figure 9 shows the circuit to be used to perform the required measurement.

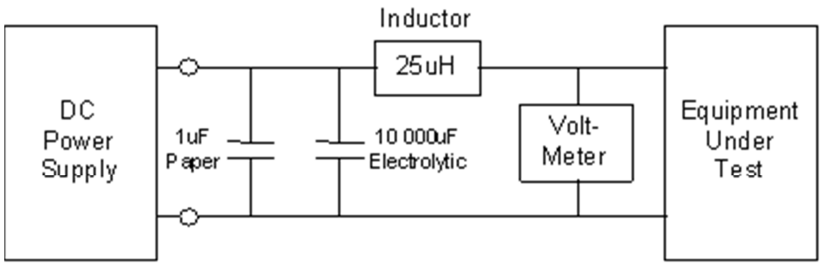

Figure 9: Test circuit for measuring reflected noise

b) A report on all the tests, including the voltage withstand capability, shall be submitted to the *Purchaser* before the FATs.

4.6.7 Vibration, shock, bump and seismic type tests

a) No damage or maloperation of the equipment should occur under the type tests specified in Table 4:

Table 4: Vibration, Shock, Bump and Seismic Type Test Requirements

Test	Compliance criteria
Vibration	
Class 2 Response	Response: 1 g, 10 Hz to 150 Hz, one sweep, energized. Contacts should not close for longer than 2 ms.
Class 1 Endurance	Endurance: 1 g 10 Hz to 150 Hz, 20 sweeps, un energized. Contacts should not close for longer than 2 ms.
Shock	
Class 1 Response	Response: 5 g, 11 ms, three pulses in each direction, energized.
Class 1 Endurance	Withstand: 15 g, 11 ms, three pulses in each direction, un-energized.
Bump	
Class 1	10 g, 16 ms, 1 000 pulses un-energized.
Seismic	
Class 1	Test method A (single axis sine sweep test) 1 Hz to 35 Hz, one sweep.

a) Electromagnetic compatibility and electromagnetic interference testsTable 5 presents the Electromagnetic Compatibility (EMC) and Electromagnetic Interference (EMI) tests that shall be conducted on the equipment.

b) The *Supplier* shall submit the results of these tests to the *Purchaser*.

Table 5: Electromagnetic compatibility and electromagnetic interference type test requirements

Electromagnetic Compatibility (Immunity Test)				
Test	**Standard**	**Test level**	**Ports[a]**	**Compliance criteria**
Power Frequency Magnetic field	SANS 61000-4-8	Class 4	ENC	30 A/m continuous, 300 A/m 1 s to 3 s, 50 Hz
1 MHz oscillatory waves	IEC60255-22-1	Class 3	PS, IO	2,5 kV CM[b], 1 kV DM[c], 2 s total test duration, 6 to 10 bursts at 400 Hz repetition.
			COM	1 kV CM, 0 kV DM, 2 s total test duration, 6 to 10 bursts at 400 Hz repetition.
Electrostatic Discharge	IEC 60255-22-2 or SANS 61000-4-2	Class 3	ENC	6 kV Contact Discharge, 8 kV Air Discharge
Radiated Radio Frequency field	IEC 60255-22-3 or	-	ENC	10 V/m unmod rms, 80% AM (1 kHz), 80 MHz to 1 GHz, 1,4 GHz to 2,7 GHz
	SANS 61000-4-3	Class 3		
Fast Transient	IEC 60255-22-4	Class B (III)	PS, IO, E	2 kV, 5 kHz
			COM	1 kV, 5 kHz
Surge	IEC 60255-22-5 or	-		1,2/50 µs (8/20 µs) voltage (current) surge:

Electromagnetic Compatibility (Immunity Test)				
Test	**Standard**	**Test level**	**Ports[a]**	**Compliance criteria**
			PS, IO	0,5; 1; 2 kV line to earth, 0,5; 1 kV line to line
			COM	0,5; 1 kV line to earth
	SANS 61000-4-5	Class 3	PS, IO	2 kV
Disturbances Induced by Radio Frequency field	IEC 60255-22-6 or	-	PS, COM, IO, E	10 V rms, 150 kHz to 80 MHz
	SANS 61000-4-6	Class 3		
Power Frequency Immunity	IEC 60255-22-7	Class B	IO	AC voltages applied to DC inputs: 150 V rms DM, 300 V rms CM

Electromagnetic Compatibility (Emissions Test)				
Test	**Standard**	**Test level**	**Ports***	**Compliance criteria**
Conducted emission	IEC 60255-25	-	PS	0,15 MHz to 0,5 MHz: 79 dB (µV) quasi peak, 66 dB (µV) ave. 0,5 MHz to 30 MHz: 73 dB (µV) quasi peak, 60 dB (µV) ave.
Radiated emission	IEC 60255-25	-	ENC	30 MHz to 230 MHz: 40 dB (µV) quasi peak. 230 MHz to 1 000 MHz: 47 dB (µV) quasi peak.
[a] EMC tests are applicable to specific 'ports' of the Equipment Under Test:-COM: (Rear) communication ports; E: Earth terminal; ENC: Relay enclosure; IO: Inputs/Outputs; PS: Power Supply. [b] CM = Common Mode [c] DM = Differential Mode				

4.6.8 Routine tests

a) All equipment shall be subjected to a routine test by the *Supplier* and which shall include the following tests:

1) Each digital input shall be checked for correct operation. (No voltage changes outside the relevant range shall be detected.)

2) All control output points shall be fully tested for correct operation.

3) Accumulator inputs shall be tested for correct registration of input pulses.

4) Accuracy of the measurand inputs and outputs shall be tested to 0%, 25%, 50%, 75% and 100% of full scale in both directions.

5) Alarm conditions, such as communications failure and power failure shall be simulated and all alarm, indication and discrepancy outputs specified shall be checked for correct operation. (For example, the Automatic Reclose Control (ARC) operation.)

6) Each digital input tested for spurious operation by applying an input pulse of 10 ms to each input.

7) A fleeting contact of 10 ms duration shall be applied to each digital input in turn and the correct registration of this input shall be checked.

8) The power supply to the equipment shall be interrupted for 100 ms and the equipment shall be checked for false outputs and/or false presentation of inputs.

9) The input voltage to the equipment power supply shall be varied between the operational limits specified in the specification and the output voltage regulation checked. The operation of any under-voltage protection devices fitted should be checked.

b) All the preceding tests shall be successfully completed before the equipment is dispatched to the *Purchaser*. Copies of the routine test certificates shall accompany the equipment.

5. Authorisation

This document has been seen and accepted by:

Name & Surname	Designation
Richard McCurrach	Senior Manager: PTM&C
Steve Papadopoulos	Manager: PTM&C - Control and Automation
Ian Naicker	Chief Engineer: PTM&C – Control and Automation
Rishi Hariram	Chief Engineer: PTM&C – Control and Automation
Marius Van Rensburg	Tx Grid Representative

6. Revisions

Date	Rev.	Compiler	Remarks
Dec 2014	2	M Sukhnandan	Updated and added the following clauses to improve understanding of certain requirements and reflect changes made via DX647 clarification questions. 3.2.3.1 (b) Edited 3.2.3.3 (b) Edited 3.2.3.18 (a) Edited 3.3.3.1 (d) Edited 3.3.3.3 (g)(5) Edited Table 1: Edited Figure 7: Edited 3.4.2.4 (b) Edited 3.6.1.2 (j) Edited SOE List Structure requirements 3.7.1 Removed “telecontrol” protocol 4.6.2 (3) Changed temperature range Added Appendix C: 60870-5-104 Interoperability Requirements.
Nov 2013	1	M Sukhnandan	First Issue

7. Development team

The following people were involved in the development of this document:

- Marlini Sukhnandan - PTM&C: Control and Automation
- Ian Naicker - PTM&C: Control and Automation
- Mpumemlelo Shangase - PTM&C: Control and Automation

8. Acknowledgements

None

Appendix A: Technical Schedules

Schedule A and Schedule B provide technical details against tendered equipment/*Supplier's* statement of compliance or non-compliance. The tenderer is requested to complete this Schedule A/B as part of the tender submission data package.

When completing the Schedule A/B, the tenderer is requested to take cognisance of the following:

It is expected of the tenderer to state clearly, for each clause that requires a statement of compliance in the Schedule A/B, either "**Comply**" or "**Do Not Comply**". The Tenderer shall provide detailed evidence for each answer specifically stating the **exact location** of the evidence in the supporting documentation i.e ***document name and reference, page number, paragraph number***.

If a clause in the Schedule A/B requires information only, e.g. describe application etc. The tenderer is at liberty to provide any information deemed appropriate.

SCHEDULE A : *PURCHASERS'S* PARTICULAR REQUIREMENT SCHEDULE B : *THE TENDERER'S* COMPLIANCE

Table A1: Schedule of technical compliance

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3	**Requirements**	Stated for Information only	
3.1	**Project phases**	Stated for Information only	
3.1.1	**General**	State Compliance	
3.1.2	**Phase 1 – Functional Design Specification (FDS)**	Stated for Information only	
a)	Phase 1 consists of the production of a Functional Specification, a System Design Report and Protocol Implementation Description.	State Compliance	
b)	It is the intention of Phase 1 to document the proposed design and protocol description to form the baseline for the following phases.	State Compliance	
c)	The deliverables for Phase 1 are:	State Compliance	
1)	Functional Specification, which details the *Purchaser's* requirements in context of the *Supplier*'s product.	State Compliance	
2)	Systems Design Report.	State Compliance	
3)	Protocol Implementation Description for each protocol (IEC 60870-5-101, and IEC61850).	State Compliance	
4)	Updated Project Programme.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.1.3	**Phase 2 – Detailed Design Specification (DDS)**	Stated for Information only	
a)	Phase 2 consists of the production of a Detailed Design Specification (DDS) for both hardware and software components of the system, and specifies the procedures for testing.	State Compliance	
b)	The deliverables for Phase 2 are:	State Compliance	
1)	DDS.	State Compliance	
2)	Factory Acceptance Test (FAT) Procedure document.	State Compliance	
3)	Site Acceptance Test (SAT) Procedure document.	State Compliance	
3.1.4	**Phase 3 – Development, System Integration and Factory Acceptance Test**	Stated for Information only	
a)	Phase 3 will commence on completion of Phase 2.	State Compliance	
b)	Phase 3 consists of the procurement of hardware required for testing, any required development and supply of software as well as all training associated with the system.	State Compliance	
c)	The *Supplier* shall perform a pre-FAT according to the accepted Factory Acceptance Test (FAT) Procedure.	State Compliance	
d)	A completed pre-FAT report incorporating all the pre-FAT results shall be provided to the *Purchaser* at least 4 weeks prior to the commencement of the FAT	State Compliance	
e)	The FAT shall only commence once the *Purchaser* has approved this pre-FAT report and results.	State Compliance	
f)	The deliverables for Phase 3 are:	State Compliance	
1)	Prototype equipment.	State Compliance	
2)	A signed-off pre-FAT report with results from the *Supplier*	State Compliance	
3)	A signed-off FAT report indicating accepted completion of FAT.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.1.5	**Phase 4 – Delivery, Installation, Testing and Commissioning**	Stated for Information only	
a)	Phase 4 will commence on completion of Phase 3.	State Compliance	
b)	Phase 4 comprises delivery of hardware, software, documentation and manuals to site, installation (assisted by the *Purchaser*) in conjunction with training. Thereafter, the system will be commissioned.	State Compliance	
c)	The deliverables for Phase 4 are:	State Compliance	
1)	Equipment delivery and installation.	State Compliance	
2)	System documentation in triplicate hardcopy and electronic format.	State Compliance	
3)	On-site training.	State Compliance	
4)	Commissioned system.	State Compliance	
3.1.6	**Phase 5 – Site Acceptance Test**	Stated for Information only	
a)	Phase 5 consists of conducting tests according to the SAT Procedure document.	State Compliance	
b)	The deliverables for Phase 5 are:	State Compliance	
1)	A signed-off SAT report indicating accepted completion of SAT.	State Compliance	
2)	Updated documentation.	State Compliance	
3)	A Handover Certificate.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.2.3	**Transmission and Distribution system description and requirements**	Stated for Information only	
3.2.3.1	**Telecommunications Interface**	Stated for Information only	
a)	A fundamental requirement of the *Purchaser's* Telecontrol system is for remote access to substation information from one or more than one master station.	State Compliance	
b)	The telecommunications interface between remote master stations and the SCS shall be accomplished by the use of an RS422/RS485/X.21 interface to the Bandwidth Management Equipment (BME) or Power Line Carrier (PLC) and an ethernet interface for Internet Protocol (IP) telecommunication links. The BME and PLC equipment are not included in the scope of this specification.	State Compliance	
3.2.3.2	**Gateway – Telecommunications Interface**	Stated for Information only	
a)	The interface between the Telecommunications infrastructure and the Gateway shall be via point-to-multipoint serial RS422/X.21, supporting the IEC 60870-5-101 serial protocols and via a IP connection supporting IP-based SCADA protocols such as:	State Compliance	
	1) IEC61850 (optional)	State Compliance	
	2) IEC 60870-5-104 (optional)	State Compliance	
3.2.3.3	**Gateway to SCADA master station interface**	Stated for Information only	
a)	The Gateway shall communicate with at least 10 master stations.	State Compliance	
b)	The Gateway shall provide a facility for master stations to communicate with all IEDs within the substation.	State Compliance	
c)	Remote master stations shall access the Gateway via multi-dropped serial link using the IEC 60870-5-101 protocol. The functional profile for the basic telecontrol tasks in the IEC60870-5-101 protocol that are used in the TEMSE Energy Management System is presented in [17].	State Compliance	

d)	Remote master stations shall also be capable of accessing the Gateway via an IP link using IP-based SCADA protocols as per 3.2.3.2.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
d)	Remote master stations shall also be capable of accessing the Gateway via an IP link using IP-based SCADA protocols as per 3.2.3.2.	State Compliance	
3.2.3.4	**Gateway to GPS receiver interface**	Stated for Information only	
3.2.3.4a)	The Gateway shall provide an interface to a substation master clock (Global Positioning System (GPS)) supporting the following protocols / standards:	State Compliance	
i	IRIG-B amplitude-modulated with IEEE 1344 compliance	State Compliance	
ii	IRIG-B unmodulated with IEEE 1344 compliance	State Compliance	
iii	IRIG-B Manchester coded modulation with IEEE 1344 compliance	State Compliance	
iv	Network Time Protocol (NTP)	State Compliance	
v	Simple Network Time Protocol (SNTP)	State Compliance	
vi	Precision Time Protocol	State Compliance	
3.2.3.5	**Gateway – external human–machine interface**	Stated for Information only	
a)	The Gateway shall be configurable to multiple HMI systems.	State Compliance	
b)	Communication with the HMI shall be via a multi-dropped serial link implementing the IEC 60870-5-101 (slave) protocol.	State Compliance	
c)	Communication with the HMI shall be via a Transmission Control Protocol (TCP)/IP supporting the IEC61850 (server) protocol.	State Compliance	
3.2.3.6	**Gateway to station remote terminal unit/IED**	Stated for Information only	
a)	Each Gateway in the system shall have the capability to interface to a minimum of 5 Station RTU/IEDs.	State Compliance	
b)	Communication between the Gateways and the new Station RTU/IED shall be via the IEC61850 protocol.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.2.3.7	**Gateway to intelligent electronic device interface**	Stated for Information only	
a)	Each Gateway in the system shall have the capability to interface to a minimum of 100 IEDs.	State Compliance	
b)	Communication between the Gateways and the new IEDs shall be via the IEC61850 protocol.	State Compliance	
3.2.3.8	**Gateway to Gateway (Legacy)**	Stated for Information only	
a)	The Gateway shall provide the capability to interface to other legacy Gateways in the substation via the IEC60870-5-101 (Master) protocol.	State Compliance	
b)	The Gateway shall provide the capability to interface to other legacy Gateways in the substation via the IEC61850 protocol.	State Compliance	
3.2.3.9	**Gateway – general functionality**	Stated for Information only	
a)	The Gateway shall maintain a database containing the current state of all RTUs and IEDs that are connected to it.	State Compliance	
b)	The Gateway shall collate all information received and, if required, it shall transmit this information to:	State Compliance	
	1) Remote SCADA master stations.	State Compliance	
	2) External HMI Clients.	State Compliance	
c)	The Gateway shall also process limit checking, disabling of reporting and manual overrides on plant inputs.	State Compliance	
d)	All oscillating status and analogue points shall be detected, reported and suppressed.	State Compliance	
e)	After a user-defined delay, the point shall be reactivated and tested. If the points continue to oscillate, they shall again be suppressed and reported.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.2.3.10	**Gateway – Control Handover Functionality**	Stated for Information only	
a)	The Gateway shall provide the facility to ensure proper handover of control functionality between the remote control centres and substation HMI. The control handover functionality required is detailed in the points below. Figure 4 presents a pictorial representation of the control handover functionality required by the *Purchaser*.	State Compliance	
1)	The Engineering Assistant (EA) or on-site operator sends a control from the substation HMI to the Gateway initiating the control handover process.	State Compliance	
2)	The Gateway shall set a "Handover Bit" indicating that the Substation HMI has control on this particular bay which will therefore block controls from any other master stations i.e National Control Centre (NCC), Regional Control Centre (RCC) and other substation HMIs.	State Compliance	
3)	The Gateway shall send this "Handover Bit" status to the Master Stations other substation HMIs.	State Compliance	
4)	If the National Control Centre (NCC) or Regional Control Centre (RCC) requires control of this bay while the EA still has control authority, a double control (double command) shall be sent to the Gateway to reset the "handover bits" of ALL bays to thus allow controls from NCC or RCC.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.2.3.11	**Gateway – Interlocking Functionality**	Stated for Information only	
a)	The Gateway shall provide the functionality for configuration and application of station and bay interlocking rules / equations. Bay level interlocking rules may also be applied at bay level IEDs.	State Compliance	
b)	There shall be no interlocking applied on all breaker "Open" / "Trip" controls.	State Compliance	
c)	There shall be interlocking applied on all breaker "Close" controls.	State Compliance	
d)	There shall be interlocking applied on the opening and closing of isolators and earth switches.	State Compliance	
e)	In the event that Gateway detects that a proposed control action is invalid, based on the interlocking rules, the control shall be blocked and a violation indication shall be sent to the master station attempting the control. This indication shall be a double bit indication. It is preferred that the interlocking rule which was violated shall also be sent to the relevant master station.	State Compliance	
f)	It is preferred that this interlock violation indication be reported via a bitstring of 32 bits message.	State Compliance	
g)	The user can acknowledge the message which shall remove the popup window. Once the reason for the violation has been corrected the user should be able to execute the supervisory control.	State Compliance	
h)	In order cater for situations when the interlock at the station/bay needs to be overridden by a remote control centre, an "override control" shall be sent from the control centre to the Gateway	State Compliance	
i)	The Gateway shall provide and host and a double bit "interlock override indication".	State Compliance	
j)	When "interlock state" is overridden, double bit state 01, the interlock text "Interlocks Overridden" shall be shown in green, on all station one-line displays both locally and remotely.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
k)	When "interlock state" is not overridden i.e. active, double bit state 10, the interlock text "Interlocks Active" shall be shown in red, on all station one-line displays both locally and remotely.	State Compliance	
l)	In the event that interlock state is set to "overridden", all supervisory controls for the entire substation shall be executed irrespective of how many interlock violations are detected.	State Compliance	
m)	The "interlock override" state shall remain active for a predefined configurable time period (range from 1min - 60mins).	State Compliance	
n)	The override timer shall be reset for the configurable time period each time a new control action is initiated as long as it takes place within the predefined configurable time period.	State Compliance	
o)	If the interlock timer times out the "interlock override indication" double bit points shall be reset and all displays shall be updated accordingly	State Compliance	
p)	Whenever the substation "interlock override" control is activated, the time and the identity of the originating source shall be logged.	State Compliance	
q)	The time at which the "interlock override" state transitions from Interlock Overidden to "Interlock Active" shall be logged.	State Compliance	
r)	All control actions shall be logged.	State Compliance	
s)	The Gateway shall support the facility to manually apply/force binary states so as to ensure the interlocking rules will be valid.	State Compliance	
t)	The Gateway shall support the addition of portable/working earth indications (which are usually handressed on the HMI) to be used in the interlocking rules.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
u)	The Gateway shall support the functionality of sending back an interlock violation indication in the event that the remote master stations attempts to perform any controls to an interlocked device.	State Compliance	
v)	Interlocking rules shall be applied via a .xml file input and the same principle shall apply for both Station and Bay level interlocks.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.2.3.12	**Gateway – Automated Operating Sequences Functionality**	Stated for Information only	
a)	The Gateway shall provide the functionality for configuring safe automated operating scenarios. An example of a typical operating exercise which shall be automated is the transfer of a feeder from one busbar to another in a dual busbar architecture.	State Compliance	
3.2.3.13	**Gateway – System Redundancy**	Stated for Information only	
a)	The Gateway shall support a redundancy architecture whereby there is a main/master gateway and standby gateway.	State Compliance	
b)	The *Supplier* shall provide details on how IP addresses and RTU addresses on both the Main Gateway and Standby Gateway is implemented to ensure seamless switch over.	State Compliance	
c)	In the event of failure of the main/master Gateway, the system shall automatically swap over to the standby Gateway. The *Supplier* shall provide details on how this is implemented.	State Compliance	
d)	This redundancy mode shall allow seamless connection to the Master Stations in the event of a swap over from the main gateway to the standby gateway. *Supplier* shall provide details on how this is achieved in their products	State Compliance	
e)	The both gateways' databases should be synchronised at all times. The *Supplier* shall provide details on how this is implemented and achieved.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.2.3.14	**Gateway – "Test Mode" functionality**	Stated for Information only	
a)	The Gateway shall support a "Test Mode" scenario that shall enable the Purchaser to completely test one half of the segregated control system (Main 1 system or Main 2 system) in isolation to the fully operational other half of the system.	State Compliance	
b)	The status of this "Test Mode" shall be reported to all Master Stations.	State Compliance	
c)	Figure 6 below presents the required functionality of the "Test Mode".	Stated for Information only	
d)	It shall be possible to place half of the segregated system in "Test Mode" via a test switch/button. The Supplier shall provide full details on how this is functionality shall be achieved.	State Compliance	
e)	Once the Gateway is in "Test Mode" it shall:		
i.	Separate/disassociate from the other gateway i.e. exits out of hot standby/redundancy mode.	State Compliance	
ii.	Not allow controls from all remote master stations. It shall also block controls from the local HMI connected to the operational half of the system.	State Compliance	
iii.	Allow full SCADA functionality from the HMI connected to the half of the system in Test Mode.	State Compliance	
iv.	Allow the HMI on the test half of the system to only send controls to that half of the system in "Test Mode".	State Compliance	
f)	The Gateway on the operational half of the system shall allow full SCADA functionality supervisory and control from all remote master stations including the HMI connected to the operational half of the system.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.2.3.15	**Gateway – control functionality**	Stated for Information only	
a)	The Gateway shall provide a facility to receive commands from either the remote master stations or external HMI Clients to control plant outputs.	State Compliance	
b)	The control shall be sent immediately to the RTU/IED.	State Compliance	
3.2.3.16	**Station remote terminal unit/IED - general functionality**	Stated for Information only	
	The new Station RTU/IEDs shall monitor and report the status of inputs to assigned Gateways, and shall execute plant output controls as instructed by assigned masters.	State Compliance	
3.2.3.17	**Station remote terminal unit Time Synchronisation interface**	Stated for Information only	
a)	The Station RTU/IED shall provide an interface to a substation time server supporting the following protocols / standards:	State Compliance	
i	Network Time Protocol (NTP)	State Compliance	
ii	Simple Network Time Protocol (SNTP)	State Compliance	
iii	Precision Time Protocol	State Compliance	
3.2.3.18	**Station remote terminal unit – plant interfaces**	Stated for Information only	
a)	The Station RTU/IED is a stand-alone device and shall interface to plant/secondary plant schemes via an IDF	State Compliance	
3.2.3.19	**General system requirements**	Stated for Information only	
a)	From a system perspective, consideration shall be given to 'tried and tested off-the-shelf' solutions/equipment.	State Compliance	
b)	The life expectancy of the new equipment shall be > 10 years. *Supplier* shall state the life expectancy of products offered.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.3	**Communications**	Stated for Information only	
3.3.1	**Introduction**	Stated for Information only	
a)	This section shall provide the necessary information required by *Supplier*'s to enable their equipment to communicate with the existing Telecontrol Network.	State Compliance	
3.3.2	**General communications requirements**	Stated for Information only	
a)	The communications system of all substation control equipment provided shall be modular and flexible with regard to functional configuration.	State Compliance	
b)	It shall only be necessary to install those communications subsystems which are required for the specific application of the substation control equipment.	State Compliance	
c)	The functioning or performance of the substation control equipment provided or user application programs shall not be compromised by any communication activity and vice versa.	State Compliance	
d)	The communication protocol and physical interface is presented in Table 1 for both higher and lower order processes. Higher order processes are processes which act as a master to the Gateway, whilst lower order processes are those to which the Gateway act as a master.	State Compliance	
e)	Adherence to the Communications Interface (CI) functionality shall enable the interconnectivity, interoperability and interchangeability of multiple suppliers' equipment/modules in the telecontrol environment.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.3.3	**Communications interface**	Stated for Information only	
3.3.3.1	**General requirements**	Stated for Information only	
a)	The CI shall handle communications to all processes by implementing the relevant protocols and physical interfaces as presented in Table 1.	State Compliance	
b)	Any changes to the CI shall not affect the applications that use the interface, i.e. the CI function shall not be 'embedded' within any specific application.	State Compliance	
c)	The CI shall at all times be able to function within a 'multi-drop' communications line environment.	State Compliance	
d)	The CI shall interface to a variety of telecommunications media. These shall include:	State Compliance	
1)	Microwave radio.	State Compliance	
2)	Power Line Carrier systems.	State Compliance	
3)	IP Networks.	State Compliance	
3.3.3.2	**Protocol requirements**	Stated for Information only	
a)	**General**	Stated for Information only	
1)	The *Supplier* shall implement all the specified protocols as described in the relevant protocol definition documentation, on all equipment provided (Gateway and Station RTU/IED).	State Compliance	
2)	The services offered by each layer and the manner in which these services are specified, shall be adhered to in the protocol implementation of the equipment.	State Compliance	
3)	The *Supplier* shall provide all relevant information on their implementation, clearly defining what services and functions contained in the subset are not supported.	State Compliance	
4)	The IEC 60870-5-101 (Slave) protocol implementation on Gateway shall be tested against the existing SCADA master stations to ensure interoperability/compatibility. It shall comply with Eskom's Slave IEC60870-5-101 Implementation standard [17].	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
5)	The IEC 60870-5-101 (Master) protocol implementation on Gateway shall be tested against the existing legacy Gateways to ensure interoperability/compatibility. It shall comply with Eskom's Master IEC60870-5-101 Implementation standard [18].	State Compliance	
6)	The IEC61850 protocol implementation on Gateway and Station RTU/IED shall be tested against the existing IEC61850 IEDs, HMIs and Test sets to ensure interoperability/compatibility. It shall with Eskom's IEC61850 Interoperability Standard – 240-68235024 [19]. It shall comply with Eskom's PICs and TICs Implementation Standard – 240 - 68107841[20].	State Compliance	
b)	Specification requirements: In terms of the IEC61850 requirements, the *Supplier* shall provide the following:	State Compliance	
1)	Compliance with IEC61850: The *Supplier* shall provide an IEC61850 compliance test certificate, obtained from an approved IEC certified test facility/organization, for each component provided that supports the IEC61850 protocol.	State Compliance	
2)	Protocol Implementation Document (PIC, PIXIT and TIC): The *Supplier* shall provide the relevant documents that describes the detail implementation of the IEC61850 protocol in terms of meeting the functional and system requirements.	State Compliance	
3)	Model Implementation Conformance document (MICs): The *Supplier* shall provide a MIC that describes the detail implementation of the IEC61850 protocol in terms of meeting the functional and system requirements.	State Compliance	
4)	Configuration, diagnostic and simulation capabilities: The *Supplier* shall provide a detailed description of all configuration, diagnostic and simulation capabilities offered by the system, as well as any other relevant information pertaining to this requirement.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
5)	*Architecture and performance: The Supplier shall provide a description of the IEC61850 architecture, performance and Supplier-specific implementations/messages.*	State Compliance	
c)	Gateway to Master Station protocols: The Gateway shall support the following Master-to-Gateway protocols:	State Compliance	
1)	**IEC 60870-5-101:**	State Compliance	
i	The Gateway shall comply with the Eskom IEC60870-5-101 (Slave) specifications as stipulated in [17].	State Compliance	
ii	The *Supplier* shall provide all details of its IEC 60870-5-101 implementation. All features supported shall be clearly stated.	State Compliance	
iii	Proof of Independent testing and verification of the protocol functionality shall be provided.	State Compliance	
2)	**IEC61850 – station to control centre:**	State Compliance	
i	The *Supplier* shall provide all details of its IEC61850 Station to Control Centre protocol implementation. All features supported shall be clearly stated.	State Compliance	
ii	Proof of Independent testing and verification of the protocol functionality shall be provided.	State Compliance	
d)	**Gateway to IED protocols: The Gateway shall support the following protocols:**	State Compliance	
1)	The Gateway shall support the IEC61850 Client Implementation.	State Compliance	
2)	The Gateway shall support the IEC61850 Server implementation.	State Compliance	
3)	Preference shall be given to those *Suppliers* that support of GOOSE Subscription and Publishing.	State Compliance	
4)	The *Supplier* shall provide all implementation details relating to this protocol. All features supported shall be clearly stated. All features not supported shall be clearly stated.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
5)	Proof of Independent testing and verification of the protocol functionality shall be provided.	State Compliance	
e)	**Gateway to Station RTU/IED protocols**	State Compliance	
1)	The Station RTU/IED shall support the IEC61850 Server implementation.	State Compliance	
3.3.3.3	**Physical Layer Requirements**	Stated for Information only	
a)	**Operation of communication ports**	Stated for Information only	
1)	All communication ports for the Gateway and Station RTU/IED shall be capable of operating independently at different baud rates with different protocols simultaneously.	State Compliance	
2)	All ports shall be individually configurable. The *Supplier* shall state all related configuration parameters in the offer.	State Compliance	
3)	The data rate for each serial communication port on the Gateway and Station RTU/IED shall as a minimum be configurable between 1 200 bit/s and 19 200 bit/s.	State Compliance	
4)	Each Ethernet port shall support a minimum data rate of 100 Mbit/s.	State Compliance	
5)	It is preferred that each port provides a protocol emulation capability, which is independent of the functioning of the other ports.	State Compliance	
6)	The Station RTU/IED shall have as a minimum the following simultaneous communications interfaces:	State Compliance	
a)	One diagnostic and configuration port. It is preferred that this be an Ethernet port.	State Compliance	
b)	Two communication ports, each configurable as either a master station or a slave interface.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
7)	The Gateway shall have as a minimum the following simultaneous communications interfaces:	State Compliance	
a)	One diagnostic and configuration port. It is preferred that this be an Ethernet port.	State Compliance	
b)	Ten communication ports, each configurable as either a master station or a slave interface.	State Compliance	
8)	For the Gateway, it is preferred that the IED communication ports be located on separate modules.	State Compliance	
9)	For the Gateway, it shall be possible to expand the number of IED ports and/or master ports by, for example, adding additional Processor/Communications modules.	State Compliance	
10)	The *Supplier* shall specify the maximum number and type of communications ports possible.	State Compliance	
b)	Communication standards. As a minimum, the Gateway and Station RTU/IED shall implement the following CCITT/ISO standards:	State Compliance	
1)	EIA RS232C: (a) Functional – V24 (EIA RS232C). (b) Electrical – V28 (EIA RS232C). (c) Connection- ISO 2110 [9 pins] (EIA RS232C).	State Compliance	
2)	EIA RS422: (a) Functional - V24 (EIA RS449). (b) Electrical - V11 (EIA RS422A). Connection - ISO 4902 [15 pins] (EIA RS449). In the event that the Gateway does not support and on-board 15 pin port, the *Supplier* shall then provide a 15 pin, RS422 interface to the telecommunications equipment.	State Compliance	
3)	EIA RS485 (4 wire): (a) Connection – Screw Terminals (minimum 2 kV Isolation).	State Compliance	
c)	**Gateway to Station RTU/IED**	Stated for Information only	
1)	The Gateway CI can interface to multiple Station RTU/IEDs.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
2)	It is preferred that there is no logical limit on the number of RTUs to which the Gateway may interface. However, for purposes of sizing the number of communications ports, the Gateway shall cater for a minimum of 5 communications ports.	State Compliance	
3)	It shall be possible to implement these communications links over Fibre-optic Cables (FOCs) due to the high levels of Electromagnetic Interference (EMI) in the substation environment.	State Compliance	
4)	The protocols that this interface shall support are indicated in Table 1.	State Compliance	
d)	**Gateway to GPS receiver interface**	Stated for Information only	
1)	The Gateway shall interface to a substation master clock (GPS).	State Compliance	
2)	The Gateway shall support the following communication ports:	State Compliance	
i.	BNC. (GK)	State Compliance	
ii.	Serial (RS485)	State Compliance	
iii.	Ethernet (Copper and FOC) (GK)	State Compliance	
3)	The protocols that this interface shall support are indicated in Table 1.	State Compliance	
e)	Gateway to IEDs	Stated for Information only	
1)	The Gateway CI shall interface to multiple IEDs.	State Compliance	
2)	It is preferred that there is no logical limit on the number of IEDs to which the Gateway may interface. However, for purposes of sizing, the number of communications ports, the Gateway shall cater for a minimum of 100 IEDs.	State Compliance	
3)	It shall be possible to implement these communications links over FOCs due to the high levels of EMI in the substation environment.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
4)	The protocols that this interface shall support are indicated in Table 1.	State Compliance	
f)	**Gateway to external HMI**	Stated for Information only	
1)	The Gateway CI shall provide an interface to the external HMIs. The Gateway shall provide a minimum of two HMI communications ports.	State Compliance	
2)	The communications between the Gateway and the HMI shall be supported by an RS232/RS422/RS485 serial link as well as an Ethernet LAN.	State Compliance	
3)	The protocols that this interface shall support are indicated in Table 1.	State Compliance	
g)	**Gateway to SCADA master station communications**	Stated for Information only	
1)	Considering the Gateway to be Data Terminal Equipment (DTE), any Data Communications Equipment (DCE) (modems, radios, etc.) shall be physically separable from the DTE to allow Eskom to supply or select the appropriate DCE.	State Compliance	
2)	The DCE shall be powered by the Gateway.	State Compliance	
3)	The Gateway shall support the following Master communications interfaces:	State Compliance	
a)	EIA-422(RS422).	State Compliance	
b)	EIA-485 (4 wire)	State Compliance	
c)	EIA-232(RS232)/EIA-423(RS423) three-wire operation.	State Compliance	
d)	EIA-232(RS232) with full telephone modem signalling.	State Compliance	
e)	Ethernet interface (Copper and Fibre).	State Compliance	
4)	The CI shall be required to interface to multiple SCADA master stations.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
5)	It is preferred that there be no limit on the number of logical master stations, which can interface to the Gateway or Station RTU/IED. However, for purposes of sizing the number of communications ports, the Gateway and Station RTU/IED shall both cater for a minimum of 10 physical master stations.	State Compliance	
h)	**Station RTU/IED to Time Synchronisation Server**	Stated for Information only	
1)	The Station RTU/IED shall interface to a substation time server.	State Compliance	
2)	The Station RTU/IED shall support an Ethernet interface (Copper and FOC)	State Compliance	
3)	The protocols that this interface shall support are indicated in Table 1.	State Compliance	
3.4	**Control and monitoring logic**	Stated for Information only	
3.4.1	**General requirements**	Stated for Information only	
a)	The Control and Monitoring Logic (CML) functionality shall maximize on the data acquisition capability of the RTUs to provide for the coordinated real time control and monitoring of substation primary plant/equipment.	State Compliance	
b)	The following CML functions are required at present:	State Compliance	
1)	Monitoring of substation plant and equipment.	State Compliance	
2)	Management of substation operation.	State Compliance	
3)	Management of the integrity of substation supply.	State Compliance	
4)	Ensuring the integrity of the SCS and related systems.	State Compliance	
3.4.2	**Monitoring of substation plant and equipment**	Stated for Information only	
3.4.2.1	**Introduction**	Stated for Information only	
a)	The Gateway and Station RTU/IED shall have the capability of monitoring plant and equipment on a real time basis.	State Compliance	
b)	The Gateway shall ensure that all indications and analogues values shall by default originate from the protection Main1 system (M1), unless it is out of service or unavailable for whatever reason upon which the Main 2 system (M2) indications and analogues values shall become active.	State Compliance	
c)	In addition, the Gateway and Station RTU/IED shall have the capability of interfacing to protection relaying schemes.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.4.2.2	**Monitoring description**	Stated for Information only	
a)	The Gateway and Station RTU/IED shall provide online monitoring of the status and operation of substation plant and equipment.	State Compliance	
b)	The data, which is captured by the Gateway and Station RTU/IEDs, shall be used to provide the basis for an online diagnostics and condition monitoring facility.	State Compliance	
c)	The data captured shall also be packaged by the CML function for transmission to the SCADA master station/s.	State Compliance	
d)	The Station RTU/IED shall provide a discrete/serial interface to some secondary plant equipment.	State Compliance	
3.4.2.3	**Monitoring requirements**	Stated for Information only	
a)	General requirements. The Gateway and Station RTU/IED shall perform inter alia, the following monitoring functions:	State Compliance	
1)	Capture of status and measurand data.	State Compliance	
2)	Sequence of event data from protection schemes.	State Compliance	
3.4.2.3b)	**Digital alarms**	Stated for Information only	
1)	Digital input 'alarms' shall be monitored and reported based on their individual or group priority.	State Compliance	
2)	The individual alarm priorities shall be software defined at both the individual and group level.	State Compliance	
3)	Each digital input shall be configurable to provide time stamping of status changes with an accuracy of 1 ms with respect to any other digital input in the same RTU.	State Compliance	
4)	The *Supplier* shall state the resolution of digital input time stamping in the offer.	State Compliance	
3.4.2.3c)	**Pseudo-variables**	Stated for Information only	
1)	Digital input 'alarms' shall be monitored and reported based on their individual or group priority.	State Compliance	
2)	The individual alarm priorities shall be software defined at both the individual and group level.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3)	Each digital input shall be configurable to provide time stamping of status changes with an accuracy of 1 ms with respect to any other digital input in the same RTU.	State Compliance	
3.4.2.3d)	Analogue windows	Stated for Information only	
1)	Software-configurable 'moving window' analogue monitoring techniques shall be applied to all analogue inputs and pseudo-analogue values. The 'moving window' concept implies that an analogue change shall not be reported or flagged as a change unless it exceeds a predefined 'window'.	State Compliance	
2)	This 'window' consists of a configurable upper and lower limit around the current value of any analogue point.	State Compliance	
3)	The 'window' shall remain static and shall only move to the new analogue value once the change has been reported.	State Compliance	
4)	These thresholds shall be provided per individual analogue.	State Compliance	
e)	Analogue reporting. Analogue changes shall be reported under the following conditions:	State Compliance	
1)	When the analogue input exceeds the 'window'.	State Compliance	
2)	When the analogue input exceeds a predefined upper maximum limit or lower minimum limits. These limits are defined as high, high-high, low and low-low values.	State Compliance	
3)	The reporting function shall feature hysteresis that inhibits repeated reporting of small changes around the thresholds. Figure 8 explains the desired functionality. The high analogue value is reported when the HIGH threshold is exceeded, i.e. at H1. It is only reported again when the value falls below HIGH - hysteresis, i.e. at H2. The low analogue value is reported if the value falls below the LOW threshold, i.e. at L1. The analogue value is only reported again when it rises above the LOW + hysteresis threshold, i.e. at L2.	State Compliance	
4)	It shall be possible to enable/disable the reporting of individual analogues.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
5)	Preference will be given to equipment that allows analogues to be configured to report on a periodic basis.	State Compliance	
c)	**Analogue time tagging**	Stated for Information only	
1)	Analogues, which have exceeded the upper maximum or lower minimum limit, shall be time tagged and logged into the Sequence of Events (SOE) list described in 3.6.	State Compliance	
2)	Time tagging shall be a configurable function for all configured analogue inputs.	State Compliance	
3.4.2.4	**Monitoring physical implementation**	Stated for Information only	
a)	The Gateway shall collate all the data received from the IEDs/Station RTU/IEDs to provide a centralized substation database.	State Compliance	
b)	The Station RTU/IED shall also collate all the data received from hardwired IEDs to provide this information to the Gateway.	State Compliance	
c)	The Gateway and Station RTU/IED shall coordinate time tagging on a substation basis, so that time-tagged information, which is passed to the SCADA master station, has a common reference within the context of the SCS	State Compliance	
3.4.3	**Management of substation operation**	Stated for Information only	
3.4.3.1	**Introduction**	Stated for Information only	
a)	The Gateway shall provide a data collation facility for remote master station(s).	State Compliance	
b)	The Gateway shall also provide the SCADA master station with the ability to remotely control substation plant and equipment.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.4.3.2	**Substation operation description**	Stated for Information only	
a)	The Gateway shall have the capability of operating substation plant under remote control of the SCADA master station(s).	State Compliance	
b)	The Gateway shall also operate substation plant under the direct control of the external HMIs in the context of the SCS.	State Compliance	
c)	The Gateway shall ensure that all controls for the protection system shall by default be sent to the Main1 system (M1), unless it is out of service or unavailable for whatever reason upon which the Main 2 system (M2) controls shall be utilised.	State Compliance	
d)	In addition, the Gateway shall provide a control path to the Station RTU/IED for the remote SCADA master stations.	State Compliance	
e)	The Gateway shall provide the ability to collate data for transmission to a remote SCADA master station.	State Compliance	
3.4.3.3	**Substation operation requirements**	Stated for Information only	
a)	**Data types/reporting**	Stated for Information only	
1)	Prioritization and reporting of data shall be implemented with the view to optimizing system performance with respect to the available data communication rates.	State Compliance	
2)	In addition, any mechanism provided, shall enable the implementation of flow control under system surge conditions.	State Compliance	
3)	Real time CML data shall consist of: (a) Digital outputs. (b) Digital status points. (c) Accumulators. (d) Analogue measurands. (e) Analogue set points.	State Compliance	
b)	Priority queues	Stated for Information only	
1)	All real-time CML data shall be provided within the concept of priority queues.	State Compliance	
2)	On a master station demand basis, the contents of these queues shall be available for transmission.	State Compliance	
3)	The Gateway and Station RTU/IED shall provide a priority queue mechanism that conforms to the requirements of IEC 60870-5-101 and IEC61850 protocols.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
4)	The Gateway shall supply data to the queues on an exception basis. That is, only those items in the database that have changed since the last time the Gateway were polled.	State Compliance	
5)	When transmitting data to the master station, the following information shall be provided:	State Compliance	
(a)	The status of each queue.	State Compliance	
(b)	The priority of the data which is being transmitted.	State Compliance	
c)	**Resynchronization of databases**	Stated for Information only	
1)	The SCADA master station shall issue a command to 'resynchronize databases'. This shall entail the Gateway transferring its entire state of database to the SCADA master station.	State Compliance	
2)	The Gateway to Station RTU/IED interaction shall be identical to the interaction between the SCADA master station and the Gateway (as described above).	State Compliance	
d)	**Time synchronization - Gateway/Station RTU/IED clock accuracy**	Stated for Information only	
1)	The time source in the Gateway/Station RTU/IED shall have an inherent accuracy of better than 250 ms during any 24 h period. This means that time lost or gained during a 24 h period shall not be > 250 ms.	State Compliance	
2)	The Gateway/Station RTU/IED shall be equipped with a battery backed up Real-time Clock (RTC) with leap year support.	State Compliance	
3)	It shall be possible to set the clock via the configuration software connected locally to within 1 ms of the Personal Computer's (PC's) clock, as well as via the Telecontrol protocol from the master station.	State Compliance	
4)	The precision of the clock shall be 1 ms or better, i.e. CCYY/MM/DD hh:mm:ss.ttt.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
5)	The RTC battery shall provide at least 50 days of total standby time.	State Compliance	
6)	The battery should not need replacing more often than every 10 years under normal operating conditions.	State Compliance	
e)	Time synchronization - Gateway to SCADA master synchronization	State Compliance	
1)	Using IEC 60870-5-101 / IEC61850 it shall be possible to synchronize the time of the Gateway to the SCADA master station.	State Compliance	
2)	The *Supplier* shall provide details of time synchronization accuracies that can be achieved.	State Compliance	
f)	**Time synchronization - Gateway to GPS receiver synchronization**	Stated for Information only	
1)	The interface between a substation master clock (GPS receiver) and the Gateway shall as per the requirements mentioned in 3.3.3.3(d)	State Compliance	
2)	The IRIG-B interface shall be designated as the primary/master time source interface, and any Gateway synchronization messages from other hosts shall be ignored.	State Compliance	
3)	If there is communication port failure, the next designated time synchronisation host shall assume responsibility for the synchronization of the Gateway/Station RTU/IED.	State Compliance	
4)	The Gateway synchronization shall be done to an accuracy of better than or equal to 1 ms when referenced to the GPS receiver. An accuracy of 1 ms means the following: (a) Any two simultaneous events on the Gateway shall not have a difference exceeding 1 ms (plus or minus). (b) The absolute time of an event that occurs simultaneously on the GPS and Gateway should not be > 1 ms from the GPS referenced absolute time.	State Compliance	
g)	Time synchronization - Station RTU/IED or bay IEDs to Gateway for time synchronization	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
1)	Using SNTP/NTP/PTP, it shall be possible to synchronize the time of any RTU/IEDs/Data Concentrators/Data Server to the Gateway to an accuracy of 1 ms.	State Compliance	
h)	**Plant control - control of plant shall be initiated in the following ways:**	State Compliance	
1)	From the remote SCADA master station to the Gateway. The Gateway in turn issues a control command to the Station RTU/IED/ or bay IED.	State Compliance	
2)	From the external HMI Clients to the Gateway	State Compliance	
i)	**Control sequence: Master station to Gateway**. A control sequence from a Master station to the Gateway, shall be performed as follows (after all control handover and interlocking rules have been passed):	State Compliance	
1)	Upon receipt of the 'Select and Execute' message, the Gateway shall select the appropriate control output relay. After checking that the correct relay has been selected, it shall execute the control by applying a voltage to the control output relay.	State Compliance	
2)	Upon successful operation of the output relay, the Gateway shall send an 'Execute Confirm' message to the master, in addition to the change of state message from the controlled device.	State Compliance	
3)	If the control operation failed, the Gateway shall send an 'Execute Fail' message to the SCADA master station, as applicable.	State Compliance	
j)	**Substation operation physical implementation**	Stated for Information only	
1)	Prioritization and reporting of data as described above shall be implemented at the Gateway.	State Compliance	
2)	The control function shall be implemented at the Gateway as described in 3.4.3.3i).	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.4.4	**Management of the integrity of substation primary supply**	Stated for Information only	
3.4.4.1	**Introduction**	Stated for Information only	
a)	Integrity of substation primary supply relates to providing an electrical supply to customers which is free of:	State Compliance	
1)	Voltage dips or surges.	State Compliance	
2)	Supply interruptions.	State Compliance	
3)	Harmonics.	State Compliance	
b)	It also relates to restoring primary supply as quickly as possible once an interruption has occurred.	State Compliance	
3.4.4.2	**Management of substation primary supply description**	Stated for Information only	
a)	The Gateway shall provide for the manual restoration of primary supply.	State Compliance	
b)	At this stage, it shall be possible to manually restore supply, i.e. under master station or operator control.	State Compliance	
c)	Depending on feasibility, some form of automatic voltage control shall be implemented.	State Compliance	
3.4.4.3	**Management of substation primary supply physical implementation**	Stated for Information only	
a)	This function is to be implemented on the Gateway.	State Compliance	
3.4.5	**Gateway/station remote terminal unit integrity**	Stated for Information only	
3.4.5.1	**Introduction**	Stated for Information only	
a)	The Gateway/Station RTU/IED is to be used for the operation of plant and equipment in substations.	State Compliance	
b)	It is essential that the integrity of the Gateway/Station RTU/IED be such that it shall at no time threaten human life or any plant and equipment.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.4.5.2	**Gateway/station remote terminal unit integrity description**	Stated for Information only	
a)	The Gateway/Station RTU/IED integrity refers to the integrity of all software processes and hardware elements provided by the *Supplier*.	State Compliance	
3.4.5.3	**Gateway/station remote terminal unit integrity requirements**	Stated for Information only	
a)	**Watchdogs**	Stated for Information only	
1)	The Gateway/Station RTU/IED shall provide hardware and software watchdogs that continuously monitor the hardware and software elements of these systems.	State Compliance	
2)	These watchdogs shall ensure safe operation of the Gateway/Station RTU/IED at all times. If the Gateway/Station RTU/IED should fail, it should fail to a 'safe' condition.	State Compliance	
b)	**Error detection/correction**	Stated for information only	
1)	Adequate coding techniques for error detection shall be used to eliminate incorrect controls being carried out due to undetected errors in code/messages.	State Compliance	
2)	Adequate coding techniques for error detection shall also be used to eliminate incorrect indications and alarms being presented due to undetected errors in code/messages.	State Compliance	
3)	For remote control functions, it is required that the effectiveness of the coding system be such that the probability of an incorrect control command being performed is 10-10 or better.	State Compliance	
4)	For remote indication purposes, it is required that the effectiveness of the coding system be such that the probability of an incorrect status indication of alarm being presented to the operator is 10-7 or better.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
5)	The *Supplier* shall substantiate how these error rates are achieved, and shall clearly state the assumptions that have been made in determining compliance with the specified error rates.	State Compliance	
c)	**Reliability/availability**	Stated for information only	
1)	The individual reliability of system components shall in no way cause the overall system availability at any one substation or site to drop below 99,98% per 1 000 h.	State Compliance	
2)	The *Supplier* shall substantiate how the availability specified in 1) is to be achieved, and shall clearly state the assumptions that have been made in determining compliance with the specified availability.	State Compliance	
3)	The *Supplier* shall clearly state the reliability of major system components in meeting the availability figure in 1). These system components shall be described in the proposal at the time of tendering.	State Compliance	
4)	It is a requirement that if 10% or more of the total number of each system component installed, fails during the warranty period, all such system components shall be replaced at the *Supplier's* expense and the warranty shall be extended for a further period under the same conditions.	State Compliance	
3.4.5.4	**Gateway/Station RTU/IED integrity physical implementation**	Stated for information only	
a)	The Gateway/Station RTU/IED shall both provide a relay contact, which is not part of the normal control output boards.	State Compliance	
b)	The relay contact shall be closed under normal operating conditions. When the Gateway/Station RTU/IED experiences a catastrophic failure, the Gateway/Station RTU/IED shall 'shut down' and the relay contact shall open. A catastrophic failure is defined as follows:	State Compliance	
1)	Any failure of a major system component.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
2)	Failure of system power supply.	State Compliance	
3)	Corruption of the configuration database.	State Compliance	
4)	Corruption of system or application software.	State Compliance	
5)	Failure of one or more control outputs, if control sensing is active.	State Compliance	
c)	The failure of a digital input or analogue input card is not classified as a catastrophic failure.	State Compliance	
d)	This relay shall be under direct control of the microprocessor unit on the RTU.	State Compliance	
e)	'Shut down' is defined as follows: The Gateway/Station RTU/IED shall be provided with an automatic and orderly closing down of databases and processes on detection of a catastrophic failure.	State Compliance	
f)	The Gateway/Station RTU/IED shall have power-on sequencing, which shall occur automatically when power is restored to a unit after an outage.	State Compliance	
g)	This power-on sequencing shall include, inter alia, automatic resynchronization of Gateway/Station RTU/IED databases and a complete diagnostic check of both the Gateway/Station RTU/IED.	State Compliance	
h)	No data changes shall be reported to the master stations or the HMI Client/Server until the power-on sequence is complete.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.5	**Plant interface**	Stated for information only	
3.5.1	**General requirements**	Stated for information only	
a)	The plant interface shall consist of the following:	State Compliance	
1)	Plant outputs.	State Compliance	
2)	Plant inputs.	State Compliance	
b)	The inputs and outputs to the RTU shall be designed to withstand the surge withstand capability tests as defined in the IEEE Std C37.90.1-1989 [9] without RTU damage, misoperation or data corruption.	State Compliance	
c)	It shall not be possible to fit an I/O module in an I/O slot or position where so doing will cause any damage or maloperation whatsoever.	State Compliance	
d)	It shall be possible to isolate/remove an I/O module for maintenance without having to power down the RTU or to take it offline.	State Compliance	
e)	Failure of any one I/O module shall not affect the performance of any of the other modules.	State Compliance	
f)	The RTU shall provide visible local diagnostic indications on all the modules.	State Compliance	
g)	Visual status indication of the I/O on each I/O module is preferred.	State Compliance	
3.5.2	**Plant outputs**	Stated for information only	
3.5.2.1	**Introduction**	Stated for information only	
a)	Plant outputs are also termed control outputs. These outputs are essentially relay outputs, which are directly activated by the Gateway/Station RTU/IED. This is the primary method for controlling substation plant and equipment.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.5.2.2	**Plant output requirements**	Stated for information only	
a)	The plant outputs shall consist of a normally open contact for each open or closed function. These contacts shall have a maximum switched voltage of UAC 250 V/UDC 50 V. The maximum switchable power of 100 V.A/60 W shall be required.	State Compliance	
b)	Each digital control output shall provide a voltage free ('dry') contact with the following minimum rating: 1 A, UDC 110 V. The *Supplier* shall provide the ratings of the control relays on the modules that are offered.	State Compliance	
c)	Control output modules providing pulse-width output functionality shall be available whereby a normally open contact will close for a configured period.	State Compliance	
d)	The duration of the closing pulse per output relay shall be variable between 0,1 s and 10 s in 100 ms steps.	State Compliance	
e)	Control output modules that support pulse-width functionality shall offer the option to prohibit the simultaneous operation of pulsed output relays on a per module basis. The *Supplier* shall state all related configuration parameters in the offer.	State Compliance	
f)	Control output modules providing latching relay output functionality shall also be available.	State Compliance	
g)	In this configuration, it shall be possible to have more than one output relay active at a time.	State Compliance	
h)	The latched relay shall not be mechanically latched.	State Compliance	
i)	Preference will be given to systems which allow control output relays on the same Digital Output (DO) module to be individually configured as either pulse-width outputs or latched outputs. The requirement is to have, for example, on the same DO module, outputs 1, 2 and 4 configured as pulsed outputs, while outputs 3 and 5 are configured as latched.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
j)	All switching shall be carried out using a double pole switching method. This implies that a common relay shall switch the common supply rail at the same instant that a specific output relay is activated.	State Compliance	
k)	The combined operation of the output relay and the control common relay shall take place in the following modes:	State Compliance	
1)	To switch through the UDC 50 V equipment derived voltage.	State Compliance	
2)	To switch an external voltage.	State Compliance	
3)	To provide a 'dry' contact to an external user.	State Compliance	
l)	A UDC 48 V output switching voltage shall be provided by the RTU. It shall also be possible to provide this voltage from an external source.	State Compliance	
m)	The 48 V switching supply shall be short circuit protected.	State Compliance	
n)	The short circuit protection should be self-healing once the short circuit is removed. The *Supplier* shall provide details of the short-circuit protection mechanism.	State Compliance	
o)	Control outputs shall use a local select-checkback-execute principle. On receipt of a control select and execute request from the Remote Master Station, the remote unit shall select and confirm, internal to the module, selection of the appropriate control output relay. Power shall only then be applied to the output relay to operate it.	State Compliance	
p)	Control outputs shall also support the direct operate principle.	State Compliance	
q)	After initiation of the control sequence, the sequence shall be terminated either:	State Compliance	
1)	automatically 10 s after commencing the sequence; or	State Compliance	
2)	after the successful execution of the sequence.	State Compliance	
r)	In the event of any failure, no erroneous control shall be executed.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
s)	Preference shall be given to an RTU system that checks control successes, and which can provide information on the source of control failures. The *Supplier* shall provide full details on such functionality if it is offered.	State Compliance	
3.5.2.3	**Number of relay outputs**	Stated for information only	
a)	The Station RTU/IED shall have a minimum of 8 output relays, each with one set of changeover contacts.	State Compliance	
3.5.2.4	**Plant output physical implementation**	Stated for information only	
a)	Plant outputs shall be implemented as relays on a separate I/O module that plugs into the Station RTU/IED rack.	State Compliance	
b)	These modules shall be separate from any Central Processing module or Communications module.	State Compliance	
c)	All I/O shall at least be opto-isolated and protected against surges. The *Supplier* shall provide full details.	State Compliance	
3.5.3	**Plant Inputs**	Stated for information only	
3.5.3.1	**Introduction**	Stated for information only	
a)	Plant inputs are the primary method of data acquisition for the Station RTU/IED	State Compliance	
b)	Plant inputs include digital inputs, analogue inputs and accumulator inputs.	State Compliance	
c)	Accumulator inputs are digital pulsed type inputs.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.5.3.2	**Plant input requirements**	Stated for information only	
a)	**Digital inputs**	Stated for information only	
1)	Cables with lengths of up to 1 km are used for connecting digital inputs to the plant. It may be assumed that each 'potential free' contact in the plant is connected to a separate pair of wires. Regardless of any 'commoning' which results from the design of the digital input circuitry in a manufacturer's equipment, and with any combination of closed and open contacts (particularly all but one contact closed), it is required that an open contact be correctly detected as such. It may be assumed that the worst case inter-core cable impedance is 1 MΩ.	State Compliance	
2)	A closed contact shall be detected when a condition of 0Ω to 200Ω exists in parallel with up to 4,0 µF at the input. The hysteresis values shall be provided by the *Supplier*.	State Compliance	
3)	The open contact shall be detected when a condition exists of 100 kΩ to 1 MΩ in parallel with up to 4,0 µF at the input. The hysteresis values shall be provided by the *Supplier*.	State Compliance	
4)	All breaker status and alarm inputs shall be derived from potential free inputs provided by the *Purchaser*. The RTU shall provide a suitable wetting voltage for reading these contacts. *Supplier* shall provide information on this wetting voltage and how it is sourced.	State Compliance	
5)	All digital circuit inputs provided shall offer a noise immunity of UDC 5 V and 10 V root mean square (rms) at 50 Hz applied transversely, and 100 V rms at 50 Hz applied longitudinally to earth.	State Compliance	
6)	Each input shall have a configurable contact closure delay, variable from 10 ms to 60 s.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
7)	The digital inputs shall be configurable as single bit inputs, double bit inputs, accumulator (counter) inputs and Binary Coded Decimal (BCD) inputs for Transformer Tap Position indicators. Normal double-bit states (i.e. 01 and 10) shall be reported immediately, while abnormal double-bit states (i.e. 00 and 11) should only be reported after the abnormal state has been sustained for a configurable period. Similarly, only stable BCD values shall be reported, i.e. invalid intermediate states should not be reported The *Supplier* shall state the related configuration parameters in the offer.	State Compliance	
8)	The ability to configure a processing delay per digital input is sought. This delay should be settable in 1 s steps from 0 to 255.	State Compliance	
9)	The status change should only be reported if the status change is sustained for the duration of the timer.	State Compliance	
10)	Delayed status changes shall be time-stamped with the time at the start of the delay and not the end of the delay. The *Supplier* shall state all related configuration parameters in the offer.	State Compliance	
11)	The Gateway/Station RTU/IED shall provide the ability to invert the logic status per digital input.	State Compliance	
12)	The Gateway/Station RTU/IED shall provide the ability to disable and enable the reporting of digital inputs on a per input basis.	State Compliance	
13)	Any digital input shall be configurable to enable the counting of digital status changes. Counter values shall be stored in non-volatile memory.	State Compliance	
14)	The reporting of counter values shall be configurable, i.e. on the transgression of a configurable value, or on the basis of a configurable freeze period. The *Supplier* shall state all related configuration parameters in the offer.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
b)	**Accumulator inputs**	Stated for information only	
1)	Each accumulator input value shall be represented by a minimum of a 16 bit binary word.	State Compliance	
2)	All accumulator inputs shall accept input pulse rates of up to 20 pulses per second. Each accumulator shall be reset under three conditions: (a) Under remote control. (b) On a preset time. (c) After a given time period.	State Compliance	
	(a) Under remote control.	State Compliance	
	(b) On a preset time.	State Compliance	
	(c) After a given time period.	State Compliance	
c)	**Analogue DC inputs**	Stated for information only	
1)	The accuracy of the Analogue to Digital (A/D) converter shall be sufficient to ensure that any specific analogue input shall have an accuracy ? 0,25% of the full-scale reading.	State Compliance	
2)	All transducers may be regarded as linear over the range ± 7,5 mA, which can be regarded as the full-scale working range of all analogue inputs.	State Compliance	
3)	The Analogue Input subsystem shall support the following input ranges: UDC ±1 V, ± 10 mA and 4 mA to 20 mA.	State Compliance	
4)	The input circuitry shall not present more than 400 ? load to the transducer.	State Compliance	
5)	Analogue input circuits shall be balanced, floating and isolated. The flying capacitor technique (or equivalent) shall be implemented to achieve the required level of isolation.	State Compliance	
6)	No potentiometers shall be used to scale any of the inputs. All input scaling shall be done via software configuration.	State Compliance	
7)	With UDC 150 V or UAC 100 V rms (50 Hz to 300 Hz) applied common mode to the analogue inputs, the A/D converter count shall not change by more than approximately two counts.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
8)	With UAC 1,5 V (50 Hz and 1 MHz) applied differentially to the analogue inputs, the A/D converter count shall not change by more than approximately two counts.	State Compliance	
9)	Each analogue input shall be represented by a minimum of a 12 bit binary value.	State Compliance	
d)	**Analogue AC inputs**	Stated for information only	
	The requirements for interfacing to analogue AC inputs are as follows:	State Compliance	
1)	Nominal input voltage UAC 115 V.	State Compliance	
2)	Nominal input current 5 A.	State Compliance	
3)	It is preferred that the analogue AC input modules provide the option for Digital Signal Processing (DSP) functionality.	State Compliance	
3.5.3.3	**Plant input physical implementation**	Stated for information only	
a)	Digital inputs and accumulator inputs shall be implemented on a separate I/O module that plugs into the Station RTU/IED rack.	State Compliance	
b)	Analogue inputs shall be implemented on a separate I/O module that plugs into the Station RTU/IED rack.	State Compliance	
c)	These modules shall be separate from any Central Processing module or Communications module.	State Compliance	
d)	All I/O shall at least be opto-isolated and protected against surges. The *Supplier* shall provide full details.	State Compliance	
3.5.4	**Plant multi input/output modules**	Stated for information only	
3.5.4.1	**Introduction**	Stated for information only	
a)	Multi I/O modules shall comprise a combination of digital I/O and analogue I/O on a single module.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.5.4.2	**Plant multi input/output module requirements**	Stated for information only	
a)	The requirements, as specified in 3.5.2.2 and 3.5.3.2 for digital inputs/outputs and analogue inputs, shall apply equally to the Multi I/O module if applicable.	State Compliance	
b)	The *Supplier* is required to provide specifications on the various types of Multi I/O modules.	State Compliance	
3.5.4.3	**Plant multi input/output module physical implementation**	Stated for information only	
a)	The multi I/O module shall provide a combination of digital and analogue I/O on a separate module that plugs into the Station RTU/IED rack.	State Compliance	
b)	These modules shall be separate from any Central Processing module or Communications module	State Compliance	
c)	All I/O shall at least be opto-isolated and protected against surges. The *Supplier* shall provide full details.	State Compliance	
3.5.5	**System sizing**	Stated for information only	
3.5.5.1	**General requirements**	Stated for information only	
a)	The RTU/Gateway architecture shall be based on a modular concept, whereby the controller, I/O modules and communications modules shall be easily separable.	State Compliance	
b)	The platform shall provide for easy expandability and functional flexibility.	State Compliance	
c)	The system sizing provides an indication on the typical rack types and I/O counts that shall constitute the Gateway and Station RTU/IED system.	State Compliance	
d)	It shall be possible to add or remove different I/O modules and communications modules to achieve the desired functionality and sizing.	State Compliance	
e)	The Gateway/Station RTU/IED shall be able to operate in the absence of dedicated plant I/O modules, performing communications and deriving plant and equipment databases serially from IEDs.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
f)	It is preferred that the same I/O modules are usable for all the different RTU/Gateway system configurations. If this is not the case, then the Supplier shall provide full details with regard to the application limitations of the different modules offered.	State Compliance	
g)	The *Supplier* shall provide full sizing details of the modules offered and shall describe how the I/O requirements of in the applications as per Table 2 will be satisfied. Small module sizes may result in large physical RTU sizes, which are not favoured. A multi I/O module is preferred for smaller applications as a way of reducing costs.	State Compliance	
3.5.5.2	**Rack types**	Stated for information only	
a)	A single 19" sub-rack with a preferred height of 4U (or less) shall be provided. The complete rack shall be mounted into a 19' floor or wall-mount cabinet as a stand-alone unit.	State Compliance	
b)	A 19 inch signal termination sub-rack with KRONE modules with a preferred height of 4U (or less) shall be provided catering for a minimum of 64 I/O terminations.	State Compliance	
3.5.5.3	**Input/output sizing – Transmission**	Stated for information only	
a)	In Eskom Transmission (Tx) the typical I/O counts for large, medium and small Gateway and Station RTU/IED systems are as indicated in Table 2. The *Supplier* shall provide a typical cost schedule for the scenarios listed in Table 2 When specifying the cost, the *Supplier* shall provide information on unit cost and the number of I/O modules, Central Processing Unit (CPU) modules, communication modules, sub-racks or any other information deemed necessary by the *Supplier* to achieve these scenarios.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.6	**Sequence of events and remote terminal unit statistical information**	Stated for information only	
3.6.1	**Sequence of events**	Stated for information only	
3.6.1.1	**Introduction**	Stated for information only	
a)	Sequence of Event (SOE) information shall be required to analyse the cause of certain events. This is a specific requirement for determining the correct operation of protection relays.	State Compliance	
b)	The Gateway/Station RTU/IED shall log the events to an SOE list in its mass storage facility and shall report the events to the required host.	State Compliance	
3.6.1.2	**Sequence of events requirements**	Stated for information only	
a)	Each digital input shall have a character description within the Gateway/Station RTU/IED database.	State Compliance	
b)	The Gateway/Station RTU/IED shall produce a report detailing the chronological sequence of events for each operation of the primary plant. This shall apply to operations initiated by the following sources:	State Compliance	
1)	Protection relays.	State Compliance	
2)	Changes in primary plant, e.g. manual changes from protection panels.	State Compliance	
3)	HMI Client/Server.	State Compliance	
4)	Remote SCADA master stations.	State Compliance	
c)	**The report shall be accessed from Gateway/Station RTU/IED (locally/remotely) in the following ways:**	State Compliance	
1)	Serially.	State Compliance	
2)	Via Ethernet port.	State Compliance	
3)	Via hard copy to a printer.	State Compliance	
d)	**SOE time tagging resolution**	Stated for information only	
1)	All digital input changes shall be time tagged, at the resolution of 1 ms, and logged.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
2)	This time tagging resolution shall allow for absolute discrimination between digital inputs.	State Compliance	
e)	**Number of SOE digital inputs**	Stated for information only	
1)	The Gateway/Station RTU/IED shall cater for a minimum of 256 digital inputs at a time tagging resolution of 1 ms.	State Compliance	
f)	**Events storage**	Stated for information only	
1)	The Gateway/Station RTU/IED shall record and store events in the sequence in which they were detected in the Gateway/Station RTU/IED.	State Compliance	
2)	The Gateway shall also store the events as they are reported from the various Station RTU/IED	State Compliance	
g)	**Masking of events**	Stated for information only	
1)	The Gateway/Station RTU/IED shall have the facility to mask single events, a group of events or all events, and thus prevent the occurrence of a masked event from being logged into its SOE list.	State Compliance	
2)	The masking of an event shall be effected via configuration tool, or as a result of the protection panel being put 'on test'.	State Compliance	
3)	The system shall be able to differentiate between 'Main 1' and 'Main 2' protection panels being put 'on test' and shall mask events accordingly.	State Compliance	
h)	**Transient operation and contact debounce filters**	Stated for information only	
1)	The Gateway/Station RTU/IED shall have the facility to activate configurable, digital debounce filters to prevent spurious triggering of events.	State Compliance	
2)	The persistence time delays shall be selectable in 1 ms steps, from 1 ms to 255 ms.	State Compliance	
i)	**Status inputs**	Stated for information only	
1)	It shall be possible to define a minimum of 20 grouped sequence of events.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
2)	If there is a change in state of any digital input, it is required to immediately record the group of status points in the SOE list.	State Compliance	
3)	The status points shall be time stamped with the time and date of the initiating event.	State Compliance	
4)	The occurrence of an initiating event shall inhibit the further recognition of any initiating events for a user defined time period. The time period shall range from 1 s to 30 s.	State Compliance	
5)	Upon completion of the time period, the recognition of initiating events shall be enabled.	State Compliance	
6)	The status data shall be transferred to the SOE list before being updated from the I/O cards. That is, if the initiating event also causes a 'status point' defined event to alter state at the plant level, the original state shall be entered in the SOE list, after which the changed state is entered in the SOE list.	State Compliance	
j)	**SOE list structure.** The SOE list shall include the following minimum fields of information:	State Compliance	
1)	Date:	State Compliance	
2)	Time:	State Compliance	
3)	State:	State Compliance	
4)	State Description	State Compliance	
5)	Event classification fields	State Compliance	
6)	Nature of event field:	State Compliance	
7)	Source of event fields	State Compliance	
8)	Bay ID field	State Compliance	
9)	Station ID field	State Compliance	
10)	User Configurable field	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
k)	**SOE data storage handling**	Stated for information only	
1)	The Gateway/Station RTU/IED SOE list storage shall be a circular buffer of non-volatile removable memory storage, with a capacity of 1 000 individual events.	State Compliance	
2)	The events shall be placed in the buffer as they occur, and also transferred to the Gateway as the Station RTU/IED is polled.	State Compliance	
3)	A facility to transfer complete files to the remote SCADA master station shall exist, as well as a facility to extract files serially from the storage device in the event of malfunction of the Gateway/Station RTU/IED.	State Compliance	
l)	**SOE data retrieval**. Data retrieval shall be defined for the Gateway/Station RTU/IED as follows:	State Compliance	
1)	Gateway/Station RTU/IED data shall be uploaded to a 'PC-based' HMI, HMI Client/Server data concentrator/server and remote SCADA master station from the Gateway/Station RTU/IED SOE list.	State Compliance	
2)	The portion of data required shall be specified by means of a start and end date and time.	State Compliance	
3)	Where the Gateway/Station RTU/IED is operational but cannot communicate with the SCADA master station and/or Gateway, data retrieval shall be effected by means of a portable PC via a dedicated serial interface to the mass storage facility.	State Compliance	
3.6.2	**Gateway/station remote terminal unit statistics**	Stated for information only	
	The Gateway/Station RTU/IED should provide non-volatile storage for each of the following values.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
a)	The Gateway/Station RTU/IED shall record the following communications statistics (i.e. counters) related to each communications port. The purpose of this requirement is to facilitate effective monitoring of the telecommunication performance:	State Compliance	
1)	Number of Gateway data messages transmitted to the Master Station.	State Compliance	
2)	Number of Gateway data messages received from the Master Station.	State Compliance	
3)	Number of Gateway data message retries to the Master Station.	State Compliance	
4)	Number of received messages with Cyclic Redundancy Check (CRC) errors.	State Compliance	
5)	Number of framing errors (preferred).	State Compliance	
6)	Number of collisions (preferred).	State Compliance	
b)	These counter values shall be available via the configuration port. It shall be possible to reset these counters locally and remotely. The *Supplier* shall provide all details with regard to these requirements.	State Compliance	
c)	The Gateway shall record the following control-related statistics related to each communications port. The purpose of this requirement is to facilitate the effective monitoring of the Control Success Rate.	State Compliance	
1)	Number of control messages received from the Master Station.	State Compliance	
2)	Number of controls successfully executed - where success is defined, as a minimum, as output contact closure or transmission of the control command to an IED. The preferred definition is current flow through the output contact or acknowledgement of the control message by the IED.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3)	The counter values shall be available locally, as well as remotely via the SCADA protocol, and it shall be possible to reset these counters locally and remotely.	State Compliance	
d)	The Gateway shall provide the following event logs:	State Compliance	
1)	A transaction log, containing a brief description of all messages transmitted to and received from the Master.	State Compliance	
2)	A Gateway diagnostics log that records all internal status changes/failures, e.g. Gateway/Station RTU/IED start-up, watchdog timer timeouts, configuration changes, card failures and communications failures. The *Supplier* shall provide a list of all the internal conditions that are monitored and stored.	State Compliance	
3)	All events/messages/internal status changes of the above-mentioned logs shall be date and time stamped accurate to 10 ms and shall be stored in the sequence in which they occurred.	State Compliance	
4)	It shall be possible to clear the logs locally as well as remotely.	State Compliance	
3.7	**Configuration, software and firmware requirements**	Stated for information only	
3.7.1	**Gateway/station remote terminal unit configuration - general requirements**	Stated for information only	
a)	All Gateway/Station RTU/IED configuration settings shall be stored in non-volatile memory. This includes any setting changes done remotely.	State Compliance	
b)	It shall be possible to upload the Gateway/Station RTU/IED's configuration parameters remotely as well as locally.	State Compliance	
c)	It shall also be possible to remotely configure Gateway/Station RTU/IED configuration parameters. Remote access philosophies shall comply with [22] 240-55410927.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
d)	It should not be necessary to download the configuration parameters if the device is reset or restarted. The *Supplier* shall provide details on how remote uploading and downloading are achieved on the Gateway/Station RTU/IED that is offered.	State Compliance	
e)	New settings shall preferably take effect immediately without the need to restart the device. The *Supplier* shall supply details of how new settings take effect and any Gateway/Station RTU/IED unavailability that will result.	State Compliance	
f)	User programmability shall be provided, i.e. the user shall be able to program a specific user application, such as a Distribution Automation (DA) algorithm, in the Gateway/Station RTU/IED.	State Compliance	
g)	Support for open programming standards such as [29] IEC 61131-3 is preferred.	State Compliance	
h)	The *Supplier* shall supply details of the type of user programming application as well as the level of user programmability and the extent to which the I/O database can be accessed on the offered Gateway/Station RTU/IED.	State Compliance	
i)	The complete Gateway/Station RTU/IED configuration shall be stored in the Gateway/Station RTU/IED to allow complete reconfiguration using an uploaded copy of the Gateway/Station RTU/IED database. This also includes any user application programmes as referred to above.	State Compliance	
3.7.2	**Gateway/station remote terminal unit configuration software**	Stated for information only	
a)	The Gateway/Station RTU/IED system shall be supplied with PC-based configuration software that shall be compatible with a Microsoft Windows 7™, 64 bit operating system.	State Compliance	
b)	The *Supplier* shall also provide details of configuration software compatibility to any other operating systems.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
c)	The software shall have an auto-install feature whereby a set-up program will prompt for options and the software will automatically be extracted to the appropriate directories with program groups and icons created (for Windows™).	State Compliance	
d)	Software shall be user-friendly and menu-driven, and comprehensive help files should be provided. Only basic computer knowledge should be required to use the software interface.	State Compliance	
e)	The *Supplier* shall specify the minimum computer hardware requirements of the software that is offered.	State Compliance	
f)	It shall be possible to save and retrieve Gateway/Station RTU/IED configurations and application programs to/from disc.	State Compliance	
g)	All software supplied with the system shall be documented comprehensively, with all the features and functions discussed, including a set of examples as to how the Gateway/Station RTU/IED systems can be configured for different applications. Included in the documentation shall be a list of possible problems and instructions on how to solve them.	State Compliance	
h)	It is preferred that the software is free or included in the price of the Gateway/Station RTU/IED system. If not, the *Supplier* shall specify the price per licence or certain number of licences (e.g. 100 licences).	State Compliance	
i)	Eskom prefers to be given an Eskom-wide licence agreement for the configuration software. The *Supplier* shall supply all terms and conditions related to the distribution of the software in the offer.	State Compliance	
j)	The *Supplier* shall specify how version control of software will be handled over a period of at least 10 years.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
k)	The tender documentation shall provide a full disclosure of the costs of annual software updates for the 10-year period commencing in January of the year following the Enquiry issue, so as to meet the following requirements:	State Compliance	
1)	Support for a Microsoft Windows™ Operating System less than two years old.	State Compliance	
2)	Full backward compatibility of the latest Configuration software for all units less than 10 years old.	State Compliance	
3.7.3	**Gateway/station remote terminal unit firmware**	Stated for information only	
a)	Firmware shall be stored in non-volatile memory and shall be upgradeable by Eskom staff.	State Compliance	
b)	The *Supplier* shall provide a detailed firmware revision history every time a new release is made. Any modifications shall be clearly specified and the impact explained.	State Compliance	
c)	Any firmware bug fixes shall be made available free of charge within a period of eight weeks after the problem has been formally communicated to the *Supplier*.	State Compliance	
d)	Any bugs discovered in a firmware version used by Eskom, by either the *Supplier* or other customers, shall be brought to Eskom's immediate attention.	State Compliance	
e)	The *Supplier* shall specify how version control of firmware will be handled over a period of at least 10 years.	State Compliance	
f)	The tender documentation shall provide a full disclosure of the costs of annual firmware upgrades for the 10-year period commencing in January of the year following the Enquiry issue, so as to provide support for the latest applicable IEC Telecontrol protocol within two years of its official release.	State Compliance	
3.8	**System performance**	Stated for information only	
3.8.1	**General**	Stated for information only	
a)	It shall be the responsibility of the *Supplier* to provide all equipment required to measure system performance.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
b)	The *Supplier* shall meet the following system performance requirements	State Compliance	
3.8.2	**Station remote terminal unit/IED performance requirements**	Stated for information only	
3.8.2.1	**General**	Stated for information only	
a)	Performance requirements are specified for the following Station RTU/IED configuration:	State Compliance	
1)	8 double control outputs.	State Compliance	
2)	64 digital inputs.	State Compliance	
3)	8 analogue inputs.	State Compliance	
4)	All monitoring functions fully operational.	State Compliance	
5)	All control and data acquisition functions full operational.	State Compliance	
b)	The following Station RTU/IED test conditions shall apply:	State Compliance	
1)	When no changes occur at any of the above digital, analogue or accumulator inputs.	State Compliance	
2)	When a continuous change of state occurs simultaneously at 30% of the above digital and analogue inputs.	State Compliance	
3)	When a continuous change of state occurs simultaneously at 60% of the above digital and analogue inputs.	State Compliance	
3.8.2.2	**Station remote terminal unit/IED controls performance**	Stated for information only	
a)	The maximum time elapsed from receipt of the 'Select and Execute' message from either the legacy ERTU, Gateway or master stations to the point where the relevant output relay operates shall be designated Te.	State Compliance	
b)	The *Supplier* shall specify Te for the Station RTU/IED test conditions.	State Compliance	
c)	Te shall not exceed 400 ms under any conditions.	State Compliance	
d)	The *Supplier* shall specify the methodology to measure and perform the above test.	State Compliance	
3.8.2.3	**Station remote terminal unit indications performance**	Stated for information only	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
a)	The time elapsed from the change of state at a digital input to the point where the indication is entered into a priority queue is designated Ti.	State Compliance	
b)	The *Supplier* shall specify Ti for the Station RTU/IED test conditions.	State Compliance	
c)	Ti shall not exceed 400 ms under any conditions.	State Compliance	
d)	The *Supplier* shall specify the methodology to measure and perform the above test.	State Compliance	
3.8.2.4	**Station remote terminal unit communications performance**	Stated for information only	
a)	The Gateway or SCADA master station shall issue 'General Poll' messages to the Station RTU/IED.	State Compliance	
b)	If the Station RTU/IED has a change, it shall respond with a 'Change Message'.	State Compliance	
c)	The time elapsed from receipt of the 'General Poll' message to the point where the RTU responds with a 'Change Message', having retrieved a valid change from its queues, shall be designated Trgp.	State Compliance	
d)	The *Supplier* shall specify Trgp for the Station RTU/IED test conditions.	State Compliance	
e)	Trgp shall not exceed 20 ms under any conditions.	State Compliance	
f)	The *Supplier* shall specify the methodology to measure and perform the above test.	State Compliance	
g)	This test shall be physically measured on the digital side of the modem (if it is used).	State Compliance	
3.8.2.5	**Station remote terminal unit processing capacity**	Stated for information only	
a)	The *Supplier* shall provide a measure for the maximum processing capacity of the Station RTU/IED. For the purposes of the following discussion, this measure shall be designated Prmax.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
b)	The *Supplier* shall specify the processing capacity (in terms of a percentage Prmax) used under the Station RTU/IED test conditions.	State Compliance	
c)	The Station RTU/IED shall have a minimum of 30% spare processing capacity under the above operating conditions (i.e. 0,7 Prmax).	State Compliance	
d)	The *Supplier* shall specify the methodology to measure and perform the above tests.	State Compliance	
3.8.3	**Gateway performance requirements**	Stated for information only	
3.8.3.1	**General**	Stated for information only	
a)	Performance requirements are specified for the following Gateway configuration:	State Compliance	
1)	Gateway with at least 2 x HMIs fully operational.	State Compliance	
2)	All functions as specified in this enquiry document are fully operational.	State Compliance	
3)	The Gateway is connected to 2 Station RTU/IEDs configured as in 3.8.2.1 (i.e. maximum configuration) and 100 bay IEDs with the total number of points as shown in Table 2, "Large Application"	State Compliance	
b)	The following Gateway test conditions shall apply:	State Compliance	
1)	When no changes occur at any of the digital, analogue or accumulator inputs at any of the Station RTU/IEDs.	State Compliance	
2)	When a continuous change of state occurs simultaneously at 30% of the digital, analogue and accumulator inputs, at all of the Station RTU/IEDs and bay IEDs.	State Compliance	
3)	When a continuous change of state occurs simultaneously at 60% of the digital, analogue and accumulator inputs, at all of the Station RTU/IEDs and bay IEDs.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.8.3.2	**Gateway controls performance**	Stated for information only	
a)	The maximum time elapsed from receipt of the 'Select and Execute' message from the master stations (including HMIs) to the point where the relevant output relay at the Station RTU/IED operates shall be designated Tee.	State Compliance	
b)	The *Supplier* shall specify Tee for the Gateway test conditions.	State Compliance	
c)	Tee shall not exceed 400 ms under any conditions. These time limits shall also apply when bay level interlocking and inter-bay interlocking are active.	State Compliance	
d)	The *Supplier* shall specify Tee with no interlocking active and Tee with interlocking fully configured.	State Compliance	
e)	The *Supplier* shall specify the methodology to measure and perform the above test.	State Compliance	
3.8.3.3	**Gateway indications performance**	Stated for information only	
a)	The time elapsed from the change of state at an Station RTU/IED digital to the point where the indication is entered into a priority queue in the Gateway is designated Tei.	State Compliance	
b)	The *Supplier* shall specify Tei for the Gateway test conditions.	State Compliance	
c)	Tei shall not exceed 400 ms under any conditions. The *Supplier* shall specify the methodology to measure and perform the above test.	State Compliance	
3.8.3.4	**Gateway communications performance**	Stated for information only	
a)	The SCADA master station shall issue 'General Poll' to the Gateway. If the Gateway has a change, it shall respond with a 'Change Message'.	State Compliance	
b)	The time elapsed from receipt of the 'General Poll' message to the point where the Gateway responds with a 'Change Message', having retrieved a valid change from its queues, shall be designated Tegp.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
c)	The *Supplier* shall specify Tegp for the Gateway test conditions.	State Compliance	
d)	Tegp shall not exceed 20 ms under any conditions. The *Supplier* shall specify the methodology to measure and perform the above test. This test shall be specifically measured on the digital side of the modem (if it is used).	State Compliance	
3.8.3.5	**Gateway processing capacity**	Stated for information only	
a)	The *Supplier* shall provide a measure for the maximum processing capacity of the Gateway. For the purpose of the following discussion, this measure shall be designated Pemax.	State Compliance	
b)	The tender shall specify the processing capacity (in terms of a percentage of Pemax) used under the Gateway test conditions.	State Compliance	
c)	The Gateway shall have minimum of 30% spare processing capacity under the above operating conditions (i.e. 0,7 Pemax).	State Compliance	
d)	The *Supplier* shall specify the methodology to measure and perform the above tests.	State Compliance	
3.9	**Power supplies**	Stated for information only	
3.9.1	**General requirements**	Stated for information only	
a)	There shall be no equipment malfunction, damage or spurious event, under any of the following conditions:	State Compliance	
1)	As a result of the loss or restoration of supply.	State Compliance	
2)	As a result of an under-voltage or over-voltage condition.	State Compliance	
3)	If either AC or DC supplies to the unit are switched off and on repeatedly at a random rate.	State Compliance	
4)	Short interruptions on any of the power supply voltages for not longer than 20 ms occurring in a random sequence for a period of no longer than 20 s.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
b)	The power supplies shall be equipped with terminals for connecting the primary power cable and capable of accepting 6 mm2 cable	State Compliance	
c)	The power supplies shall have the necessary current overload cut-outs and over-voltage limiting, with automatic reset on removal of the fault.	State Compliance	
d)	Each unit shall include a power supply-isolating switch (two pole preferred). Miniature circuit-breakers are preferred in place of fuses.	State Compliance	
e)	A Light-emitting Diode (LED) indication, with a check facility, shall be provided to indicate a supply healthy condition for all internal supply voltages. It is preferred that a contact be available to communicate power supply health remotely. The *Supplier* shall provide details of this feature.	State Compliance	
f)	The design shall allow for three isolated power sources, which shall supply the electronic logic circuitry, the output and the input circuitry.	State Compliance	
g)	In addition, the design shall provide a floating power supply regardless of any earthing which may exist on the DC supply rails.	State Compliance	
h)	If the Gateway or Station RTU/IED is supplied from a DC source, the noise measured across the power supply terminals of the equipment under test shall not be greater than 2 mV peak-to-peak or 58 dBV (0 dBV = 0,775 V) measured psophometrically.	State Compliance	
i)	The equipment derived supply voltage (output voltage) shall be a floating 48 V, 2 A, supply and shall energize the 48 V, 110 V, 220 V DC protection breaker control relays either via a 'potential' contact or 'dry' contract.	State Compliance	
j)	The power supply unit shall provide galvanic isolation between the primary supplies and the electronic circuitry.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
k)	The *Supplier* shall make provision for a power supply unit output for a radio operating at 1,5 V to 13,8 V DC and 4 A average current. These output terminals should be capable of accepting 2,5 mm2 cable.	State Compliance	
l)	The *Supplier* shall provide details regarding RTU power consumption to enable Eskom to decide on a suitable power supply source. The maximum current drain per module (considering the inputs to be in a 'worst case' configuration regarding power consumption) and any inrush current parameters shall be stated.	State Compliance	
3.9.2	**Power supply physical implementation**	Stated for information only	
3.9.2.1	**Gateway power supply**	Stated for information only	
a)	The standard supply voltage options for the Gateway/Station RTU/IED unit shall be:	State Compliance	
1)	UDC 48 V (voltage tolerance, as per Table 3)	State Compliance	
2)	UDC 110 V (voltage tolerance, as per Table 3) (floating input).	State Compliance	
3)	UDC 220 V (voltage tolerance, as per Table 3) (floating input).	State Compliance	
4)	UAC 220 V at 50 Hz (voltage tolerance, as per Table 3).	State Compliance	
3.10	**Enclosures and connectors**	Stated for information only	
3.10.1	**Equipment modules**	Stated for information only	
a)	All modules shall be clearly labelled and identified, thereby simplifying the fault finding, maintenance and replacement of units or modules within the equipment racks.	State Compliance	
b)	The design and construction of any part of the equipment shall be such that any component or module thereof may be easily removed for replacement or testing.	State Compliance	
3.10.2	Equipment enclosures	State Compliance	
a)	The cabinets that house the 19" equipment racks shall be floor-mounted units.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
b)	The *Supplier* should note that these cabinets, which will be mounted inside the substation control building, will be ventilated but may not have air conditioning.	State Compliance	
c)	The cabinets shall have upper and lower gland plates to allow top and bottom cable access. These gland plates shall be interchangeable and shall have holes drilled for 20 mm cable glands. Each hole shall be closed with a suitable, removable plastic or rubber cover.	State Compliance	
d)	Doors shall have top and bottom louvres, which shall be covered on the inside of the door with wire gauze. The doors shall be removable by lifting them off the hinges. The spindle of the bottom hinge shall be longer than the spindles of the middle and upper hinges to allow easy reinstallation of the door. The doors shall have dust proof seals around the perimeter.	State Compliance	
e)	All cabinets offered shall conform to the Eskom Specification for Standard Equipment Cabinets [21]	State Compliance	
f)	All cabinets shall permit easy access to the cable looms and plant interface connectors	State Compliance	
g)	The RTU equipment and enclosure shall be suitably protected against corrosion, in accordance with [21]. Given that the equipment offered will be installed inside cabinets whose doors will normally be closed, the *Supplier* shall fully disclose all ventilation requirements, if any.	State Compliance	
h)	The following enclosure options shall be offered:	State Compliance	
1)	Option 1: Standard fixed frame cabinet with front and rear doors. These cabinets shall have front and rear access	State Compliance	
	Width: 600 mm fixed frame cabinet.	State Compliance	
	Depth: 600 mm not including doors.	State Compliance	
	Height: 2 400 mm overall, including 100 mm plinth.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
2)	Option 2: Standard swing frame cabinet with front door only	State Compliance	
	Width: 800 mm swing frame cabinet.	State Compliance	
	Depth: 600 mm not including doors.	State Compliance	
	Height: 2 400 mm overall, including 100 mm plinth.	State Compliance	
3.10.3	**Input/output connectors and terminating blocks**	Stated for information only	
a)	Each connector and terminating block shall be clearly marked using a unique identification method, which is in accordance with the identification shown on the circuit diagram and/or logic diagram.	State Compliance	
b)	A mechanism shall be provided to logically group and route all I/O functions to suitable high-density termination connectors.	State Compliance	
c)	All connectors used shall be terminated by the use of mass termination techniques.	State Compliance	
d)	In some applications, all plant-to-equipment connections shall be connected by use of cabling supplied by the *Supplier*.	State Compliance	
e)	The *Supplier* should note that installation of the RTU equipment will be done by the *Purchaser*. The *Purchaser* will supply and install all cabling that interfaces to the RTU system as dictated by the design.	State Compliance	
f)	The preferred termination method for all I/O cables onto the RTU system is via high-quality Insulation Displacement Connections, e.g. Krone Insulation Displacement Connection (IDC) modules. The *Supplier* shall specify the terminations offered.	State Compliance	
g)	The *Supplier* shall include the cost of all termination hardware required to terminate the Eskom cables (standard telephone cable - TPH*AX) to the RTU/I/O modules.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
h)	All analogue connectors that interface to transducer outputs shall permit the in-circuit measurement of current, without the disconnecting of any associated wiring.	State Compliance	
i)	It shall be possible to remove an I/O module without having to individually remove plant terminations.	State Compliance	
3.11	**Test equipment**	Stated for information only	
3.11.1	***Purchaser's* test equipment**	Stated for information only	
a)	It shall be the responsibility of the *Supplier* to provide adequate test equipment and facilities to verify system functionality and performance. Full functionality on the available test equipment and test requirements shall be defined during Phase 1 of the contract.	State Compliance	
3.11.2	***Supplier's* test equipment**	Stated for information only	
a)	The *Supplier* is required to clearly describe the functionality and purpose of all test equipment provided for the system. However, preference shall be given to systems that maximize on the utilization of the *Purchaser's* test equipment as opposed to systems that require dedicated proprietary-based test equipment.	State Compliance	
b)	Test equipment should not be regarded as an integral part of the RTU system and will be ordered separately by Eskom.	State Compliance	
c)	All applicable test equipment shall operate from a UAC 240V 50 Hz supply, or directly from the unit under test.	State Compliance	
3.11.3	**Remote terminal unit test facilities**	Stated for information only	
a)	The RTU shall have clearly marked and easily accessible measuring and test points to aid fault finding.	State Compliance	
b)	The test points shall allow for the measurement of important voltages, currents, waveforms and signals.	State Compliance	
c)	Comprehensive fault finding procedures shall be provided as part of the maintenance manual.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.12	**Documentation**	Stated for information only	
3.12.1	**General**	Stated for information only	
a)	Documentation will be ordered by Eskom separately from the RTU equipment.	State Compliance	
3.12.2	**Drawings**	Stated for information only	
a)	Drawings shall be submitted in English and shall form an essential part of the contract.	State Compliance	
b)	Schematic diagrams shall be drawn and conform to the following layout:	State Compliance	
1)	The schematics shall have a logical data flow left to right, and top to bottom.	State Compliance	
2)	This implies that all inputs to the schematic are on the left-hand side of the page, and outputs on the right-hand side.	State Compliance	
3)	Inputs from and outputs to other schematic pages are to be referenced accordingly.	State Compliance	
4)	Logic symbols to be drawn such that inputs are on the left (or top) and outputs to the right (or bottom).	State Compliance	
c)	Duplicate copies of a schedule listing all drawings and circuit diagrams applicable to all equipment included in the contract, shall be supplied with or before the notification of readiness for acceptance testing.	State Compliance	
d)	As a minimum the following drawings should be provided by the *Supplier*/Tenderer:	State Compliance	
1)	Block schematic diagrams showing the functional arrangement of the equipment.	State Compliance	
2)	Detailed schematic diagrams.	State Compliance	
3)	Functional drawing showing the overall operation of the equipment.	State Compliance	
4)	Cabinet equipment layout.	State Compliance	
5)	Module sub-rack and cabinet wiring diagram, including functions and designations of the terminal blocks.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
6)	Details of terminals and terminal blocks.	State Compliance	
7)	Outline dimensions of cabinets and fixing details.	State Compliance	
e)	Detailed drawings of all equipment shall be supplied not later than the notification of the first item of equipment readiness for FAT.	State Compliance	
f)	The drawings shall not be submitted as separate drawings, but shall be incorporated in the instruction manuals. In addition, documents shall be available in electronic format e.g. CD ROM, for use in a document management system.	State Compliance	
g)	When changes to the equipment are envisaged, either by the *Supplier* or the *Purchaser*, during the contract period, the *Supplier* shall submit details of these changes in writing together with modified drawings for the *Purchaser's* approval, before proceeding with the implementation of these changes.	State Compliance	
h)	The *Supplier* shall comply with the *Purchaser's* drawing specifications for all necessary drawings.	State Compliance	
3.12.3	**Instruction manuals**	Stated for information only	
a)	Approximately 3 hard copies of the instruction manuals and related documentation shall be supplied, covering all equipment in the Contract, before the first items of equipment are dispatched to site.	State Compliance	
b)	Single sets of instruction manuals shall be made available as an option within the contract.	State Compliance	
c)	The instruction book shall only cover the equipment variant supplied to the *Purchaser*.	State Compliance	
d)	Typical circuit diagrams and descriptions are not acceptable in the instruction books.	State Compliance	
e)	The diagrams shall correspond in exact detail with the equipment delivered.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
f)	The instruction books shall have a hard-covered, ring file construction and they shall open flat at any page. Folders that do not comply with these requirements are not acceptable. Different sections of the handbooks shall be separated by means of thumb tab separators.	State Compliance	
g)	The instruction book shall contain a master key or block schematic, which shall clearly indicate the reference numbers of the individual detailed circuit diagrams against the appropriate blocks.	State Compliance	
h)	Block schematics of the complete equipment shall indicate clearly the interconnections between the various units. Wiring schematics with cable harnesses are not acceptable for this purpose.	State Compliance	
i)	The equipment handbooks shall basically consist of the following sections:	State Compliance	
1)	Index.	State Compliance	
2)	Electrical and Mechanical specifications and parameters of the equipment.	State Compliance	
3)	Basic description of the equipment and its operations.	State Compliance	
4)	Basic mechanical designs of the equipment and the cabinet and inter sub-rack wiring. Description, block schematic and wiring schematic of the complete equipment.	State Compliance	
5)	Sub-rack mechanical design and wiring.	State Compliance	
6)	Individual modules.	State Compliance	
7)	Description, Parts layout, Electrical Schematic and Parts List.	State Compliance	
8)	Installation, commissioning and maintenance procedures.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
9)	The individual module description shall contain a written description of the operation of the module; the module test and commissioning procedures where applicable; as well as the technical ratings of the unit. This shall be followed by the module schematic, the component layout and a component list giving the component values, rating, tolerance and manufacturer. The module schematic shall detail the nominal DC and AC voltages on the semiconductor devices. The functions of various input and output points shall be given on the schematic.	State Compliance	
10)	All handbook drawings and descriptions shall conform to the international A4 series (295 mm 220 mm). Larger drawings that cannot be accommodated on this size of drawing shall be folded in a single plane, along the 220 mm axis of the standard A4 series. Handbook drawings, which must be unfolded in two directions, are not acceptable.	State Compliance	
11)	In the event of any changes being made to the equipment, as detailed in the Documentation Section (3.12), 3 sets of drawings and descriptions, if applicable, shall be provided to update the equipment handbooks.	State Compliance	
3.13	**Delivery of drawings, handbooks and test certificates**	Stated for information only	
a)	All drawings and handbooks shall be delivered to: The Manager, PTM&C Control and Automation, Group Technology, Eskom, PO Box 107, Germiston, 1400.	State Compliance	
b)	One copy of all routine test reports and one copy of the type test reports shall be sent to the address specified in (a) as well.	State Compliance	
c)	All correspondence relating to equipment supplied shall be headed with the Eskom National Contract number allocated by the *Purchaser*.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
d)	All technical inquiries shall be addressed to the PTM&C Manager at the address specified in a), and all commercial enquiries shall be addressed to The Procurement Advisor/Manager, Eskom, PO Box 1091, Johannesburg, 2000.	State Compliance	
e)	Drawing and instruction manuals form an essential part of the Contract. No payment shall be made for any equipment supplied as part of the Contract until all drawings and handbooks have been supplied in accordance with the requirements detailed in the Contract.	State Compliance	
3.14	**Training**	Stated for information only	
a)	The *Supplier* shall provide training courses conducted in South Africa.	State Compliance	
b)	The training shall be targeted at three different user groups, and shall therefore be divided into three categories:	State Compliance	
1)	System overview and operations guide: The system overview shall provide an overall understanding of the system and its capabilities and limitations. In addition, system configuration shall be covered in such a way that the user shall understand how to construct a system from the building blocks to meet his/her requirements.	State Compliance	
2)	System configuration and system maintenance training: This training would include computer system operation, hardware maintenance, computer supplier software and relevant operating system aspects.	State Compliance	
3)	Detailed system training on all hardware and software aspects: It is intended that any person attending this course shall be in a position to maintain the system down to PCB and/or component level.	State Compliance	
c)	All aspects of the training shall be supplemented with periods of practical training; this shall apply to all courses and shall be implemented where applicable.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
d)	All training shall be given directly through the medium of English.	State Compliance	
e)	The *Purchaser* shall give the *Supplier* at least one month prior notice before any training course is scheduled.	State Compliance	
f)	The *Supplier* shall provide the following information:	State Compliance	
1)	Location of training centre in South Africa.	State Compliance	
2)	Duration of training course(s).	State Compliance	
3)	Syllabus of training courses(s).	State Compliance	
4)	Entrance requirements (basic knowledge required) for trainees.	State Compliance	
5)	The preferred number of candidates per course.	State Compliance	
g)	The *Supplier's* quotation for training shall include the cost of tuition and documentation, but shall exclude all travelling and accommodation costs for the candidates, as these shall be provided by the *Purchaser*.	State Compliance	
h)	The *Supplier* shall quote separately as an option the cost of subsequent training courses during a period of 10 years from start of the supply contract.	State Compliance	
3.15	**Spares, maintenance and quality assurance**	Stated for information only	
3.15.1	**Spares**	Stated for information only	
a)	A detailed spares list shall be provided with its individual price schedule. This shall include items such as semiconductors, lamps and fuses. The component list shall include the component type, the component value, the type number and the manufacturer's component name.	State Compliance	
b)	A detailed and individually priced list of all fully assembled PCBs shall be provided.	State Compliance	
c)	A detailed and individually priced list of all test equipment shall be provided. This shall include extender cards, test plugs, diagnostic/monitoring cards and test sets.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
d)	A recommended spares holding list for the guarantee of 12 months, shall be provided.	State Compliance	
e)	Spares shall be packed in separate cases marked 'Spares'. Each spares item shall be clearly identified by means of a metal or plastic label, or indelible marking.	State Compliance	
f)	The availability of spares shall be guaranteed for a minimum period of 10 years from the date of latest delivery. If, during this 10-year period, the *Supplier* or one of its sub-suppliers intends to discontinue the manufacture of spares or replacement parts for the equipment, the *Supplier* shall forthwith give written notice to the *Purchaser* of such intention and offer the *Purchaser* the opportunity, which the *Purchaser* shall have the right to exercise within six months, of ordering at reasonable prices the quantities of spares or replacement parts as the *Purchaser* shall require.	State Compliance	
g)	Although Eskom will administer its own spares holding, the *Supplier* should be able to deliver any required spare part within a maximum of four weeks.	State Compliance	
h)	In the case where the *Supplier* operates and administers a spares holding (5% of delivered equipment), a faulty module exchange facility shall be made available, whereby Eskom may receive a functional module within 48 hours while a faulty module is being repaired. The original module sent in for repairs should be returned within three weeks (or less). The *Supplier* shall indicate what the additional cost would be for such a facility.	State Compliance	
i)	The delivery lead-time for required spares is four weeks (or less) from date of order.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3.15.2	**Maintenance**	Stated for information only	
a)	The *Supplier* shall, for the duration of the contract, including the guarantee period, supply the necessary infrastructure in South Africa which shall provide the following services:	State Compliance	
1)	A well-documented and controlled PCB repair service with a one-week turnaround time. A complete list of all PCBs and their repair cost shall be detailed within the enquiry document.	State Compliance	
2)	A software maintenance service in the form of a maintenance contract.	State Compliance	
3)	A systems level maintenance service.	State Compliance	
4)	A list of support centres and facilities shall be submitted with the offer.	State Compliance	
b)	The *Purchaser* desires to be as self-sufficient as possible in both the first line (field) maintenance and system engineering aspects of the Gateway and Station RTU/IED System, to achieve maximum flexibility for system applications. Thus, the *Supplier* shall detail, via a proposal, the suggested approach to system engineering and first line (field) maintenance, with due consideration to the self-sufficiency requirements mentioned.	State Compliance	
3.15.3	**Quality assurance**	Stated for information only	
a)	The requirements of [15] SABS ISO 9001 (2000 version), are included as requirements of this specification.	State Compliance	
b)	The *Supplier* shall be responsible for the complete quality assurance requirements to be imposed on its subcontractors and suppliers of materials, in terms [15] SABS ISO 9001.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
4	**Testing and acceptance**	Stated for information only	
4.1	**Testing**	Stated for information only	
a)	After the *Supplier* has completed each module (object) during Phase 3 (Development, System Integration and FAT), the *Supplier* shall carry out system tests on that module at the *Supplier's* works.	State Compliance	
b)	The *Purchaser* may elect to witness such tests. These tests would constitute informal factory acceptance tests.	State Compliance	
4.2	**Factory acceptance test**	Stated for information only	
a)	The Supplier shall perform a pre-FAT according to the accepted Factory Acceptance Test (FAT) Procedure.	State Compliance	
b)	A completed pre-fat report incorporating all the pre-fat results shall be provided to the Purchaser at least 4 weeks prior to the commencement of the FAT.	State Compliance	
c)	The FAT shall only commence once the Purchaser has approved this pre-FAT report and results. The Purchaser and the Supplier shall agree upon a date when formal FAT shall commence. The testing shall then be carried out in accordance with the FAT procedure.	State Compliance	
d)	In the event of any tests malfunctioning, the Purchaser may elect to restart the complete test procedure from the beginning.	State Compliance	
e)	The Purchaser shall also carry out an unstructured testing programme (Free-form Tests), at its discretion, on the Supplier's premises for a duration of two weeks. This two week shall not include the time taken to repair any faults.	State Compliance	
f)	The Supplier, at no extra charge to the Purchaser, shall correct any errors detected.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
4.3	**Site acceptance test**	Stated for information only	
a)	After delivery of the production unit to a *Purchaser*-selected site, the *Supplier*, assisted by the *Purchaser*, shall install the equipment in a substation in accordance with the *Purchaser's* standards.	State Compliance	
b)	The *Purchaser* shall be informed in writing of the completion of the installation. Within a three-week period or less after completion of installation, the SAT shall commence.	State Compliance	
c)	These formal tests shall be defined in the SAT procedure. In the event of an error being detected, the *Purchaser* may elect to restart the SAT.	State Compliance	
d)	For a period of one month after the successful completion of the formal SAT, the equipment shall undergo random testing while being subjected to a soak test.	State Compliance	
e)	In the event of any non-conformance being detected, the *Supplier* shall be required to commence the correction of the errors within a 72 h period. Only on completion of the correction procedure, the one month test and soak test period shall commence.	State Compliance	
f)	Depending on the nature of the fault, the *Purchaser* may at its sole discretion elect to restart the SAT. During this SAT, the *Supplier* shall make available at no extra charge to the *Purchaser*, the relevant hardware, software and/or system specialist.	State Compliance	
4.4	**General**	Stated for information only	
a)	All equipment shall be subjected to the *Supplier's* standard works test and inspection.	State Compliance	
b)	The equipment under test shall be switched on and allowed to soak (burn in) for 48 h before the type tests are started.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
c)	A representative single sample of all types of equipment supplied shall be subjected to type tests, which shall be continued for at least 10 h at the extreme conditions specified in 4.6 of this specification.	State Compliance	
4.5	**Witnessing of tests**	Stated for information only	
a)	The *Purchaser* reserves the right to appoint a representative to inspect the equipment at any stage of manufacture, or to be present at the specified tests.	State Compliance	
b)	The *Supplier* shall ascertain in writing whether inspection or witnessed tests, or both, are required.	State Compliance	
c)	The *Supplier* shall then give the *Purchaser* not less than seven working days' notice in the case of local manufacture, and 20 working days' notice in the case of foreign manufacture, of when the equipment shall be ready for inspection or the witnessing of tests.	State Compliance	
4.6	**Type tests**	Stated for information only	
4.6.1	**General**	Stated for information only	
a)	The *Supplier* shall provide all certificates and type test results.	State Compliance	
4.6.2	**Environmental and electrical classes**	Stated for information only	
	The environmental and electrical classes for the equipment type tests are specified in this clause.	State Compliance	
a)	**Gateway and station remote terminal unit**	Stated for information only	
1)	Temperature and Humidity: Class C [refer to [14] IEC60870-2, Part1, Table 1].	State Compliance	
2)	Electrical	State Compliance	
i.	The device shall operate within an electrical interference environment, where equipment is placed within high voltage switching compounds (132 kV or above) such that it is subject to high levels of radiated electrical interference, due to its physical placement or its direct connection to electrical plant.	State Compliance	
ii.	The device shall not be affected by other device frequencies.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
3)	Cyclic Temperature and Humidity ([1] IEC 60068-2-30 25°C and 95% relative humidity/55°C and 95% relative humidity, 12 h + 12 h cycle).	State Compliance	
4)	Altitude: The device shall operate within an altitude range between 0 - 2500m.	State Compliance	
b)	Enclosure protection: As per [3] IEC 60529 - Degrees of Protection Provided by Enclosures (IP code) the equipment enclosure should satisfy the IP51 rating which dictates protection from ingress of dust particles as well as dripping water.	State Compliance	
c)	The RTU equipment and panel shall be suitably protected against corrosion, in accordance with [21].	State Compliance	
4.6.3	**Dielectric withstand test (as per IEC60255-5 [2] IEC 60255-5)**	State Compliance	
a)	No damage shall be caused to the equipment when the impulse voltage test is applied to the equipment in the following manner:	State Compliance	
1)	Differentially to all analogue input and output terminals.	State Compliance	
2)	Differentially to all digital input terminals.	State Compliance	
3)	Differentially to power supply input terminals.	State Compliance	
4)	Differentially to communication line input and output terminals.	State Compliance	
5)	Between all control and digital output terminals commoned together and earth.	State Compliance	
6)	Between all measured input commoned together and earth.	State Compliance	
7)	Between all power supply input terminals commoned together and earth.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
4.6.4	**Insulation test (as per [2] IEC 60255-5)**	State Compliance	
a)	For the purpose of this test, any surge diverters shall be removed.	State Compliance	
b)	As per [2] IEC 60255-5, a test voltage of UDC 500 V shall be applied for at least 1 MIN to all circuits entering or leaving the equipment (excluding measurand outputs).	State Compliance	
c)	The test voltage shall be applied between each circuit and earth and between independent circuits, i.e. circuits not normally connected together.	State Compliance	
d)	The leakage resistance shall be > 20 M?.	State Compliance	
e)	A test voltage of UDC 50 V shall then be applied between all input and output terminals (excluding measurand outputs) and earth, with any surge diverters previously removed having been replaced.	State Compliance	
f)	The leakage resistance during this test shall be > 100 M?.	State Compliance	
g)	Full details shall be provided of the standard equipment voltage withstand capabilities.	State Compliance	
h)	If special modifications are required to meet the requirements of [2] IEC 60255-5, these should be detailed and the cost of these modifications shall be quoted.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
4.6.5	**Electric impulse test (As per [2] IEC 60255-5)**	State Compliance	
a)	No damage or maloperation should result when a 5 kV, 1,2/50 µs waveform (0,5 J) is applied to the equipment. The test should be conducted as per [2] IEC 60255-5	State Compliance	
4.6.6	**Reflected noise**	Stated for information only	
a)	The equipment shall be checked for compliance with the reflected noise requirements as specified in Power Supplies Section 3.9. Figure 9 shows the circuit to be used to perform the required measurement.	State Compliance	
b)	A report on all the tests, including the voltage withstand capability, shall be submitted to the *Purchaser* before the FATs.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
4.6.7	**Vibration, shock, bump and seismic type tests**	Stated for information only	
a)	No damage or maloperation of the equipment should occur under the type tests specified in Table 4	State Compliance	
	Test Compliance criteria Vibration Class 2 Response Response: 1 g, 10 Hz to 150 Hz, one sweep, energized. Contacts should not close for longer than 2 ms. Class 1 Endurance Endurance: 1 g 10 Hz to 150 Hz, 20 sweeps, un energized. Contacts should not close for longer than 2 ms. Shock Class 1 Response Response: 5 g, 11 ms, three pulses in each direction, energized. Class 1 Endurance Withstand: 15 g, 11 ms, three pulses in each direction, un-energized. Bump Class 1 10 g, 16 ms, 1 000 pulses un-energized. Seismic Class 1 Test method A (single axis sine sweep test) 1 Hz to 35 Hz, one sweep.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
4.6.8	**Electromagnetic compatibility and electromagnetic interference tests**	Stated for information only	
a)	Table 5 presents the Electromagnetic Compatibility (EMC) and Electromagnetic Interference (EMI) tests that shall be conducted on the equipment.	State Compliance	
b)	The *Supplier* shall submit the results of these tests to the *Purchaser*.	State Compliance	
4.6.9	**Routine tests**	Stated for information only	
a)	All equipment shall be subjected to a routine test by the *Supplier* and which shall include the following tests:	State Compliance	
1)	Each digital input shall be checked for correct operation. (No voltage changes outside the relevant range shall be detected.)	State Compliance	
2)	All control output points shall be fully tested for correct operation.	State Compliance	
3)	Accumulator inputs shall be tested for correct registration of input pulses.	State Compliance	
4)	Accuracy of the measurand inputs and outputs shall be tested to 0%, 25%, 50%, 75% and 100% of full scale in both directions.	State Compliance	
5)	Alarm conditions, such as communications failure and power failure shall be simulated and all alarm, indication and discrepancy outputs specified shall be checked for correct operation. (For example, the Automatic Reclose Control (ARC) operation.)	State Compliance	
6)	Each digital input tested for spurious operation by applying an input pulse of 10 ms to each input.	State Compliance	
7)	A fleeting contact of 10 ms duration shall be applied to each digital input in turn and the correct registration of this input shall be checked.	State Compliance	

Clause No	Description of Clause	Schedule A (*Purchaser's* Particular Requirement)	Schedule B (*Tenderer's* Compliance and Supporting Evidence)
8)	The power supply to the equipment shall be interrupted for 100 ms and the equipment shall be checked for false outputs and/or false presentation of inputs.	State Compliance	
9)	The input voltage to the equipment power supply shall be varied between the operational limits specified in the specification and the output voltage regulation checked. The operation of any under voltage protection devices fitted should be checked.	State Compliance	
b)	All the preceding tests shall be successfully completed before the equipment is dispatched to the *Purchaser*. Copies of the routine test certificates shall accompany the equipment.	State Compliance	

Signature: _____

Print Name: _____

Company: _____

Date: _____

Appendix B: Questionnaire

The following questionnaire shall be completed and attached to the *Supplier's* tender.

B.1. Company Profile

1. Please provide the following information:
   1.1. Name of Company.
   1.2. Company address.
   1.3. Date of establishment of Company.
2. Outline the Company's management structure.
3. State the company's staff complement.
   4.1. Administrative.
   4.2. Design (electronic/telecontrol hardware).
   4.3. Software.
   4.4. Production (electronic/telecontrol hardware).
   4.5. Drawing Office.
   4.6. Inspection and Quality Assurance.
   4.7. Support
   4.8. Other.
4. Briefly describe the sizes and capacities of your design, production and testing facilities.
5. Give a brief summary of your present range of equipment.
6. Briefly describe the nature of your resources in the Republic of South Africa: workshop facilities, test equipment, etc.

B.2. Industry Experience

1. If not already detailed in your answers to the above questions, state what experience you have had with substation control equipment.
2. *Supplier's* comparable sized Gateway/RTU project references:
   a) State the customer and hardware/software configurations of comparable-sized Gateway/RTU.
   b) List the systems that you have delivered or that are still in progress during the past five (5) years.
   c) Provide customers references and the contract values of similar Gateway/RTU systems listed above.
   d) Highlight the implementation details of those Gateway/RTU systems listed above, that utilized an OSI model protocol for the interchange of operational data between RTU functional units.
3. Schedule and completion history:
   a) Provide the original and actual delivery dates of those Gateway/RTU systems listed above.
   b) Where applicable, provide the major reasons for the delivery delays for those RTU systems that were delivered more than six months behind the original delivery schedule.

c) List and describe the number of Gateway/RTU projects that are currently in progress and/or planned to start through 2013/2014 versus the number of technical staff directly involved with the production of RTU systems.

4. Briefly describe your Gateway/RTU system development facilities.

B.3. Quality Assurance

1. Briefly describe your methods of ensuring that hardware and software ready for customer delivery has been quality assured and tested.
2. Indicate the quality assurance standards that are adhered to and indicate any nationally and internationally recognised body to which the *Supplier* is registered.

B.4. Technical Requirements

1. Provide, where applicable, the following Gateway and RTU computer subsystem information:
   a) Manufacturer and model.
   b) Processor details.
   c) Additional modules.
   d) Hardware limits. For example, minimum to maximum main memory sizing, processor upgrade possibilities, I/O sizes.
   e) Operating systems details.
   f) Direct Memory Access features.
3. Provide the basic Gateway and RTU hardware configuration diagram(s) with the upgrade path drawings or diagrams.
4. Equipment offline hardware diagnostics:
   a) List the offline hardware diagnostics provided and their features.
   b) Can the offline diagnostics be run from a remote position, down low speed communications links?
   c) Describe the testing procedure for equipment that does not have offline diagnostics.
   d) Describe to what level the offline diagnostics can detect a fault (e.g. subsystem level, board level, chip level).
5. Equipment online hardware diagnostics:
   a) List the online diagnostics provided.
   b) What is the degradation to the system while online diagnostics are running?
   c) How will the online diagnostics be executed?
6. State what operating systems and versions will be supplied.
7. Descriptions of *Supplier's* existing RTU software standards and programming languages:
   a) What programming languages are used?
   b) What percentage of RTU's software is not coded in a high-level, structured programming language?
   c) Describe your software design standards.
8. *Supplier's* Database Management System (DBMS).
   a) Provide a brief overview of the DBMS facilities provided.

b) Describe the resources required to generate the RTU database.

c) Describe the DBMS data creation and data modification procedures.

d) What security is provided to prevent unauthorized access to the database?

e) What DBMS backup procedures are provided?

f) What application language interfaces are provided for DBMS interfacing?

g) Describe the facilities provided for historical data collection.

h) Describe the expansion capabilities engineered into the ERTU and RTU hardware and software for point count increases beyond the expected maximums.

B.5. Communications equipment.

1. Provide the following information regarding any proposed communications equipment:
   a) Give the maximum number of communications channels handled, and the standard channels utilized.
   b) Give the types and descriptions of protocols utilized.
   c) Describe the type of communication link (ASYNC, X.21 etc.).
   d) Specify the modem channel expansion capabilities, and the estimated cost.
2. Describe the Communication software and its interfaces to the DBMS.
3. Describe how the RTU system availability requirements will be achieved with the proposed SCS configuration.
4. Briefly describe the extent of RTU software modification required when installing a new device driver into the system.
5. Identify any RTU programs that are still under development.
6. Describe the areas of your tender that specifically work towards satisfying the *Purchaser's* Gateway/RTU self-sufficiency goals.
7. *Supplier's* Details of the Proposed Gateway Configuration.
8. Briefly describe the testing techniques used to verify system performance with respect to response time and loading requirements.

B.6. Maintenance/Commissioning/Obsolescence/Spares/Repairs

1. State what development tools the *Purchaser* will require to implement and maintain the Gateway/RTU system.
2. Describe the maintenance policy for the system, both during and after the warranty period.
3. Describe the proposal recommendations regarding SCS system maintenance procedures for the life of the system.
4. Will the *Supplier* honour all warranties and guarantees if the *Purchaser's* personnel perform system maintenance functions?
5. Describe any specialized test equipment required for system maintenance that is generally not commercially available.
6. Describe how your proposed SCS configuration will combat premature system obsolescence.

7. Describe the recommended SCS spares holding with respect to the *Purchaser's* geographical location and system availability requirements.
8. Will all maintenance or repairs to equipment be done locally?
9. Describe your policy on availability of spare parts, expansion parts and technical support for a period of 10 years after system commissioning.

B.7. Telephonic and Local Support

1. *Suppliers* are to indicate if they are willing to provide local support to RTU/Gateway equipment at site, as well as all costs associated with this.
2. *Suppliers* are to specify the turnaround time required to commence such support and the volume of work, which can be catered for, as indicated in 1.
3. *Suppliers* are to indicate if they are willing to provide telephonic support, as well as the costs associated with this.

Appendix C: Eskom IEC60870-5-104 Interoperability Requirements

C.1. Interoperability List for the Eskom Implementation of IEC 60870-5-104 on a slave device

This interoperability list presents sets of parameters selected from the IEC60870-5-104 protocol for use on an Eskom slave device.

Certain parameter values, such as the number of octets in the common address of ASDUs, represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system.

Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in the IEC 60870-5-104 standard. The text descriptions of parameters which are not applicable to the IEC 60870-5-104 standard are strike-through (corresponding check box is marked black).

NOTE: In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows:

☐ Function or ASDU is not used

☒ Function or ASDU is used as standardized (default)

☒ **R** Function or ASDU is used in reverse mode

☒ **B** Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in the IEC 60870-5-104 standard.

C.1.1 System device

(System-specific parameter, indicate the definition of a system or a device by marking one of the following with an "**X**")

☐ System definition

☐ Controlling station definition (master)

☒ Controlled station definition (slave)

C.1.2. Network Configuration

(network-specific parameter, all configurations that are used are to be marked with an "X")

■ ~~Point-to-point~~

■ ~~Multiple point-to-point~~

■ ~~Multipoint-party line~~

■ ~~Multipoint-star~~

C.1.3. Physical Layer

(network-specific parameter, all interfaces and data rates that are used are to be marked with an “X”)

Transmission speed (control direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange Circuit X.24/X.27	
~~100 bit/s~~	~~2 400 bit/s~~	~~2 400 bit/s~~	~~56 000 bit/s~~
~~200 bit/s~~	~~4 800 bit/s~~	~~4 800 bit/s~~	~~64 000 bit/s~~
~~300 bit/s~~	~~9 600 bit/s~~	~~9 600 bit/s~~	
~~600 bit/s~~		~~19 200 bit/s~~	
~~1 200 bit/s~~		~~38 400 bit/s~~	

Transmission speed (monitor direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange Circuit X.24/X.27	
~~100 bit/s~~	~~2 400 bit/s~~	~~2 400 bit/s~~	~~56 000 bit/s~~
~~200 bit/s~~	~~4 800 bit/s~~	~~4 800 bit/s~~	~~64 000 bit/s~~
~~300 bit/s~~	~~9 600 bit/s~~	~~9 600 bit/s~~	
~~600 bit/s~~		~~19 200 bit/s~~	
~~1 200 bit/s~~		~~38 400 bit/s~~	

C.1.4. Link Layer

(network-specific parameter, all options that are used are to be marked with an “X”. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the type ID and COT of all messages assigned to class 2.)

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.~~

Link transmission procedures

- ~~Balanced transmission~~
- ~~Unbalanced transmission~~

Address

- ~~Not present (balanced transmission only)~~
- ~~One octet~~
- ~~Two octets~~
- ~~Structured~~
- ~~Unstructured~~

Frame length

~~Maximum length L (number of octets)~~

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission
9,11,13,21	<1>

~~A special assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission

~~NOTE: In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.~~

C.1.5. Application Layer

Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(System-specific parameter, all configurations that are used are to be marked with an "**X**")

~~One octet~~ [X] Two octets

Information object address

(System-specific parameter, all configurations that are used are to be marked with an "**X**")

■	~~One octet~~	[X]	Structured
■	~~Two octets~~	[X]	Unstructured
[X]	Three octets		

Cause of transmission

(System-specific parameter, all configurations that are used are to be marked with an "**X**")

■	~~One octet~~	[X]	Two octets (with originator address) Originator address is set to zero if not used

Length of APDU

(System-specific parameter, specify the maximum length of the APDU per system)

The maximum length of APDU for both directions is 253. It is a fixed parameter.

■ Maximum length of APDU per system in control direction

■ Maximum length of APDU per system in monitor direction

Selection of Standard ASDUs

Process information in monitor direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

[X]	<1> := Single-point information	M_SP_NA_1
■	~~<2> := Single-point information with time tag~~	~~M_SP_TA_1~~
[X]	<3> := Double-point information	M_DP_NA_1
■	~~<4> := Double-point information with time tag~~	~~M_DP_TA_1~~
[X]	<5> := Step position information	M_ST_NA_1
■	~~<6> := Step position information with time tag~~	~~M_ST_TA_1~~
[X]	<7> := Bitstring of 32 bit	M_BO_NA_1
■	~~<8> := Bitstring of 32 bit with time tag~~	~~M_BO_TA_1~~
[X]	<9> := Measured value, normalized value	M_ME_NA_1
■	~~<10> := Measured value, normalized value with time tag~~	~~M_ME_TA_1~~
[X]	<11> := Measured value, scaled value	M_ME_NB_1

■	~~<12> := Measured value, scaled value with time tag~~	~~M_ME_TB_1~~
X	<13> := Measured value, short floating point value	M_ME_NC_1
■	~~<14> := Measured value, short floating point value with time tag~~	~~M_ME_TC_1~~
X	<15> := Integrated totals	M_IT_NA_1
■	~~<16> := Integrated totals with time~~	~~M_IT_TA_1~~
■	~~<17> := Event of protection equipment with time tag~~	~~M_EP_TA_1~~
■	~~<18> := Packed start events of protection equipment with time tag~~	~~M_EP_TB_1~~
■	~~<19> := Packed output circuit information of protection equipment with time tag~~	~~M_EP_TC_1~~
X	<20> := Packed single-point information with status change detection	M_PS_NA_1
X	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
X	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
X	<31> := Double-point information with time tag CP56Time2a	M_DP_TB_1
X	<32> := Step position information with time tag CP56Time2a	M_ST_TB_1
X	<33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
X	<34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
X	<35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
X	<36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
X	<37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
X	<38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
X	<39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
X	<40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Process information in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	<45> := Single command	C_SC_NA_1
X	<46> := Double command	C_DC_NA_1
X	<47> := Regulating step command	C_RC_NA_1
X	<48> := Set point command, normalized value	C_SE_NA_1
X	<49> := Set point command, scaled value	C_SE_NB_1
X	<50> := Set point command, short floating point value	C_SE_NC_1
X	<51> := Bitstring of 32 bit	C_BO_NA_1
X	<58> := Single command with time tag CP56Time2a	C_SC_TA_1
X	<59> := Double command with time tag CP56Time2a	C_DC_TA_1
X	<60> := Regulating step command with time tag CP56Time2a	C_RC_TA_1
X	<61> := Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
X	<62> := Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
X	<63> := Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
X	<64> := Bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> - <51> or of the set <58> - <64> are used.

System information in monitor direction

(Station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	<70> := End of initialization	M_EI_NA_1

System information in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	<100> := Interrogation command	C_IC_NA_1
X	<101> := Counter interrogation command	C_CI_NA_1
X	<102> := Read command	C_RD_NA_1
X	<103> := Clock synchronization command	C_CS_NA_1
■	~~<104> := Test command~~	~~C_TS_NA_1~~

X	<105> := Reset process command	C_RP_NA_1
■	~~<106> := Delay acquisition command~~	~~C_CD_NA_1~~
X	<107> := Test command with time tag CP56Time2a	C_TS_TA_1

Parameter in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	<110> := Parameter of measured value, normalized value	P_ME_NA_1
X	<111> := Parameter of measured value, scaled value	P_ME_NB_1
X	<112> := Parameter of measured value, short floating point value	P_ME_NC_1
X	<113> := Parameter activation	P_AC_NA_1

File transfer

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	<120> := File ready	F_FR_NA_1
X	<121> := Section ready	F_SR_NA_1
X	<122> := Call directory, select file, call file, call section	F_SC_NA_1
X	<123> := Last section, last segment	F_LS_NA_1
X	<124> := Ack file, ack section	F_AF_NA_1
X	<125> := Segment	F_SG_NA_1
X	<126> := Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
X	<127> := Query Log – Request archive file	F_SC_NB_1

Type Identification and Cause of Transmission Assignments

(Station-specific parameters)

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: functions or ASDU not used.

Mark type identification/cause of transmission combinations:

"**X**" if used only in the standard direction;

"**R**" if used only in the reverse direction;

"**B**" if used in both directions.

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1		X	X		X						X	X		X					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1		X	X		X						X	X		X					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1		X	X		X						X	X		X					
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1		X	X		X									X					
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1	X	X	X		X									X					
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1	X	X	X		X									X					
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	X	X	X		X									X					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1			X												X				
~~<16>~~	~~M_IT_TA_1~~																			
~~<17>~~	~~M_EP_TA_1~~																			
~~<18>~~	~~M_EP_TB_1~~																			
~~<19>~~	~~M_EP_TC_1~~																			
<20>	M_PS_NA_1		X	X		X						X	X		X					
<21>	M_ME_ND_1	X	X	X		X									X					
<30>	M_SP_TB_1			X		X						X	X							
<31>	M_DP_TB_1			X		X						X	X							
<32>	M_ST_TB_1			X		X						X	X							
<33>	M_BO_TB_1			X		X														
<34>	M_ME_TD_1			X		X														
<35>	M_ME_TE_1			X		X														
<36>	M_ME_TF_1			X		X														
<37>	M_IT_TB_1			X												X				
<38>	M_EP_TD_1			X																
<39>	M_EP_TE_1			X																
<40>	M_EP_TF_1			X																
<45>	C_SC_NA_1						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	C_RC_NA_1						X	X	X	X	X						X	X	X	X
<48>	C_SE_NA_1						X	X	X	X	X						X	X	X	X
<49>	C_SE_NB_1						X	X	X	X	X						X	X	X	X
<50>	C_SE_NC_1						X	X	X	X	X						X	X	X	X
<51>	C_BO_NA_1						X	X			X						X	X	X	X

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<58>	C_SC_TA_1						X	X	X	X	X						X	X	X	X
<59>	C_DC_TA_1						X	X	X	X	X						X	X	X	X
<60>	C_RC_TA_1						X	X	X	X	X						X	X	X	X
<61>	C_SE_TA_1						X	X	X	X	X						X	X	X	X
<62>	C_SE_TB_1						X	X	X	X	X						X	X	X	X
<63>	C_SE_TC_1						X	X	X	X	X						X	X	X	X
<64>	C_BO_TA_1						X	X			X						X	X	X	X
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X	X	X	X						X	X	X	X
<101>	C_CI_NA_1						X	X			X						X	X	X	X
<102>	C_RD_NA_1																X	X	X	X
<103>	C_CS_NA_1						X	X									X	X	X	X
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1						X	X									X	X	X	X
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1						X	X									X	X	X	X
<110>	P_ME_NA_1						X	X							X		X	X	X	X
<111>	P_ME_NB_1						X	X							X		X	X	X	X
<112>	P_ME_NC_1						X	X							X		X	X	X	X
<113>	P_AC_NA_1						X	X	X	X							X	X	X	X
<120>	F_FR_NA_1													X			X	X	X	X
<121>	F_SR_NA_1													X			X	X	X	X
<122>	F_SC_NA_1					X								X			X	X	X	X
<123>	F_LS_NA_1													X			X	X	X	X
<124>	F_AF_NA_1													X			X	X	X	X
<125>	F_SG_NA_1													X			X	X	X	X
<126>	F_DR_TA_1[a)]			X		X														
<127>	F_SC_NB_1[a)]					X								X			X	X	X	X

[a)] Blank or X only.

C.1.6. Basic Application Functions

Station initialization

(Station-specific parameter, mark with an "**X**" if function is used)

[X] Remote initialization

Cyclic data transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[X] Cyclic data transmission

Read procedure

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[X] Read procedure

Spontaneous transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[X] Spontaneous transmission

Double Transmission of information objects with cause of transmission spontaneous

(station-specific parameter, mark each information type with an "X" where both a type ID without time and corresponding type ID with time are issued in response to a single spontaneous change of a monitored object)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

[ ] Single-point information	M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M _PS_NA_1
[ ] Double-point information	M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
[ ] Step position information	M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
[ ] Bitstring of 32 bit	M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
[ ] Measured value, normalized value	M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
[ ] Measured value, scaled value	M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
[ ] Measured value, short floating point number	M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

- [X] global
- [X] group 1
- [X] group 2
- [X] group 3
- [X] group 4
- [X] group 5
- [X] group 6
- [X] group 7
- [X] group 8
- [X] group 9
- [X] group 10
- [X] group 11
- [X] group 12
- [X] group 13
- [X] group 14
- [X] group 15
- [X] group 16

Information object addresses assigned to each group must be shown in a separate table

Clock synchronization

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

- [X] Clock synchronization
- [ ] Day of week used
- [ ] RES1, GEN (time tag substituted/ not substituted) used
- [ ] SU-bit (summertime) used

Command transmission

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

- [X] Direct command transmission
- [X] Direct set point command transmission
- [X] Select and execute command
- [X] Select and execute set point command
- [X] C_SE ACTTERM used
- [X] No additional definition
- [X] Short-pulse duration (duration determined by a system parameter in the controlled station)
- [X] Long-pulse duration (duration determined by a system parameter in the controlled station)
- [X] Persistent output
- [X] Supervision of maximum delay in command direction of commands and set point commands
- [**65535**] Maximum allowable delay of commands and set point commands

Transmission of integrated totals

(Station- or object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[X] Mode A: local freeze with spontaneous transmission

[X] Mode B: local freeze with counter interrogation

[X] Mode C: freeze and transmit by counter interrogation commands

[X] Mode D: freeze by counter-interrogation command, frozen values reported spontaneously

[X] Counter read

[X] Counter freeze without reset

[X] Counter freeze with reset

[X] Counter reset

[X] General request counter

[X] Request counter group 1

[X] Request counter group 2

[X] Request counter group 3

[X] Request counter group 4

Parameter loading

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[X] Threshold value

[X] Smoothing factor

[X] Low limit for transmission of measured value

[X] High limit for transmission of measured

Parameter activation

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[X] Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[X] Test procedure

File transfer

(Station-specific parameter, mark with an "**X**" if function is used)

File transfer in monitor direction

[X] Transparent file

[X] Transmission of disturbance data of protection equipment

[X] Transmission of sequences of events

[X] Transmission of sequences of recorded analogue values

File transfer in control direction

[X] Transparent file

Background scan

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[X] Background scan

Acquisition of transmission delay

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

[ ] ~~Acquisition of transmission delay~~

Definition of time outs

Parameter	Default value	Remarks	Selected value
t_0	30 s	Time-out of connection establishment	30 (configurable)
t_1	15 s	Time-out of send or test APDUs	15 (configurable)
t_2	10 s	Time-out of for acknowledges in case of no data messages $t_2 < t_1$	10 (configurable)
t_3	20 s	Time-out of for sending test frames in case of a long idle state	20 (configurable)

Maximum range for timeouts t_0 to t_2: 1s to 255 s, accuracy 1 s.

Recommended range for timeout t_3: 1s to 48 h, resolution 1 s.

Long timeouts for t_3 may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).

Maximum number of outstanding I format APDUs *k* and latest acknowledge APDUs *w*

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	12 (configurable)
w	8 APDUs	Latest acknowledge after receiving *w* I format APDUs	8 (configurable)

Maximum range of values *k*: 1 to 32767 (2^{15} – 1) APDUs, accuracy 1 APDU.

Maximum range of values *w*: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation *w* should not exceed two-thirds of *k*).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	In all cases

Redundant connections

10	Number N of redundancy group connections (simultaneous) used

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard.

- [X] Ethernet 802.3
- [ ] Serial X.21 interface
- [ ] Other selection form RFC 2200

C.2. Eskom Information Object Address Values

This section lists the Information Object Address values for the different ASDUs and address structure used on the Eskom master and slave devices.

C.2.1. Eskom ASDU information object values

IEC ASDU	Information Object Address Range
Single point information	1 to 10 000
Double point information	10 001 to 15 000
Step position information	15 001 to 20 000
Measured value	20 001 to 25 000
Integrated totals	25 001 to 30 000
Single command	30 001 to 35 000
Double command	35 001 to 40 000
Bitstring of 32 bit command (lamp drive outputs)	40 001 to 43 000
Bitstring of 32 bit command (AGC outputs)	43001 to 45 000
Set-point command (meter drive outputs)	45 001 to X
Set-point command (set-point outputs)	(X+1) to 65 355

Notes:

1. Bitstring of 32 bit commands for AGC are fixed to start at address 43 001
2. If no meter drives are present then set-point commands start at address 45 001.

C.2.2. Eskom Address Structure

Field	Length in octets
Type identification	1
Variable structure qualifier	1
Cause of transmission	2
Common address of ASDU	2
Information object address	3

C.3. Additional Eskom Information

This section outlines additional information.

C.3.1. Clock Synchronisation

If the Remote Terminal Equipment is unable to be time synchronised by the local GPS due to the failure of the local GPS, then Remote Terminal Equipment must be synchronised by the Eskom Master device.

C.3.2. Classes of Data

Table 1 below indicates the assignment of ASDUs to Class 1 and Class 2 messages.

	Type Identification
Class 1	1,3,30,31
Class 2	5,7,9,11,13,15,21,32,33,34,35,36,37

Table 1: Assignment of ASDUs