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TITLE **SPCIFICATION FOR SCADA RTU**

REFERENCE **CP_TSSPEC_268**

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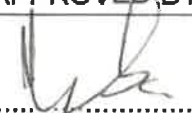

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FOREWORD

This standard was prepared by the following work group members:

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The work group was appointed by the Distribution Study Committee, which, at the time of approval, comprised of the following members:

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INTRODUCTION

1. SCOPE

This document specifies the details of the Substation SCADA and equipment requirements for City Power that shall be suitable for a combination of hardwiring of Inputs and Outputs as well as network based communication between IEDs for newer equipment and bays and the RTU/Gateway. The specification outlines City Power's requirements for the Supply, Installation Configuration and commissioning of its RTUs.

All communication and interfacing between the RTU and existing/older plant equipment shall be hardwired and network based. The hardwiring shall make provision for all required Inputs and Outputs which will include Digital Inputs, Analogue Inputs and Accumulator Inputs as well as Digital Outputs. All relays will either be interfaced to an IED interface module in the RTU, or alternatively an Ethernet switch using the IEC61850 Protocol which is connected to a gateway.

The range of SCADA equipment to be supplied shall comprise of the following:

- Remote Terminal Units (RTUs).
- Modems
- Ethernet Switches.
- Peripheral equipment such as power supplies, cabinets, cabling, etc.

2. NORMATIVE REFERENCES

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

Document	Description
NRS 083 - 3:	<i>Electromagnetic Compatibility (EMC) in Electricity Utility Networks. Secondary equipment installations in substation rooms</i>
IEC 60870-5::	<i>Telecontrol Equipment and Systems (Transmission Protocol)</i>
IEC 61850-3:	<i>General Requirements Part 3</i>
IEC 61850-5	<i>Communication requirements for functions and device models Part 5</i>
IEC 61850-9-1:	<i>Specific Communication Service Mapping (SCSM). Sampled values over serial unidirectional multi-drop point to point link Part 9-1</i>
IEC 60255 - 27	<i>Measuring Relays and Protection Equipment (Product safety requirements)</i>
IEC 61850-7-1:	<i>Basic communication structure for substation and feeder equipment. Principles and models Part 7-1</i>
SANS 60529	<i>Degrees of Protection Provided by Enclosures (IP Code)</i>
IEC 60255 - 1	<i>Measuring Relays and Protection Equipment (Common Requirements)</i>
IEC 60068 - 2:	<i>Electronic Equipment And Product Standards</i>
IEC 60950 - 1:	<i>Standard on Information And Technology Equipment</i>
IEC 60870-5-6:	<i>Telecontrol equipment and systems – Part 5-6 (Guidelines for conformance testing for the IEC 60870-5 companion standards)</i>
IEC 60068-2-6:	<i>Environmental testing</i>

3. DEFINITIONS AND ABBREVIATIONS

IED – Intelligent Electronic Device/Relay capable of serial communication

The Service provider – person or company responsible for the execution of work as defined in this contract document.

Relay – protection device and/or control device.

Work - The maintenance or commissioning of the protection and control systems as detailed in this contract document.

Distribution Network – The 11kV and the 6.6kV network.

Transmission Network – The 22kV, 33kV, 44kV, 88kV, 132kV and 275kV network.

DC- Direct Current

CT- Current Transformer

VT- Voltage Transformer

RTU – Remote Terminal Unit

SCT- Saturation of Current Transformer

AutoCAD- Commercial computer-aided design and drafting software application

Mini RTU - radio communication modem with built in inputs and outputs that can be set and read using the IEC-680870-5-101/104 and DNP3. Must have serial data interfaces (RS-232 or RS-485/422) and an Ethernet (10/100 Mbits/sec) port.

4. REQUIREMENTS

4.1 Environmental conditions

Ambient temperature range of -20°C to $+65^{\circ}\text{C}$ with relative humidity 5-95% @ 50°C

- a) Storage temperature range of -20°C to $+65^{\circ}\text{C}$
- b) Mechanical vibrations, Sinusoidal 0.07mm @ 10 to 30 Hz, 0.035 mm @ 30-60 Hz
- c) Altitudes from -200m to +2000 meter relative to sea level

4.2 General Requirements

- 4.2.1 The RTU shall be suitable for industrial enclosure or 19" (19 inch) rack installation.
- 4.2.2 The RTU/Gateway equipment shall be supplied within its own steel cabinet.
- 4.2.3 All hardwired functionality shall be connected to the RTU/Gateway I/O modules through rail mounted or plug in DIN rail where required.
- 4.2.4 The RTU (and therefore the Substation-LAN or S-LAN) shall operate on at least a fast-Ethernet link (i.e. 100Mbps).
- 4.2.5 The RTU shall interface by means of serial, optical, copper and Ethernet networks using industrial grade, managed switches or hubs where applicable.
- 4.2.6 The modems offered in this tender shall be compatible to the existing Tetra and fibre telecommunication network.

-
- 4.2.7 The Remote Terminal Unit (RTU) shall be an intelligent unit capable of performing data acquisition, data processing and local control. It shall be able to monitor and control or exchange information with local equipment.
- 4.2.8 The I/O shall be of modular construction where large I/O capability is required and to accommodate future expansion.
- 4.2.9 The RTU shall be supplied with the number and type of I/O points indicated later in these specifications. Future expansion of a modular product shall be possible by simply plugging additional I/O modules into the I/O bus on the interconnect board.
- 4.2.10 All hardwired functions shall be connected to the gateway input / output modules through rail mounted disconnect terminals, with facility to connect to I/O modules without restriction at a future date, and to enable testing of these functions.

4.3 Power Supply Modules

- 4.3.1 THE RTU shall be powered by one of the dedicated substation DC' Supplies detailed below.
- 4.3.2 RTU Voltage Range
- a) Option1; 20 to 55v DC
 - b) Option2; 100 to 300v DC
 - c) Option3: 100 to 240 v AC
- 4.3.3 The RTU shall be equipped with short circuit protection outputs and overheating protection.
- 4.3.4 The Power supply module shall indicate on and off status using LED's
- 4.3.5 The module shall switchover to battery upon power failure and to main power upon power return
- 4.3.6 The module shall be capable of over-charging protection over-discharge protection
- 4.3.7 The DC power supply shall be equipped with two auxiliary voltage outputs, short circuit protection outputs, Overvoltage protection for CPU and I/O's as well as reverse voltage protection.
- 4.3.8 The RTU shall generate and send an alarm whenever the power fails.

4.4 Communication Ports

- 4.4.1 The RTU shall have a built-in Ethernet ports 10/100 Mbps (expandable to three ports)
- 4.4.2 The RTU shall have a built-in serial RS-232 ports (expandable to four ports)
- 4.4.3 The RTU shall have a built-in serial RS-485 ports (expandable to three ports)
- 4.4.4 Have atleast one USB Port.

4.5 Communication Protocols

- 4.5.1 The RTU shall as a minimum support the following third party standard SCADA Protocols:
- a) IEC 61850
 - b) IEC 60870-5-101: Slave on RS-232 or RS - 485
 - c) IEC 60870-5104: SLAVE on Ethernet
 - d) DNP 3.0 Plus: Master & slave on RS-232/RS-485/Ethernet

4.6 Input/output Modules

- 4.6.1 The RTU shall be capable of addressing various I/O configurations by addition of modules. Each module shall communicate with the CPU module via a high-speed data bus.
- 4.6.2 IO modules shall have LEDs to indicate status on each module

4.7 I/O Sizing

4.7.1 The typical I/O counts for large, medium and small RTU/Gateway systems are provided below:

A. Bulk Substation I/O Count

- Digital Inputs: 1000
- Control Outputs: 200
- Analogue Inputs: 50
- Counters: 30

B. Major Substation I/O Count

- Digital Inputs: 500
- Control Outputs: 100
- Analogue Inputs: 20
- Counters: 20

C. Satellite Substation with IEDs I/O Count

- Digital Inputs: 200
- Control Outputs: 70
- Analogue Inputs: 16
- Counters: 10

D. Satellite Substations without IEDs (Mini RTU) I/O Count

- Digital Inputs: 32
- Control Outputs: 8
- Analogue Inputs: 4

4.7.2 Analogue inputs shall also be capable of accepting 0 - 5mA, 0 - 20mA and 4 - 20mA signals from such transducers. Critical Analogue transducers shall have 4 - 20mA outputs in order to detect a broken link or transducer failure should the signal drop below 4mA.

4.7.3 The input circuitry shall not present more than 250 Ohms load to the transducer.

4.7.4 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.

4.7.5 No potentiometers shall be used to scale any of the inputs. All input scaling shall be done via scaling adapters and software configuration.

4.7.6 With 150 volts D.C. or 100 volts r.m.s. A.C. (50 Hz - 300 Hz) applied common mode to the analogue inputs, the Analogue to Digital converter count shall not change by more than ± 2 counts.

4.7.7 With 1.5 volts A.C. (50 Hz and 1 MHz) applied differentially to the analogue inputs, the Analogue to Digital converter count shall not change by more than ± 2 counts.

4.7.8 Each analogue input shall be represented by a minimum of a 12 bit signed binary value. Each input shall be provided with individual software filtering.

4.8 Accumulator Input Modules

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

4.8.2 All accumulator inputs shall accept input pulse rates of up to 20 pulses per second. Each accumulator shall be reset under three conditions:

- Under remote control.
- On a pre-set time.
- After a given time period.

4.9 Digital Output Modules

4.9.1 Digital outputs shall comprise potential free contacts rated for switching. Relays shall conform to IEC 60255-3.

4.9.2 Loads shall be typically:

- 125V DC 0,5 Amp Resistive
- 240V AC 2 Amps
- 24V DC 1 Amp

4.9.3 Appropriate relays shall be selected for the specific type of load.

4.10 CPU Module

4.10.1 The RTU shall be microprocessor based. Once power is supplied to the unit, it shall be designed to operate without manual intervention; additionally, it shall auto restart and be able to communicate with the master station without reporting spurious state changes on power resumption after a power failure.

4.10.2 Suitable, reliable indicators such as LEDs shall be provided for personnel to readily ascertain the status of the RTU.

4.10.3 The processor shall monitor the health of the RTU with built-in diagnostics, which are capable of remote interrogation including diagnostics for memory and bus errors, buffer overflows, local software routine health, communication ports status, input/output card health.

4.10.4 Diagnostics shall also be supplied that shall permit complete testing of the RTU with a portable computer. Diagnostic checking of the communication ports shall be provided to permit checking by a portable computer.

4.10.5 Power supply and battery low volts or failure conditions shall be monitored.

4.10.6 The RTU shall be equipped with sufficient memory to permit storage of a minimum of 2000 events (input changes) locally for subsequent transmission to the SCADA master station and these events shall not be lost on buffer overflow.

4.10.7 An indication shall be provided of this latter condition. Events will be retained in the buffer until they are correctly read by the master station. As a minimum, separate buffers shall be provided for digital and analogue events.

4.10.8 To enable fault finding to occur, there shall be a separate event list to record internal RTU events such as health, time synchronisation and any internal errors. This shall permit storage of up to 2000 events.

4.10.9 When memory is provided for the purposes of local control or communications routines, spare capacity shall be provided equal to the amount utilised.

4.10.10 The RTU shall have a real time clock, with a resolution of 1ms. It shall have the capability of time stamping events. The RTU clock is normally synchronised by the master station every 5 minutes. In the advent that this does not occur, the RTU clock shall drift no more than 1 second in 24 hours.

4.10.11 Within the RTU, events shall be reported to an accuracy of +/-1ms.

4.10.12 The RTU clock shall be capable of linking to an external high accuracy real time clock in the future such as (Irig-B).

4.10.13 The RTU shall be equipped with a "controls isolate" switch, which shall inhibit all control outputs from being executed. The status of this switch shall be monitored by the RTU.

- 4.10.14 The RTU shall be capable of programming in a high level language to implement local control and logic routines. It shall also be capable of being programmed using at least two IEC1131-3 programming languages.

TABLE1: Response time

FUNCTION	MAXIMUM RESPONSE TIME (seconds)
Display Update	1
Detection and annunciation of an alarm	2
Analogue updates	4
Status indications update	3
Counter updates	30

- 4.10.14.1 32 double control outputs.
- 4.10.14.2 192 digital inputs.
- 4.10.14.3 24 analogue inputs.
- 4.10.14.4 24 accumulator inputs.
- 4.10.14.5 All monitoring functions fully operational.
- 4.10.14.6 All control and data acquisition functions full operational.
- 4.10.14.7 The following RTU/Gateway test conditions shall apply:
- 4.10.14.8 When no changes occur at any of the above digital, analogue or accumulator inputs.
- 4.10.14.9 When a continuous change of state occurs simultaneously at 30% of the above digital, analogue and accumulator inputs.
- 4.10.14.10 When a continuous change of state occurs simultaneously at 60% of the above digital, analogue and accumulator inputs.

4.11 Communication modules

4.11.1 Type: TETRA

- 4.11.1.1 Standard and Band: DMR: ETSI TS 102 361
- 4.11.1.2 Bandwidth
- 4.11.1.3 TX Power; 1 – 25 W (adjustable)
- 4.11.1.4 RX sensitivity; 70 dB
- 4.11.1.5 Interface; Serial, Ethernet, Antenna and USB
- 4.11.1.6 Protocol; IEC60870-5-101 and 104, DNP3, 61850
- 4.11.1.7 Antenna: SMA male
- 4.11.1.8 Power input 48v DC Terminal block interface

4.11.2 Type: Fiber

- 4.11.2.1 Wavelength: Multimode or Single Mode (850/1300/1550nm)
- 4.11.2.2 Distance; 80KM
- 4.11.2.3 TX Power; 1 – 25 W (adjustable)
- 4.11.2.4 RX sensitivity; 70 dB
- 4.11.2.5 Interface; Serial, Ethernet, Fiber Optic Connectors, ST,
- 4.11.2.6 Protocol; IEC60870-5-101 and 104, DNP3
- 4.11.2.7 Antenna SMA male
- 4.11.2.8 Power input 48v DC Terminal block interface

5. TESTS

The RTU shall be subjected to conformance testing as to IEC 60870 -5 -6

5.1 Factory Acceptance Test (FAT)

When the Service provider is satisfied with the correct functioning of the equipment, City Power shall be notified in writing. Within a two (2) week period from the date of this letter, and then City Power and the Service Provider shall agree upon a date when formal factory acceptance testing shall commence. The testing shall then be carried out in accordance with the FAT procedure.

Manufacture, of when the equipment shall be prepared and ready for inspection or the witnessing of tests.

5.2 Routine Tests

- 5.2.1 All equipment shall be subjected to a routine test by the Contractor and which shall include the following tests:
- 5.2.2 Each digital input shall be checked for correct operation. (No voltage changes outside the relevant range shall be detected).
- 5.2.3 All control output points shall be fully tested for correct operation.
- 5.2.4 Accumulator/counters inputs shall be tested for correct registration of input pulses.
- 5.2.5 Accuracy of the measurand inputs and outputs shall be tested to 0, 25%, 50%, 75% and 100% of full scale in both directions.
- 5.2.6 Alarm conditions, such as communications failure, power failure, etc., shall be simulated and all alarm, indication and discrepancy outputs specified shall be checked for correct operation. (For example the ARC operation).
- 5.2.7 Each digital input shall be tested for spurious operation by applying an input pulse of 10 milliseconds to each input.
- 5.2.8 A fleeting contact of 10ms duration shall be applied to each digital input in turn and the correct registration of this input shall be checked.

- 5.2.9 The power supply to the equipment shall be interrupted for 100ms and the equipment shall be checked for false outputs and/or false presentation of inputs.
- 5.2.10 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.
- 5.2.11 All the tests mentioned above shall be successfully completed before the equipment is dispatched to City Power. Copies of the routine test certificates shall accompany the equipment

Annex A – Bibliography

Annex B - Revision information

DATE	REV. NO.	NOTES
NOVEMBER 2019	0	First issue.
February 2021	1	Second issue
		Added Clause 1.7, 1.8 and 1.9
		Updated technical schedule

Annex C

Technical schedules A and B for Remote Terminal Units

Schedule A: Purchaser's specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

ITEM NO.	DESCRIPTION	UNIT	SCHEDULE A	SCHEDULE B
1.	Remote Terminal Unit			
1.1	Manufacturer	-		
1.2	Type	-		
1.3	Environmental Conditions as to clause 4.1		Comply	
1.5	Power Voltage range (24v, 48v, 110vdc or 220vc AC	V DC	Comply	
6	Auxiliary Power Consumption	W		
7	Protocols Supported as to clause 4.5		Comply	
1.8	IED / Ethernet Switch Interfacing port as to clause 4.4		Comply	
1.9	Supported Communication/Interfacing Ports (RS232, RS485, Ethernet) as to 4.4		Comply	
1.10	CPU Status Indication LEDs		Comply	
1.11	Power Supply Failure and Voltage Level Monitoring		Comply	
1.12	Number of Events to be stored on Events Register at least 10% of total alarms		State	
1.13	Real Time Clock Synchronization with Master Station		Yes	
1.14	Real Time Clock Resolution	ms	≤ 1 substantiate)	
1.15	Real Time Clock Drift per 24 Hours	s	≤ 1 substantiate)	
1.16	Time Stamping Events Capability		Yes	
1.17	Time Stamping Events Accuracy	ms	≤ 1 substantiate)	
1.18	General Compliance with the Specification?		Yes (remove)	
1.3	Analogue Input Module			
1.3.1	Manufacturer	-		
1.3.2	Type	-		
1.3.6	Analogue Signals Inputs type	mA	Bipolar: 0 - ±5mA, 0 - 20mA, 4 - 20mA	
1.3.7	Analogue Signal Balanced, Floating and Isolated		Yes	
1.3.8	Number of Analogue signals per Analogue Input Module		4,8,12,16,	
1.3.9	Analogue to Digital Conversion Resolution substantiate)		Signed 12-Bit	
1.3.10	Accuracy substantiate)	%	≤ 0.25% over the Full Range	
1.3.11	Over Range Capability	%	150%	
1.3.12	Software Filtering Enabled		Yes	

ITEM	DESCRIPTION	UNIT	SCHEDULE A	SCHEDULE B
1.4	Digital Input Module			
1.4.1	Manufacturer	-		
1.4.2	Type	-		
1.4.3	Power Supply Arrangement (dual redundant or Auto change over)		Dual Redundant	
1.4.5	Auxiliary Power Consumption	W		
1.4.6	Digital Signals Inputs type		Opto-Isolated	
1.4.7	Number of Digital Signals per Digital Input Module		8,16,32,64	
1.4.8	Input Current Limited		Yes	
1.4.9	Anti-bounce Conditioning and Noise Filtering	ms	30	
1.4.10	Low to High Input Threshold Value	%	65%	
1.4.11	High to Low Input Threshold Value	%	35%	
1.5	Digital Output Module			
1.5.1	Manufacturer	-		
1.5.2	Type	-		
1.5.3	Power Supply Arrangement(dual redundant or Auto change over)		Dual Redundant	
1.5.5	Auxiliary Power Consumption	W		
1.5.6	Digital Signals Output type		Potential Free Relay Contacts	
1.5.7	Number of Digital Signals per Digital Output Module		8,16,32,64	
1.5.8	Maximum Current Capability (2a at 24vdc	A	2	
1.5.9	Minimum Voltage Switching Capability	V	125VDC, 240VAC	
1.6	Accumulator Input Module			
1.6.1	Manufacturer	-		
1.6.2	Type	-		
1.6.3	Power Supply Arrangement		Dual Redundant	
1.6.5	Auxiliary Power Consumption	W		
1.6.6	Storing Capacity per Input substantiate)		16-Bit Binary Word	
1.6.7	Input Frequency substantiate)		Min 20 Input Pulses/s	
1.6.8	Time/Remotely Resettable substantiate)		Yes	
1.7	Modem 1			

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1.7.1	Manufacturer	-		
1.7.2	Type	-		
1.7.3	Compatible to City Power Tetra Network		Yes	
1.8	Modem 2			
1.8.1	Manufacturer	-		
1.8.2	Type	-		
1.8.3	Compatible to City Power Fibre Telecommunication Network		Yes	
1.9	Mini RTU (Refer to Definitions in Section 3)			
1.9.1	Manufacturer	-		
1.9.2	Type	-		
1.9.3	Digital Inputs	32		
1.9.4	Control Outputs	8		
1.9.5	Analogue Inputs	8		

Note: Ticks, Cross [X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.

Tender Number: _____

Tenderer's Authorised Signatory: _____
Name in block lettersSignature

Full name of company: _____

Deviation schedule for RTU'S

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost-effective than that specified by City Power.

Item	Sub-clause	Proposed deviation

Tender Number: _____

Tenderer's Authorised Signatory: _____

Name in block lettersSignature

Full name of company: _____

Annex D – Stock Items

Not intended for stores