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TITLE	STANDARD FOR MAINTENANCE AND REPAIR OF SCADA FIELD EQUIPMENT.	REFERENCE	REV
		CP_TSSTAN_104	0
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## **FOREWORD**

Recommendations for corrections, additions or deletions shall be addressed to the:

Technology Services General Manager

City Power Johannesburg (SOC) Ltd

P O Box 38766

Booyens

2016

## **INTRODUCTION**

City Power uses SCADA systems for remote Monitoring, control and operation of the electricity network and for safety and emergency network operations. The SCADA system further assists with quicker restoration of customers during power outages. City Power's Tele-control network consists of SCADA system that interface of the Master Station to the electrical network via a system of RTU's and Gateway's over the City Power telecommunications communication network.

All communication and interfacing between the RTU and /or gateway and field equipment are either wired or wireless. The interface makes provision for all required Inputs and Outputs which includes Digital Inputs, Analogue Inputs and Accumulator Inputs as well as Digital Outputs. IEDs are typically interfaced through either an IED interface module in the RTU or an industrial Ethernet switch using the IEC61850 Protocol via a gateway.

City Power requires the services of a knowledgeable Service Provider to compliment the current existing staff through the maintenance of SCADA field devices which includes without being limited to RTU, Gateways and modems.

## **1. SCOPE**

The scope entails maintenance and repair of City power's SCADA RTU's and associated filed equipment. The document provides functional and performance requirements for RTU and Gateways. It also gives details on inspections, maintenance, commissioning and repairs of all SCADA system. SCADA equipment comprises of without out being limited to the equipment listed below which includes devices such as peripherals, power supplies, cabling and cabinet accessories.

- A. Remote Terminal Units (RTUs).
- B. RTU Input/output Modules Components
- C. Digital Input Modules
- D. Analogue Input Modules
- E. Annunciator Input Modules
- F. Digital Output Modules
- G. Dummy Relay
- H. CPU Module
- I. Data Concentrators or Gateways.
- J. Ethernet/Multilink Switches.
- K. System Performance

## **2. NORMATIVE REFERENCES**

The following standards and specifications contain provisions that, through reference in the text, constitute requirements of this specification. At the time of publication, the editions indicated were valid. All standards and specification are subject to revision and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards and specification listed below.

IEC 61850, *Communication Networks and Systems in Substations*.

IEC 60870-6, *control Equipment and Systems*.

IEC 60529, *Degrees of Protection Provided by Enclosures (IP Code)*.4

IEEE Std 525™, *IEEE Guide for the Design and Installation of Cable Systems in Substations*.

IEEE Std 1379™, *IEEE Recommended Practice for Data Communications between Intelligent electronic Devices IED and Remote Terminal Units RTU's in a Substation*.

IEEE Std 1588™, *IEEE Precision Clock Synchronization Protocol for Networked Measurement and*

*Control Systems.*

IEEE Std 1613™, IEEE Standard Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations.

IEEE Std 1615™, IEEE Recommended Practice for Network Communication in Electric Power Substations.

IEEE Std 1646™, IEEE Standard Communication Delivery Time Performance Requirements for Electric Power Substation Automation.

IEEE Std C37.115™, IEEE Standard Test Method for Use in the Evaluation of Message Communications between Intelligent Electronic Devices in an Integrated Substation Protection, Control, and Data Acquisition System.

### **3. DEFINITIONS AND ABBREVIATIONS**

The definitions and abbreviations in the above documents shall apply to this specification.

#### **3.1 Terms and Definitions**

**Accuracy:** *The difference between the actual value of a measurement and the indicated value of the measurement.*

NOTE—Accuracy is usually expressed in terms of percentage deviation from a reference value, commonly full scale of the measuring device and less commonly the actual value at the input.

**Chatter filter:** *A facility that is used to disable a digital input point if the number of state changes of that point during a defined time interval is excessively high.*

**Clear time:** *The amount of time that the selected relay will continue to operate after the master trip or close has operated. Clear time can also mean operating time.*

**Diagnostics:** *Programs executed to check the health of the device on either a periodic or random interval.*

**Local area network (LAN):** *A LAN is a network normally designed for a limited geographical area, such as a utility substation or an office area. It is generally capable of transmitting data, voice, and image and video information.*

**Virtual input/output (I/O):** *An I/O point such as status, control, or analogue that is not physically wired to an IED.*

**Distributed Network Protocol:** *is a set of communications protocols used between components in process automation systems. Its main use is in utilities such as electric and water companies.*

**MUX: (Multiplexer)** *multiplies signals into a single fibre using different wavelengths / frequencies of light where each wavelength can send different types of data. DEMUX separates the signals again at the receiving end.*

**SENS card-** *is a card with a relay in series with the Tireg card, to provide power to the tireg card and protect the microprocessor from any short circuit output. It also used as a sensor for output voltage used for controls.*

**Ancill card** – *this card is used to power the Tireg card ancillary card ON/OFF and fro disabling the control functions.*

**Tireg card** – *Power supply card with three regulated D.C. output voltage s: +5v, -15v and +15v.*

**TOTA card** - Is used as digital inputs for alarms and C/B status.

**Modbus:** is a serial communication protocol developed by for use with its programmable logic controllers (PLCs). In simple terms, it is a method used for transmitting information over serial lines between electronic devices.

### 3.2 Abbreviations

CPU	Central Processing Unit.
DNP3	Distributed Network Protocol
EMS	Energy Management System.
GUI	Graphical User Interface.
HMI	Human Machine Interface.
IEC	International Electro technical Commission.
IED	Intelligent Electronic device. Generic name given to all microprocessor based substation secondary devices e.g. Relays, tariff meters, etc.
I/O	Input / Output.
ISA	Instrumentation, Systems and Automation Society.
ISO	International Standards Organization.
LAN	Local Area Network.
LCP	Local Control Panel.
MTBF	Mean Time Between Failures.
MUX	Multiplexer
RTU	Remote Terminal Unit.
SABS	South African Bureau of Standards.
SC	Serial Cable.
SCADA	Supervisory Control And Data Acquisition.
TNC	Transmission National Contract
ORHVS	Operations Regulation for High Voltage Systems
UPS	Uninterruptable Power Supply.

## 4. GENERAL

- 4.1 Integration between the substation's secondary plant and the SCADA Master Station system is by means of RTU's or Gateway's to facilitate supervisory functions as well as network based communication for the purpose of monitoring, controlling and operating equipment such as transformers, feeder bay equipment, fire detection, Load Management / Ripple control, optical fibre, battery chargers and AC changeover systems.
- 4.2 Integration of this equipment entails configuration of a stand-alone RTU/Gateway, interfaced to plant via dedicated I/O cards, including wired or wireless connectivity between Protection schemes (IEDs) and the RTU/Gateway in compliance with SANS 61850.
- 4.3 SCADA system components or accessories shall comply with the standards applicable when they were originally installed or with an alternative standard, or better than, the specified standard. Equipment used in the SCADA networking communication system installation shall be certified as compliant with the relevant standards and approved by City Power.
- 4.4 Communicate to the Master Station directly via modems or via the MUX system and use the protocols - DNP3.0, or IEC61870 or Tetra or GSM. Some stations may use Modbus and use proprietary protocols such as ABB SPA bus.

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- 4.5 Equipment used shall meet City Power's functional and interface requirements, be economically feasible and conform to industry standards as specified in this document and.
- 4.6 Communications between IEDs and the gateway is by means of electrical or optical Ethernet networks using industrial grade switches or hubs (where applicable). Supply of all plant-side communication equipment is the responsibility of the Service Provider.
- 4.7 The system polls each IED individually which enables the RTU or gateway to apply quality flags to the data elements derived from an individual IED – should the unit fail or communication to the unit fail, the data is marked as off-line within the RTU or gateway real-time database and communicated as such to the master station.
- 4.8 All plant communication equipment is powered by the dedicated 48VDC battery and DC supply. No standalone UPS units are to be used to power any of the IEDs or communication equipment
- 4.9 To cater for the failure mode where the relay detects an internal fault, but is still able to communicate with the RTU/gateway - such failure status is communicated to the RTU/gateway provided that all other potentially corrupt data from the IED is flagged as 'off-line' and communicated as such to the master station. Alternatively, if the IED detects an internal fault, it is programmed to halt all communications to the RTU/gateway, whereupon the RTU/gateway shall mark the data as indeterminate, generate an 'IED faulty' alarm and communicate such to the master station.
- 4.10 Full support for data quality flags is required to ensure that indeterminate states are reported as such, and no possibility exists of communicating stale data to the SCADA master station as a result of the failure of a system component or the communication network.

## **5. DETAILS OF RESPONSIBILITIES**

### **5.1 Service Providers Responsibilities**

- 5.1.1 The Service Provider shall undertake emergency repairs of SCADA systems. The Service Provider shall perform emergency repairs on short notice during and after normal working hours. The above repairs shall be executed within the agreed upon time frames as detailed in the table below (response time).
- 5.1.2 AD-hoc work shall consist of connecting and testing alarms and/or monitoring systems to SCADA. This shall only apply where DC alarms are available from the DC system and SCADA is also available at the station, thereby only requiring the connection and testing of the alarms to SCADA.
- 5.1.3 The Service Provider shall replace faulty equipment with equivalent or better while and ensure business continuity while the faulty component is sent for repairs.
- 5.1.4 The Service Provider Shall perform on site end-to-end testing on each connected function from primary plant and protection devices to remote control centre.
- 5.1.5 Ensure safety and operating procedures are adhered to while testing functions in remote locations.
- 5.1.6 Assist with the creation and continuous improvement of safe working procedures.
- 5.1.7 Test systems under simulated outage conditions to ensure continuous operation in order to supply vital information to system control under real outage conditions.
- 5.1.8 Repair faulty alarms, controls and status indications (point faults).
- 5.1.9 Witnessing of commissioning of new RTU/Gateway installations and commissioning of RTU/Gateway installations as required.
- 5.1.10 The Service Provider Shall assist in ensuring that all installations have been properly commissioned and alarms correctly configured.
- 5.1.11 The Service Provider shall ensure the availability of its resources as and when required to address arising problems.
- 5.1.12 A standby roister shall be provided for dispatching purposes.

5.1.13 It is the Service Provider's responsibility to provide the appropriate tools and test equipment which includes vehicles, test equipment and laptops.

## **5.2 Tests:**

- 5.2.1 Each digital input shall be checked for correct operation. (No voltage changes outside the relevant range shall be accepted).
- 5.2.2 Control output points shall be fully tested for correct operation.
- 5.2.3 Annunciator/counters inputs shall be tested for correct registration of input pulses.
- 5.2.4 Accuracy of the measured inputs and outputs shall be tested to 0, 25%, 50%, 75% and 100% of full scale in both directions.
- 5.2.5 Alarm conditions, such as communications failure, power failure, etc., shall be simulated and all alarm, indication and controls outputs shall be checked for correct operation. (For example the C/B operation).
- 5.2.6 Tests for SCADA equipment shall be covered by or the extension of SANS 61850 and other related standards. The tests agreed upon shall be witnessed by City power's authorized personnel.  
**NB!!! Test certificates shall be provided by the Service Provider after any modifications or alterations. Templates shall be agreed upon by City Power and the Service Provider.**

## **5.3 Maintenance/Repairs.**

- 5.3.1 The maintenance duties shall include preventative maintenance of all the other components of the RTU/Gateway, fault finding and repair of the RTU/Gateway and the SCADA communication systems. Also required shall be the upgrade of obsolete RTU/Gateway where necessary and this service shall include the fitting, connection and configuration of the RTU/Gateway system.
- 5.3.2 The commissioning duties shall include the testing of any new, refurbished or modified RTU/Gateway system to Master Station.
  - a) IEC 60870-5-101/104 Point Mapping Convention and Protocol Compatibility
  - b) Time Tagging
  - c) Overall System Response Time
  - d) Plant to IED Addressing Scheme
- 5.3.3 The service provider shall perform monthly routine maintenance on each site. The attached checklist shall be used during maintenance

## **5.4 Qualifications And Access Requirements**

- 5.4.1 The Service Provider shall have skilled and experienced resources with a National Diploma in Electrical Engineering (HC/LC) as a minimum qualification and a minimum of two years' experience in the SCADA environment. Skilled staff shall be knowledgeable and familiar the standards under normative reference.
- 5.4.2 Access to city Power's network shall be granted subject to a valid ORHVS certificate as per OHS ACT and City Power's System Operating Regulation. The ORHVS course shall be rendered by city power at the Service Providers cost and the resource shall be issued with a certificate as proof of qualification. Equivalency certificates by an accredited organization shall be validated and approved by City Power's authorized personnel.
- 5.4.3 The Service Providers need to have full knowledge and understanding of SCADA systems which includes SCADA equipment, interconnecting devices and related protocols.
- 5.4.4 Service Providers shall not access or work on City Power's network in absence of City powers authorized personnel. The standard Service Provider's responsibility form shall be signed to authorize and grant access.
- 5.4.5 Resources shall be granted access by City powers management when all the requirements stated in clause6 have been met and the Service Provider shall be penalized for the deployment of unrecognized and unapproved resources on City Power's Network.

- 5.4.6 The Service Provider shall be responsible for its resources as well as liable for any damages. The Service Provider shall be penalized for outages and prolonged outages that result from its negligence.

## **5.5 City Powers Responsibilities**

- 5.5.1 The plan shall be approved by City power's Secondary Plant maintenance.
- 5.5.2 City power shall only recognize names that were submitted with the tender document as qualifying and available to work on City power's network. Additional and replacement personnel shall not be permitted unless approved and authorized by City power's secondary plant management following a written application, with valid reasons, accompanied by the required supporting documents and the above mentioned qualification criterion.

## **6. TRAINING**

- 6.1 The suppliers shall provide comprehensive training courses in a language that shall be understandable to all City Power personnel on the following:
- i. 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.
  - ii. System configuration and system maintenance training:**  
This training would include computer system operation, hardware maintenance, computer Service Provider software and relevant operating system aspects.
  - iii. 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 printed circuit board and/or component level.
- 6.2 All aspects of the training shall be supplemented with periods of practical training; this shall apply to all courses and be implemented where applicable.
- 6.3 The Service Provider shall also be required to provide training to City Power technical resources on the system when enhanced features and functionality becomes available as the system is upgraded.
- 6.4 The tenderer shall quote separately as an option the cost of subsequent training courses for the duration of the contract.
- 6.5 The suppliers shall provide technical support on system and equipment queries for the duration of the contract.

## **7. DOCUMENTATION**

- 7.1 Technical product catalogue and operating manuals for all equipment shall be provided.
- 7.2 A copy of proposed maintenance schedules shall be provided.
- 7.3 The service provider shall make available all documentation for all equipment used and services rendered in both hard and soft copy.
- 7.5 The Service provider shall prepare Inspection; repairs and functional performance test report covering all information, data sheets, and a comprehensive summary describing any test. The test report shall be submitted to a City Power Responsible person.
- 7.6 In cases where services of the 3<sup>rd</sup> party or Service Provider are used, the Service Provider shall supply copies of all test reports manually and electronically. Preference shall be given to computerized test reports submitted via email and with a hard copy issued later to Secondary Plant Management.

- 7.7 Test results for all repairs and installations shall be submitted. A hardcopy as well as electronic reports (Excel readable) shall be submitted for any repair or ad-hoc work done.
- 7.8 Each test report submitted by the Service Provider shall have as a minimum the following information displayed on the front page:
- a) The Service Provider's company logo.
  - b) The name and signature of the person who has compiled the report.
    - c) The date and time of the test.
    - d) The substation name and the equipment make, model and serial number.
- 7.9 Each test certificate submitted by the Service Provider shall have as a minimum the following information:
- 7.10 This shall imply that the Service Provider shall make available an RTU/Gateway and an IEC 60870-5-101/104 simulator to City Power for use in system testing directly connected to SCADA Master Station. However, it shall be the responsibility of the Service Provider to provide all equipment required to measure system performance.
- NB. No handwritten reports shall be accepted, reports shall be typed.**

## **8. QUALITY MANAGEMENT**

A Quality Management Plan/System shall be set up in order to assure the quality of the SCADA system during design, development, production and servicing. Guidance on the requirements for a quality management system may be found in the following standards: ISO 9001:2015. The details shall be subject to agreement between the City Power and Supplier/Service Provider.

## **9. HEALTH AND SAFETY**

A Health and Safety Plan/System shall be set up in order to ensure proper management and compliance of the SCADA system during installation, operation, maintenance, and decommissioning phase/s. Guidance on the requirements of a Health and Safety Plan/System may be found in OHSAS 18001:2007 standards. This is to ensure that the asset/service conforms to standard operating procedures and City Power SHERQ Policy. The details shall be subject to agreement between City Power and the Supplier/Service Provider.

## **10. ENVIRONMENTAL MANAGEMENT**

An Environmental Management Plan/System shall be set up in order to ensure the proper environmental management and compliance of the SCADA system during its entire life cycle (i.e. during design, development, production, installation, operation and maintenance, decommissioning as well as Rehabilitation, Recycling or Disposal phase/s). Guidance on the requirements for an environmental management plan/system may be found in ISO 14001:2015 standards. The details shall be subject to agreement between City Power and the Supplier. This is to ensure that the asset created conforms to environmental standards and City Power SHERQ Policy

## 11. SCHEDULE OF RATES

ITEM NO.	DESCRIPTION	COST PER KM
<b>6</b>	<b>TRAVEL COST</b>	
6.1	From office to site (per radius)	R
	<b>SUB TOTAL</b>	R
	<b>15% VAT</b>	R
	<b>TOTAL</b>	R

**Table1. Travelling Costs**

<b>4</b>	<b>SKILLS COST DURING OFFICE HOURS (08H00 TO 17H00)</b>	<b>COST PER HOUR</b>
4.1	Engineer (B.Sc. Eng.) per hour	R
4.2	Technologist (B.Tech.) per hour	R
4.4	Technician (S4/N6) per hour	R
	Matric / N3 per hour	R
	<b>SUB TOTAL</b>	R
	<b>15% VAT</b>	R
	<b>TOTAL</b>	R

**Table 2 — Labour costs during office hours**

<b>4</b>	<b>SKILLS COST AFTER OFFICE HOURS</b>	<b>COST PER HOUR</b>
4.1	Engineer (B.Sc. Eng.) per hour	R
4.2	Technologist (B.Tech.) per hour	R
4.4	Technician (S4/N6) per hour	R
	Matric / N3 per hour	R
	<b>SUB TOTAL</b>	R
	<b>15% VAT</b>	R
	<b>TOTAL</b>	R

**Table 3 — Labour costs After office hours including weekends and public holidays.**

The following tables shall be completed. The rate per hour shall be inclusive of all chargeable items.

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4	SKILLS COST	COST PER HOUR
4.1	Simulation and/or repair of relay data points for SCADA functionality	R
4.2	Signal mapping on RTU.	R
4.4	Programming and software configuration of telecom microprocessor /RTU/Gateway/Multilink manage switches.	R
	Retrieval of electronic modules (potables) which are repaired and stored for future use.	R
	Perform on-site, end-to-end commissioning of individual connected functions from primary plant and protection devices to remote control centre.	R
	Investigate and remedy faulty alarms, controls and status indications (point faults).	R
	Calibration of measurement modules.	R
	RTU/Gateway Installation and commissioning.	R
	Inspections	R
	Repairs	R
	Equipment failure and alarm	R
	Remote control	R
	Configuration and programming	R
	Circuit breaker status	R
	Analogue discrepancy	R
		R
	<b>SUB TOTAL</b>	R
	<b>15% VAT</b>	R
	<b>TOTAL</b>	R

#### Table 4 List of tasks maintenance tasks and Rates

[illegible]

### Table5 Repair and replacement when required

The service provider shall price repair and maintenance for each component as per table below. The installation price shall be factored into the overall price. Obsolete equipment that has outlived the support life shall be replaced with latest and compatible device of similar quality.

## **Annex A – Bibliography**

None

**Annex B – Revision information**

<b>DATE</b>	<b>REV. NO.</b>	<b>NOTES</b>
APRIL 2019	0	First issue

**Annex C: CHECKLISTS**

Name	ID Number	Function	Highest Qualification /Courses	Date accredited	ORHVS Expiry date	Years experience	Type of experience

Checklist 1 the following Checklist shall be completed. Detailed CV's shall also be submitted with the tender.

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ITEM	VISUAL INSPECTION	OUTCOME	COMMENTS
1	Micro processor		
2	Gateway		
3	Digital I/O cards		
4	<b>Analogue protection card</b>		
5	Power supply		
6	Modem		
7	Communication convertor		
8	Protocol convertor		
9	<b>Sens execute card –</b>		
10	<b>Ancill card –</b>		
11	<b>Tireg card</b>		
12	<b>TOTA card -</b>		

## Checklist 2 Inspection

ITEM	TEST DESCRIPTION	OUTCOME	COMMENTS
1	RTU processor testing and power supply		
2	RTU Power supply source, AC or DC		
3	Analogue module communication to RTU		
4	RTU communication to master station		
5	Digital modules, communication to RTU		
6	Control modules, communication to RTU		
7	Communication of IED's to RTU		
8	Status of CB's at System Control		
9	CB's analogues updating at System Control		
10	Battery Charger alarms to system control		
11	battery charger AC voltage level		
12	Battery charger DC voltage level		

## Checklist 3 Test

Comments	Defects	Corrective Action

## Checklist 4 Comments and defects

Equipment Checklist:

Date: \_\_\_\_\_

Substation Name: \_\_\_\_\_

Responsible Person: \_\_\_\_\_

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