REPUBLIC OF IRAQ
MINISTRY OF ELECTRICITY

DIRECTORATE GENERAL
FOR
ELECTRICAL ENERGY
PRODUCTION PROJECTS

PART III

TECHNICAL SPECIFICATION

SECTION (3)

STANDARD SPECIFICATION FOR TELECOMMUNICATION AND SCADA SYSTEM

Standard Specifications of telecommunication & SCADA Systems

Contents

1. INTRODUCTION

1.1 General

This Specification provides for the survey and verification of existing systems and equipment parameters, design, manufacture, testing in factory, supply, delivery, off-loading on site, erection, testing on site, training of Employer's staff (in the use and maintenance of), commissioning, setting to work and the remedying of all defects during the Defect Notification Period of the equipment detailed herein.

It shall be the responsibility of the Contractor to determine the parameters of the existing systems and equipment owned by the Employer and to ensure that new equipment supplied by the Contractor is fully compatible with such existing systems and equipment. It shall be the responsibility of the Contractor, assisted by the Employer, to demonstrate by means of tests at site that the Employer's existing equipment and any supplied by the Contractor perform satisfactorily together, subject to the proviso that any fault or failure of existing equipment shall be the responsibility of the Employer.

It shall be the responsibility of the Contractor to furnish equipment, which shall meet in all respects the performance specified under the prevailing site conditions.

This Specification shall be read in conjunction with standard specifications for substations and or power stations available from Employer. Except where specified herein to the contrary or where the context indicates otherwise, the requirements of such specifications shall apply to this Scope of Work as if specified herein.

The Contractor shall agree with the Employer any specific operating parameters that need to align with the Employer's existing equipment and networks eg the system operating frequencies for Power Line Carrier, protection settings etc.

1.2 Telecommunications

This document provides the specification for telecommunications equipment that forms the communications network that supports the primary transmission and distribution power system within Iraq. It includes Power Line Carrier, PDH/SDH Optical Communications, Microwave Radio, PABX telephone exchange and telecommunications cables. It does not cover the communications strategy or details of the network that exists, or is planned. The specific equipment specifications within this document are referred to in substation supply contract specifications, where equipment is not separately detailed in them.

1.3 Supervisory Control and Data Acquisition System for the Regional Control Centre

The facilities for the Regional Control Centre for the control and monitoring of the power system in Iraq are split into two parts. The specification for the Master Station equipment located at the Control Centre and the Remote Terminal Units. RTU's are to be installed at substations to receive plant controls from the Control Centre, and to return data on the state of the plant. A list of the minimum facilities envisaged is also provided, although this will need to be tailored to the specific configuration and equipment at each site.

1.4 Supervision, Test Witnessing, Training and Maintenance Equipment

These requirements need to be in accordance with the requirements of the associated power station or substation contract specification, together with any specific supplemental requirements stated in this document.

1.5 Other Light Current Site Facilities

The document also specifies a number of non power system related common site facilities

2. COMMUNICATION SYSTEM FOR 400, 132, 33 / 11 KV SUBSTATIONS

2.1 Indoor Equipment

The indoor equipment shall be located in the Communications Room of the 400/132kV and 132/33/11kV substations, and in the main switch room of the 33/11kV substation. The equipment to be provided is:

2.1.1 Power Line Carrier - PLC

This specification defines the requirements for power line carrier equipment with integrated teleprotection device. The equipment shall be available in single and double channel versions.

2.1.1.1 General Requirements

(a) The equipment shall comply with the following standards:
- Carrier equipment characteristics: IEC pub**. 60495**, second edition, Sept. 1993
- Protection signaling equipment characteristics: IEC pub. 60834-1, 1999-10
- Electromagnetic compatibility: IEC 60801-2/3/4..., IEC 60255-22-1, IEC 60255-4/5

(b) Type test certificates: Compliance with the above mentioned standards have to be demonstrated by type test certificates.

(c) One 19 ‘‘ chassis shall include all modules exclusive of power amplifier required for double channel operation.

(d) All main functions of the equipment shall be implemented in Digital Signal Processing technology.

(e) It shall be possible to connect a management console to the equipment for status information retrieval and configuration and to integrate the equipment into a network management system.

(f) The equipment shall have an automatic channel equalizer.

(g) An integrated teleprotection equipment is preferable.

(h) An integrated programmable FSK modem shall be available.

(i) The integrated telephony interface must support the following operations
- 2/4 wire voice interface with E&M signaling.
- 2 wire voice interface with telephone subscriber signaling, subscriber side (FXS) and exchange side (FXO).
- 2 wire hotline connection
- Telecontrol inputs

This interface must integrate an internal digital transit filter to support VF transit applications.

(j) The PLC equipment must be fully compatible with existing analogue services or analogue PLC circuits. The following features shall be possible
- Four wire through-connection of the aggregate AF-multiplex signal without the need of additional external hardware
- Through-connection of individual FSK or modem signals
- Operation of dial up modems in the speech band 300 … 3100 Hz

(k) It shall be possible to connect a Signal Converter/Multiplexer to the PLC equipment with voice compression and data multiplexing functions, in order to enhance capacities.

(l) A fully digital transmission PLC i.e where the signal converter/multiplexer is integrated, will be considered.
- Signal time delay due to the introduction of the above converter/multiplexer should be stated clearly on the transmission side and measured from input to output at the receiving end.
- Frequency bands for the transmission side and receiving side shall not to exceed 8 KHZ in one block and shall be selectable. Frequency bands of 16 kHz continuous in one block are not acceptable from a frequency allocation scheme point of view.

2.1.1.2 PLC Transmission Equipment

(a) The operating mode shall be SSB with suppressed carrier. Bandwidth and sideband mode shall be programmable with the management console.

(b) The modulation shall be single step without use of intermediate frequencies. It shall be implemented fully in DSP technology and allow conversion from AF to RF band eliminating any analogue circuits and complex filters thereby reducing temperature drift and aging phenomenon. to insignificance.

(c) The carrier frequency shall be programmable with the management console.

(d) It shall be possible to operate transmitter and receiver in adjacent frequency bands or in non-adjacent frequency bands

(e) Carrier frequency bands shall be programmable to be in erect or in inverted position

(f) PLC circuit shall work reliably for S/N down to 25 dB for conventional operation and S/N of 30 dB for full digital operation.

(g) The automatic channel equalizer shall be able to compensate gain and phase variations. It shall be possible to initiate the equalization process at any time via the management console. The

equalization quality shall be selectable.

(h) A serial service interface shall be provided for connection of a management console. The following management functions shall be available:
- Collection of alarm information, local & remote
- Collection of operational status information, local and remote
- Setting of parameters, local and remote

(i) With the management console it shall be possible to control both the local and the remote (opposite) PLC equipment of a link. Communication with the remote PLC shall be established through an integrated service channel.

(j) The management console shall be PC based. The software shall use the Windows graphical user interface.

(k) The MMI (Man Machine Interface) must feature a software based measuring utility which can access a number of test points internal to the PLC equipment and present it in a graphical form, on the time scale and on the frequency scale (Built in oscilloscope function).

(l) The MMI must also feature a utility for tuning and testing of the PLC with generation of all signals required to tune and test the RF filters and AF options. It should also support 'help utility functions' with explanations for all actions performed.

2.1.1.3 Integrated Teleprotection Equipment

(a) The integrated teleprotection shall have four commands in the speech band (300 Hz to 2000 kHz): two direct trip commands, two permissive commands or three permissive and one direct trip.

(b) It shall operate within the speech band without requirement of additional bandwidth.

(c) Security, dependability and command transmission time shall be programmable.

(d) The following test facilities shall be built into the teleprotection equipment:
- Automatic in-service loop testing
- Continuous link supervision
- Trip counters
- Event Recording

(e) It should be possible to configure the equipment in local and remote mode. Likewise supervision of local and remote equipment status must be possible.

(f) Comprehensive alarm monitoring features must be supported. All parameters must be software configurable.

(g)The command interface module must be software configurable for solid-state output, relay output or alarm output.

(h)The teleprotection interface must incorporate event recording with time stamp. The resolution must be 1 ms or better.

(j) It shall be possible to perform the following management functions with the management console of the PLC equipment:
- Collection of alarm information
- Collection of operational status information
- Configuration of input-outputs, event recorder, alarms, delay and hold times

2.1.1.4 Integrated FSK Modem

(a) The integrated FSK modem shall be programmable for bit rates from 50 bits per second up to 2400 bits per second.

(b) The modem shall be protocol transparent and data format transparent.

(c) Point-to-point and Point-to-multipoint operation shall be supported..

2.1.1.5 Universal AF Interface Module

This interface must support the following functions :

(a) The 2/4-wire speech module shall interface to two or four wire speech circuits.

(b) Associated signaling criteria (E and M signals) shall be transmitted by keying the pilot oscillator (out-of-band signaling).

(c) A switch able commander circuit shall be provided on the module.

(d) The speech cut-off frequency shall be programmable.

(e) The following modes of operation shall be programmable.
- link between two 2-wire telephone sets (FXS-FXS)
- link between 2-wire exchange interface and 2-wire telephone set (FXO-FXS)
- link between 4-wire exchange interface and 2-wire telephone set with the 2/4 wire speech module connected at the exchange end

(f) Ringing generator shall be integrated on the module.
(g) The telecontrol module shall have three balanced, DC isolated inputs and outputs each for connection of modems and VFT channels.

2.1.1.6 Converter/Multiplexer Unit

In order to meet the requirement of higher transmission capacities within the 4 kHz or 8kHz bandwidth, the PLC system should support operation with a high speed modem and integrated multiplexer. The following features must be provided:

(a) The concept shall support a seamless migration from the existing digitized single side- band PLC into a full digital PLC through the implementation of a converter/multiplexer unit.
(b) In cases where a full digital PLC with increased channel capacity is not specified for the moment, the migration step to full digital must be possible any time on site, without affecting the frequency allocation or existing coupling arrangement.
(c) The modem should be robust and capable of reliable digital transmission of up to 64 kbit/s depending on channel characteristics, (SNR, distortion etc). Speed must be adjustable in smooth steps to ensure optimal adaptation to the prevailing transmission conditions.
(d) The transmission bandwidth shall be programmable to provide optimum utilization of the PLC channel
(e) The step size (granularity) of the aggregate data rate shall be 2400 bit/s or less in order to ensure smooth and optimal adaptation to the prevailing channel conditions
(f) The type of modulation employed is preferable to have multi-carrier modulation (MCM).
(g) The equipment is preferably automatic transmission speed adaptation (fallback/fallforward) in programmable steps as per item e) according to the actual prevailing channel conditions. Automatic speed adaptation may be enabled or disabled by choice.
(h) It should be possible to accommodate within the aggregate a combination of speech and data signals of varying speeds by means of time multiplexing
(i) The data rate of the multiplexer channels shall be individually programmable
(j) Data interfaces shall be electrically isolated from ground and against each other
(k) The data rate of the compressed voice shall be programmable for 2400 bit/s, 4800 bit/s, 7200 bit/s, 8000 bit/s, 9600 bit/s, 14400 bit/s
(l) Voice circuits shall support automatic detection and transmission of facsimile signals.
(m) Protection signaling must not be affected or influenced by this converter/multiplexer. Protection signaling must be possible with the same level of security and dependability as with SSB transmission.
(n) The system configuration must be flexible and allow various modes of operation with the Digital PLC
- pure digital PLC configuration, i.e. utilizing the full 4 kHz or 8 kHz bandwidth for the digital transmission
- hybrid analogue/digital configuration, e.g. using 4 kHz for conventional SSB transmission and 4 kHz for the digital signal transmission

(o) The operation of the PLC with High Speed Modem and Multiplexer for enhanced channel Capacity must not impose any restrictions on the coupling equipment. Any existing Line Traps and coupling devices available must be utilized..

2.1.1.7 Technical Schedule

General Data

System Data

	Required	**Offered**
Operating mode:	SSB, Direct Digital Synthesis (DDS).	
Sidebands	Erect or inverted side band, programmable	
Carrier frequency range Frequency steps	20 to 500 kHz 500 Hz	
Gross bandwidth Nominal	 4 kHz	
Line attenuation Theoretical limits Practical limits	single channel dual channel 60 dB 54 dB 35 to 40 dB 30 to 35 dB	
Nominal output impedance	75 or 125 □ unbalanced Optional 150 □ balanced	
Useful AF bandwidth	300 to 3850 Hz	
AF channel distortion	complies with or better than Fig. 8/10/9/10, IEC 60495	
Linearity: Without compandor and limiter	To be stated by the bidder not be greater than ± 0.3 dB	
Compandor characteristics Harmonic distortion Speech Telecontrol signals	Complies with ITU-T G. 162 ≤ -40 dBm0 for each comp ≤ 1% at max. gain	
Near and far-end cross-talk: Superimposed data into speech channel	To be stated by the bidder	
Near and far-end cross-talk attenuation in multi-channel operation	To be stated by the bidder	
Idle noise	To be stated by the bidder	
AF offset	To be stated by the bidder	
Alarm conditions	Link alarm low Rx signal poor SNR Synch loss Hardware alarm	
Alarm O/P contacts:	Link alarm Hardware alarm Cabinet alarm 3 up to max. 11 dry C/O contacts	
Alarm contact ratings	To be stated by the bidder	
Interface for Service PC	V.24 / RS-232 C	

Ambient Conditions

Ambient conditions	IEC 60721-3-3, Class 3K5	
Temperature range	-5 to +55 °C	
Relative humidity	≤ 95%	

Power supplies

AC supply	115/230 V	
DC supply	48 VDC	
Power consumption ETL541 ETL542 Normal operation	single channel dual channel To be stated by the bidder	

Insulation and electromagnetic compatibility

Product standard	IEC 60495	
EMC	EN 50081-2 cl. A (emission) EN 50082-2 (immunity)	
Safety requirements	IEC 60950 / EN 60950	

Physical dimensions and weights

Equipment shelves	19" conforming to ASA Standard	
Dimensions for single channel version Height Width Depth	To be stated by the bidder	
Dimensions for dual channel version Height Width Depth	To be stated by the bidder	

PLC Section

Transmitter Data

RF peak envelope power (PEP) including pilot signal under nominal load conditions at coaxial O/P	40 W (+46 dBm)	
Spurious signal suppression at the limits of the bandwidth 4 kHz from the band limits 8 kHz from the band limits Harmonic suppression	single channel dual channel To be stated by the bidder = = =	
Pilot channel Modulation Frequency Functions	 Type of modulation to be stated by the bidder Selectable in steps of ….. Hz to be stated by the bidder anywhere in the AF range AGC, Synchronisation, Telephone signalling, Link quality monitoring, EOC, TP Guard signal	

Receiver Data

RF sensitivity	-30 dBm	
Selectivity ≥ 0.3 kHz from band limits ≥ 4 kHz from band limits	 70 dB 100 dB	
Automatic gain control RF level range AF level stable within Time constant	 To be stated by the bidder but not less than 40 dB To be stated by the bidder but not less ±0.5 dB 1-2 dB/ sec for level inc./decr.	
Automatic equalization Amplitude distortion Group delay distortion	 To be stated by the bidder =	

Integrated Teleprotection Equipment

Product standard	IEC 60834-1	
EMC	EN 50081-2 cl. A (emission) EN 50082-2 (immunity	
Safety	IEC 60950 / EN 60950	
Ambient conditions	IEC 60721-3	
Nominal transmission delay with solid state command O/P and PLC delay included Blocking Permissive tripping Direct tripping	 < 10 ms < 14 ms To be stated by the bidder but not more than 26 ms	
Number of commands	At least Total 4 commands Permissive : number of permissive command To be stated by the bidder Direct - 2 or 1	
S/N required for dependable command transmission	6 dB	
Security Permissive Tripping Direct tripping	Programmable figures are to be stated by the bidder =	
Dependability Permissive Tripping Direct tripping	Programmable To be stated by the bidder =	
Inputs Galvanically isolated battery voltage Input current	 yes 48 VDC to 250 VDC < 10 mA	
Alarms Guard Signal Level SNR Alarm Galvanically isolated Tx/Rx Single Component Failure Loop Test Error	Required Variation of +/- 3 dB To be provided To be provided To be provided After 3 attempts	
Event Recorder No of events Resolution Display	Must be provided min 1000 1 ms Text & graphical	
Trip Counter Facility Range – Send/Receive	Must be provided 10^9	
Solid state relay output contact rating	4 (galvanically isolated) To be stated by the bidder but not less than 250 VDC, 1 A	
Mechanical relay output Contact rating Rated Current	2 (galvanically isolated) 250 VDC ≤ 5 A	

Integrated FSK Modem

Transmission speed according to ITU - T R35/ R37/R38B/R38A (programmable)	50/100/200/300 Bps 600 Bps 1200 Bps V.23 1200 Bps above speech 2400 Bps	
Serial data interface Inputs Outputs	 ITU -T V.10/V.28/RS232D/RS423A ITU -T V.28/RS232D	
EMC	EN 50081-2 cl. A (emission) EN 50082-2 (immunity)	
Ambient conditions	IEC 60721-3	

AF Interface Module

The PLC integrated AF interface module must be fully programmable to support the following operations

2/4 wire Speech Operation

VF-Inputs 2-wire nominal input level Input level range, (programmable) 4-wire nominal input level Input level range (programmable) Return Loss in Speech Band	 To be stated by the bidder = = = = = =	
VF-Outputs 2-wire nominal O/P level O/P level range (programmable) 4-wire nominal O/P level O/P level range (programmable) Return Loss in Speech Band	 To be stated by the bidder = = = = = =	
PAX Blocking output	Contact closes on receiver alarm	

2-wire Point – Point Operation

2-wire VF input/output		
Nominal I/P level	To be stated by the bidder	
I/P level range (programmable)	= =	
Nominal O/P level	=	
O/P level range (programmable)	= =	
Standard cut-off frequencies	=	
Return Loss in Speech Band	=	
Exchange side		
DC-loop resistance	off-hook ≤ 250 Ω;on-hook ≥ 5 MΩ	
AC resistance 17 Hz ~ 55 Hz	≥ 10 kΩ	
AC ring detector	130 VRMS; 17 ~ 55 Hz	
Subscriber side		
Max. Ringing Voltage	Open circuit 70 VRMS	
AC ring generator	20 or 25 Hz, +/- 1 Hz	

Telecontrol Operation

Inputs		
Number of inputs	3	
Impedance	600 □	
Nominal I/P level	0 dBm	
I/P level range (Programmable)	-20 to +4 dBm, in steps of 0.5 dB	
Return Loss in Speech Band	≥ 14 dB	
Outputs		
Number of outputs	3	
Functions	Transit filter or broadband	
Impedance	600 □	
Nominal O/P level	0 dBm	
O/P level range (programmable)	–20 to +8 dBm in steps of 0.5 dB	
Return Loss in Speech Band	≥ 14 dB	
Transit filter	Must be built-in	

Converter / Multiplexer Unit

Aggregate data rate	≤ 64kbit/s, programmable in steps	
Data rate step size	To be stated by the bidder but not less than 2400 bit/s or less	
Automatic speed adaptation	In programmable preset steps	
Modulation	Multi-carrier (MCM) / or any other type to be stated by the bidder	
Gross Bandwidth	1 kHz to 7.3 kHz, programmable in steps / or to be stated by the bidder	
Multiplexer Channels	To be stated by the bidder	
Channel data rate	Individually adjustable for each channel	
Data Format	Synchronous, Asynchronous, Anisochronous	
Data Interface	V.11, X.24, RS422A, RS232, electrically isolated	
Voice Interface	• Vocorder with speech compression • 2/4 wire operation with DTMF signalling and E&M line seizure • Remote subscriber operation	
Voice compression data rates	2400, 4800, 7200, 8000, 9600, 14400 bit/s / or to be stated by the bidder	
Telefax transmission	Automatic detection and transmission 2400, 4800, 7200, 9600 bit/s	
Power supply	48 VDC electrically isolated	
Service Interface for configuration, parameter setting and alarm monitoring	To be provided	

2.1.2 Standard 19" Equipment Practice Cabinet

The cabinet shall be equipped for a maximum number of 2 PLC & 2 PSE terminals, having the following characteristics:.

- steel structure
- swinging frame to mount the equipment providing an easy means of inspection and installation of cables
- one lockable front door
- cable access – from the bottom or from the top
- suitable for back to back installation
- no internal wiring is to be provided with the exception of the power supply
- mains socket outlet
- ground bar.

2.1.3 Main Distribution Frame – MDF

The MDF shall be a wall mounted type and be supplied with sufficient terminal blocks, fittings, fuses and surge arrestors to cater for the communications equipment specified.

2.1.4 D.C. System

A 48V dc battery system shall be provided to supply the site communications equipment, If one is not included in the associated main plant supply contract. The system output shall conform to IEC Recommendation 61204. The Tenderer shall propose battery and charger capacities to supply the equipment loads within the supply contract, and at least 600Ah for 400kV substations and 260Ah for 132kV substations (8 hours discharge).

2.1.4.1 Batteries

(i) Battery Voltage:

The battery voltage shall be 48 volts nominal with a 48V ± 10% maximum in operation. The Contractor shall submit calculations of voltage drops and provide a list of the maximum and minimum allowable voltages on all the 48V dc devices and relays within the scope of supply.

(ii) Batteries

The Contractor shall provide a design suitable for communications equipment use. Batteries of nickel-cadmium of the pocket or sintered plate, open or semi-sealed design housed in suitable translucent plastic containers to BS 6290 shall be provided. Each cell shall be provided with a vent cap and/or filler plug and a pressure operated gas release valve.

Sufficient electrolyte reserve shall be provided to give six monthly maintenance periods. The plates shall be designed and constructed so that the plates are rigidly held so as to avoid distortion and short-circuiting of the plates.

The battery shall be suitable for float and boost charging and capable of providing the required output throughout the specified ambient conditions.

The battery cells shall be arranged in tiers on suitable racks and spaced so to allow sufficient access for maintenance. The racks shall be of a design to withstand corrosion by battery electrolyte.

All cells shall be consecutively numbered and terminal cells marked to indicate polarity.

Each battery shall be designed to provide sufficient capacity for operation at full load for eight (8) hours in the event of charger failure.

The environmental and climatic conditions shall be as stated in the relevant power station or substation specification.

The main battery and charger fuses shall be mounted as close to the battery terminals as possible. Battery and charger cables shall be separately fused and linked.

2.1.4.2 Battery Chargers

The Contractor shall provide for each battery bank a solid-state battery charger, suitable with respect to size and design for the defined operating conditions. The mode of charging shall be by the constant voltage method and the charging voltage shall be variable to compensate for internal losses in the cells and constant loads, etc. Voltage selection shall be such as to avoid overcharging.

Each battery charger shall be suitably sized so as to be capable of charging both batteries at the same time should one of the chargers fail or be out of service for maintenance.

The system shall be designed for the selection of float and equalizing voltage levels most. appropriate to the system conditions and co-ordinate this with the rating.

Voltage regulation shall be designed to ensure that the voltage is within ± 1 per cent of the output over the load range zero to full load with an output voltage ripple of less than 2 per cent rms.
The charger output shall be sufficient to return the battery to full charge in twelve hours, after an eight-hour discharge at full load, while maintaining normal service.
The equalising and float voltage levels shall be adjustable and suitable for the range of operating conditions recommended by the battery manufacturer.
The output voltage shall be maintained within ± 1 per cent of its set value for combined input and load variations of:
Load 0 - 100%
Nominal line voltage ± 10%
Frequency ± 2Hz
The regulation response time shall be better than 50 milliseconds.
A suitable DC ammeter and a DC voltmeter shall be provided for each battery, charger and DC main output.
An under-voltage alarm shall be provided at the charger or its associated distribution board .
Acontact shall be provided to extend the alarm to external annunciator equipment.

Charger Main Features :

- Input voltage 380 V , 50 Hz , 3 – phase .
- Out put voltage 48 V regulated .
- Accuracy of regulation of the chargers on D.C side shall be ± 1 % with a variation of ± 10 % of r.m.s input voltage and ± 5 % of input frequency variation of load fluctuation of 0- 100 % of rated current .
- The r.m.s ripple voltage on the D.C side shall be less than 0.1% of the mean D.C Voltage .
- Constant charging voltage / current - charging characteristic .
- The switch over from one mode to the other should be possible manually & automatically and no break in voltage should happen during such electronically controlled .

The charger shall normally remain in the float charge mode when ever necessary , it should be possible to put it on the Boost charge mode . When the batteries get fully charged the chargers should automatically regulate the charging current.

- Silicon dropper should provided to keep rated out voltage within the required 10% even under boost condition .
- Automatic change over to boost change in case of main voltage interruption . By the use of the timer regulator time setting for the boost changer should be possible .
- All alarm should be indicated on the main control panel .
- Charger should be protected by suitable devices against each earth fault .

2.1.4.3 DC Distribution Panels

A suitable designed battery distribution board shall be provided for each charger and battery system. The distribution board shall serve as the main distribution point to the communications equipment cubicles and racks.

(i) Design Features:

The distribution board shall have as a minimum requirement:

- Fuses and links for up to twelve sub-circuits.
- Provision for the fitting of additional groups of fuses and links for twelve additional sub-circuits.
- Minimal manual changeover interconnection between the two systems so that the loss of one battery bank, charger or distribution board does not jeopardize the second system, but the two distribution boards can be connected if a charger or battery should fail or be maintained.
- Load ammeter.
- Charger ammeter.
- Earth link for earthing one side of the battery, if required.
- Battery alarm.
- Voltmeter.

(ii) Cabling:

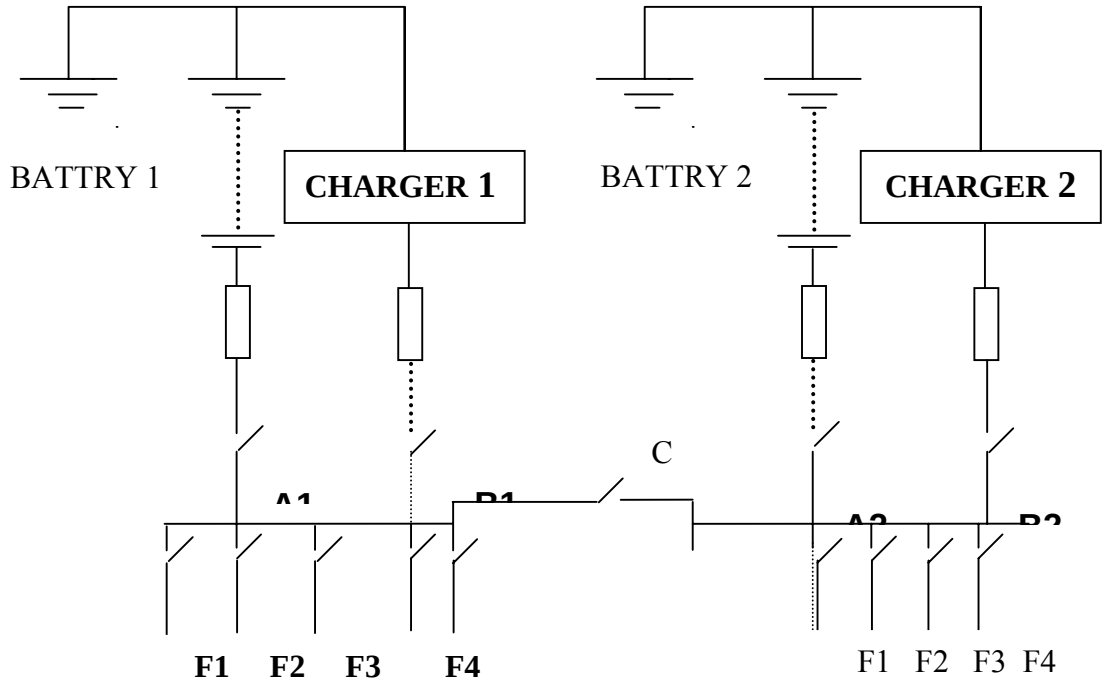
Suitable arrangements shall be made for the glanding and termination of all cables entering and leaving the distribution panel in a manner that allows easy addition of future cables as required.
All distribution cabling shall be radial. All fuses and links shall be fed from suitable low

impedance busbars that shall in turn be connected to the battery terminals via the main battery cable.

2.1.4.4 Documentation

The following documentation shall be supplied by the contractor:

- Charging characteristics
- Voltage /current curve
- Regulation system
- Efficiency curve from zero load to full load at different ambient temperatures.
- Percentage of ripple.
- Full circuit description, supported by relevant circuit diagrams.
- Weights & dimensions..



General Pattern of DC Distribution for telecommunication For 400KV & 132KV substations

2.2 Outdoor Equipment

The equipment to be provided is:

2.2.1 400 kV Line Traps

(a) Scope of Work

Provide, deliver to site, and install 400kV line traps at 400/132kV substations as part of the overall requirements for Power Line Carrier circuits as agreed as part of the specific site survey process and in accordance with **IEC Recommendation 60353**. Line traps shall be fitted to two phases only.

(b) General Electrical Characteristics

These shall be in accordance with the general plant requirements of the supply contract, or where this is not specified, generally rated current 2000A, short circuit current 40kA for 1 second.

(c) General Mechanical Characteristics

The equipment should be of modern lightweight design. All parts should be fully protected against deterioration due to the environmental conditions. If the design of line trap requires them, barriers should be provided to prevent the entry of birds.

(d) Mounting

The line trap should be suitable for pedestal or suspension mounting.

(e) Blocking Impedance

The blocking impedance shall be a minimum of 400 ohms over the required band of frequencies.

(f) Bandwidth Requirements

Precise frequencies have not yet been allocated. The expected bandwidth requirement will be 36 kHz. The geometric mean frequency approximately 100 kHz. Two 4 kHz full duplex power line carrier terminals may be required on each 400 kV line.

(g) Rated Inductance

The inductance of the line trap should be chosen to optimize the design of the coupling equipment with due consideration being given to cost, overall dimensions and the use of standard, proven, designs and inductance values.

(h) Surge Diverters and Protective Devices

Line traps and tuning units shall be provided with suitable surge diverters and protective spark gaps to protect the equipment against transient over voltages. The power line carrier equipment will be used for protection signaling purposes. The operation of any protective device associated with the line trap should not affect the protection signaling system.

(j) Accessories and Mounting Hardware

The line traps shall be provided complete with all necessary accessories and mounting hardware required for their installation and operation in the overall power and communications systems.

2.2.2 132 kV and 33kV Line Traps

(a) Scope of Work

Provide, deliver to site, test and install 132 kV and 33kV line traps at 400/132kV, 132/33/11kV and 33/11kV substations as part of the overall requirements for Power Line Carrier circuits and in accordance with IEC Recommendation 60353. Line traps shall be fitted to two phases only.

(b) General Electrical Characteristics

These shall be in accordance with the general plant requirements of the supply contract, or where this is not specified, generally:

132kV rated current 1600A, short circuit current 40kA for 1 second

33kV rated current 800A, short circuit current 31.5kA for 1 second

(c) General Mechanical Characteristics

The equipment shall be of modern lightweight design. All parts shall be fully protected against deterioration due to the environmental conditions. If the design of the line trap requires them, barriers should be provided to prevent the entry of birds.

(d) Mounting

The line trap should be suitable for pedestal or suspension mounting.

(e) Blocking Impedance

The blocking impedance shall be a minimum of 800 ohms over the required band of. frequencies.

(f) Bandwidth Requirements

The line trap shall be suitable for wide band application in the frequency range 40-500 kHz by fitting the appropriate tuning part.

(g) Rated Inductance

The inductance of the line trap should be chosen to optimise the design of the coupling equipment with due consideration being given to cost, overall dimensions and the use of standard, proven, designs and inductance values.

(h) Surge Diverters and Protective Devices

The line trap and associated tuning units shall be provided with suitable surge diverters and protective spark gaps. The power line carrier equipment will be used for protection signalling purposes. The operation of any protective device associated with the line trap should not affect the protection signaling system.

(j) Accessories and Mounting Hardware

The line trap shall be provided complete with all necessary accessories and mounting hardware required for its installation and operation in the overall power and communications system.

2.2.3 400 kV, 132 kV and 33KV Line Coupling Capacitors

(a) Scope of Work

Provide, deliver to site, test and install 400 kV, 132kV and 33kV line coupling capacitors at 400/132kV, 132/33/11kV and 33/11kV substations in Iraq as part of the overall requirements for Power Line Carrier circuits. The 132kV and 33kV Line Coupling Capacitor may be provided as part of the capacitive voltage transformer. Coupling equipment shall be fitted to all three phases.

(b) Coupling Capacitors

Electrical characteristics of 400 kV, 132 kV and 33kV systems:

- The general electrical characteristics contained in the relevant power station or substation specifications shall apply
- System surge impedance To be determined during specific site surveys

(c) Capacitance

The value of capacitance shall be decided by the power line carrier system design requirements.

(d) Mechanical Characteristics

The coupling capacitors shall be suitable for reliable operation outdoors under the specified climatic conditions. Drawings shall be provided with the tender documents clearly showing the available methods of mounting, principal dimensions, etc.

(e) Drain Coil, Earth Switch and Tuning Components

A suitable drain coil and earth switch, protected by suitable protective spark gaps shall be provided in the capacitor base housing. Provision shall also be made for mounting tuning components. A heater shall be provided if required by the design. The heater shall be suitable for operation from 200 Volt, 50 Hz, single-phase supplies.

(f) Earthing

An adequate means of earthing shall be provided.

(g) High Voltage Connection

Details of high voltage connections shall be given in the tender documents.

(h) Materials and Manufacturing Standards

The materials used and manufacturing methods employed must conform to the standards laid down for substation equipment.

(j) Nameplates

The following minimum information shall appear on the nameplates of all coupling capacitors:

- Manufacturer's name.
- Type and form designation.
- Instruction book number.
- Operating voltage rating.
- BIL rating.
- Capacitance.
- Weight.

2.2.4 Coupling Filters

A coupling filter conforming to **IEC Recommendation 60481** shall be provided for matching. the coaxial cable impedance with that of the power line.

It has to be adjustable by simple strapping according to the type of connection used (single phase, phase to phase, inter circuit).

Input impedance and output impedance shall be variable and according to the type of connection and coaxial cable impedance used. Power dissipation and losses shall be in accordance with CCITT recommendations.

3. PRIVATE AUTOMATIC BRANCH EXCHANGE (PABX)

The PABX shall be designed to fulfill the requirements for the utility private telecommunication networks and combine both operation and administration into one PABX.

3.1 System Architecture

3.1.1 General

The PABX shall be of very compact and sophisticated design based on an ISDN kernel. The uniform hardware architecture and software platform shall provide a PABX system, which can scale to meet the needs of any organization simply by adding applications. The system shall cover sizes from 50 ports to 10000 ports and it shall be optimized to meet the different communication needs from small substations to large administrative campuses.

This uniform hardware shall be based on a distributed architecture, which divides the platform into three functional modules:

3.1.2 Peripheral Module (PM)

The Peripheral Module is the interface to end-user equipment. It shall contain all kinds of line interfaces that adapt external line protocols and signal levels to 64 kbit/s signals, which is the PABX internal standard.

3.1.3 Switching Module (SM)

The Switching Module shall establish 64 kbit/s transmission paths between end-users by using a single stage non-blocking PCM/TDM switching matrix.

3.1.4 Central Module (CM)

The Central Module controls the Switching Module and the Peripheral Module(s). It is responsible for the over all system operation, for the storage of user data and for providing central access to external applications.

3.1.5 Mechanical Construction

The PABX shall be available in three different configurations, optimized for different applications:

•

Small size system (up to 500 ports)

• Medium size system (up to 1,000 ports)

• Large size system (up to 10,000 ports)

All three configurations shall share common peripheral circuit interfaces. For small and medium size configurations a cost-optimized central control module integrating functions of SM and CM as defined above shall be available.

It shall be possible to equip the large size system with duplicated central control, switching and power supply modules.

3.2 Power Systems Facilities

3.2.1 Priority Call in Analogue Tie-Line Network

Priority call facility makes the communication networks always available for urgent calls..

• Intrusion on busy extensions, throughout the network

• Intrusion on busy tie-line trunk, throughout the network

• Forced release on busy tie-line trunk throughout the network

3.2.2 Test Call

Test call (Section dialing) allows authorized users to make calls via specific trunks or hardware to test these trunk lines. Test call shall be extended through out in the multi-vendor networks, when this feature in the other PABXs involved is also available.

3.2.3 Remote Extensions

The PABX shall support remote extensions on its trunk interfaces. Using appropriate transmission equipment (power line carrier, microwave or fibre optical systems) such trunks shall support direct connection to telephone sets at the remote end. This facility shall be available on the following trunk interfaces:

• Remote extensions via analogue trunks (E&M or CEPT L1)

• Remote extensions via 2Mbits/s connection, up to 30 extensions for each connection

3.2.4 PC Based Dispatch Console

The PABX shall support Computer Telephony Integration (CTI) to allow telephony

functions, such as call set up, call logging, directory dialing, call transfer and conference calls, etc. to be performed by a PC based touch-screen terminal. A flexible CTI console application shall be provided allowing the implementation of integrated utility control centres, e.g. hotline telephone systems.

3.2.5 Networking and Routing

The PABX shall provide variants of interfaces to interconnect with the public switched telephone network or private tie-line networks according to the Employer's network environment. Analog and digital interfaces shall be available.

On digital trunks it shall be possible to connect PABXs from various vendors to build a multi-vendor Integrated Services NET +work (ISNET). The ISNET makes the features for single digital PABX available for the entire network. The DPNSS protocol shall be used for ISNET applications.

Private Virtual Network (PVN) shall be built on the combination of traditional tie line trunk connections with "network on demand" by dial-up connections through public networks.

The PABX shall be fully compatible with many types of existing exchanges used currently in private utility networks such as DCS, ECS-F/FX, VDZ, DNS, DCX as well as other analogue or digital PABX's.

The routing architecture of the PABX shall allow routing according to the following criteria as a minimum:

- Preference route
- Overflow routes
- Alternative routing with digit conversion
- Least cost call routing
- Priority extension routing

3.2.6 System Management

A modular System Management suite shall be available for the PABX. It shall be based on the Windows operating system. Management shall be possible either through a local direct connection to the PABX or remotely via dial-up modems. It shall be possible to manage several PABXs from a single centralized management system The software suite shall be modular with a choice of applications as defined below:

- Multi-user Login Module
- Configuration management Module
- Call Reporting Module
- Fault management Module
- Directory Services Module
- Announcement Management Module
- DECT Management Module
- File Management Module
- External Application Interface Module
- Performance Module

3.3 Administrative Facilities

The PABX shall support the following facilities as a minimum:

3.3.1 System Facilities

- Abbreviated Dialing
- Alarm Signaling
- Announcements On Calls Waiting For Answer
- Answering Machine Connection
- Auto-Attendant
- Automatic Call Distribution (ACD)
- Automatic Message Entry
- Automatic Repeat To Night Extension
- Break-in/Listening-in
- Busy Lamp Field
- Call Statue Display
- Call Identification
- Central/Distributed Operator
- Collect-Call Allowance
- Day/Night Mode
- Directory Assistance / Programming

• Directory Dialing
• Emergency Alarm
• Give a Line
• Free Numbering on ISNET
• Identification Services
• Incoming/Outgoing Digit Conversion
• Integrated Announcement Server
• Hardware-Less DNR
• Least Cost Call Routing
• Message
• Message Answering
• Multi Tenant Operator
• Music On Hold
• Night Extension Hierarchy
• Paging
• Password Protection
• Privileged Route Selection
• Remote Maintenance
• Sub-Addressing
• Terminal Portability
• Voice Server Interface
• VPN Combined with Voice Compression

3.3.2 Extension Facilities

• Abbreviated Dialing
• Add-On Conference (3-parties)
• Automatic Ring-Back
• Automatic Trunk Find
• Break-In/Break-In Protection
• Call Break At Zero Budget
• Call Forwarding
• Call Hand Over
• Calls Logged When Absent
• Camp-On-Busy
• Call Waiting
• Cost Center Dialing
• DDI Barred
• Desk sharing
• Distinctive Ringing
• Do Not Disturb
• Enquiry/Call Hold
• Follow-Me
• General Facility Cancel
• Hot Line Dialing
• Last External Number Repetition
• Long Line Extension
• Malicious Call Trace
• Message Waiting
• Multi Party Conference
• Password Dialing
• Permanent Line Extension
• Personal Identification Dialing
• Post Dialing
• Priority Access To Routes And Trunks
• Priority To Operator
• Private Call
• Remote Contact Control
• Shuttle/Transfer
• Single Digit Dialing
• Test Call
• Tones During Call Set-Up

• Traffic Class Selection
• Twinning
• Wake-Up

3.3.3 Digital Extension Facilities

Additional facilities shall be available for digital extensions depending on the type of the digital telephone

• Auto Answer
• Call Charge Display
• Calling Duration Display
• Caller List
• Calling Number Display
• Calling Name And Number Display (CNND)
• Camp-On-Busy Queue Position Display.
• CLIP/CLIR
• Data Communication Interface
• Date And Time Display
• Hot Line Mode
• In Call Modification
• Intercom Call
• Name Dialing
• Off Line Number Preparation
• Programmable Keys on digital phones
• Programmable Ringing
• Status Monitoring on digital phones
• User to User Message
• Wireless Extension Features

3.3.4 Wireless Facilities

The following facilities shall be available for wireless extensions

• Message Over DECT
• Roaming
• Seamless Handover
• Speech Encryption

3.3.5 Data Facilities

The following facilities shall be available for data extensions

• Closed User Group
• Data Protection
• Data Security
• Data Transparency
• Hot Line Connection
• Modem Pool

3.3.6 Group Facilities

Within a group arrangement the following facilities shall be available

• Absent/Present Switching
• Absent Statue Indication
• Call Diversion
• Call Pick-up
• Camp-On-Busy Queue
• Camp-On-Busy Queue Length Display
• Group park
• Group Follow-Me
• Group Hunting Mechanism
• Group Statue Display
• Monitoring Absent/Present, Idle/Busy, Ringing Statue
• Private Park
• Manager/Secretary Features
• Absent overrule by Secrecy
• Absent/Present Switching
• Alternative Secrecy
• Break-in overrule by Secrecy

• Break-in Protection
• Call Diversion
• Multi-Manager/Multi-Secrecy Arrangements
• Private Number.
• Status Monitoring
• Operator/Night Service Features
• Operator/Night Service features depending on the type Operator/Night terminal used

3.3.7 Other Facilities

Wireless DECT (Digital Enhanced Cordless Telephony)

Wireless DECT (Digital Enhanced Cordless Telephony) shall be an optional part of the PABX and shall provide full wireless communication based on the DECT. The DECT cluster controllers and associated software functions shall be integrated in the PABX by adding DECT boards. Wireless telephones shall be able to access and use all the features available to fixed-wire telephones, in exactly the same way.

3.3.8 IP Functionality

3.3.8.1 IP Gateways

IP Gateways shall be available to extend the PABX with IP capabilities. The IP gateway shall be capable of transporting voice and signaling over an IP-based data network. It shall support following main functions:

• Tie-line replacement (IP Trunk)
• IP Private Virtual Networking (IP-VPN), i.e. carrying of DPNSS or QSIG signaling over the IP network
•
Combination of IP Trunk and IP-VPN

3.3.8.2 Standalone IP System

The control software of the PABX shall be available on a standard PC platform to act as a voice server in a local area network environment. A comprehensive set of telephone sets with built-in IP interface shall be available to interface with the voice server. Voice-server based LANs shall be connectable with IP Gateways to form a fully integrated voice network.

3.3.8.3 Voice Mail

An integrated Voice Mail Systems based on a board in the PABX shall be available. For larger PABXs a large-capacity PC-based Voice Messaging system shall be available. Both the integrated and the standalone systems shall support the following functions:

• Voice Messaging
• Automated Attendant
• Fax package (fax mail & fax on demand) (standalone system only)
• LAN/WAN connectivity (standalone system only)

3.4 Hardware Interfaces

3.4.1 Public Network Interfaces

The PABX can be connected to the public network using ISDN and analogue interfaces. The following interface types shall be supported:

3.4.1.1 Digital Interfaces

• ISDN Primary rate 30B+D interface conforming to ITU-T I.431. ETSI ISDN protocol
• ISDN Basic Rate 2B+D interface conform ITU-T I.430, ETSI ISDN protocol
• 30B+D Channel Associated Signaling (CAS) protocol.

3.4.1.2 Analog Interfaces

• Subscriber signaling ALS70.
• DDI/DDO via pulse, DTMF, MFC
• Non-DDI Loop Disconnect interface
• Polarity detection
• Metering (50Hz, 12 or 16kHz)
• Power fail switch (ESU)

3.4.2 Private Network Interfaces

The following interfaces to private networks shall be supported:

3.4.2.1 Analog Interfaces

• 2-wire or 4-wire E&M interface
• 2-wire Cailho interface

• 4-wire interface using the AC15/CEPT-L1 protocol.
• 2-wire Loop-Disconnect interface
• 2-wire Local Battery interface

3.4.2.2 Digital Interfaces

• 30B+D interface conform ITU-T G.703/G.704, to 1TR6, DPNSS or QSIG protocol.
• 30B+D Channel Associated Signaling (CAS) protocol. Partial primary rate services (fractional E1) shall be supported.
• 2B+D interface conform ITU-T I.430, with DPNSS or QSIG protocol
• 64 kbit/s interface conform ITU-T G.703, with voice compression and the DPNSS protocol

3.4.2.3 IP Gateway:

• 4, 8 or 30 channels
• G.711, G.723.1, G.729

3.4.3 Extension Interfaces

The following extension interface characteristics shall be supported:

3.4.3.1 Analogue Interfaces

• Standard Pulse/DTMF 2-wire loop circuit, allowing distances of 6 km as a typical value (0.5 mm cable).
•
It shall be possible to extend analogue extensions remotely over the following trunk line interfaces:
- 4-wire E&M trunk interface
- 4-wire trunk interface with CEPT L1 signaling
- 2 Mb E1 interface (CAS signaling, up to 30 remote extensions supported)

3.4.3.2 Digital Interfaces

• A standard Basic Rate Access (BRA) 4-wire ISDN S0 bus conforming to the ITU-T recommendation I.430. This interface allows distances of up to 600 m (0.5 mm cable) for point-to-multipoint configurations or 150 m (0.5 mm cable) for a multi-terminal passive bus.
• A 2-wire Upon interface allowing distances of 1000 m with 0.5-mm cable. The interface shall be configurable in a 1B+D or 2B+D mode
• A 2-wire Uk0 interface for distances up to 5500 m with 0.5-mm cable. A Network Terminator shall transform this interface into a standard 4-wire ISDN S0 bus.

3.4.3.3 Wireless Interfaces

DECT complies to ETSI PAP and GAP standard.

3.4.3.4 Data Interfaces:

• V.24 (async., up to 19.2kbps; sync. Up to 64kbps), V.35 or X.21 (all via an ISDN Terminal Adapter or data port of a digital phone)
• Shared modem pool access

3.4.3.5 Auxiliary Interfaces

• Paging (ESPA)
• Operator consoles
• Music on hold
• Voice mail
• Announcer
• Ethernet 10baseT
• Front office
• Conference units
• Door openers

3.5 Technical Data

3.5.1 Cabinet Dimensions/Weights

The following are the anticipated dimensions/weights but the Tenderer shall state the figures for his equipment: •
Small to Medium Systems (H x W x D):
• 740x440x440mm/35-54 kg
• Medium to Large Systems (H x W x D):
• 1960-2040x950x525mm/935-115 kg

3.5.2 Power Supply

• 48 volt dc nominal

• 230 VAC for Small to Medium Systems only, depending on usage (48v dc for operational sites)

3.5.3 Ground Resistance

Max 8 §ظ - Tenderer to state limit

3.5.4 Power consumption

The Tenderer shall state the figures for his equipment:

• Fixed, for each PM
• For each analogue extension
• For CM/SM in large systems

3.5.5 Environmental Conditions

• Conforming to ETS-300-019:.
• Stationary use class 3.1
• Storage class 1.2
• Transport class 2.3

3.5.6 Temperature and Humidity

• Operation -5..50 °C/10%..85% humidity/non-condensing
• Storage -25..55 °C/10%..80% humidity/non-condensing
• Transport -40..70 °C/10%..80% humidity/non-condensing

3.5.7 Electro-Static Discharge

• EN 61000-4-2
• 12TR21, 25 26, 27,30

3.5.8 Electro Magnetic Compatibility

• Conforming to EN 61000 series of standards
• EN55022 class B
• EN50082-1
• EN61000-3-2
• EN61000-3-3

3.5.9 Over-Voltage Protection

ITU-T K.20

3.5.10 Safety

• Conforming to the European directive 73/23/EEC
• EN41003
• EN60950

3.5.11 Quality

• ISO9001 certified
• TickIT certified

3.5.12 Maximum System Capacity

• Minimum 288 Ports
• Maximum 10,000 Ports

3.5.13 System Traffic Handling Capacity

• Small to Medium Systems45,000 BHCA
• Large Systems 100,000 BHCA

3.5.14 System Mean Time Between Failures

• Small to Medium Systems>7.5 years
• Large Systems >250 years.

3.5.15 System Availability

• Small to Medium Systems99.97%
• Large Systems 99.999%

3.6 Telephone Instruments

3.6.1 Indoor Telephone Instruments

These shall be desk mounted for office locations. In switch rooms and other plant rooms, they shall be wall mounted and dust proof.

3.6.2 Outdoor Dialing Telephone

These shall be water, dust and sun proof, and are required for the switchyard and other outdoor areas. The mounting frame shall be robust and firmly bolted to a suitable structure. The telephone instrument handset shall be easily removed from the mounting frame. The Tenderer shall provide a full specification for the instrument.

3.6.3 Telephone Booths

Telephone booths shall be provided for noisy areas such as alternator and fuel pumps to provide a sound barrier, with an attenuation of noise no less than 25 dB. Inside the booth, pressure – gradient microphones shall be used. A special loud bell shall be provided and installed outside the booth, to provide a sound level of no lees than 15 dB.

4. PDH/SDH (STM-1) OPTICAL FIBRE EQUIPMENT

4.1 General Requirements

The digital multiplex equipment shall be universal, software-controlled, and provide various interface cards to connect tributary interfaces signals such as voice, teleprotection and data to aggregate interfaces. On aggregate level 2Mbit/s electrical and 8Mbit/s optical interfaces complying with ITU-T recommendations G.703 / G.704 and 2Mbit/s HDSL interfaces shall be available. In addition, optical STM-1 aggregate interfaces on 155Mbit/s shall be available. All modules shall form an integrated part of a 19" shelf.

The multiplexer shall provide means to drop and insert individual 64 kbit/s signals and allocate them to determined time slots in the 2Mbit/s streams. Path protection on 64 kbit/s and 2Mbit/s shall be supported.

It shall be suitable for operation in a substation with harsh environment as is found in Iraq and with high electromagnetic interference, be highly reliable and provide secure communication for real time signals such as voice, SCADA, teleprotection and status/control signals.

The equipment offered shall already be working successfully in telecommunication networks operated by power utilities. It shall comply with the latest ITU-T standards and be able to be interconnected with telecommunication equipment.

Any equipment in the network shall be manageable from a control center and there shall be means to supervise external/existing equipment as well.

As a minimum, modules for the following user signals shall be available as plug-in units for the digital multiplexer:

- Analogue subscriber interface: subscriber and exchange side
- 4-wire E&M voice interface
- G.703, 64kbit/s data Interface
- X.24/V.11 (RS-422), N x 64kbit/s data interface
- V.24/V.28 (RS-232), data interface
- V.35, N x 64kbit/s data interface
- Data interface V.36 (RS-449), N x 64kbit/s data interface (V.10)
- Alarm collection interface
- Teleprotection command interface.
- Optical protection relay interface
- Binary signal (status and control) interface
- 2Mbit/s electrical interface for unframed signals acc. to ITU-T G.703 and framed signals acc. to G.703 and G.704.
- LAN interface 10BaseT Ethernet
- ISDN U interface

Additionally, the equipment shall provide the following aggregate interfaces:

- STM-1 (155 Mbit/s) optical 1+1 interface for medium and long distances, with automatic laser shut down.
- STM-1 (155 Mbit/s) optical add-drop interface for medium and long distances, with automatic laser shut down
- STM-1 (155 Mbit/s) electrical interface
- 34/45 electrical interface
- 8 Mbit/s optical interface
- Mbit/s HDSL interface

The equipment shall be equipped with a ringing generator for analogue subscriber interfaces.

4.2 General Conditions

The same equipment shall be used as a terminal, for through connections (transit, repeater) and as add-drop multiplexer (ADM) with integrated optical line modules.
First order multiplexing (2048 Mbit/s), second order multiplexing (8448 Mbit/s) and STM-1 multiplexer shall be integrated.
Conference for voice channels and point-multipoint function for data signals shall be possible.
The equipment shall be of fully modular design, based on a single 19" shelf.

4.2.1 Channel Capacity: Digital Cross Connection

functions. The cross connect capacity should be in the form n x2Mbit/s and should be **stated** by the bidder and non-blocking. For high-density applications the cross connect capacity shall be upgradeable up to 128x 2Mbit/s.
It shall cross-connect 64kBit/s as well as 2Mbit/s (G.703 unframed and G.704 framed) and VC12
The bidder should stated cross connect capacity for high density application ..

4.2.2 Redundant Centralized Functions

The equipment shall be equipped with redundant circuits for all centralized functions.

4.2.3 Power Supply

The multiplex equipment shall operate at 48VDC +/- 15%.
Redundant power-supply shall be supported.
In addition it shall also be possible to use a redundant power source (Dual power feeder).

4.2.4 ITU Compliance

The Equipment shall comply to the latest ITU-T recommendations for the Plesiochronous and synchronous hierarchies, such as:
G.702-704, G.706, G.711-714, G.732, G.735-737, G.742, G.826, G.823, Q.552

4.2.5 Electromagnetic Compatibility and Safety Regulations

The equipment shall comply with the EN50022, EN 61000 series of documents, IEC 801-2, IEC 801-6 and shall be conformant with CE..

4.2.6 Ambient Conditions

Storage and transport: -40 ... +70°C; 98% (no condensation)
Operation: -5 ... +50 °C, humidity of max. 95% (no condensation)

4.2.7 Mechanical Construction

The equipment shall be of robust design. All tributary and aggregate units shall be integrated in the same shelf.
All connectors shall be accessible from the front.

4.2.8 Network Configuration/Management System

The equipment shall be software programmable, either by a local craft access terminal - preferably notebook - or a centralized Network Management System (NMS).
Traffic through the multiplexer shall under no circumstances depend on the Network Management System; i.e. the multiplexer has to operate without being connected to any management system.
The Network Management System shall be used to supervise the PDH and SDH.

4.2.9 1+1 Path Protection

The equipment shall provide means to protect 64kBit/s channels. The protection shall be end to end from one interface (telephone or data) to the other. It shall switch automatically from the main channel to the standby channel. It shall be configurable whether the system switches back to the main channel (reversible switching) or not (non-reversible).
If a path has switched to its standby route because the main route is disturbed this shall be indicated with an alarm.
The switching shall be done within the multiplexer without using the Network Management System.

4.2.10 1+1 Section protection

The equipment shall provide means to protect 8Mbit/s and 155 Mbit/s connections. It shall be possible to use two independent links: one as the main and the other as the standby.
The system shall automatically switch to the standby connection and generate an alarm if the main connection is disturbed.
The switching shall be done within the multiplexer without using the Network Management System.

4.2.11 Network Topology

It shall be possible to build point to point, linear, ring, T, and meshed networks.

4.2.12 Synchronization

The equipment shall be synchronisable with an external clock, with connected 2048 Mbit/s signals and/ or with internal oscillator. The synchronization shall be configurable and it shall be possible to distribute the synchronization to other equipment as well.
The system shall have means to switch to select the synchronization source as well as means to prevent the system from switching synchronization loops. The equipment shall be capable select the synchronization source by means of the SSM (Synchronization Status Messaging) feature according to ITU-T G.704 or priority based.

4.2.13 Alarms

Each module shall supervise its functions and shall have an alarm-indication LED on its front. All alarms shall be collected by the NMS.
Each node shall be capable to collect up to 50 external alarms..

4.2.14 Test Loops

The equipment shall provide means to loop signals on 64kBit/s level as well as on 2Mbit/s level. It shall indicate an alarm if a loop is activated. It shall have the possibility to determine the time after which an activated loop is switched back.

4.2.15 Maintenance Facilities

Every Network Element shall have a built-in Signal Generator and Analyzer to analyze communication paths. It must be possible to cross connect the Generator and Analyzer to transmission channels and terminate the signal in other Network Elements. The configuration must be possible locally with the craft access terminal and remotely with the NMS or the craft access terminal.
It must be possible to loop-back signals locally and remotely using the craft access terminal or the NMS.

4.3 Requirements for Transport Level

4.3.1 SDH Aggregate Units

The interface shall be designed for use on single mode fiber at 1310nm and 1550nm .
The Bidder should be state the type of optical connectors .

The following main functions shall be supported :
- Termination of the OS-, RS-, MS- and VC-4 layer
- Extraction and insertion of the SOH communications information
- Through connections of VC-12 and VC-3

The following maintenance functions shall be supported :
- Status indications
- Loops
- Restart after ALS
- TTI monitoring
- BIP Error Insertion

The following SDH interfaces shall be available :
- STM-1 (155Mbit/s) optical 1-port interface
- STM-1 (155Mbit/s) optical 2-port interface

This interface shall provide Multiples Section Protection (MSP) :
- 1+1 Section Protection
- STM-1 (155Mbit/s) electrical 1-port interface

4.3.2 HDSL Trunk Units

2Mbit/s HDSL interface
The HDSL interface shall provide means to interconnect the multiplexer over two pairs of copper wire up to a distance to be stated by the bidder and the type of modulations should be mentioned l
It shall communicate either with another interface of the same type or with a remote desktop terminal.

4.4 2 Mbit/s HDSL Desktop Terminal

This Terminal shall provide a HDSL interface to transmit 2Mbit/s over two pairs of copper over a distance up to 12 km. It shall be housed in a metallic indoor case. The following interfaces shall be available:

- G.703, 2Mbit/s, 75 ohm
- G.703, 2Mbit/s, 120 ohm
- X.21/V11, N x 64kBit/s (N = 1 .. 32)
- V.35, N x 64kBit/s (N = 1 .. 32)
- V.36 / RS449, N x 64kBit/s (N = 1 .. 32)
- LAN connection:

10BaseT Ethernet connection for e.g. router supporting
LAN protocols: IP, IPX; Routing Protocols: RIP; WAN protocols: HDLC, PPP, Frame Relay (including RFC 1490). It shall inter-operate with Cisco, Wellfleet, 3Com etc. and be manageable. locally, remotely, and with Telnet and SNMP. Two such Desktop Terminals shall be connectable to provide a 2Mbit/s link over two pairs of copper.

4.4.1 HDSL Repeater

An HDSL repeater solution for distances longer than 12km shall be offered including a remote powering solution.

4.4.2 HDSL Line Protection

The HDSL equipment shall (where necessary) be protected against influences of induced voltages up to 10 kV.

4.5 Tributary Units

4.5.1 Wire Interface (VF interface)

This interface shall provide multi voice channels with a bandwidth of 300 Hz ...3.4 kHz and 2 signaling channels (M => E, M' => E') per voice channel.
Each interface shall be configurable to operate with or without CAS. The bist which will be used with CAS should be stated according to ITU recommendation **.**
The level shall be software adjustable
Modules where each interface can be individually configured with 1+1 path protection shall be available.

4.5.2 Analogue Subscriber Interface

The number of interface should be stated by the bidder .
High-density subscribers can be provided with number of subscriber to be stated by the bidder. The ringing generator shall be integrated in the
subscriber module interface. The ringer frequency shall be adjustable for 20Hz, 25Hz, and 50Hz.
The following main functions shall are supported:

Downstream signaling
- Ringing
- Metering
- Polarity reversal
- Reduced battery
- No battery

Upstream signaling
- On/off-hook
- Pulse and DTMF dialing
- Flash impulse
- Earth key

General:
- Constant current line feeding
- Line test
- Permanent line checks
- CLIP (On-hook VF transmission)
- Metering after on-hook

4.5.3 Exchange Interface

This interface shall provide many interfaces to connect remotely connected analogue subscribers to an exchange. The number of interfaces should be specified by the bidder It shall provide the following functions:

pulse dialing
tone dialing (DTMF)
earth key function
metering function(12 kHz or 16 kHz).
flash impulse
polarity reversal
indication of busy lines

The following parameters shall be configurable by software:
input voice level -5 to +4 dBr
output voice level -7.5 to -1 dBr
metering pulse enable/disable
signaling bit definition
loop back of voice to the telephone

4.5.4 Party Line Telephone System (Engineering Order Wire)

An engineering order wire (EOW) facility shall be provided at each multiplexer. The EOW shall be configured as a party line and use in band DTMF signaling to call another EOW-Terminal. The Terminal shall have an integrated DTMF decoder allowing to program a subscriber call number (….. digits), and ….. group call numbers (….. digits each). The EOW functionality can also be realized by using Voice over IP (VoIP) routed over the management channel.

4.5.5 V. 24/V.28 RS232 Interface

It shall support the following bit rates:
0 to 0.3 kbit/s transp. (V.110)
0.6 to 38.4kbit/s synchronous / asynchronous (V.110).
Modules where each interface can be individually configured with 1+1 path protection shall be provided.

4.5.6 V.11/X.24 Interface

This interface shall comply to the ITU-T X.24 recommendation for signal definition and to V.11 for electrical characteristics.
It shall support the following bit rates:
48, 56, N x 64 kbit/s (N = 1 to 30) synchronous
0.6 to 38.4kbit/s synchronous / asynchronous (X.30)
Modules where each interface can be individually configured with 1+1 path protection shall be provided.

4.5.7 V.35 Interface

This interface shall comply with the ITU-T V.35 and V.110 recommendations.
It shall support the following bit rates:
48, 56, N x 64kbit/s (N = 1 to 30) synchronous
0.6 to 38.4kbit/s synchronous / asynchronous
Modules where each interface can be individually configured with 1+1 path protection shall be provided.

4.5.8 V.36 / RS 449 Interface

This interface shall comply with the ITU-T V.36 and V.110 recommendations.
It shall support the following bit rates:
48, 56, N x 64kbit/s (N = 1 to 30) synchronous
0.6 to 38.4kbit/s synchronous / asynchronous
Modules where each interface can be individually configured with 1+1 path protection shall be provided.

4.5.9 64 kbit/s Co-directional Interface

This interface shall comply with the ITU-T G.703 part 1.2.1 for co-directional data transfer.
A module shall have at least 8 interfaces.
Modules where each interface can be individually configured with 1+1 path protection shall be provided..

4.5.10 LAN Interface

There shall be a 10BaseT interface available with Router Bridge and FRAD Function available. The following specification shall be covered:
Ethernet connection: 10BaseT
LAN protocols: IP, IPX
Routing Protocols: static IP route, OSPF2 V2

WAN protocols: PPP, Frame Relay (including RFC 1490)
The interface shall be manageable locally, remotely, with the management system of the platform.
The LAN interface shall support linear-, ring- and star-configurations.
The WAN side shall support link capacities n*64kBit/s and 2Mbit/s.

4.5.11 Alarm Interface

This interface shall provide means to collect various alarms, which will be displayed, on the Network Management System. It shall be used to manage non-PDH equipment with the PDH Network Management System.
It shall have at least 24 binary inputs and at least 4 outputs, which can be switched by the Network Management System.
It shall be possible to connect an input to an output so that if an alarm occurs, the output contact will be switched.
It shall be possible to label an alarm. The label-text shall be read from the interface module so that it can be indicated on the Network Management System as well as on the local craft terminal.

4.5.12 Tele protection Interface

This interface shall provide a means to transmit four bi-directional command channels.
The signals shall be adjustable from 24 to 250Vdc by means of software.
All inputs and outputs shall be isolated and with EMC immunity for harsh environment.
Security, Dependability and Transmission speed shall be selectable and programmable.
It shall be able to drop and insert commands, transfer commands as a transit station and to have AND- and OR-connections between commands.
The interface shall support T-nodes.
The teleprotection interface shall provide an integrated non volatile event-recorder which shall be synchronisable either internally or by GPS or a command counter which counts trip commands.
The teleprotection interface shall provide means for signal delay measurement.
1+1 protection must be available; the switching shall be done within less than 10ms**.** (possible time to be stated by the bidder)
The interface shall do automatic loop test as frequently as possible .
Under no circumstances shall the interface cause trip-commands in case of power supply failure or when put in or out of service.
It shall be possible to synchronies all teleprotection interfaces with one GPS in one station.
The GPS time shall be distributed over the teleprotection channel.

4.5.13 Optical Protection Relays Interface

This interface shall have an optical port to connect protection relays for teleprotection to the multiplexer. It shall operate according IEC 60870-5-1, format class FT 1.2 on 1300nm using MCMI line coding.

4.5.14 Binary Contact Interface

This interface shall provide means to transmit binary signals.
The inputs and outputs shall be isolated.
The inputs shall be suitable for 24Vdc to 60Vdc.
Outputs shall be solid state relays.
The interface shall provide a 24Vdc short circuit proofed auxiliary power supply.
It shall be able to drop and insert commands, transfer commands as a transit station and. to have AND- and OR-connections between commands,.
The Teleprotection interface shall provide an integrated event recorder, which shall be synchronisable either internally or by GPS.

4.5.15 2 Mbit/s G.703 / G.704 Interface

This interface shall comply with the ITU-T G.703 and G.704 recommendations.
The interface module shall have at least four interfaces to be activated individually. It shall be possible to have 128 interface modules per multiplexer.
In order to connect different equipment, the interfaces shall be available with the impedance of 120 ohms and 75 ohms.
The interface shall support CRC-4 multi-frame according to ITU-T G.704 (enabled and disabled by software).
The CAS signaling according to ITU-T G.704 table 9 shall be activated optionally.
The interface shall be able to extract the 2.048 MHz clock, which can be used to

synchronize the multiplex equipment.
The interface module shall support 2Mbit/s loop-back of the incoming signal as well as the loop-back of the internal signals.

4.5.16 ISDN U Interface

There shall be ISDN U interfaces available for subscriber and exchange side. The interface shall be based on 2B1Q code and provide 8 ISDN U lines.

4.6 Optical Amplifier

In case of long distance communication, which cannot be covered by standard a optical interface, an optical amplifier shall be applied.

4.7 Summary of Standards

The Equipment shall comply with the latest ITU-T recommendations for the Plesiochronous and synchronous hierarchies.
The equipment shall be KEMA type tested.
In particular the mentioned recommendations shall be covered:

4.7.1 PDH Interfaces

The PDH interfaces shall conform to the following recommendations:
ITU
- ITU-T G.702: General aspects of digital transmission systems – Terminal equipment - Digital hierarchy bit rates
- ITU-T G.703: Digital transmission systems – Terminal equipment – General Physical/electrical characteristics of hierarchical digital interfaces
- ITU-T G.704: Digital transmission systems – Terminal equipment – General Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels
- ITU-T G.706: General aspects of digital transmission systems – Terminal equipment - Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in recommendation G.704
- ITU-T G.711: Pulse code modulation (PCM) of voice frequencies
- ITU-T G.712: Transmission performance characteristics of pulse code modulation channels
- ITU-T G.732: General aspects of digital transmission systems – Terminal equipment - Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s
- ITU-T G.735: Characteristics of primary multiplex equipment operating at 2048 kbit/s and offering synchronous digital access at 384 kbit/s and/or 64 kbit/s
- ITU-T G.736: General aspects of digital transmission - Characteristics of a synchronous digital multiplex equipment operating at 2048 kbit/s.
- ITU-T G.737: Characteristics of external access equipment operating at 2048 kbit/s and offering synchronous digital access at 384 kbit/s and/or 64 kbit/s
- ITU-T G.823: The control of jitter and wander within digital networks, which are based on the 2048 kbit/s hierarchy
- ITU-T G.826: Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate

4.7.2 Architecture of Optical SDH interfaces

The architecture of optical SDH interfaces shall conform to the following recommendations:
ETS/EN
- ETS 300 147: Synchronous digital hierarchy multiplexing structure
- ETS 300 417: Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment
- ETS 300 417-1-1 / EN 300 417-1-1 V1.1.2: Generic Processes and Performance
- ETS 300 417-2-1 / EN 300 417-2-1 V1.1.2: SDH and PDH Physical Section Layer Functions
- ETS 300 417-3-1 / EN 300 417-3-1 V1.1.2 : STM-N Regenerator & Multiplex Section Layer Functions
- ETS 300 417-4-1 / EN 300 417-4-1 V1.1.2 : SDH Path Layer Functions
ITU
- ITU-T G.707: Network node interface for the synchronous digital hierarchy
- ITU-T G.783: Characteristics of synchronous digital hierarchy (SDH): equipment functional blocks
- ITU-T G.803: Architecture of transport networks based on the synchronous digital hierarchy (SDH)
- ITU-T G.805: Generic functional architecture of transport networks
- ITU-T G.826: Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate
- ITU-T G.841: Types and characteristics of synchronous digital hierarchy (SDH) network protection

architectures
- ITU-T G.957: Optical interfaces for equipment and systems relating to the synchronous digital hierarchy
- ITU-T M.2101.1: Performance limits for bringing into service and maintenance of international SDH paths and multiplex section
- ITU-T T.50: International Reference Alphabet (IRA) - Information technology 7 bit coded character set for information interchange

4.7.3 Synchronization and Timing of Optical SDH Interfaces

The synchronization and timing of optical SDH interfaces shall conform to the following recommendations:

ETS/EN

- ETS 300 417-6-1 / EN 300 417-6-1 V1.1.2: Synchronisation Layer Functions
- ETS 300 462-1 / EN 300 462-1-1 V1.1.1: Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 1: Definitions and terminology for synchronization networks
- EN 300 462-4-1 V1.1.1: Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 4-1: Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronuous Digital Hierarchy (PDH) equipment
- ETS 300 462-5 / EN 300 462-5-1 V1.1.2: Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 5: Timing characteristics of slave clocks suitable for operation in Synchronous Digital Hierarchy (SDH) equipment

ITU

- ITU-T G.813: Timing characteristics of synchronous digital hierarchy (SDH) equipment slave clocks (SEC)

4.8 Synchronization Equipment

A master clock for the synchronization of the SDH equipment shall be provided. This shall be a Type XL-DC or similar. The supplier should be True Time or similar

4.9 Test Equipment

The following test equipment shall be provided:

4.9.1 Optical Power Meter

Optical Power Meter for 1300 nm and 1550 nm, handheld: OLP-6 or similar Suppliers: Acterna or similar

4.9.2 Digital Communication Analyzer

Digital Communication Analyzer: for signal analysis on 64kbit/s and 2Mbit/s level
Suppliers: Acterna or similar

4.9.3 Optical Time Domain Reflectometer OTDR

Optical Time Domain Reflectometer
Suppliers : Anritsu, Fujicura or similar

4.9.4 Test Equipment for Telprotection Module

Test equipment for Telprotection Module: Testset or similar
Suppliers: Teleprotection module producer or similar

4.10 Abbreviations

ADM Add-drop multiplexed
ALS Automatic Laser Shutdown
BIP Bit Interleaved Parity
CAS Channel Associated Signaling
CAP Carrier-less Amplitude and Phase
CRC Cyclic Redundancy Check
DTMF Dual Tone Multi-Frequency
EN European Norm
EOW Engineering Order Wire
ETS European Telecommunications Standards
GPS Global
HDSL High Density Subscriber Line
IEC International Electrical Commission
ITU International Telecommunication Union.
IP Internet Protocol
ISDN Integrated Services Digital Network

MCMI Multi Coded Mark Inversion
MS Multiplex Section
NE Network Element
NMS Network Management System
LAN Local Area Network
OS Optical Section
OSPF Open Shortest Path First
PDH Plesiochronuous Digital Hierarchy
PPP Point-to-Point Protocol
RS Regenerator Section
SDH Synchronous Digital Hierarchy
SNMP Simple Network Management Protocol
SOH Section Overhead
STM Synchronous Transport Module
TCP Transmission Control Protocol
TTI Trail Trace Identifier
VC Virtual Container
VF Voice Frequency.

AddendumA:

Data about offered integrated equipment to be filled in by the bidder.

Name of Manufacturer:_____

Model : _____

Type: _____

		REQUIRED	**OFFERED**
1. GENERAL:			
Type of multiplexer		SDH: ADM	
Complying to ITU-T rec.		Yes	
Transmission Capacity	Mbit/s	STM-1: 155	
Access capacity on 64 kbit/s	channels	to be state by the bidder	
Access capacity on 2 Mbit/s	channels	Minimum 40	
Equipment used in substation environment		List of 10 reference substation projects	
Redundant central processor		Shall be available	
Digital cross connect function		Fully non-blocking	
The equipment is KEMA type tested		YES	
2. Teleprotection functionality:			
Integrated distance teleprotection functionality		YES	
Integrated optical teleprotection functionality			
Addressing system for commands		YES	
Loop test for delay time		YES	
Switch-over less than 10ms		YES	
3. Available AGGREGATES:			
Optical SDH aggregates (ITU-T G.957)		S-1.1, L-1.1, L-1.2	
4. Available TRUNK INTERFACES:			
Optical 8Mbit/s interface		Yes	
Electrical 34/35 Mbit/s interface		Yes	
HDB3, 2 Mbit/s interfaces per module	No.	Minimum 8	
Complying to ITU-T rec.		G.703, transparent G.704, selectable	
HDSL, 2Mbit/s interface: no of copper wires Capacity on 2Mbit/s or on 1Mbit/s Capacity selectable	No. ch ch / pair of wire	4 or 2 30 or 15 30 / 2 pairs 30 / 1 pair	

HDSL line codes CAP, PAM16, G.SHDSL		All codes available	
5. Available USER INTERFACES			
5.1 Voice interfaces for trunk lines:			
1 + 1 com path protection, available for all		Yes	
Analogue, 4wire with E&M: Input level Output level	dBr	to be stated by the bidder according to standard recommendation international	
Analogue, 2wire with E&M: Input level Output level	dBr	+6.5 .. –12.5 1.0 .. -20–	
Digital, 2Mbit/s CAS or PRI		Yes	
5.2 Voice interfaces for remote subscriber:			
2wire, subscriber side	dBr	-5 .. +4 / -7.5 .. -1	
Minimal number of subscriber	No.	10	
2wire, PABX side	dBr	-5 .. +4 / -7.5 .. -3	
Minimal number of PABX	No.	10	
6. Integrated teleprotection			
6.1 Interface for Commands:			
Number of independent commands	No.	4	
Transmission time max.	ms	to be stated by the bidder	
Signal voltage	Vpeak	250	
1 + 1 com path protection		Yes	
6.2 Interface(s) for Differential Protection:			
Electrical interface: G.703	kbit/s	64	
Optical Interface	kbit/s	to be stated by the bidder	
7. Data: channels per module			
1 + 1 com path protection, available for all		Yes	
V.24/V.28 (RS-232): up to 38.4kbit/s	No.	to be stated by the bidder	
V.11/X.24 (RS-422): 64kbit/s	No.	to be stated by the bidder	
V.35: 64kbit/s	No.	to be stated by the bidder	
V.36 (RS-449): 64kbit/s	No.	to be stated by the bidder	
G.703: 64kbit/s	No.	to be stated by the bidder	
Ethernet:: 10BaseT WAN capacity Protocols	No. Mbit/s	to be stated by the bidder Min: 2x 2Mbit/s Min.: IP	
Integrated Ethernet Hub 10/100 Base T	No.	Min. 5	
8. Integrated alarm gathering module:			
Number of external alarms per module	No.	Min. 20	
Auxiliary power supply for ext. contacts		Yes	
9. Configuration Management			
Type/Name of configuration tool			
For local / remote operation		Yes / yes	
Data communication network (DCN)		Ethernet / IP or Ethernet / OSI	
Integrated Management of Teleprotection Commands		Yes	
10. Network Management System			

Type/Name of configuration tool			
For fault / configuration management		Yes / yes	
For local / remote operation		Yes / yes	
Data communication network (DCN)		Ethernet / IP or Ethernet / OSI	
Graphical network representation		Yes	
Integrated Management of Teleprotection Commands		Yes	
Synchronization view option		Yes	
Networking Package option (end to end configuration)		Yes	
11. Technical Requirements			
11.1 Ambient Conditions:			
Storage: ETS 300 019-1-1, class 1.2	C / % hum°	-25 .. + 55 / class 1.2	
Transport: ETS 300 019-1-2, class 2.2	C / % hum°	-25 .. + 70 / class 2.2	
Operation: ETS 300 019-1-3, class 3.1E	C / % hum°	-5 .. +45 / class 3.1E	
11.2 Power Supply			
Operation	VDC	48 / 60 (-15/+20%)	
Fully redundant power supply		Yes	
Dual power feeder		Yes	
11.3 Optical amplifier			
Minimal Launched power (A)	dBm	to be stated by the bidder	
Minimum sensitivity (B)	dBm	to be stated by the bidder	
Available bit rates PDH: 8 and 34 Mbit/s, SDH: STM-1 (155 Mbit/s),STM-4 (622 Mbit/s)		All bit rates available	
Dispersion limits for STM-4 application (on SM Standard fibre G.654)	km	>250	
Optical connectors E2000		Yes	
Alarm output		Yes	
LAN management interface		Yes	

Bidder shall provide all necessary information which deemed to be necessary to complete the project in all respects.

5. MICRO WAVE SYSTEM

A Microwave link communication system shall be provided to connect the substation site with the Public Telecommunications Network at the centre of the nearest city.
The Microwave system shall be equipped with STM-1 to handle a traffic level of 155 Mbps bit stream.
Two PCs with FMX multiplexers shall be provided.

5.1 Main Specification for 2.5 GHz Point to Point Digital

(Alternative frequencies to be considered)

RADIO LINK

MAIN SPECIFICATION FOR 2.5 GHZ POINT TO POINT DIGITAL RADIO LINK		
	DESCRIPTION	**REQUESTED SPECIFICATION**
	Frequency band	2.5 to 2.7 Ghz
1		Alternative frequencies to be considered
2	Frequency channel arrangement	As per ITU-R 1243
3	Go/return frequency split	74 Mhz
4	Traffic capacity	1E1, 2E1, 4E1 software selectable
5	Adjacent channel separation for:	
5.1	Traffic capacity set to 1E1	1 Mhz
5.2	Traffic capacity set to 2E1	1.75 Mhz
5.3	Traffic capacity set to 4E1	3.5 Mhz
		28 Mhz
6	RF tuning range	otherwise to stated by the bidder
7	Frequency stability	+/- 5 ppm
8	Frequency agility	Software programmable in 250 Khz steps a different programmable state to be considered
		+26.5 dBm
9	Output power at antenna flange	other value to be stated by the bidder
10	Modulation scheme	16 QAM
		Alternative modulation scheme to be considered
10.1	Receiver sensitivity for BER10-3 (antenna port) for:	
10.2	Traffic capacity set to 1E1	-91.5 dBm
10.3	Traffic capacity set to 2E1	-88.5 dBm
11	Traffic capacity set to 4E1	-85.5 dBm
12	Spurious emission and rejection	According with ETSI standard
13	System configuration	1+1 MHSB on single antenna
14	System installation	Designed for full indoor installation, 19" rack
15	RF channel identification	Yes
16	Selective E.O.W. channel	Yes
17	IT TX/RX frequencies	70 Mhz
18	Operating temperature range	-10 to +55°C
19	No internal ventilation fan	Yes
20	Power supply voltage	220 Vac or 48/60 Vdc
21	Compatible with ABB NMS sw LOM	Yes, for integration with existing equipment

5.2 Technical Specifications for SHD Digital Radio Terminals

5.2.1 General Requirements

SDH digital radio equipment shall be in the split mount configuration, in order to optimize RF frequency planning and reduce spare parts stock, to be stated by the bidder**.**
Due to possible frequency resource congestion, especially in the city areas, terminals would preferably feature 128 Block Code Modulation (BCM) scheme.
BCM Block Code Modulation is anyway preferred compared to QAM.
XPIC (Cross Polar Interference Canceller) mechanism in the radio and improved XPD microwave antenna dishes will be preferable and applicable irrespective of adopted modulation scheme. For 128 BCM modulation, this will allow the transmission of 2*STM-1 streams on 28 MHz only. The availability of standard power and high power versions is preferred.
Terminal configuration might be, according with system planning:

1+0 unprotected
1+1 protected MHSB
1+1 Frequency diversity
1+1 Space diversity
1+1 Frequency diversity and space diversity

5.2.2 Radio Terminal Main Technical Performances

The system gain shall be as high as possible to maximize link availability and minimize antenna dish sizes. The performance shall be as follows:

Output power, at antenna port 1+0 configuration, example at 18 Ghz; +17 dBm for 128 BCM, +20 dBm for 32 Bcm minimum values **Different values to be state**d
ATPC Automatic Transmit Power Control at least 20 dB with corresponding power consumption reduction, minimum 1 dB steps
21 taps fractionally spaced transversal equalizer
Base band/IF test loop backs, RF loop-back for 32 BCM modulation scheme
Receive sensitivity, at antenna port 1+0 configuration, example at 18 Ghz: -67.5 dBm ate 128 BCM, -72.5 dBm at 32 BCM **Other value to be stated**

5.2.3 User Side Port Interfaces

These shall be available in a number of configurations for better engineering flexibility as follows:

Integrated 63 * 2 Mb/sec (120 or 75 Ohm)
Integrated 8 * 2 Mb/sec with 2 * electrical 10/100 Base T and 1 * Optical 100 Base FX with integrated layer 2 functionalities such as VLAN, QoS, …
STM-1 optical (short or long distance)
PDH 140 Mb/sec electrical

5.2.4 Wayside Service Channels

In addition, the following wayside service channels shall be available in case of 32 BCM modulation scheme:
In the case of a 32 BCM modulation scheme:

SERVICES FROM SOH BYTES:
3 * 64 Kb/sec V.11 or G.703 channels
EOW Engineering Order Wire with selective call facilities
192 Kb/sec DCC channel
SERVICES FROM RFCOH BYTES:
1 * 9.6 Kb/sec V.11 channel
2 * 9.6 Kb/sec V.28 channels
2 * 64 Kb/sec G.703 channels
ADDITIONAL CAPACITY FROM RFCOH
11.1 Ambient Conditions:

Storage: ETS 300 019-1-1, class 1.2	°C / % hum	-25 .. + 55 / class 1.2
Transport: ETS 300 019-1-2, class 2.2	°C / % hum	-25 .. + 70 / class 2.2
Operation: ETS 300 019-1-3, class 3.1E	°C / % hum	-5 .. +45 / class 3.1E
ADDITIONAL CAPACITY FROM RFCOH		
2 * 2 Mb/sec G.703 channels		

In the case of a 128 BCM modulation scheme:

SERVICES FROM SOH BYTES:
3 * 64 Kb/sec V.11 or G.703 channels
EOW Engineering Order Wire with selective call facilities
192 Kb/sec DCC channel
SERVICES FROM RFCOH BYTES:
2 * 9.6 Kb/sec V.28 channels
1 * 64 Kb/sec G.703 channel

5.2.5 Radio Terminal Programming and Controlling

Radio terminals shall feature build-in LCD diagnostic display for direct simplified equipment programming and controlling without a PC. For accessing more comprehensive radio link functionalities, dedicated software and lap-top PC shall be employed, as follows:

Operating under Microsoft Windows 9x/NT/XP
Event logger, at least 10 000 alarms
Capable of managing at least 100 Network Elements
Link performance management according with G.826
Software and equipment configuration up-down load
Selectable duration of all manual commands
Communication port PPP a sync RS232 and Ethernet 10 Base2 or 10BaseT

6. STAFF LOCATION SYSTEM

A Staff Location system shall be provided to cover all major and remote areas of the station. The system can either be of the wired or wireless type. A wired system shall include a digital display indicating the called party telephone number, together with an audible sound to attract the called person's attention. On wireless systems, radio links shall be utilized to either display the telephone number, or initiate an alarm tone in a pocket sized receiver carried by the called party.
However, it is preferable to use the PABX with wireless mobile pocket telephones. The system requires capacity for communication with 150 subscribers. The actual numbers of handsets possible, and the original manufacture company, should be quoted by the Tenderer. Dect system would be considered, as would any other proposal by the Tenderer.

7. WIRED BROADCASTING SYSTEM

A Wired Broadcasting System shall be provided to cover the whole station and outdoor area for announcements etc. Sufficient 250Watt amplifiers shall be installed in the Communication Room in the Administrative Building. Adequate indoor and outdoor type loudspeakers shall be provided to ensure that the broadcasts are audible throughout the site. Outdoor loudspeakers shall be weatherproof.
The facility to connect the National Radio broadcasting to the Wired Broadcasting System shall be provided to allow important public announcement by the authorities. Between announcements, music broadcast shall be provided using tape recorders connected to the system. Through a suitable interface with the Fire Alarm System, the Wired Broadcasting System shall issue a special alarm sound in case of a fire. The Tenderer shall state the number of amplifiers and the number, type, rating and location of the loud speakers proposed, together with details of the manufacturer.

A full study and design of the system, with a bill of quantities, shall be provided for approval by the Employer.
Any alternative proposal for the above system will be considered.

8. INTER COMMUNICATION SYSTEM

An Inter communication System shall be provided with slave receivers units mounted on walls in Boiler and Turbine areas, for each unit to communicate with the master set located in each Unit Control Room, and with an overall master set placed in the Main Control Room. Communication between master sets is not desirable.
The number, type and manufacturer of master sets and slave units shall stated by the Tenderer.

9. FIRE & CIVIL DEFIANCE ALARM SYSTEM

A fire and civil defiance alarm system shall be provided for reasons of personal protection.
Two possible systems are acceptable, either Electrical or Pneumatic.
Both systems should have the same result in producing a sound alarm in case of fire of .intensity 140 db relative to 0.0002 dyne/square cm, at one meter from the horns. The horns shall be placed high upon a pole to spread the alarm in all directions.
The system shall be capable of producing a different sound alarm rhythm in case of an air raid.
These alarms shall be operated either manually, or by dialing a special coded number from any Telephone and the number shall be displayed by a special device in the Main Control Room.
Numbers, Types and Manufacturer of the equipment shall be stated by the Tenderer.

10. TIME DISPLAY SYSTEM

A time display system shall be provided based on the following:

10.1 Master Electronic Clock

A Master Electronic Clock with an accuracy of 1part in 1,000,000, with temperature variation of 10 degree C, shall be provided.
The unit shall be installed in the Communication Room and shall include all wiring and circuitry for the additional displays.

10.2 Slave digital displays

Slave digital displays, synchronized with the master clock showing time in hours and minutes, shall be installed in all major places.

10.3 Clock display

A clock displaying hours, minutes, seconds, month and day shall be installed in the Control Room.

10.4 Details required with Tender

Numbers, Types and Manufacture of all components shall be stated by the Tenderer.

11. INTRUDER WARNING SYSTEM

11.1 Introduction

A suitable perimeter security system shall be provided for each site. Each system shall detect, locate and monitor all intruders to the site at any location around the perimeter fence. It shall be capable of detecting any abnormal movements outside of the fence, to adistance stated by the Tenderer that shall be consistent with the equipment offered and the site specific conditions.
Visual display of intruders detected around the perimeter fence and any abnormal movements outside the fence shall be provided on monitors located in anumber of locations in the site or remote from the site.
This section does not specify thephysical protection requirements of the site and the Tenderer shall state how he intends to satisfy the functional requirements of this specification .
For each site a perimeter fence(s) and gated access point(s) shall be provided as specified in the associated power station or substation contract specification.

11.2 General

The site security system shall contain a number of sub-systems and major components and shall be complete with all necessary equipment and installation accessories, installed,

tested and commissioned. The systems provided shall have the following general characteristics: -

(a) All of the equipment proposed shall be suitable for the Iraqi environment and perform without degradation in all the expected weather conditions specified in the associated power station or substation contract specification..

(b) All of the equipment provided shall incorporate current, up to date technology relevant to the site being protected.

(c) The transmission media proposed between the security control room and the equipment (sensors, cameras etc) shall be stated by the Tenderer and be consistent with the requirements of this specification. It should be noted that the sites to be protected have high voltage equipment, high operating currents and consequently very high continuously varying electric and magnetic fields both at mains frequency and at high frequency due to electrical high voltage discharges.

(d) Any equipment provided shall be self-contained and not require equipment mounted outside the perimeter fence. The Tenderer shall detail any techniques proposed that require equipment mounted outside the perimeter fence that would significantly enhance the site security.

(e) Spare parts and consumables items shall be provided, sufficient to operate the system for 2 years of normal operation.

(f) User Training shall be provided and the Tenderer shall state what training is available and what is recommended to allow the Employer to be able to maintain the system.

11.3 Requirements

Sites to be protected will have differing characteristics and thus differences in configurations between sites are to be expected. The site specific conditions shall be determined during the Tenderer's site survey, in agreement with the Engineer's Representative. However each site security system is expected to consist of, but not limited to, the following major components or sub-systems.

(a) Cameras

(b) Intrusion detectors

(c) Operator facilities.

11.3.1 High resolution cameras

High-resolution colour cameras shall be located around the fence to provide a continuous view of the inside of the fence line. Additionally a number of cameras shall be capable of an unobstructed view of any abnormal movement outside of the fence, to a distance away from the fence stated by the Tenderer, consistent with clause 11.4 (f) below. All active cameras shall have their pictures recorded by solid-state video recorders located in the site control room. All of each specific camera's functions and operation shall be remotely controllable (automatically and manually).

The camera's provided shall have, but not be limited to, the following specifications:-

(a) Heavy duty.

(b) Outdoor type.

(c) Zoom in/out, remotely controlled.

(d) Motorized pan & tilt movement, remotely controlled, with a number of pre-set positions.

(e) Auto-focusing.

(f) Pole mounted and wall mounted.

(g) The cameras shall not require any regular maintenance.

(h) Infrared illuminator for low light level or night-time, automatically controlled by photocell, and including a time delay.

(I) There have to be enough sensor to cover the whole area of the station especially outdoor area , the whole fence and the perimeter of the station .

11.3.2 Outdoor intrusion sensors

Intrusion sensors (incorporating anti-crawl technology) shall be provided to detect unauthorized site intrusion and abnormal movement or activity. The intrusion sensors shall initiate an alarm and the display and recording of the relevant video pictures providing

coverage of the area where the intrusion or abnormal activity is detected.

(a) The type and technology of the sensors is to be stated by the Tenderer.

(b) The sensors shall be capable of discriminating between animals and human beings whether walking, running or crawling, with a high level of probability of detection and a very low level of false alarms.

(c) The sensors shall be able to locate an intruder to within an area of less than 10 square meters.

(d) The sensors shall be suitable for the Iraqi environment and shall function normally during the day or night in all weather events, including sand storms..

(e) The user shall have the capability of designating each fence zone with a different detection criteria or sensitivity. This facility shall be configurable by the system manager via password access to the system configuration.

(f) Site access points shall not adversely affect the system operation and performance. Detection zones at access points shall be user configurable as active or passive . When passive the sensor system shall still function but the associated alarms muted. Adjacent areas shall function without any derogation in performance irrespective of the operating state of the access points.

(g) The sensors supplied shall not be affected in anyway by security systems on adjacent sites or other equipment mounted locally with similar operating characters (e.g. adjacent or mobile radar systems, power plant etc).

(h) The intrusion sensors shall not require regular maintenance

(I) There have to be enough sensor to cover the whole area of the station especially outdoor area , the whole fence and the perimeter of the station.

11.3.3 Alarm and Video Transmission System

A transmission system shall be provided to convey the alarms from the intrusion detection system (if located outside) and video signal to the appropriate main control room and the remote control and monitoring locations where provided.

(a) The transmission system shall be immune from interference from any of the plant in the site being protected or from plant on adjacent sites. This immunity shall apply even during 'normal fault conditions' and 'transient fault conditions' for the site or adjacent power generation or transmission sites. Site fault conditions can induce very high voltages in adjacent plant and significant ground step potential and circulating ground currents.

(b) The transmission system shall be capable of conveying all video pictures and alarms to the control and monitoring locations, simultaneously and without delay. Each control and monitoring location shall be able to view and control all cameras without any limitations.

11.3.4 Computerized control and management system

Acomputerized control and management system shall be provided and shall have, but not be limited to, the following characteristics: -

(a) It shall include suitable size colour monitors. The Tenderer shall recommend the number of monitors required at each operator position to provide an adequate facility.

(b) Manual camera controls for each operator position.

(**c)** A number of preset positions for each camera, selectable by the operators and able to be incorporated into a number of pre-set autonomous scan or 'patrol routes'.

(d) Manual instigation and termination of video recording from a selected camera or cameras.

(e) In the event of an intrusion, an alarm shall be automatically operated and monitor(s) in the control room shall switch to cover the zone where the alarm event(s) has been detected.

(f) The audible alarm shall sound.

(**g)** A general schematic configuration (mimic board) of the plant shall be provided and the visual indication activated in the affected area of it.

(h) When a detection zone is classed as 'passive' the user shall be able to configure the system to continue to display the video pictures in the event of intruder detection in the associated zone (see 11.3.2 above).

(i) Permit alarm reporting, control and monitoring from more than one location.

(j) Facilities for system and sensor management and configuration as well as the capability to run diagnostic routines to aid fault finding and maintenance.

(k) Permit system management and configuration, via a password control system.

11.3.5 Uninterruptible power system (UPS)

A UPS shall be provided for each site security system, sufficient to power the total system including all externally mounted equipment, for a minimum of 2 hours during a power failure. The Tenderer shall indicate the power requirements for any external illumination, if needed, and the different UPS options where the external perimeter illumination is not supported during a power failure.

11.4 Outline Specifications

The site security system(s) shall perform without degradation continuously for 24 hours a day, 365 days a year in all expected weather conditions. The tenderer shall state any. qualifications to the performance of the system as a whole, and specific equipment proposed in the tender.

The overall system shall have, but not be limited to, the following basic performance characteristics: -

(a) achieve a detection probability of 95%.

(b) false alarm rate of less than 1% of the total alarms over a period of 1 month in all expected weather conditions, with a maximum false alarm rate in any 1 hour period of not greater than 5%.

(c) mean time between failure (MTBF) of 99%.

(d) mean time to repair (MTTR) of 4 hours from arrival at site.

(e) The intruder sensors shall be able to locate an intruder to within a 50m length of the fence and an area of less than 10 square meters for abnormal movement or activity in the external monitored area.

(f) The video system shall permit an operator to identify individuals in all expected weather conditions at any location inside the perimeter fence and at any location between the perimeter fence and to a distance of 200m perpendicular from the fence.

(g) The cameras shall have a MTBF of 99.5% and a MTTR of 2 hours from arrival at site. The video signal at the control room monitors shall have a signal to noise ration of at least 47dB in all light conditions.

(h) The equipment shall have an operational life of 10 years without replacement, which shall include the video recorders and external intrusion sensors. The tenderer shall list any items that he considers has a shorter life and are thus classed as consumable items.

(i) The control system in the main control location shall have two operator positions. Any remote control and monitoring locations shall have one operator position each. All operator positions shall be able to be operated simultaneously.

12. DATA ACQUISITION SYSTEM FOR TRANSMITTING INFORMATION TO THE DISPATCH CENTRE

12.1 Purpose of the System

Regional Control Centres (RCC) are equipped with a modern SCADA system to overcome the difficulties of controlling and monitoring the various substations under their command.

12.2 Description and Specification

The system shall consist of a number of RTU's located in different substations to process the various information signals to be transmitted to the RCC via the communication network, which is based mainly on Power Line Carrier , optical fiber network is at the study and planning stage at the present . and to receive operational command signals from the R.C.C. Therefore a star connected RTU to R.C.C network is envisaged.

12.3 Regional Control Centre Master Station Equipment

See attached commentary.

12.4 Remote Terminal Units

12.4.1 Introduction

Remote Terminal Units (RTUs) will be installed at power station and substation sites that are controlled from a particular control centre. They are required to gather digital and

analogue input data representing various plant states and to output digital and analogue data to control various items of plant. The RTUs shall transfer input data to, and receive output data from, the Master Station (MS) located at the National Control Centre via communication links, as part of the overall Supervisory Control and Data Acquisition (SCADA) system.
The Contractor shall be responsible for the design, supply and installation, commissioning, including the modification of existing plant that may be required for the correct interfacing. of RTU equipment with the existing National Control Centre, including all protocols and communications as required. It is essential that the Contractor carries out tests to demonstrate that the full SCADA facilities are available over the communications interface and that the implementation of the standard protocols at the existing NCC Master End and the new RTU are the same.
The RTU shall be a stored program device with its software (firmware) resident in non-volatile memory. It shall be readily possible to update the software (eg. by PROM replacement) to alter or extend the RTUs functionality. The application specific parts of the RTU software must be generated from a high level language source or from an easily understood graphical symbolic representation.
Facilities for the end user to perform updates to the RTU software shall be available.

12.4.2 RTU Functionality

The following clauses set out the functional requirements of an RTU:

12.4.2.1 Design Principles

The RTU shall be designed to achieve a high level of availability, reliability and safety in operation. The design shall be 'fail safe' such that failure of any component shall result in all functions affected by the failure defaulting to a defined 'safe' state. It shall be fault tolerant such that the failure of any single component within the overall system shall not affect the ability of the remaining healthy components in the system to continue to operate normally and for its functionality to remain available.
Essential functionality, i.e. that required for the continued overall operation of the RTU, shall be tolerant to single component failures. This may be achieved, for example, by using dual redundant hot/standby arrangements or by automatically re-distributing the functionality over the remaining operational components so that loss of any one component does not result in the loss of any functionality.
The system shall continuously monitor its own health and produce alarms for all detected failures. These alarms shall become part of the Facility List of data to be returned to the MS and, as far as possible, by lighting 'fault' warning LEDs on the affected equipment itself, e.g. on individual circuit cards. There shall be no cases in which undetected failures could occur anywhere within the overall RTU.
The equipment and the enclosures it is mounted in shall be designed to facilitate ease of maintenance, particularly fault-finding and replacement of components, e.g. replacement of rack mounted circuit cards. As far as possible, and consistent with safe operation, it shall be possible to 'hot swap' components such as I/O cards.
The equipment shall be robust, suitable for the operating environment in which it is installed and require minimal maintenance.
Each sub-system within the RTU shall be designed to meet an overall availability of at least 99.98 per cent based on a Mean Time To Repair (MTTR) of 8 hours.
The Contractor shall provide a Functional Design Specification that will allow the Employer to review and approve the facilities being provided in the RTU, and on which the testing documentation can be based.

12.4.2.2 Hardware

The design of all RTU equipment shall be such as to ensure satisfactory operation in an electrically hostile environment typical of high voltage electrical installations.
The equipment may be either of single board design or of rack mounted modular construction. All computer equipment shall be supplied with a real-time multi-tasking operating system which conforms to a recognized industry standard and not unique to one manufacturer. Interconnecting cables shall be made via substantial, secure plugs and sockets, which shall be mounted in accessible positions and clearly labeled.
A technical description of each item of equipment, together with evidence to show that the stated guaranteed reliability figures are supported by actual service conditions, shall be supplied with the Tender.

12.4.2.3 Software

The software shall be of modular construction, developed using structured design. techniques and written in a commonly used programming language. Where possible, standard library software shall be utilised. The contractor shall identify all standard proprietary software and any software specially developed for this project.
The application software shall ensure the secure execution of RTU functions.
Protocol IEC 60870-5-101 has to be included with other protocol.

12.4.2.4 Capacity

The Tenderer shall provide capacity and technical details of the following:
- Central Processing Unit(s) (CPU)
- Memory (all types)
- Real time clock
- Communication port data rates and format (all types)

The design shall meet the following general requirements with regard to capacity and expandability:
- The RTU shall be designed, delivered and commissioned with sufficient capacity for performing the requirements of this specification and the specific operational data required at the specific site, as determined by the site survey process, and in agreement with the Employer's Representative.
- The maximum system capacity and system loading shall not be less than 200% of the specified system capacity.
- In addition to the agreed Facility List, approximately 10% spare input/output capacity shall be provided within the contract (this figure shall be confirmed at the specific site survey in agreement with the Employer's Representative). These spare facilities shall be fully fitted and pre-wired.
- The design shall provide for future expansion, modification and testing with the minimum of disruption to existing facilities.

12.4.2.5 Performance

The RTU shall process all information required to be transmitted to the MS and have it available for transmitting within two seconds of a plant change occurring. The RTU shall be capable of handling all alarms and status changes occurring during avalanche conditions without loss of any data. Avalanche conditions are defined as follows:
• A fault on a HV switchgear busbar (resulting in the generation of multiple alarms)
• Occurrence of 100 + 0.1N + .N changes is 5 seconds where N is the total number of data inputs (double signals count as two data inputs).

12.4.2.6 Electrical and Environmental

The electrical and environmental conditions to be applied shall be those within the associated power station or substation contract specification. The RTU shall operate from the site battery installation (normally 48V dc).

12.4.3 Data Acquisition

The data acquired by the RTU shall include the following:

12.4.3.1 Analogue Values

Analogue inputs shall be capable of processing standard voltage and milliamp current inputs continuously. The inputs shall be digitized to a resolution of at least 11 bits plus sign bit.
eg. MW, MVAr, kV, Hz, A and transformer tap changer position
Transducer-less inputs with direct connection to CTs or VTs for the measurement of frequency, voltage, current, phase angle, watts, VArs and VA for both single and three phase power circuits shall be provided.

12.4.3.2 Binary Coded Values

Binary Coded Values shall be provided
Eg. Transformer tap changer position.

12.4.3.3 Status Indications

Plant alarms and indications shall be derived from voltage free contacts with the wetting current supplied from the respective RTU input card. Equipment with two normal states e.g. circuit breakers and isolators, shall be represented by two source contacts to provide a positive indication of state, including illegitimate states (double indication) .

Alarm signals may be derived from contacts that either close momentarily (fleeting) or remain closed for the duration of the alarm condition (sustained).
The change of state of a digital input shall be time tagged to a resolution of 1 ms for Sequence of Events (SOE) reporting.

12.4.3.4 Pulse accumulators

Pulse counting inputs shall acquire and count impulses produced by "volt free" contacts, which can be either normally open or normally closed. Pulse counting inputs shall be provided as either a separate input module or using digital inputs.
eg. KWh
Pulse accumulators shall continuously increment until the end of the metering period, at which time the count shall be stored, together with its time tag, and the accumulator set to zero. The metering period shall be configurable and it shall be possible to download the appropriate parameters to the RTU from the MS. In addition, RTUs shall support the use of external reset pulses for accumulators. The RTU shall be capable of storing a series of accumulator values, in the event of extended loss of communications with the MS, and subsequently transmitting them upon request. A continuous accumulator shall be associated with each accumulator subject to periodic reset and the MS shall have access to the values of both accumulators upon request. The accumulators shall roll over to zero when the maximum value is exceeded and continue to count. A minimum count of 2^{24} (ie. 24 bit binary number) shall be capable of being held by the accumulator.

12.4.3.5 Values derived by logical/mathematical processing

Values derived by logical/mathematical processing of the data types above shall be possible eg summated MW.

12.4.3.6 Data Requests

The RTU shall be capable of giving the correct response to two different types of information request:

(a) A request for data that has changed significantly since the last similar request. The facility to redefine which data is significant at any time must be provided for all classes of data.

(b) A request for the current state of any item or set of items of data.

The master station shall poll outstations to request status changes and measured values on a cyclic basis. Where a report-by-exception technique is used, such that only changes that have occurred since the last poll will be returned by the RTU the master station shall in certain circumstances initiate a full scan of each RTU to retrieve the actual state or value of each point. This is to ensure that the network image held in the master station database is a true reflection of the power system condition. Such full scans shall be initiated following a master station start up, an RTU reset, upon restoration of communications and cyclically (at least every 24 hours).
Information requests received by the RTU will normally be of type (a) but type (b) requests will be received during start-up of either the MS or RTU, and as a means of confirming the validity of the representation of system state at the Master Station.
Changes of digital data shall be assessed for significance as follows. Each digital point at an RTU is to be allocated one of the following categories that shall have the stated response:

(a) Insignificant - ignore all changes
(b) Active - report all changes which persist for more than 20 ms.

The initial state of the RTU shall be that all digital changes are insignificant. During the. Initialization process and at any subsequent time, the category of any digital point may be changed.
Changes to analogues shall be assessed for significance as follows. Each analogue point at an RTU is to be allocated one of the following categories which shall have the stated response:

(a) Insignificant - ignore all changes
(b) Active - report all values that differ by a pre-defined amount from the last value reported to the MS.

The initial state of the RTU shall be that all analogue changes are insignificant. During the Initialization process and at any subsequent time, the category and the significant difference of any analogue point may be changed.
The difference value, or dead band, setting for analogue reporting shall be a user-configurable parameter. It shall be possible to define difference settings independently for

individual or groups of analogues. The Tenderer shall provide details in their Tender.

12.4.4 Time Tagging

Certain status signals may be configured for local time tagging to be applied at the RTUs. These events shall be reported to the master station with a time tag embedded in the message. The resolution should not be greater than 2msec within the RTU. The Tenderer shall provide details of the following:

(a) Time tagging resolution at the RTU
(b) Method of synchronising the RTU's real time clock to the master clock
(c) Method of transmitting time tag information with event data to the master station
(d) Means of selecting events for time tagging and the maximum number definable at each RTU
(e) Method of handling overflow of SOE data at the RTU

12.4.5 Control Outputs

12.4.5.1 General

The RTU shall generate signals to implement the commands issued by the MS, such as circuit breaker open/close, tap change raise/lower, etc. These signals shall be pulses whose length can be configured by commands from the MS. The period of the command pulse shall be configurable between 2 seconds and 30 minutes to allow for circuits with synchronising facilities. The command pulse timer shall reset immediately the command is executed or the synchronising is cancelled.

The Control Outputs will be used to operate control relays located remotely within the plant control panels.

To afford a high degree of command security against data corruption in the communication systems, command outputs shall be designed to provide ‘‘select and execute’’ operation. The select output shall energise the interposing control relays allowing the open or close execute command to actuate the appropriate control relay. The RTU shall conform to the following four stage sequence of operation:

(a) Master Station issues select command
(b) RTU confirms receipt of selection
(c) Master Station issues execute command
(d) RTU confirms execution (via normal event reporting)

Upon selection of a control output circuit, the RTU shall carry out a 1-out-of-N check to verify that only one circuit is in the 'selected' state. The health of the output circuit shall also be verified.

12.4.5.2 Circuit Breaker Synchronising

Circuit breaker closing may be initiated by a 'cb close' command issued by the operator. Checking for synchronism and dead line conditions will be carried out locally by the switchgear control scheme, by means of appropriate check synchronism and dead bus relays.

Alternatively, certain circuit breaker closing command schemes will incorporate. synchronising relays. Three special control signals are associated with such breakers: 'cb sync select', 'cb sync close' and 'cb deadline close'.

The 'cb sync select' command is latched within the switchgear control panel and connects the appropriate "running", "incoming" and "phase angle" voltages to buswires. These voltages are also transmitted to the MS for display to the operator. Unlatching will be performed locally by the closing logic, or through the 'cb sync deselect' command (common for the substation).

Circuit breaker closure will be controlled as follows:

(a) Where voltages are present on both sides of the cb, the 'cb sync close' command should be issued by the operator. This will initiate the synchronising action of the local synchronising relay, which will latch the command until one of the following occurs: the relay closes the cb, a watchdog timer expires, or the 'cb sync deselect' command is issued by the operator.

(b) Where voltage exists on only one side of a cb, the 'cb deadline close' command should be issued by the operator. This command shall be interlocked in software to prevent its issue if voltages exist on both sides of the cb.

12.4.5.3 Transformer Tap Changer Supervisory Control

Under normal operation, transformer tap changers will be controlled by automatic voltage

regulating (AVR) relays, at the substation.
When selected to supervisory control, it shall be possible for raise and lower commands or AVC set points to be issued to the tap changers from the master station.
The raise and lower commands shall not require an execute action by the operator.
Feedback of command execution will be by an associated change in the indicated tap position etc.

12.4.5.4 Set Point Outputs

The RTU shall be capable of issuing set point outputs, either as binary coded decimal digits with a strobe or as an analogue value. The set point outputs are to use the same sequence of operation as described for command outputs.
The need for set point acknowledgement may vary and therefore this aspect shall be user configurable.
Where set points are used for the transmission of MW and MVAr target indications to displays at power stations, the following principle of operation is expected to apply. Receipt of new set point values at the remote station will produce an indication that requires acknowledgement by power station operators. Power station operator's acknowledgements shall be transmitted to the master station via the remote station RTU. Once acknowledgement is received, the master station automatically resets the indication to show that acknowledgement is no longer required.

12.4.6 RTU Checking Facility

The RTU shall perform checks to ascertain the integrity of its processor(s), memory and input/output cards. The results of these checks shall be made available to the MS on demand.
The checks shall include:

(a) A watchdog mechanism to isolate the processor from the output cards if the RTUs ability to drive outputs is compromised. The action of outputs when isolated by the watchdog shall be selectable in sets of eight or less. The options that may be selected shall include "maintain current state" and "set to zero".

(b) A digital output connected to a digital input to confirm the integrity of digital input and output functions.

(c) An analogue output connected to an analogue input to confirm the integrity of analogue input and output functions. The output shall be derived from a source different to that used as the input reference. A pre-settable input source shall be used where the RTU is not fitted with analogue output facilities.
The following conditions shall be included:
(a) RTU faulty - evidence from watchdog
(b) Command output faulty - evidence from monitoring circuit
(c) Set point output faulty - evidence from monitoring circuit.
The detailed design of the communication arrangement shall be agreed with the Employer's Representative before implementation.
(d) Input/output card faulty - cannot be addressed
(e) Power supply faulty
(f) RTU high temperature
(g) VFT low receive level
(h) RTU transmit buffer overflow.
(i) Where dual communications routes or duplicated modules are employed the RTU shall annunciate failures to the master station.
(j) Input signal faulty (see below)
The RTU shall be capable of detecting a faulty input signal that is changing state with an abnormally high frequency. Upon detection of a fault condition the RTU shall suppress further reporting of the signal and send a corresponding fault report message to the MS (this signal suppression requirement applies particularly to time tagged inputs). The RTU shall automatically reinstate normal reporting upon detection of clearance of the fault condition; this shall be accompanied by an appropriate fault clearance message to the MS.

12.4.7 RTU Configuration

All RTU configuration data, for example the significance allocated to each data point, shall be held in alterable non-volatile memory so that the RTU can re-initialise itself automatically. Tenderers shall state the method by which configuration data is loaded into

the RTU. The preferred method is by downloading the configuration data from the master station. If this is not a standard feature of the Tenderer's product, it may be offered as an option.
If the RTUs are configured on site, Tenderers shall describe how this is achieved and shall include any equipment required for this function in their offer.
The master station database shall be kept updated with the current configuration data for each RTU. Tenderers shall state how this is achieved.

12.4.8 Remote Terminal Unit / Master Station Communication Systems

The RTU shall be designed and equipped to communicate with the master station via the communication links available. The Contractor is responsible for providing all necessary equipment required to achieve such connections.
Where available, the Contractor shall provide direct digital links between the RTU and Master Station. Otherwise, the Contractor shall provide communication equipment, as specified elsewhere in this specification eg microwave radio etc, to provide communication links over the Employer's communications network.
The Tenderer shall state what arrangements of communications links his equipment can support, eg star, multi-drop etc.
The communication interface shall support dual redundant communication links to remote control sites (NCC) and have the ability to automatically change to a healthy link if one link should fail.
As a minimum, the SCS device providing the remote communications interface shall support the **IEC 60870-5-101** and DNP3 protocols. The Tenderer shall provide details in their Tender of the SCADA communication protocols supported by their system.
The protocol used by the Master Station to interrogate the RTU shall feature positive confirmation to the RTU that information transmitted by the RTU has been received by the Master Station. The RTU shall keep a copy of each set of data that it attempts to transmit until positive confirmation of its delivery to the MS is received or the RTU is re-initialised.

12.4.9 Maintenance Facilities

The RTU design shall facilitate first line fault location and maintenance to be readily performed on site.
Maintenance equipment shall include an engineer's portable test unit. The test unit shall enable all the RTU's functions to be tested on site, with the RTU in both off-line and on-line states. It shall provide an indication of the presence and location of any detected RTU fault. Safeguards shall prevent the activation of RTU control outputs with the test unit connected and the RTU in the on-line state.
A master station emulator is required to facilitate the testing of RTU communications .
The. emulator shall provide a means of interrogating the RTU, via its normal communications line, and of monitoring and interpreting responses. It is preferred that a portable PC-based unit is supplied, that is capable of providing both the MS emulation and local testing facilities specified above.
A comprehensive description of all available RTU maintenance facilities, including any functions available for remote diagnosis of RTU's from the MS, shall be included in the Tender.

12.4.10 Maintenance and Spares

The intended maintenance strategy for the RTU is that the Employer shall be able to:
(a) Perform 'first-line-maintenance' of all subsystems, i.e. be able to locate faulty hardware components and replace them with spare parts with the faulty parts being returned to the original equipment supplier for repair or replacement.
(b) Analyse and define software faults and protocol interface problems with NCC.
(c) Re-configure and extend the RTU facilities with minimal assistance being necessary from the original equipment supplier, including updating databases, modifying and building new display screens and adding new equipment and devices to the RTU.
Spare parts for the RTU shall be provided to support the maintenance strategy described above, particularly bearing in mind the 'turn around time' to repair/replace faulty components.
The Tenderer shall include an itemised and individually priced list of recommended spare parts in their offer. It is anticipated that this list would include at least one item of each hardware component used within the RTU for use in first-line-maintenance (or 10% of the components for components that occur in larger numbers within the system, e.g. I/O cards). Any special tools, including software and hardware (e.g. lap-top computers)

maintenance tools shall also be itemised. The Employer shall be at liberty to purchase any numbers of those items at the tendered price until 3 months after contract placement.

12.4.11 Testing

12.4.11.1 Approach to Testing

The testing philosophy for the RTU shall ensure that the equipment functionality and site specific facilities are thoroughly exercised and validated at the Contractor's premises before delivery, and that the site specific facilities are confirmed during commissioning.
The site specific data requirements shall produced in the form of an Overall Facility Schedule and this shall be agreed with the Employer. This shall be used as a basis for testing the site specific aspects of the RTU. The test methodology shall complement the design methodology and the two shall be developed in parallel.
Since the RTUs will be made up of common components and facilities, Type Tests shall be performed to confirm that the non site specific, functional facilities are acceptable. Factory Acceptance Testing shall be carried out on each site specific configuration on test equipment similar to the site target equipment and configured to represent the site target configuration.
The principle of testing shall be that, at stages throughout the work, formal tests shall be performed and recorded against written test specifications, to provide a high level of confidence to the Contractor and the Employer that subsequent stages can proceed.
The responsibility for specifying, conducting and recording tests shall be with the Contractor, but all aspects must be to the satisfaction of the Employer. The degree to which the Employer intervenes in the process will depend upon the level of confidence built up during the project.
This document does not constitute a Test Specification or Test Procedure for any part of the system, rather it sets out the stages at which tests are required and the subjects, location and purpose of each stage. All Test Documentation for all tests shall be written by the Contractor and submitted to the Employer for approval at least 12 weeks before they are first used.
Inspection of incoming goods and components, and subassembly testing, shall be undertaken by the Contractor in accordance with the procedures set out in the Contractor's own Quality Plan and are not described here..

12.4.11.2 Responsibilities

The Contractor's responsibilities shall include but not be limited to requirements to:

(a) Produce written test plans, schedules, procedures, method statements, test record sheets and procedures for fault reporting, for all tests.
All test documentation associated with a subsystem or system test shall be submitted for approval by the Employer at least 12 weeks prior to the commencement of the associated test.

(b) Ensure that all test documentation associated with any testing has been approved by the Employer prior to the commencement of the corresponding testing.

(c) Provide the equipment, test equipment, test software, personnel and facilities to conduct the tests.

(d) Successfully carry out all tests according to the approved test procedures and correct any errors, with subsequent re-testing of functions that may be affected by the correction, prior to the witnessed acceptance tests.

(e) Provide facilities for the Employer to witness any Factory or other tests.

(f) Produce permanent records of all test progress and results in a formal systematic manner.

(g) Carry out all remedial work and re-testing found to be necessary in order that the equipment should pass the tests.

Each of the above responsibilities shall be discharged to the satisfaction of the Employer, but approval by the Employer shall not imply any diminution of the Contractor's responsibilities.
It is expressly the responsibility of the Contractor to satisfy himself that items ‘supplied by others' are in a satisfactory condition for the Contractor's tests to be conducted.

12.4.11.3 Test Equipment and Facilities

The Contractor shall provide all equipment and services required for testing, including, but not limited to:

(a) Type Test and site specific facility test bed equipment

(b) Laboratory test instruments

(c) Special test equipment, emulators, simulators and test software, to permit full testing of System functions and performance (in particular a means of connecting to or emulating the NCC Master Station)

(d) Other items of the System, specified elsewhere as being part of the Contractor's supply, even if not part of the Subsystem under test

(e) Consumables.

All test instruments shall be subject to routine inspection, testing and calibration by the Contractor. All test instruments shall be subject to approval by the Employer and, if required by the Employer, shall be calibrated at the expense of the Contractor by an approved standards laboratory prior to being used during the testing.

12.4.11.4 Testing Stages

Inspection of incoming goods and components, and subassembly tests, shall be performed in accordance with the Contractor's Quality Plan. Software production and integration testing shall also be performed in accordance with the Contractor's Quality Plan.

The RTU shall be subject to acceptance testing as specified in this document. The stages of testing to be performed at higher levels shall be based on the following:

(a) Type Testing To check that the operation of all of the RTU facilities perform in accordance with the Contract requirements.

Type Testing shall be performed on test equipment at the factory similar to the site target equipment and configured to represent the largest target site configuration. The Tests shall. exercise and prove the correct operation of all of the functions of the RTU, using simulation where necessary, including the interface for connection to the National Control Centre SCADA system. The Tenderer shall state how they will undertake the Type Tests of the RTU in their offer.

(b) Factory Acceptance Testing (FAT)

To check that site specific aspects of each RTU performs in accordance with the Contract requirements.

Factory Acceptance Testing (FAT) shall be performed on test equipment at the factory similar to the site target equipment and configured to represent the site target configuration.

The FAT shall exercise and prove the correct operation of all of the site specific functions of the RTU, using simulation where necessary, including the interface for connection to the National Control Centre SCADA system. The Tenderer shall state how they will undertake the FAT of the RTU in their offer.

(c) Site Acceptance Testing (SAT) To check that the totality of the equipment supplied under the Contract performs in accordance with the Contract requirements and interacts correctly with equipment supplied by others and interfaces correctly to the Works.

Site Acceptance Testing (SAT) shall be performed with the complete RTU installed on site with all interfaces to the substation plant connected and functional and be conducted after the successful completion of the Contractor's own testing of the system. The SAT shall exercise and prove the correct operation of the functions of the site RTU, including all the testing of all facilities between the National Control Centre and RTU. The Tenderer shall state how they will undertake the SAT of each RTU in their offer.

(d) 500 Hour Trial Period (following System SAT) Each RTU shall be subject to a 'hands on' test period to demonstrate the reliability, stability and robustness of the RTU.

12.4.11.5 Notice & Witnessing of Tests

The Contractor shall provide, as part of the Programme of Work documentation, a master plan showing the scheduled dates of testing and shall provide updates to this plan, when any changes are known, at least 6 weeks in advance of the tests.

The Contractor shall advise the Employer in writing of the actual date of commencement of every test at least 10 working days before the commencement.

The Employer shall have the right to witness any tests whether conducted at the Contractor's premises or elsewhere. Records of every test, whether witnessed or not, shall be taken by the Contractor and copies sent to the Employer within 3 weeks of completion of the tests.

12.4.11.6 Test Procedures and Result Sheets

The Contractor shall prepare test procedures and result sheets for all tests. The Contractor shall also prepare a cross reference listing to show that all of the requirements of the Functional Design Specification have been included in the tests.

Separate test procedures and result sheets shall be provided for factory and site

acceptance tests. All test procedures and result sheets will be subject to review and approval by the Employer.

Test result sheets will be retained as part of the permanent QA record for the RTU.

12.4.11.7 Contractor's Prior Tests

The Contractor shall successfully complete a prior run of all tests, using the test procedures and result sheets described above, before the commencement of the formal tests.

Any revisions to the test documents found necessary as a result of the prior tests shall be made before the commencement of formal tests.

Test results from the prior tests shall be made available to the Employer, on request, to indicate the readiness of the equipment for testing to commence.

12.4.11.8 Conduct of the Tests

The Contractor shall conduct the tests in accordance with the approved test procedures. and shall enter the results in the result sheets.

For each test, the Employer will determine whether the test has passed or failed. In general, the test will be considered to have failed if either:

(a) the result of the test is not in accordance with the expected result described in the test procedure, or

(b) the result of the test is in accordance with the expected result described in the test procedure but some other unexpected or unexplained event occurred which the Employer considers to be a fault.

Full use shall be made during the tests of operator manuals and other documentation provided by the Contractor to provide a series of tests of their accuracy. The Employer may refuse to allow the commencement of the testing if this documentation is not available at the test site.

12.4.11.9 Failures

The Contractor shall correct all faults found during testing, and shall arrange for the test to be repeated. The test shall only be repeated when the fault has been remedied and the equipment demonstrated to be functioning correctly.

Where remedial measures involve significant modifications that might, in the Employer's opinion, affect the validity of earlier tests, then the Contractor shall repeat the earlier tests and obtain satisfactory results before repeating the test in which the fault was first identified.

The Employer shall have the right to order the repeat or abandonment of any test in the event that results demonstrate that the equipment is significantly non-compliant with the Contract requirements, without in any way prejudicing his rights.

The Employer shall have the right to suspend any test in the event that errors or failures have become unacceptable. The Employer shall also have the right to suspend any test in the event of a fault being detected by the Contractor but not reported to the Employer within 24 hours. In this event, the suspension shall remain in effect until reporting has been brought up to date to the satisfaction of the Employer.

12.4.11.10 Fault Categories

The Employer will allocate a category to each fault, which shall determine the future tests required. Test categories shall be as defined in the Table at the end of this section.

12.4.11.11 Repeat Tests

The Contractor shall correct and re-test every fault detected during the tests.

12.4.11.12 Fault Log

The Contractor shall maintain a fault log throughout each series of tests. Every fault detected during the tests will be entered in the log, together with the actions taken to clear and re-test the fault.

The fault log will be retained as part of the permanent QA record for the RTU.

12.4.11.13 Hardware Failure Reports

For each hardware failure that occurs at any stage of testing, the Contractor shall investigate the failure and prepare a report on its cause(s) and design implications. The report shall clearly show:

(a) the most likely cause of the failure

(b) an analysis of any stress that may have been caused to other components of the equipment being tested as a result of the failure

(c) whether the failure is a result of any component operating outside its design range
(d) whether any design changes should be made to avoid further failures.
All such reports will be retained as part of the permanent QA record for the RTU.

12.4.11.14 Software Failure Reports

For each software failure that occurs, once the software has been approved for inclusion into the system and is subject to configuration control, the Contractor shall generate a software failure report. The report shall clearly show:.

(a) The observed symptoms
(**b)** The likely cause
(c) The fault category

The report shall also clearly show the following information that shall be entered when the failure has been investigated:

(a) The actual cause of the failure
(b) The corrective action taken
(c) All software modules affected.

All such reports will be retained as part of the permanent QA record for the RTU..

Table -1 Fault Categories

Category	Definition
0	An item recorded as a fault during testing, and subsequently considered to be a normal acceptable occurrence. Testing may continue.
1	Minor fault. An event not affecting the functionality being tested in that session. Testing may continue.
2	Repeatable fault not affecting the functionality being tested in the session. Testing may continue at the discretion of the Employer
3	Repeatable fault affecting the functionality being tested in the session. The fault must be rectified before re-test of the affected test session. Testing may proceed on other sessions if permitted by the Employer.
4	Major fault affecting the functionality being tested in the session. The fault must be rectified before recommencing testing.
5	Non-repeatable fault affecting functionality being tested in the session. The action taken will depend on the severity of the fault. Discussion is needed to establish the most appropriate course of action.
6	Documentation error or deficiency. The error will usually be amended during the test and the test will continue. The documentation shall be corrected before the tests are considered complete
7	Deficiency in the ability of the test or test equipment to demonstrate the function being tested in the session. Discussion is needed to establish the most appropriate action which will usually result in a more appropriate test being devised by the Contractor and the function re-tested using that new test. The test documentation shall be updated to include the new test procedure
8	Other fault not covered above, but requiring explanation and, in some cases, correction.

.
.

.

12.4.12 Documentation

Documentation for the RTU shall be provided in line with the general provisions specified. in the relevant power station or substation Tender documentation. The documentation shall include the complete functional specification of all hardware and software and complete maintenance and user manuals for both hardware and software. In particular,

the maintenance documentation shall include detailed fault finding flow charts to assist with first line maintenance of all subsystems and the user manuals shall provide detailed instructions on system configuration such that the Employer may re-configure and extend the RTU facilities without assistance being necessary from the original equipment supplier. Complete and original copies of all software programs, operating system, drivers, data bases, tools, and emulators etc shall be provided on CD all in English .

12.4.13 Training

Training of the Employer's maintenance personnel shall be provided in line with the general provisions specified in the relevant power station or substation Tender documentation to enable them to safely and competently maintain the system to the levels described.

It is anticipated that a limited number of formal structured training courses will be provided for both hardware and software for the Employer's specialist engineers, working alongside those of the equipment supplier at the equipment supplier's factory. In addition, 'on the job' training shall be provided to the Employer's local maintenance staff, on the first line maintenance aspects of the equipment. This may take place during the site commissioning stages.

Details of the training available shall be provided by the Tenderer, including the type of training, the training locations and the numbers of personnel to be trained. All expenses associated with the training including international and local travel, hotel accommodation and meals and sundry expenses for all the trainees shall be included.

12.4.14 Warranty and Support.

The Warranty Period shall be as stated in the provisions specified in the relevant power station or substation Tender documentation contract conditions.

The Tenderer shall provide details of maintenance agreements, including prices, for the various levels of support that may be purchased after the completion of the Warranty Period.

12.5 Data Acquisition System Cabinet

A cabinet shall be provided to house the RTU equipment and to terminate and jumper all of the cabling associated with the signals listed in the enclosed Substation Data Requirements list. The Tenderer shall state what equipment mounting practice is required by his RTU and terminations and the type of cabinet proposed.

12.6 Modems

Any modems provided by the Contractor for communication between the RTU and the RCC must not be specified to function on telephone wires. They are to function on power line carrier. This is to allow various data related to different substations to be transmitted on the same PLC, each using a specified frequency band within the range 4 kHz starting from 600 Hz up to 3480 Hz, with baud rate of 200. Accordingly, the required modem has to have a filtering arrangement allowing, incoming and outgoing, the required frequency tone only in the allowed bandwidth of 240 Hz (± 120 Hz from mid-frequency) for 200 baud data speed. Any modem that uses 4 kHz in an undifferentiated manner will not work in the Iraq network, and the Supplier therefore required to strictly adhere to the above note. The following Modem Technical Data table illustrates the requirements (reference FWT 2000I SIEMENS type). The offered equipment must be of a similar specification.

The specification for the provision of PLC communications equipment is contained in the PLC section of this document..

Technical data

	50 Bd SB	50Bd FM 120	100 Bd SB	100Bd FM 240	200 BdSB	200Bd FM 240	600 Bd	1200 Bd	2400 Bd
Nominal signaling speed Bd	50	50	100	100	200	200	600	1200	2400

Maximum signaling speed	Bd	50	75	100	150	200	300	600	1200	2400
Frequency shift	Hz	± 22.5	±30	±45	± 60	± 90	±120	± 200	±400	± 800
Send/receive level, normal Value per channel	dBm	-24.5	-22.5	-21.5	-19.5	-18.5	-16.5	-13.5	-10.5	-7.5
Minimum frequency band width	Hz	90	120	180	240	360	480	1100	1700	3100
Inherent distortion (text) For nominal Signaling speed	%	< 4	< 3	< 4	< 3	< 4	< 3	< 3	<4	< 12
Approx. signal transfer delay*)	ms	48	35	26	20	15	10	4.5	3.5	2.5
Approx. operate delay of leve l monitor**)	ms	30	23	15	12	7.5	6.5	2 .5	2.0	1.5
Number of Channels in a frequency Band of 0.3 to 7.2.		76	57	38	28	19	14	8	4	2
Maximum deviation of VFT Frequencies	Hz	± 0. 1								
Frequency range	kHz	0.3 …7.2								
Raster of adjustable channel mid- frequencies	Hz	30								
Maximum deviation of Send level Referred to set value	dB	± 0.5								
Operating range of receiver Referred to nominal channel level	dBr	-20…+10								
Send level adjustment In 2 dB steps referred to nominal level	dBr	-22…+18								
Display of receive level referred To nominal channel level		8V at RL socket , in accordance with 0 dBr								
Threshold value of receiver Level monitor Referred to nominal level	dBr	adjustable from – 25…-10 in steps of 1 dB								
Threshold value of signal Monitor ,adjustable in steps, In accordance with Telegraphic distortion	%	ca.20, 30								
Neutral setting automatically Sets 1:1 signaling , initialized Via pushbutton in range	%	± 25								
The relevant ITU – T recommendation s Apply to FM 120 , FM 240,a nd FM 480 systems										
Input Impedance	Ohm	600								

*) please observe level control for multi – channel operation .

**) Receive filter without increased suppression loss .

12.7 Transducers

The watt and VAr transducers shall be suitable for measurement of unbalanced load and shall have two current and 3 phase voltage elements.
The scale of the measured voltage should range more or less by 10% of the rated input voltage.

12.8 Substation Data Requirements for Data Acquisition System

The following facilities are the minimum that shall be provided in the RTU. Where specific plant and equipment has facilities that are additional to these, they shall be included at no additional cost to the Employer. The facilities that shall be provided by the RTU at the power station or substation, and those that are transmitted to/from the NCC shall be agreed with the Employer using the Overall Facility Schedule. The agreed Overall Facility Schedule shall then be used to configure the RTU and used as a basis for RTU testing.

12.8.1 400/132kV Substations

12.8.1.1 Controls/Commands

400kV Circuit Breaker	Trip
400kV Circuit Breaker	Close

11 kV tertiary reactor capacitor bank circuit breaker	Trip
11 kV tertiary reactor capacitor bank circuit breaker	Close
400kV Disconnect Switch	Open
400kV Disconnect Switch	Close
400kV Auto Transformer On Load Tap Changer	Raise tap for position R, S, T
400kV Auto Transformer On Load Tap Changer	Lower tap =
400kV Auto Transformer AVR	Set voltage (1 – n)
400kV Auto Transformer	AVR AVC auto
400kV Auto Transformer	AVR AVC manual
132kV Circuit Breaker	Trip
132kV Circuit Breaker	Close
132kV disconnect switch	Open
132kV disconnect switch	Close.
400 and 132kV Feeder	Auto Reclose In Service
400 and 132kV Feeder	Auto Reclose Out of Service

12.8.1.2 Indications/Status

400kV Circuit Breaker	Open
400kV Circuit Breaker	Closed
400kV Circuit Breaker	On test
11 kV tertiary reactor capacitor bank circuit breaker	Open
11 kV tertiary reactor capacitor bank circuit breaker	Closed
400kV Disconnect Switch	Open
400kV Disconnect Switch	Closed
400kV Auto Transformer	On Load Tap Changer Tap position
400kV Auto Transformer	On Load Tap Changer Master (Follower)
400kV Auto Transformer	AVR Auto (Man)
400kV Auto Transformer	AVR Set voltage (1 – n)
400kV Earth Switch	Open
400kV Earth Switch	Closed
132kV Circuit Breaker	Open
132kV Circuit Breaker	Closed
132kV Circuit Breaker	On test
132kV disconnect switch	Open
132kV disconnect switch	Closed.
132kV Earth Switch	Open
132kV Earth Switch	Closed
400 and 132kV Feeder	Auto Reclose In Service
400 and 132kV Feeder	Auto Reclose Out of Service

12.8.1.3 Alarms

400kV Circuit Breaker	Breaker trip
400kV Circuit Breaker	Breaker fail protection operated
400kV Circuit Breaker	CT stack protection operated
400kV Circuit Breaker	Auto reclose operated
400kV Circuit Breaker	Auto reclose successful
400kV Circuit Breaker	SF6 pressure falling
400kV Circuit Breaker	SF6 pressure low lock out
400kV Circuit Breaker	Low operating oil pressure
400kV Circuit Breaker	Gas heater fail (SF6)
400kV Circuit Breaker	Trip circuit fail
400kV Disconnect Switch	Transformer disconnect switch opening automatically
400kV Disconnect Switch	Transformer disconnect switch out of step
400kV Disconnect Switch	Feeder disconnect switch opening automatically
400kV Disconnect Switch	Feeder disconnect switch out of step
400kV Feeder	Distance trip - Group A.
400kV Feeder	Distance trip - Group B
400kV Feeder	Over current trip
400kV Feeder	Back up protection
400kV Feeder	Earth fault trip

400kV Feeder	Directional earth fault trip
400kV Feeder	Direct transfer trip received
400kV Feeder	Permissive transfer trip received
400kV Feeder	Block signal received
400kV Feeder	SF6 pressure falling
400kV Feeder	SF6 pressure low lock out
400kV Feeder	Protection fail - Group A
400kV Feeder	Protection fail - Group B
400kV Feeder	110 V DC fail
400kV Feeder	PLC channel fail
400kV Feeder	PT voltage fail
400kV Feeder	Reactor Line reactor trip - Group A
400kV Feeder	Reactor Line reactor trip - Group B
400kV Feeder	Reactor Over current trip
400kV Feeder	Reactor Earth fault trip
400kV Feeder	Reactor Differential trip
400kV Feeder	Reactor Buchholz stage 1 - gas alarm
400kV Feeder	Reactor Buchholz stage 2 - trip.
400kV Feeder	Reactor Oil temp 1st stage
400kV Feeder	Reactor Oil temp 2nd stage
400kV Feeder	Reactor Winding temp stage 1 - alarm
400kV Feeder	Reactor Winding temp stage 2 - trip
400kV Feeder	Reactor Low oil
400kV Feeder	Reactor Neutral reactor O/C
400kV Feeder	Reactor Neutral reactor Buchholz stage 1 - gas alarm
400kV Feeder Reactor	Neutral reactor Buchholz stage 2 - trip
400kV Feeder Reactor	Neutral reactor temp stage 1 - alarm
400kV Feeder Reactor	Neutral reactor temp stage 2 - trip
400kV Feeder Reactor	Neutral reactor low oil
400kV Feeder Reactor	SF6 pressure falling
400kV Feeder Reactor	SF6 pressure low lock out
400/132kV Auto Transformer (400kV)	Transformer Distance trip
400/132kV Auto Transformer (400kV)	Over current trip
400/132kV Auto Transformer (400kV)	Earth fault trip
400/132kV Auto Transformer (400kV)	400 kV differential protection operated
400/132kV Auto Transformer (400kV)	132 kV differential protection operated
400/132kV Auto Transformer (400kV)	Back up protection operated
400/132kV Auto Transformer (400kV)	Transformer Buchholz stage 1 - gas alarm
400/132kV Auto Transformer (400kV)	Transformer Buchholz stage 2 - trip
400/132kV Auto Transformer (400kV)	Tap changer Buchholz stage 1 - gas alarm.
400/132kV Auto Transformer (400kV)	Tap changer Buchholz stage 2 - trip
400/132kV Auto Transformer (400kV)	Transformer low oil stage 1 - alarm
400/132kV Auto Transformer (400kV)	Transformer low oil stage 2 - trip
400/132kV Auto Transformer (400kV)	Tap changer low oil stage 1 - alarm
400/132kV Auto Transformer (400kV)	Tap changer low oil stage 2 - trip
400/132kV Auto Transformer (400kV)	Tap changer gas pressure relay
400/132kV Auto Transformer (400kV)	Transformer oil temp stage 1 400/132 -alarm
400/132kV Auto Transformer (400kV)	Transformer oil temp stage 2 400/132 - trip
400/132kV Auto Transformer (400kV)	Winding temp stage 1 400/132 - alarm
400/132kV Auto Transformer (400kV)	Winding temp stage 2 400/132 - trip
400/132kV Auto Transformer (400kV)	Transformer cooling fail
400/132kV Auto Transformer (400kV)	On Load Tap Changer HI/LO limit
400/132kV Auto Transformer (400kV)	On Load Tap Changer Out of step
400/132kV Auto Transformer (400kV)	On load Tap Changer Protection trip
400/132kV Auto Transformer (400kV)	Transformer protection fail - Group A
400/132kV Auto Transformer (400kV)	Transformer protection fail - Group B
400/132kV Auto Transformer (400kV)	Tap change incomplete
400/132kV Auto Transformer (400kV)	Transformer 11kV winding/bus bar protection trip
400/132kV Auto Transformer (400kV)	Transformer 11kV winding/bus bar differential trip
400/132kV Auto Transformer (400kV)	Transformer 11kV winding/bus bar Ove current trip

400/132kV Auto Transformer (400kV)	Transformer 11kV winding/bus bar eart fault. trip
400/132kV Auto Transformer (400kV)	Tertiary reactor protection trip
400/132kV Auto Transformer (400kV)	Tertiary reactor differential trip
400/132kV Auto Transformer (400kV)	Tertiary reactor over current trip
400/132kV Auto Transformer (400kV)	Tertiary reactor Buchholz stage 1 - alarm
400/132kV Auto Transformer (400kV)	Tertiary reactor Buchholz stage 2 - trip
400/132kV Auto Transformer (400kV)	Tertiary reactor low oil
400/132kV Auto Transformer (400kV)	Tertiary reactor oil temp stage 1 - alarm
400/132kV Auto Transformer (400kV)	Tertiary reactor oil temp stage 2 - trip
400/132kV Auto Transformer (400kV)	Tertiary capacitor bank protection trip
400/132kV Auto Transformer (400kV)	Tertiary capacitor bank over current trip
400/132kV Auto Transformer (400kV)	Tertiary capacitor bank unbalance trip
400/132kV Auto Transformer (400kV)	Earthing transformer protection trip
400/132kV Auto Transformer (400kV)	Earthing transformer low oil
400/132kV Auto Transformer (400kV)	Earthing transformer oil temp stage 1 - alarm
400/132kV Auto Transformer (400kV)	Earthing transformer oil temp stage 2 - trip
400/132kV Auto Transformer (400kV)	Services transformer protection trip
400/132kV Auto Transformer (400kV)	Services transformer low oil
400/132kV Auto Transformer (400kV)	Services transformer Buchholz stage 1 - alarm
400/132kV Auto Transformer (400kV)	Services transformer Buchholz stage 2 - trip
400/132kV Auto Transformer (400kV)	Services transformer oil temp stage 1 - alarm
400/132kV Auto Transformer (400kV)	Services transformer oil temp stage 2 - trip.
400/132kV Auto Transformer (400kV)	SF6 pressure falling
400/132kV Auto Transformer (400kV)	SF6 pressure low lock out
400kV Busbar	Differential trip
400kV Busbar	Bus protection operated
400kV Busbar	Bus protection fail
400kV Busbar	110 V DC fail
400kV Busbar	SF6 pressure falling
400kV Busbar	SF6 pressure low lock out
400kV Busbar	Protection fail (CT secondary circuit fail)
Communications	PLC equipment fail
Communications	Back up comms equipment fail
Communications	PABX fail
Communications	Fuse failure (composite)
Communications	Communications equipment alarm (composite)
132kV Feeder	Line protection trip
132kV Feeder	Back up protection trip
132kV Feeder	Distance trip
132kV Feeder	Over current trip
132kV Feeder	Earth fault trip
132kV Feeder	Breaker fail protection operated
132kV Feeder	Transformer trip received (if required)
132kV Feeder	Auto reclose operated.
132kV Feeder	Auto reclose successful or definite tripping
132kV Feeder	Permissive transfer trip received
132kV Feeder	SF6 pressure falling
132kV Feeder	SF6 pressure low lock out
132kV Feeder	Gas heater fail (SF6)
132kV Feeder	Trip circuit fail
132kV Feeder	PT voltage fail
132kV Feeder	PLC channel fail
132kV Feeder	Pilot circuit fail
132kV Feeder	110V DC fail
132kV Bus coupler	Over current trip
132kV Bus coupler	Earth fault trip
132kV Bus coupler	Breaker fail protection operated
132kV Bus coupler	SF6 pressure falling
132kV Bus coupler	SF6 pressure low lock out
132kV Bus section	Over current trip

132kV Bus section	Earth fault trip
132kV Bus section	Breaker fail protection operated
132kV Bus section	SF6 pressure falling
132kV Bus section	SF6 pressure low lock out
132kV Bus bar	Busbar protection operated
132kV Bus bar	Differential trip.
132kV Bus bar	Protection fail (CT secondary circuit fail)
132kV Bus bar	110V DC fail
132kV Bus bar	SF6 pressure falling
132kV Bus bar	SF6 pressure low lock out
400/132kV Auto Transformer	(132kV) Distance trip
400/132kV Auto Transformer	(132kV) Over current trip
400/132kV Auto Transformer (132kV)	Earth fault trip
400/132kV Auto Transformer (132kV)	Differential trip
400/132kV Auto Transformer (132kV)	Breaker fail protection operated
400/132kV Auto Transformer (132kV)	Winding temp 1st stage (alarm)
400/132kV Auto Transformer (132kV)	Winding temp 1st stage (trip)
400/132kV Auto Transformer (132kV)	Earthing transformer trip E/F
400/132kV Auto Transformer (132kV)	SF6 pressure falling
400/132kV Auto Transformer (132kV)	SF6 pressure low lock out
Fire Alarm	Fire alarm
Fire Alarm	Fire in the relay room
Station General	Station common fail
Station General	Load shedding Stage 1
Station General	Load shedding Stage 2
Station General	Load shedding Stage 3
Station General	Fault recorder operated
Station General	Fault recorder fail.
Station General	Under voltage alarm ac station service section No 1
Station General	Under voltage alarm ac station service section No 2
Station General	Station Services Transformer No.1 trip
Station General	Station Services Transformer No.2 trip
Station General	Diesel generator protection operated
Station General	Diesel generator running
Station General	110V charger fail (composite)
Station General	110V battery earth fault (composite)
Station General	110V battery alarms (composite)
Station General	110V DC station service section A under voltage
Station General	110V DC station service section B under voltage
Station General	48V charger fail (composite)
Station General	48V battery alarms (composite)
Station General	48V DC station service section A under voltage
Station General	48V DC station service section B under voltage
Station General	Low frequency
Station General	Substation Control System faulty
Station General	Annunciator alarm fuse fail
Station General	Low water level
Station General	Compressor system fail.
Station General	Microwave tower lighting fail
Station General	Air conditioning fail (relay building)
Station General	Air conditioning fail (control building)
Station General	Supervisory command received
Station General	Station Audible warning
Station General	Station Audible Tripping
Station General	Station AC failure

12.8.1.4 Analogue Measurements

400kV Feeder	kV	for each phase R ,S ,T

400kV Feeder	Amps for each phase R ,S ,T
400kV Feeder	MW
400kV Feeder	MVAr
400kV Busbar	kV
400kV Busbar	frequency
400/132kV Auto Transformer (400kV)	kV
400/132kV Auto Transformer (400kV)	Amps for each phase R ,S ,T
400/132kV Auto Transformer (400kV)	MW
400/132kV Auto Transformer (400kV)	MVAr
400/132kV Auto Transformer (400kV) OLTC	position
400kV Feeder Reactor	MVAr
11kV tertiary	kV
11kV tertiary	MVAr
11kV tertiary	Amps
Station voltage (400kV)	kV
Station frequency	Hz.
132kV Feeder	kV
132kV Feeder	MW
132kV Feeder	MVAr
132kV Feeder	Amps
132kV Busbar	kV
400/132kV Auto Transformer (132kV)	kV
400/132kV Auto Transformer (132kV)	MW
400/132kV Auto Transformer (132kV)	MVAr
400/132kV Auto Transformer (132kV)	Amps
132kV Bus section	Amps
132kV Bus Coupler	Amps
Station voltage (132kV)	kV

12.8.1.5 Energy Impulses

400kV Feeder	MWh export
400kV Feeder	MWh import
400kV Feeder	MVarh export
400kV Feeder	MVarh import
400/132kV Auto Transformer	MWh export
400/132kV Auto Transformer	MWh import
400/132kV Auto Transformer	MVarh export
400/132kV Auto Transformer	MVarh import
Station total MVarh	MVarh export
Station total MWh	MWh export
Station total MVArh	MVarh import
Station total MWh	MWh import
11kV tertiary MVArh	MVArh export
11kV tertiary MVArh	MVArh import
11kV tertiary - Station MVArh Summated	MVArh export
11kV tertiary - Station MVArh Summated	MVArh import
132kV Feeder	MWh export
132kV Feeder	MWh import
132kV Feeder	MVarh export
132kV Feeder	MVarh import
132kV Transformer	MWh export
132kV Transformer	MWh import
Auxiliary Transformer	MWh

12.8.2 Power Station (in addition to 400/132kV Substation)

12.8.2.1 Alarms

400kV Main Transformer	Over current trip

400kV Main Transformer	Earth fault trip
400kV Main Transformer	Neutral earth fault trip
400kV Main Transformer	Total differential trip
400kV Main Transformer	Buchholz stage 1
400kV Main Transformer	Buchholz stage 2
400kV Main Transformer	Oil temp 1st stage
400kV Main Transformer	Oil temp 2nd stage.
400kV Main Transformer	Winding temp 1st stage (alarm)
400kV Main Transformer	Winding temp 1st stage (alarm)
400kV Main Transformer	110V DC fail
400kV Main Transformer	SF6 pressure too low
400kV Main Transformer	Oil level low
General Service transformer	Transformer Distance trip
General Service transformer	Over current trip
General Service transformer	Earth fault trip
General Service transformer	Differential protection operated
General Service transformer	Transformer Buchholz stage 1 - gas alarm
General Service transformer	Transformer Buchholz stage 2 - trip
General Service transformer	Transformer oil temp stage 1 - alarm
General Service transformer	Transformer oil temp stage 2 - trip
General Service transformer	Winding temp stage 1 - alarm
General Service transformer	Winding temp stage 2 - trip
General Service transformer	Neutral earth fault trip
General Service transformer	C.B mechanism failure
General Service transformer	Oil level low
General Service transformer	SF6 pressure low 1
General Service transformer	SF6 pressure low 2
Auxiliary Unit Transformer	Over current trip
Auxiliary Unit Transformer	Earth fault trip
Auxiliary Unit Transformer	Differential protection operated
Auxiliary Unit Transformer	Transformer Buchholz stage 1 - gas alarm
Auxiliary Unit Transformer	Transformer Buchholz stage 2 - trip
Auxiliary Unit Transformer	Transformer oil temp stage 1 - alarm
Auxiliary Unit Transformer	Transformer oil temp stage 2 - trip.
Auxiliary Unit Transformer	Winding temp stage 1 - alarm
Auxiliary Unit Transformer	Winding temp stage 2 – trip
Auxiliary Unit Transformer	Oil level low

12.8.2.2 Analogue Measurements

400kV Main Transformer	kV
400kV Main Transformer	Amp
400kV Main Transformer	MW
400kV Main Transformer	MVAr
Generator	kV
Generator	Amp
Generator	Speed
Generator	MW
Generator	MVAr
Unit Auxiliary transformer	MW
Unit Auxiliary transformer	MVAr
Unit Auxiliary transformer	Amp
Unit Auxiliary transformer	KV
General Service transformer	MW
General Service transformer	MVAr

12.8.2.3 Energy Impulses

Generator	MWh
Generator	MVarh
Total Power Generation	MWh
Total Gas Consumption	Volume

Crude Oil Flow (for Each Unit)	Volume
Diesel Oil Flow (for Each Unit)	Volume
Total Natural Gas Consumption	Volum
Station Total	MWh
Auxiliary Transformer Unit	MWh
Auxiliary Transformer Unit	MVarh
General service transformer	MWh
General service transformer	MVarh

12.8.3 Gas Power Station (in addition to 400/132kV Substation)

12.8.3.1 Alarms

400kV Main Transformer	Over current trip
400kV Main Transformer	Earth fault trip
400kV Main Transformer	Neutral earth fault trip
400kV Main Transformer	Total differential trip
400kV Main Transformer	Buchholz stage 1
400kV Main Transformer	Buchholz stage 2
400kV Main Transformer	Oil temp 1st stage
400kV Main Transformer	Oil temp 2nd stage
400kV Main Transformer	Winding temp 1st stage (alarm)
400kV Main Transformer	Winding temp 1st stage (alarm)
400kV Main Transformer	110V DC fail

12.8.3.2 Analogue Measurements

400kV Main Transformer	kV
400kV Main Transformer	Amp
400kV Main Transformer	MW
400kV Main Transformer	MVAr.
Generator	kV
Generator	Amp
Generator	Speed
Generator	MW
Generator	MVAr
Unit Auxiliary Transformer	Amp
Unit Auxiliary Transformer	KV
Unit Auxiliary Transformer	MW
Unit Auxiliary Transformer	MVAr

12.8.3.3 Energy Impulses

Generator	MWh
Generator	MVarh
Main Transformer	MWh
Total Power Generation	MWh
Total Gas Consumption	Volume
Crude Oil Flow (for Each Unit)	Volume
Diesel Oil Flow (for Each Unit)	Volume
Total Natural Gas Consumption	Volume
Station Total	MWh
Unit Auxiliary Transformer	MWh

12.8.4 132/33/11kV Substation

12.8.4.1 Controls/Commands

132kV Circuit Breaker	Trip
132kV Circuit Breaker	Close
132kV Feeder Auto Reclose	In Service.

132kV Feeder Auto Reclose	Out of Service
132kV Transformer On Load Tap Changer	Raise tap
132kV Transformer On Load Tap Changer	Lower tap
132kV Transformer AVR	Set voltage (1 – n)
132kV Transformer AVR	AVC auto
132kV Transformer AVR	AVC manual
33kV Circuit breaker	Trip
33kV Circuit breaker	Close
11kV Circuit breaker	Trip
11kV Circuit breaker	Close

12.8.4.2 Indications/Status

132kV Circuit Breaker	Open
132kV Circuit Breaker	Closed
132kV Circuit Breaker	On test
132kV Isolator	Open
132kV Isolator	Closed
132kV Feeder Auto Reclose	In Service
132kV Feeder Auto Reclose	Out of Service
132kV Transformer On Load Tap Changer	Tap position
132kV Transformer AVR	Auto (man)
132kV Transformer On Load Tap Changer	Master (Follower).
400kV Auto Transformer AVR	Set voltage (1 – n)
33kV Circuit breaker (Transformer)	Open
33kV Circuit breaker =	Closed
11kV Circuit breaker =	Open
11kV Circuit breaker =	Closed

12.8.4.3 Alarms

132kV Feeder	Distance trip
132kV Feeder	Over current trip
132kV Feeder	Earth fault trip
132kV Feeder	Breaker fail protection operated
132kV Feeder	Auto reclosed
132kV Feeder	Direct Transfer trip received
132kV Feeder	Permissive Transfer trip received
132kV Feeder	Blocking signal received
132kV Feeder	SF6 pressure falling alarm
132kV Feeder	SF6 pressure low lock out
132kV Feeder	110V DC Fail
132kV Feeder	PLC TX failure
132kV Feeder	PLC RX failure
132kV Feeder	C.B mechanism failure
132kV Bus Coupler	Over current trip
132kV Bus Coupler	Earth fault trip.
132kV Bus Coupler	Distance trip
132kV Bus Coupler	Breaker fail protection operated
132kV Bus Coupler	C.B mechanism failure
132kV Bus Coupler	110V DC Fail
132kV Bus Coupler	SF6 pressure falling alarm
132kV Bus Coupler	SF6 pressure low lock out
132kV Bus Section	Over current trip
132kV Bus Section	Earth fault trip
132kV Bus Section	Breaker fail protection operated
132kV Bus Section	110V DC Fail
132kV Bus Section	SF6 pressure falling alarm
132kV Bus Section	SF6 pressure low lock out
132kV Bus Section	C.B mechanism failure
132kV Busbar	Differential trip
132kV Busbar	Earth fault
132kV Busbar	SF6 pressure low

132/33/11kV Transformer (132kV)	Over current trip
132/33/11kV Transformer (132kV)	Earth fault trip
132/33/11kV Transformer (132kV)	Differential trip
132/33/11kV Transformer (132kV)	Transformer Buchholz stage 1 - gas
132/33/11kV Transformer (132kV)	Transformer Buchholz stage 2 - trip
132/33/11kV Transformer (132kV)	Breaker fail protection operated
132/33/11kV Transformer (132kV)	Winding temp 1st stage (alarm)
132/33/11kV Transformer (132kV)	Winding temp 1st stage (trip).
132/33/11kV Transformer (132kV)	Oil temp 1st stage (alarm)
132/33/11kV Transformer (132kV)	Oil temp 1st stage (trip)
132/33/11kV Transformer (132kV)	Earthing transformer trip E/F
132/33/11kV Transformer (132kV)	110V DC Fail
132/33/11kV Transformer (132kV)	SF6 pressure falling alarm
132/33/11kV Transformer (132kV)	SF6 pressure low lock out
132/33/11kV Transformer (132kV)	Oil level low
132/33/11kV Transformer OLTC	OLTC H/L
132/33/11kV Transformer OLTC	OLTC Out of step
132/33/11kV Transformer OLTC	OLTC prot
33kV Feeder	Over current trip
33kV Feeder	Earth fault trip
33kV Feeder	Differential trip
33kV Feeder	Auto reclosed
33kV Feeder	110V DC Fail
33kV Bus Section	Over current trip
33kV Bus Section	Earth fault trip
33kV Bus Section	110V DC Fail
132/33/11kV Transformer (33kV)	Over current trip
132/33/11kV Transformer (33kV)	Earth fault trip
132/33/11kV Transformer (33kV)	110V DC Fail
33kV Auxiliary Earthing Transformer	Over current trip
33kV Auxiliary Earthing Transformer	Earth fault trip
33kV Auxiliary Earthing Transformer	Transformer Buchholz stage 1 - gas
33kV Auxiliary Earthing Transformer	Transformer Buchholz stage 2 - trip
33kV Auxiliary Earthing Transformer	110V DC Fail.
33kV Capacitor Bank	Over current trip
33kV Capacitor Bank	Earth fault trip
33kV Capacitor Bank	Over voltage trip
33kV Capacitor Bank	Capacitor bank unbalance trip
33kV Capacitor Bank	110V DC Fail
11kV Feeder	Over current trip
11kV Feeder	Earth fault trip
11kV Feeder	Auto reclosed
11kV Feeder	110V DC Fail
11kV Bus Section	Over current trip
11kV Bus Section	Earth fault trip
11kV Bus Section	110V DC Fail
132/33/11kV Transformer (11kV)	Over current trip
132/33/11kV Transformer (11kV)	Earth fault trip
11kV Auxiliary Earthing Transformer	Over current trip
11kV Auxiliary Earthing Transformer	Earth fault trip
11kV Auxiliary Earthing Transformer	Transformer Buchholz stage 1 - gas
11kV Auxiliary Earthing Transformer	Transformer Buchholz stage 2 - trip
11kV Auxiliary Earthing Transformer	110V DC Fail
Fire Alarm	Fire alarm
Fire Alarm	Fire in the relay room
Station General 33kV	Load shedding Stage 1.
Station General 33kV	Load shedding Stage 2
Station General 33kV	Load shedding Stage 3
Station General 11kV	Load shedding Stage 1
Station General 11kV	Load shedding Stage 2

Station General 11kV	Load shedding Stage 3
Station General	Station common fail
Station General	Fault recorder operated
Station General	Fault recorder fail
Station General	Undervoltage alarm ac station service section No 1
Station General	Undervoltage alarm ac station service section No 2
Station General	Station Services Transformer No.1 trip
Station General	Station Services Transformer No.2 trip
Station General	Diesel generator protection operated
Station General	Diesel generator running
Station General	110V charger fail (composite)
Station General	110V battery earth fault (composite)
Station General	110V battery alarms (composite)
Station General	110V DC station service section A under voltage
Station General	110V DC station service section B under voltage
Station General	48V charger fail (composite)
Station General	48V battery alarms (composite).
Station General	48V DC station service section A under voltage
Station General	48V DC station service section B under voltage
Station General	Low frequency
Station General	Substation Control System faulty
Station General	Annunciator alarm fuse fail
Station General	Low water level
Station General	Compressor system fail
Station General	Microwave tower lighting fail
Station General	Air conditioning fail (relay building)
Station General	Air conditioning fail (control building)
Station General	Supervisory command received
132kV Communications	Communication "TX" failure
132kV Communications	Communication "RX" failure
132kV Communications	Telephone failure

12.8.4.4 Analogue Measurements

132kV Feeder	MW
132kV Feeder	MVAr
132kV Feeder	Amps
132kV Feeder	kV
132kV Busbar	kV
132kV Busbar	frequency
132kV Bus Coupler	Amps
132kV Bus Section	Amps
132kV Transformer	MW
132kV Transformer	MVAr
132kV Transformer	Amps
132kV Transformer	kV
33kV Feeder	MW
33kV Feeder	MVAr
33kV Feeder	Amps
33kV Busbar Section	kV
33kV Bus Section	Amps
33kV Transformer	MW
33kV Transformer	MVAr
33kV Transformer	Amps
33kV Transformer	kV
33kV Capacitor Bank	MVAr
33kV Auxiliary Earthing Transformer	MW
33kV Auxiliary Earthing Transformer	MVAr
33kV Auxiliary Earthing Transformer	Amps
11kV Feeder	MW
11kV Feeder	MVAr
11kV Feeder	Amps.

11kV Busbar Section	kV
11kV Bus Section	Amps
11kV Transformer	MW
11kV Transformer	MVAr
11kV Transformer	Amps
11kV Transformer	kV
11kV Auxiliary Earthing Transformer	MW
11kV Auxiliary Earthing Transformer	MVAr
11kV Auxiliary Earthing Transformer	Amps

12.8.4.5 Energy Impulses

132kV Feeder	MWh export (MDI)
132kV Feeder	MWh import (MDI)
132kV Feeder	MVArh export
132kV Feeder	MVArh import
132kV Transformer	MWh (MDI)
132kV Transformer	MVArh
33kV Transformer	MWh (MDI)
33kV Transformer	MVArh
33kV Capacitor Bank	MVArh
33kV Auxiliary Earthing Transformer	MWh (MDI)
33kV Auxiliary Earthing Transformer	MVArh
11kV Transformer	MWh (MDI)
11kV Transformer	MVArh
11kV Auxiliary Earthing Transformer	MWh (MDI)
11kV Auxiliary Earthing Transformer	MVArh

12.8.5 33/11kV Substation

12.8.5.1 Controls/Commands

11 kV Circuit Breaker	Trip
11 kV Circuit Breaker	Close
11 kV Transformer Tap Changer	Raise
11 kV Transformer Tap Changer	Lower
11kV Transformer AVR	Set voltage (1 – n)
11kV Transformer AVR	AVC auto
11kV Transformer AVR	AVC manual
11 kV Bus Section Alarm	relay reset

12.8.5.2 Indications/Status

11 kV Circuit Breaker	Open.
11 kV Circuit Breaker	Closed
11 kV Circuit Breaker	Out of service
33 kV Transformer Tap Changer	Tap position
33kV Transformer	AVR Auto (man)
33kV Transformer On Load Tap Changer	Master (Follower)
33kV Auto Transformer AVR	Set voltage (1 – n)

12.8.5.3 Alarms

11 kV Circuit Breaker	Remote control permissible
A.C. Supplies	Aux Failure
D.C. Supplies	Failure
D.C. Supplies	Earth fault
Transformer Tap Changer	Upper position
Transformer Tap Changer	Lower position
Transformer Tap Changer	AVR Failure (out of step)
Transformer	Transformer Buchholz (Stage 1) - alarm
Transformer	Transformer Oil Temp. stage 1 – alarm
Transformer	Transformer Wind. Temp. stage 1 – alarm
Transformer	Transformer Buchholz stage 2 – trip

Transformer	Transformer Oil Temp. stage 2 – trip
Transformer	Transformer Wind. Temp. stage 2 – trip
Transformer	Gas Receiver for tap changer.
Transformer	Differential Protection trip
Transformer	Pressure Relief Device trip
Transformer	Oil Level Low
Transformer	VT LV circuit breaker trip
Auxiliary transformer	Buchholz
11 kV Circuit Breaker	O/C Trip
11 kV Circuit Breaker	E/F Trip
33 kV CB Transformer	Remote control permissible
33 kV CB Transformer	O/C Trip
33 kV CB Transformer	E/F Trip
Fire. Alarm	Fire'
Door open Alarm	'Door'
Busbar	Under frequency
Load Shedding	Trip Stage 1
Load Shedding	Trip Stage 2
Load Shedding	Trip Stage 3

12.8.5.4 Analogue Measurements

11 kV Circuit (all)	Current
11 kV CB Capacitor Bank	MVAr
Transformer (11 kV)	KV
Transformer (11 kV)	MW
Transformer (11 kV)	MVAr
Transformer (33 kV)	Current
Transformer (33 kV)	KV

13. CABLES

13.1 General

The Contractor shall provide a list of all of the cables supplied for the control and telecommunications equipment together with the following details:

- Quantity of each type of cable
- The type and construction of each cable eg size and number of cores/pairs, insulation, screening, armoring, sheathing
- Manufacturer
- Type of termination eg specific plugs, sockets and connectors
- Price per metre for additional quantities of cable

13.2 Coaxial Cables

The coaxial cable shall have the following properties:

- Impedance of 75 Ohm
- Steel wire armoured
- Lead sheathed if it is used outside the substation fence
- Losses less than 0.5 db per 100 m at 500 kHz frequency
- Closed cell dielectric
- Withstand voltage shall comply with that of coupling device, but in any case not less than 2000V r.m.s.
- Suitable for installation in cable trenches
- Suitable for cable runs of up to 600 meters without adversely affecting the data transmission.

13.3 Communication Cables

Twisted pair cable with overall cable shield shall be used for communication cables.
To minimize exposure to interference, the communication cables shall be isolated from power cables wherever practicable..

Twisted pair cable shall conform to the relevant parts of BS 7870. Twisted pair cables shall be used for interconnection between protection signaling equipment and protection equipment and shall be suitable for carrying signals over distances of up to 300 meters without adversely affecting them.

Armoured cable shall be used where they run outside of the substation buildings..

Cables used for telephony shall be twisted pair and shall not be more than 0.6mm diameter solid copper conductor, suitable for Insulation Displacement Connections (IDC). Cables entering the substation from outside shall be of paired construction and the entry conduits shall be non-metallic, and non-corrosive.

The Contractor shall supply and install all necessary cables between the equipment in his scope of supply. The interface point for plant to communications equipment cabling shall be agreed with the Employer.

13.4 RTU Cabling

All cables for measurements and status indication are to be multi-conductor, shielded, twisted pairs.

The Contractor shall supply and install all necessary cables between the equipment in his scope of supply, and between the RTU and the Data Acquisition System Cabinet marshaled plant interface connections. The interface point for plant to communications equipment cabling shall be agreed with the Employer

14. MAINTENANCE

14.1 Tools and Instruments

The provision of lists of recommended tools and instruments by the Tenderer and of the equipment itself by the Contractor, shall be in accordance with the relevant power station or substation supply contract. This shall include measuring instruments, special apparatus and special tools essential for the installation, operation, testing and checking the status of the system before and during operation.

14.2 Documentation

Documents for the installation, operation and maintenance of all equipment shall be provided in accordance with the relevant power station or substation supply contract.

14.3 Spare Parts

The provision of lists of recommended spare parts by the Tenderer and of the spares themselves by the Contractor, shall be in accordance with the relevant power station or substation supply contract, together with the specific requirements within this document for RTU's.

15. SUPERVISION, TRAINING AND TEST WITNESSING

The provision of supervision and training by the Contractor, and the opportunity for test witnessing by the Employer, shall be in accordance with the relevant power station or substation supply contract, together with the specific requirements within this document for RTU's.

The Client's Supervision Staff shall give its approval on all communication and SCADA equipment installation work before the equipment is put into operation, and they shall supervise the operation of the equipment prior to handover.