Ministry of Power, Energy and Mineral Resources
The People's Republic of Bangladesh

THE STUDY
ON
GAS SCADA SYSTEM REHABILITATION AND EXPANSION PROJECT
FOR
GAS TRANSMISSION COMPANY LIMITED (GTCL)
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

FINAL REPORT

VOLUME 2

MARCH 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.

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IN

BANGLADESH

VOLUME 2: TECHNICAL SPECIFICATIONS (DRAFT)

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Abbreviations & Definitions

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Abbreviations

ACC	: Auxiliary Control Center
ADB	: Asian Development Bank
BGFCL	: Bangladesh Gas Field Co., Ltd.
BGSL	: Bakhrabad Gas System Ltd.
CGS	: City Gate Station
DRS	: District Regulating Station
FAT	: Factory Acceptance Test
FF	: Fertilizer Factory
GMS	: Gas Manifold Station
GTCL	: Gas Transmission Co., Ltd.
IP-PBX	: Internet Protocol Private Branch Exchange
JICA	: Japan International Cooperation Agency
JGTDSL	: Jalalabad Gas Transmission & Distribution System Ltd.
KGDCL	: Karnaphuli Gas Distribution Company Ltd.
MCC	: Main Control Center
MS	: Metering Station
MTS	: Master Telemetry Station
NMS	: Network Monitoring System
OCT	: Operation Company Terminal
PS	: Power Station
RMS	: Regulating & Metering Station
RTU	: Remote Terminal Unit
SAT	: Site Acceptance Test
SCADA	: Supervisory Control and Data Acquisition
SGFL	: Sylhet Gas Field Ltd.
STS	: Slave Telemetry Station
TBS	: Town Bordering Station
TGTDCL	: Titas Gas Transmission & Distribution Co., Ltd.
UPS	: Uninterruptible Power Supply
VS	: Valve Station
WB	: World Bank

Definitions

Access Point	: Provider's network station where Master Telemetry Station of The New System shall be linked with.
Additional Site	: Existing site which is currently not covered by The Existing System but shall be covered by The New System.
Employer	: GTCL
Future Site	: Upcoming site which is planned to be added into The New System after the completion of the Project.
Master Telemetry Station	: The radio station which communicate with its associated New RTU(s) and Control Center as relay station.
Original Site	: Existing site which has been covered by The Existing System, and shall be covered by The New System.
Project	: Detail design, procurement, construction, installation, commissioning and training for the rehabilitation and expansion of The Existing System.
Site	: Place where gas pipeline related facilities are or will be situated.
Slave Telemetry Station	: The local radio station installed with New RTU that communicates with Master Telemetry Station.
Study	: All activities by experts selected by JICA to examine the requirement for the rehabilitation and expansion of The Existing System and to formulate a detailed future investment plan for the efficient gas transmission inclusive of training for transfer of technical know-how.
The Engineer	: Consultant to supervise the tendering stage and the implementation of the Project, representative of the Employer.
The Existing System	: Existing SCADA and Telecommunication System which had been previously established and shall be rehabilitated in the Project.
The New System	: New SCADA and Communication System which shall be established in the Project.

1. General Requirements

1.1. Introduction

(1) This document is the Functional and Performance Specification for 'Gas SCADA System Rehabilitation and Expansion Project' for GTCL in Bangladesh, and form Volume XX of the Invitation to Tender for the said Project.

(2) Gas Transmission Company Ltd. (GTCL) are the Employer for this Contract who own, control, operate and maintain the high pressure gas transmission trunk pipelines that shall be covered by New SCADA and Communication System.

(3) The Project is implemented under Japan's ODA (Official Development Assistance) loan.

1.2. Background Information

The existing gas SCADA-Telecommunication system operated by GTCL (the Existing System) was installed under DFID (Department for International Development, UK Government) assistance in 1996-2003 for the efficient operation and monitoring of the gas supply in Bangladesh. However, it currently has fallen into malfunction due to the following serious problems.

(1) Since the installation and subsequent operation of the Existing System, there has been a significant growth in the gas sector. Many new gas fields have started the gas production and delivery to the GTCL pipelines, and also new gas off-take points have been developed. However, no measure to expand the Existing System have been taken by GTCL, and all newly developed gas sites have remained outside the coverage of the Existing System.

(2) Due to the lack of maintenance support from the previous Contractor and others after the operation & maintenance support service period, the Existing System was not maintained properly, and has become old and dilapidated.

(3) The TGTDCL microwave analog communication system, which was used as the backbone of the Bramaputra Basin pipeline from Monohordi to Elenga and Tarakandi, has become old and unusable.

(4) The Existing System was designed in 1995 (15 years ago), and is approaching the final stage of its lifetime. Also, the procurement of spare parts for the system has become difficult year after year and thereby the operation and maintenance of the system has been seriously affected.

On the other hand, the Bangladesh gas sector has been coping to achieve the vision of 2025, and many expansion/extension gas pipeline projects to meet the strong gas demand forecast are under implementation or planning.

Due to the above situation, an integrated SCADA-telecommunication system, which will be built up through the rehabilitation and expansion of the Existing System and will realize the effective and sustainable gas supply to the whole country, is urgently required.

1.3. Project Description

1.3.1. Introduction

(1) The Contractor shall provide new SCADA and Communication System through rehabilitation and expansion of the existing SCADA and Telecommunication System for effective operation/control of the nationwide gas pipeline network.

(2) This chapter provides information on the Project, the Employer, other operating companies and the sites at which new SCADA and Communication System are to be implemented.

(3) The New System shall be implemented as an EPC (Engineering, Procurement and Construction) Contract according to the requirements specified in this document.

(4) The New System shall consist of a SCADA System and a Communication System specified in this document.

(5) The New System shall provide the Employer with a unified voice and data communication services to support their operations including but not limited to the following:
   1) Monitoring of gas parameters at specified sites.
   2) Control of gas flow either remotely or through instruction to third parties.
   3) Planning the strategic use of gas in accordance with gas production and consumption.

4) Fault identification and diagnosis of the gas grid covered by the New System.
5) Transfer of reports within the Petrobangla group of companies.

(6) These Specifications have been based on a conceptual design in order to allow the requirements to be adequately specified. The design of the System architecture and configuration shall be the responsibility of the Contractor in accordance with the functional and performance requirements described in these Specifications.

1.3.2. Project Geography

(1) Gas development in Bangladesh is mostly restricted to the eastern half of the country.

(2) Bangladesh is a predominantly flat country with the only hilly area of note being in the Sylhet region, starting at Hobigonj and extending to the south and east of Chittagong.

(3) A far more prominent natural feature is water, with the land being dominated by rivers and, for much of the year during and after the monsoon, floodplains.

(4) Other geographical features of note are the high probability of extreme climatic and meteorological conditions including prolonged periods of high temperatures and humidity, electrical storms and cyclones, and a monsoon season.

(5) Bangladesh has three seasons; winter, between November and February which is dry and cool, the pre-monsoon season between March and May which exhibits increasing temperatures and periodic thunderstorms and increasing rainfall, and the monsoon season itself from June to October which is hot and humid and in which more than 80% of the annual rainfall occurs.

(6) Such conditions have a direct impact on the transport infrastructure within Bangladesh with some roads becoming temporarily impassable or washed away in sections.

(7) The Contractor shall study the geographic and climatic conditions of Bangladesh and address them in all areas of the System design.

(8) The Contractor shall address the geographical, meteorological and environmental conditions in the Project Plan and demonstrate that sufficient contingency has been

included to ensure the program is both realistic and achievable.

1.3.3. Petrobangla and the Employer

(1) The gas sector in Bangladesh, whilst being a public utility, is run semi-autonomously from the Government by Petrobangla. Petrobangla's Head Office is located in Dhaka.

(2) The Employer, GTCL, is an operating company of Petrobangla which owns and operates the Bangladesh National Gas Grid, and responsible for the transmission of gas from gas fields to distributors.

1.3.4. Operating Companies

(1) Introduction

There are several Operating Companies of sites that are to be monitored by the New System, and their main activities are described below.

(2) Bakhrabad Gas Systems Limited (BGSL)

1) BGSL is a company of Petrobangla and is engaged in the gas distribution within the southeastern part of Bangladesh covering Chittagong Division excluding Brahmanbaria District.
2) The Employer supplies gas to BGSL sites.
3) BGSL’s head office is located in Comilla where new OCT and extension telephone shall be installed.

(3) Jalalabad Gas Transmission and Distribution Systems Limited (JGTDSL)

1) JGTDSL is a company of Petrobangla and is engaged in the gas transmission and distribution within the northeastern part of Bangladesh covering Sylhet Division.
2) The Employer supplies gas to JGTDSL sites.
3) JGTDSL’s head office is located in the commercial building on the outskirts of Sylhet where a new OCT and extension telephone shall be installed.

(4) Titas Gas Transmission and Distribution Company Limited (TGTDCL)

1) TGTDCL is a company of Petrobangla and is engaged in the gas transmission and distribution within the central and northern part of Bangladesh covering Dhaka

Division and Brahmanbaria District.

2) The Employer supplies gas to TGTDCL sites.
3) TGTDCL's head office is located in Dhaka where a new OCT and extension telephone shall be installed.

(5) Bangladesh Gas Field Company Limited (BGFCL)

1) BGFCL is a company of Petrobangla who owns and operates several gas fields in the districts of Brahmanbaria, Comilla, Hobigonj, Narsingdi and Gazupur. Gas is supplied to the Employer and also directly to TGTDCL.
2) BGFCL's head office is located in Brahmanbaria where a new OCT and extension telephone shall be installed.

(6) Sylhet Gas Fields Limited (SGFL)

1) SGFL is a company of Petrobangla who owns and operates several gas fields in Sylhed Division. Gas is supplied to the Employer.
2) SGFL's head office is located at Horipur gas field, Sylhet where a new OCT and extension telephone shall be installed.

(7) Other Companies

There are some other companies operating or constructing gas facilities which shall be covered by the new SCADA System such as:

1) Chevron: International oil company operating three gas fields in Sylhed Division.
2) Tullow: International oil company operating a gas filed in Comilla District.
3) BAPEX: Company of Petrobangla constructing and operating several gas fields.

1.3.5. The National Gas Grid

(1) Sections of the national gas grid that shall be covered by The New System are indicated in Figure 1.1.

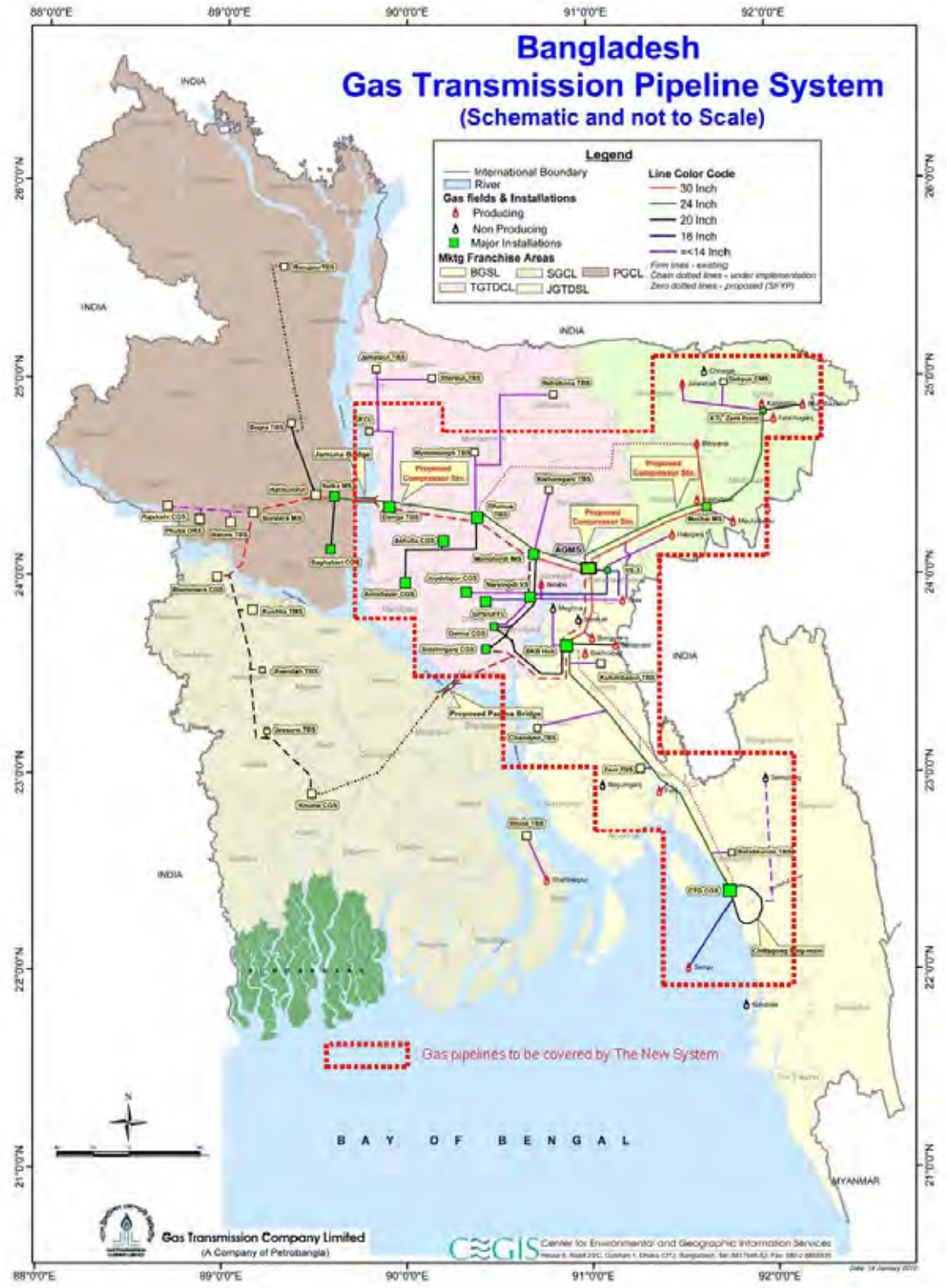


Figure 1.1. Gas Grid covered by the New System

1.3.6. Site Description

(1) Introduction

There are several classifications of sites which are defined below. The Site List (Appendix-1) identifies the classification of each site to be included in The New System.

(2) Control Center (CC)

1) The Main Control Center (MCC) of the New System is located at Demra approximately 20km east of Dhaka.
2) The Auxiliary Control Center (ACC) of the New System is located at Ashuganj approximately 90km northeast of Dhaka.
3) Both Control Centers enable the Employer to supervise and control the entire gas pipeline network covered by the New System.

(3) Master Telemetry Station (MTS)

1) There are 20 Master Telemetry Stations that communicate with their associated New RTU(s) and Control Center as relay station. The existing radio equipment rooms and towers shall be utilized for MTS.

(4) Gas Metering and Regulating Station

1) There are dozens of gas metering & regulating stations to be monitored by the New System under different classifications as below.
   - GMS: Gas Manifold Station
   - CGS: City Gate Station
   - TBS: Town Bordering Station
   - RMS: Regulating & Metering Station
   - DRS: District Regulating Statio
   - CMS: Customer Metering Station
   - MS: Metering Station
2) The New System shall monitor the gas flow volume at these sites.

(5) Gas Field

1) There are 20 Gas Fields to be incorporated in the New System.
2) The New System shall monitor the inlet gas volume from these sites.

(6) Bulk Consumers

1) Power stations (PS) and fertilizer factories (FF), which are the largest consumers of gas in the industrial sector, are defined as bulk consumers to be monitored by the New System.
2) The New System shall monitor the outlet gas volume feeding the bulk consumers.

(7) Main Line Valve Stations (VS)

1) There are dozens of main line valve stations (VS) to be monitored by the New System.
2) The New System shall monitor the open/close status of these valves. Further control these valves shall be provided.

(8) Petrobangla and Operating Companies' Head Office

The head office of Petrobangla and other major operating companies shall be equipped with an Operating Company Terminal (OCT) and extension telephone for the monitoring of the entire gas grid covered by the New System and for internal/direct liaison.

1.3.7. Gas Pipeline Operation Philosophy

(1) The Employer will receive requests or nominations from distribution companies for the supply of gas at designated sites on a periodical basis.

(2) The Employer will also establish the levels of gas to be provided to the National Gas Grid by production companies on a regular basis.

(3) The Employer will plan for the transmission of gas through the National Gas Grid in accordance with the demand as put forward by distribution companies under their contract with the production companies.

(4) The Employer will provide figures for the quantity of gas flowing into and out of the National Gas Grid to Petrobangla and the other Operating Companies to support billing and payment for gas and other financial systems such as periodic accounts or planning.

1.4. Intended Purpose of the New System

(1) SCADA System

The intended purpose of the SCADA System is to ensure for GTCL that the natural gas transmission pipeline is:

1) Capable of being operated and maintained safely, effectively and efficiently.
2) Equipped with operational interfaces that will enable the efficient monitoring and control of the natural gas transmission pipeline from both of the Master Control Center (MCC) and the Auxiliary Control Center (ACC).

The SCADA System shall permit data acquisition and control functions to be performed at remote locations while providing the capability to monitor and control distributed functions from MCC and ACC.

The Master Control Center (MCC) shall be the central operating center to monitor and control the pipeline network.

The Auxiliary Control Center (ACC) shall be the hot-standby operating center with the same functionality and operating capability as the MCC.

(2) Communication System

The intended purpose of the Communication System is to:

1) Provide adequate communication ability such as ensuring that the GTCL natural gas transmission pipeline is capable of being operated and maintained safely, effectively and efficiently.
2) Provide properly integrated communication interfaces among all sites and operating companies.
3) Make the operating staff aware of any abnormal operating conditions in a timely and effective manner to enable them to minimize consequential damage.

1.5. Brief Description of the New System

1.5.1. The SCADA System

The system shall be based around two Control Centers geographically separated for security purposes, with identical facilities and a redundant server configuration for resilience and

additional security.

The Main Control Center (MCC) is located at Demra, 20 km south-east of Dhaka and the Auxiliary Control Center (ACC) is at Ashuganj, 90 km north-east of Dhaka. The database will be transferred via communication network between the servers at MCC and ACC.

The servers shall support HMI workstations in the control rooms and Operating Company Terminals (OCTs) to be installed at the Gas Operating Company Head Offices throughout Bangladesh to provide the facilities for Gas Plant monitoring, pipeline operation management, maintenance dispatch, production planning and training.

An on-line modeling package shall be incorporated into the SCADA System to support gas leak detection, load balancing and scheduling.

RTUs shall be installed at sites classified as below, throughout the existing gas pipeline network covered by the Project, to retrieve data and transmit them to the MCC and the ACC.

(1) At Original Sites
All RTUs that are currently installed at original site shall be replaced with New RTU.

(2) At Additional Sites
Currently no RTUs are installed at the Additional Sites, thus New RTUs shall be installed.

(3) At Future Sites
GTCL and operating companies plan to construct some sites for gas transmission operation. These planned sites may not be constructed by the completion of the Project therefore RTUs shall be designed and supplied to the Employer.

Batteries shall be installed in the RTU cabinet to provide power back up and maintain equipment operation for a full 24 hours on loss of the public electricity supply. Solar panels are equipped at some existing sites without public electricity supply and these existing solar panels shall be replaced. At additional sites without public electricity supply, solar panels shall be installed on the RTU shelter roofs to provide the power necessary to energize the RTU equipment and pipeline instrumentation.

Field Instruments shall be installed for all the Additional Sites and some of the Existing Sites that have extended streams without flow measurement. The applicable sites, type and quantity of the instruments are shown in the RTU list.

A schematic diagram of the SCADA System is shown in Figure 1.2.

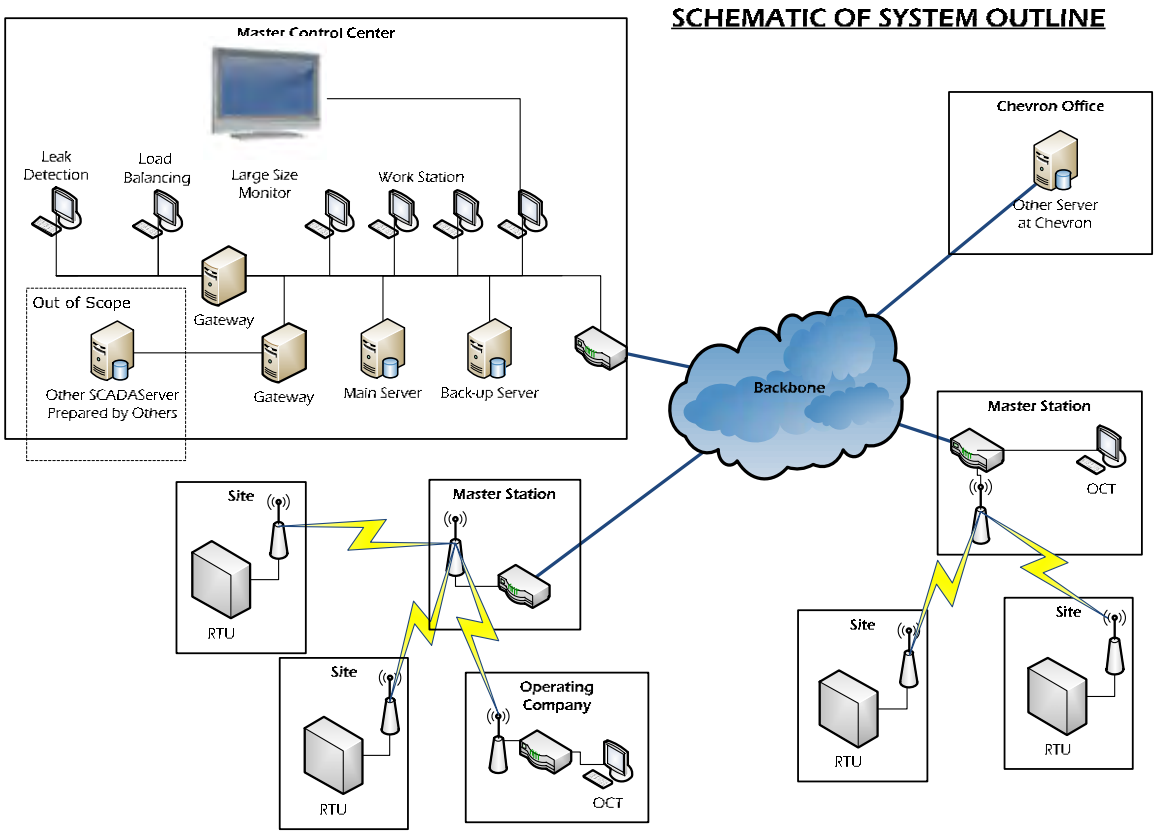


Figure 1.2 Schematic Diagram of SCADA System

1.5.2. The Communication System

The Communication System shall be composed of following network, links and other subsystems:

(1) Leased E1 circuits from Provider's Network, (BTCL's network is recommended.)
(2) IP Radio link between Provider's Access Point (AP) and Master Telemetry Station (MTS)
(3) Telemetry Radio Link between MTS and Slave Telemetry Station (STS)
(4) IP PBX
(5) Network Monitoring System (NMS)

The leased E1 circuits from the provider’s network and an IP radio link shall form the SCADA backbone to connect the MTS and MCC/ACC.

The telemetry radio link shall be used to connect the MTS and the STS.

The IP PBX shall be located at ACC and shall connect the extension lines located at the MCC, ACC, MTS and OCT through the SCADA backbone by using VoIP transmission.

The network monitoring system shall monitor the equipment connected with the network. A computer with adequate software for monitoring shall be installed at MCC and ACC.

A schematic diagram of the Communication System is shown in Figure 1.3.

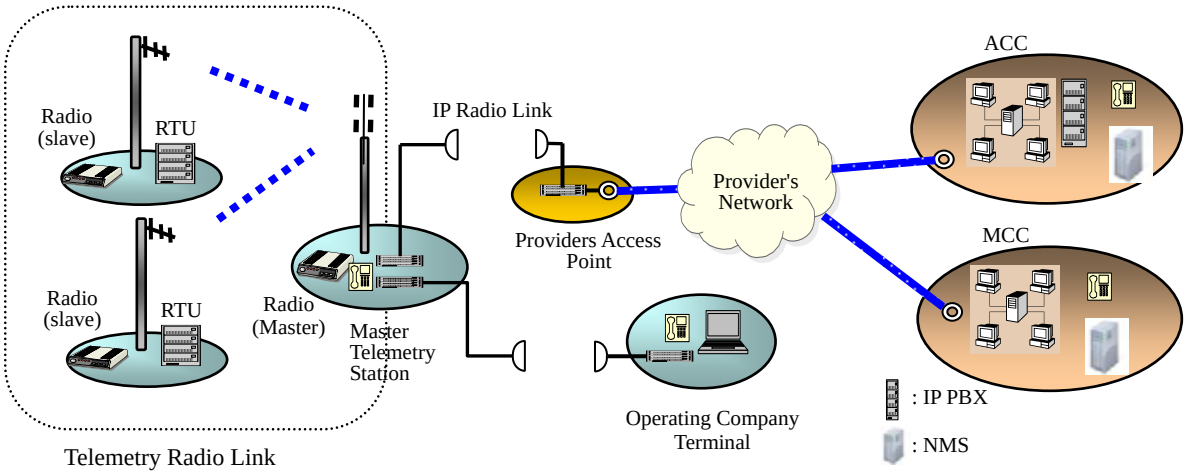


Figure 1.3. Schematic Diagram of Communication System

1.6. Applicable Standards

(1) A “standard” is a published specification that establishes a common language and contains a technical specification or other precise criteria; it is designed to be used consistently, as a rule, guideline or definition. For the purpose of the Contract the term “standard” encompasses the expression “code of practice” and “regulation”.

(2) The design, execution and completion of the Works shall be governed by, but not limited to, the applicable standards and codes listed in the following table:

Table 1.1. List of Applicable Standards and Codes

REFERENCE	**PUBLICATION TITLE**
AGA Report No. 3	Orifice Metering of Natural Gas (Part 2); specification and installation requirements
AGA Report No. 7	Measurement of Gas by Turbine Meters
AGA Report No. 8	AGA Compression factor of Natural gas and Hydrocarbon gas Report No. 8
AGA Report No. 9	Measurement of Gas by Multi-path Ultrasonic Meters
API 1104	Standard for Welding Pipelines and Related Facilities
API 2530	Manual of Petroleum Measurement Standards
API 2534	Measurement Control Charts and Statistical Methods for Petroleum Metering Systems
API RP 17A	Pipe Flanges and Pipe Fittings
API RP 500	Classification of Locations for Electrical Installations
API RP 550	Manual on installation of Refinery, Instruments and Control Systems
API RP 551	Processing, Measurement, Instrumentation
API RP 554	Process Instrumentation and Control
API RP 2003	Protection against Ignitions arising out of Static Lighting and Stray Currents
API Spec 2B	Fabrication of Structural Steel Pipe
API RP 750	Management of Process Hazards
ASME B1.20.1	Pipe Threads, General Purpose, Inch
ASME B16.5	Pipe Flanges and Flanged Fittings

REFERENCE	**PUBLICATION TITLE**
ASME B16.9	Factory Made Wrought Steel Buttwelding Fittings
ASME B16.10	Face to Face and End to End Dimension of Valves
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B16.20	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral Wound and Jacketed
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.25	Buttwelding Ends
ASME B16.36	Orifice Flanges
ASME B18.2.1	Square and Hex Bolts and Screws, Inch Series, including Hex Cap Screws and Lag Screws
ASME B18.2.2	Square and Hex Nuts (Inch Series)
ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ASME PTC 19.1	Measurement Uncertainty
BS 7430	Earthing
BS6031	Code of practice for earth works
BS EN 1992-1-1:2004	Design of concrete structures. General rules and rules for buildings
BS EN 1993-1-1:2005	Design of steel structures. General rules and rules for buildings
DIN 10204	Certification Requirements
EN 10204	European Standards – Certification Requirements
ERA 69-30	Current Rating Standards for Distribution Cables
GPA 2172	Publication for Calculation of Gross Heating Value, Relative Density and Compressibility Factor for Natural Gas Mixtures from Compositional Analysis
GPA 2261	Publication for Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography
IEC 76	Power Transformers
IEC 79	Equipment for Hazardous Areas
IEC 79-10	Electrical Apparatus for Explosive Gas Atmospheres, Part 10; Classification of Hazardous Area
IEC 79-13	International Electro Technical Commission – Construction and Use of Rooms or Buildings Protected

REFERENCE	PUBLICATION TITLE
	by Pressurisation
IEC 228	Conductors of Insulated Cables
IEC 331	Fire Resistant Cabling and Wiring
IEC 332	Flame Retardant Cabling and Wiring
IEC 364-5-54	Electrical Installations of Buildings Part 5; Selection and Erection of Electrical Equipment, Chapter 54; Earthing Arrangements and Protective Conductors
IEC 446	Identification of Conductors by Colors or Numerals
IEC 502	Extruded Solid Dielectric Insulated Power Cables for Rated Voltage for 1kV up to 30kV
IEC 529	Classification of Degrees of Protection Provided by Enclosures
IEC 584	Thermocouples
IEC 605	Equipment Reliability Testing
IEC 654	Operating Conditions for Industrial Process Measurement and Control Equipment
IEC 751	Industrial Platinum Resistance Thermometer Sensors
IEC 754	Test on Gases Evolved During Combustion Of Electric Cables
IEC 801	Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment
IEC 1034	Measurement of Smoke Density of Electric Cables Burning under Defined Conditions
IEC 60228	Plain annealed copper, stranded, class 2
IEC 60502-1	XLPE
IEC 60332-3 Cat. A	Outer sheath
IEC 61508	Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems
IEC TC 65	Software Safety (WG9) and Functional Safety-Generic Aspects (WG 10)
IEE Wiring Regulations	Regulations for Electrical Installations
IEEE C37.90.1	Guide for Surge Withstand Capability Tests
ISA S5.1	Instrumentation Symbols and Identification
ISA S5.2	Binary logic Diagrams for Process Operations
ISA S5.3	Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Symbols

REFERENCE	**PUBLICATION TITLE**
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA RP-55.1	Hardware testing of Digital Process Computer
ISA RP-5517	Hardware testing of Digital Process Computer Codes of practice testing computer based system.
ISA S71.04	Environmental Conditions
ISA SP84/E/E	Programmable Electronic systems for Use in Safety Applications
ISO 1519	Paint and Varnishes - Bed Test (Cylindrical Mandrel)
ISO 2632	Roughness Comparison, Specimens Spark Eroded, Shot Blasted and Grit Blasted, Part II
ISO 2714	Liquid hydrocarbons-Volumetric Measurement by Displacement Meter Systems Other Than Dispensary Pumps
ISO 2808	Paint and Varnishes - Determination of Film Thickness
ISO 3170	Petroleum Products Liquid hydrocarbons Manual Sampling
ISO 3511	Process Measurements Control Functions Instrumentation Representations
ITU-T G711-G729	Coding of voice and audio signals
ITU-T V35 serial	Wideband modems
ITU-T X21 serial	Interfaces
ITU-T X805	Security architecture for systems providing end-to-end communications
MSS SP-9	Spot-Facing for Bronze, Iron and Steel Flanges
MSS SP-25	Standard Marking System for Valves, Fittings Flanges and Unions
MSS SP-44	Steel Pipe Line Flanges
MSS SP-45	By-pass and Drain Connections
MSS SP-53	Quality Standard for Steel Castings - Magnetic Particle Method
MSS SP-54	Quality Standard for Steel Casting - Dry Particle Magnetic Inspection
MSS SP-55	Quality Standard for Steel Castings - Visual Method

REFERENCE	PUBLICATION TITLE
MSS SP-61	Hydrostatic Testing of Steel Valves
MSS SP-80	Bronze Gate, Globe and Check Valves
MSS SP-82	Valve Pressure Testing Methods
MSS SP-92	Valve User Guide
NFPA 101	Code for Safety to Life from Fire in Building and Structures
NFPA 110	Emergency and Standby Power Systems
NFPA 321	Standard on Basic Classification of Flammable and Combustible Liquids
NFPA 496	Standard for Purged and Pressurised Enclosures for Electrical Equipment
OSHA	Construction Standard for Excavations
RS-222-C	Structural Standards for Steel Antenna Towers and Antenna Supporting Structures
SAMA PMC 33.1C	Radio Frequencies Sensitivity Test
UTM	Universal Transverse Mercator

(3) The Contractor shall demonstrate compliance with all of the above standards and codes at all stages of implementation of the Works. In the event of conflict between the various listed standards, the stricter provisions shall prevail.

(4) The Contractor shall comply with all Bangladeshi Safety Legislation and Regulations insofar as they are applicable to the carrying out of the Works.

(5) The Contractor shall be responsible for sourcing and obtaining copies of the latest edition of all standards and codes, of which two copies of each shall be provided to the Engineer.

(6) The latest versions of the above standards and codes shall be applicable for implementation purposes unless otherwise specifically stated elsewhere in this document.

(7) If circumstances are encountered in which the requirements of a standard or code cannot be met, then a variation request shall be prepared by the Contractor and submitted to the Employer. The Contractor shall provide full technical justifications for such variation request.

(8) Where specific standards, codes of practice or industry norms are stated in this document, the Contractor may nonetheless use any other standard that will result in the quality of the Works being equivalent to or higher than the quality that would have resulted through the application of the stated standard.

(9) All of the relevant standards are to be adhered to and used in the integrated and interdependent manner in which the issuing body intended.

(10) In certain areas of science and engineering there are no published standards. In such cases the Contractor is obliged to ensure that in the design, execution and completion of the Works the Contractor has at all times complied with established “best practice”. To demonstrate compliance the Contractor may draw upon the latest technical references in such areas and refer thereto in the preparation of the Design.

(11) The Contractor’s technical documents for their design, installation, commissioning and testing shall identify the standards which are applied to.

2. Scope of Work

2.1. Introduction

(1) The Project shall be implemented by EPC (Engineering, Procurement and Construction) Contract. The Contract Scope of Works shall include, but are not limited to, engineering, detailed design, manufacture, installation, construction, testing, commissioning, training and post-implementation services.

(2) The Scope of Work to be carried out by the Contractor at each site is specified in the Site Information & Scope of Work (Appendix-2).

(3) The Site Information & Scope of Work is based on a conceptual design and provides basic information of each site and an overview of each site's scope of work. The Contract is the EPC Contract therefore, the Site Information & Scope of Work does not relieve the Contractor of any responsibility for any aspects of the design and implementation, nor for allowing for any variation between the Site Information & Scope of Work and the specific aspects of implementing the Contract Works.

2.2. Project Management

(1) The Contractor shall be responsible for the Project Management, and nominate a single Project Manager to be mainly based in Bangladesh. The Project Manager shall be the point of contact during the Contract and shall be responsible for all aspects of the Contractor's work including, but not limited to, program management, progress reporting, finance, safety and technical compliance.

(2) The Contractor shall produce a Project Plan as specified in Section 3.2.1. This shall address both Bangladesh and overseas based activities.

(3) The Contractor shall monitor performance against the Project Plan and produce monthly reports detailing progress, activities undertaken, problems and future activities.

2.3. Site Investigation

(1) The Contractor shall be responsible for defining and implementing all necessary Site investigations, including a sampling and testing program.

(2) The purpose of the Site investigations shall be to identify and quantify those characteristics or properties of the materials found on or under the Site for use in the design and execution of the Works. The definition of what investigation is required shall take into account the data provided at the bid stage and any assumptions or conclusions drawn from such data with respect to the characteristics or properties of materials.

2.4. Engineering and Detailed Design

The Contractor shall be responsible for the engineering and detailed design of the New System in accordance with the requirements specified in this document.

2.5. Manufacture

The Contractor shall manufacture the equipment required for the New System in accordance with the design.

2.6. Factory Acceptance Test (FAT)

(1) The requirements for FAT are specified in greater detail in Section 11.3.1.

(2) The Contractor shall perform the Factory Acceptance Test (FAT) of the equipment manufactured for the New System before any item of the equipment is packed or delivered from the manufacturer's factory.

(3) The FAT shall be witnessed by the Employer and/or the Engineer.

2.7. Pre-Installation Site Works

The Contractor shall be responsible for pre-installation site works including, but not limited to, the following works:

(1) The Contractor shall refurbish existing rooms, foundations and sunshades where equipment is installed prior to the installation works as specified in Section 10.

(2) The Contractor shall construct the foundations and sunshades for new equipment prior to the installation works as specified in Section 10.

(3) The Contractor shall carry out all necessary cabling works prior to the installation works as specified in Section 9.

2.8. Installation

(1) The requirements for delivery and installation are specified in greater detail in Section 5.

(2) The Contractor shall be responsible for delivery of all equipment, materials and tools to Bangladesh and onward to the sites.

(3) The Contractor shall be responsible for providing adequate and appropriate storage facilities for all equipment, materials and tools.

(4) The Contractor shall install equipment in accordance with the design, specification, safety plans and method statements.

2.9. Site Acceptance Test (SAT)

(1) The requirements for SAT are specified in greater detail in Section 11.3.2.

(2) The Contractor shall perform the Site Acceptance Test (SAT) of the equipment and software for the New System after they are fully assembled/installed at sites.

(3) The SAT shall be witnessed by the Employer and the Engineer.

2.10. Commissioning

The Contractor shall carry out commissioning tests to demonstrate the satisfactory operation of the New System prior to Taking-Over as specified in Section 11.3.3.

2.11. System Taking-Over

Following satisfactory completion of the Final System Tests as specified in Section 11.3.4. and provided the other requirements have been met, the System Taking-Over shall take place when the Employer commences full operation of the New System.

2.12. Operation and Maintenance Support

(1) The requirements for the operation and maintenance support are specified in greater detail in Section 12.

(2) The Contractor shall support two years warranty period along with Operation and Maintenance (O&M) support.

2.13. Training

(1) The requirements for training are specified in greater detail in Section 13.

(2) Training shall be provided to the Employer's staff during installation, commissioning, operation and maintenance of the New System. This activity shall be scheduled to allow these staff to contribute to the site testing and setting work.

2.14. Temporary Site Facilities

2.14.1. General

(1) The Contractor shall be fully responsible for all necessary temporary facilities for the

implementation of the Project.

(2) The Contractor shall provide temporary local site facilities for the Employer and the Engineer where travel back to Dhaka, Demra or Ashuganj is not feasible in a day.

(3) The Contractor shall provide temporary office and accommodation facilities for the Employer and the Engineer at Demra and Ashuganj with the facilities as outlined below.

(4) The Contractor shall be fully responsible for locating and arranging the use of sites for the temporary facilities, temporary accommodation and such utilities as required by the Contractor, the Employer and the Engineer.

(5) Alcohol, liquor, firearms and drugs shall be strictly forbidden in the camp area and construction site.

2.14.2. Local Site Facilities

In addition to that required by himself, the Contractor shall provide, in areas where travel back to Dhaka, Demra or Ashuganj is not feasible in a day, local site facilities for the Employer and the Engineer including:

(1) Indoor working space at site (or reasonably close to the site) with adequate office furniture for the Employer and the Engineer (minimum 4 staff).

(2) Full board accommodations for the Employer with following facilities:
- One air conditioned bedroom for each staff
- Western style attached and/or common bathroom with hot water
- Communication facilities such as internet connection and/or facsimile

2.14.3. Office Facilities

2.14.3.1. General

(1) In addition to that required by himself, the Contractor shall further provide the following facilities at each of Demra and Ashuganj;

1) Project Office
2) Computer equipment

for the exclusive use of the staff of the Employer and the Engineer during the construction period and with a demobilization period of up to three (3) months after issue of the Taking-Over Certificate.

(2) All items in Sections 2.14.3.3. shall become the property of the Employer at the time of issuance of the Taking-Over Certificate.

2.14.3.2. Project Office

(1) The Contractor shall provide office space adequate for minimum 10 staff with following facilities, and be responsible for the security, cleaning and regular maintenance.
   1) Air conditioned office rooms.
   2) 1 No. air conditioned meeting room.
   3) Broadband internet connection and LAN system with regular maintenance.
   4) Office furniture adequate for the entire office space mentioned above.
   5) Kitchen with cold & hot water supply, refrigerator, table wares and other necessary facilities for tea/coffee and light meal services.
   6) Toilets adequate for minimum 10 staff's use.
   7) Fire extinguishers in accordance with local regulation.
   8) Office boys to provide general office service.
   9) Provision of all consumable items for daily office use throughout the Project.
   10) Adjacent parking space for minimum 5 vehicles.

2.14.3.3. Computer Equipment

As a minimum the following computer equipment shall be provided by the Contractor and be dispersed as directed by the Engineer:

(1) 1 No. reputable brand name latest desktop PC with UPS.
(2) 2 No. reputable brand name laptop PC.
(3) 1 No. A3/A4 size color laser printer/scanner/photocopier with regular maintenance service.
(4) Latest version of following software shall be pre-loaded on all PCs mentioned above and also provided on CD/DVD-ROM:
   1) Microsoft Windows
   2) Microsoft Internet Explorer

3) Microsoft Outlook
4) Microsoft Office
5) Word module for word processing in Bangla script
6) Microsoft Project
7) Anti-virus software
8) AutoCAD

2.14.4. Living and Messing Accommodation (Demra and Ashuganj)

(1) The Contractor shall provide two fully furnished houses (or flats) with following facilities for the accommodations of the Employer during installation and commissioning period and with a demobilization period of up to three (3) months after issue of the Taking-Over Certificate at each of Demra and Ashuganj, and be responsible for the security, cleaning and regular maintenance.
   1) One air conditioned master bedroom with attached bathroom.
   2) Two air conditioned bedrooms
   3) One common bathroom
   4) Hot water supply at all bathrooms and kitchen.
   5) Kitchen, Dinning and Lounge space
   6) Satellite TV
   7) Fire extinguishers in accordance with local regulation.
   8) Three meals per day for all staff
   9) Cooks and bearers necessary for daily meal, cleaning and maintenance.
   10) Provision of all consumable items for general daily use.
   11) Adjacent parking space for minimum 2 vehicles.

2.14.5. Supply of Electricity and Water

(1) The Contractor shall be solely responsible for all arrangements for, and charges associated with, the provision and use of drinking quality water and electrical power (230V 50Hz) to the offices, living and messing accommodation for the duration of the Construction Period.

(2) Drinking water quality shall be subject to independent laboratory tests at the expense of the Contractor.

(3) Attention is drawn to the non-reliability of electricity supplies from the National Power Grid in Bangladesh. Supplies of power are often discontinuous for several hours during each day. The Contractor shall provide and maintain an independent full capacity diesel fuelled generator system, with standby, for supply of electricity to the offices, living and messing accommodation.

2.14.6. Inspection Equipment

The Contractor shall supply for the exclusive use of the Engineer and his staff the equipment required for inspection of the works. This equipment will be retained by the Employer at the time of issuance of the Taking-Over Certificate.

2.14.7. Vehicles

(1) Within forty-five (45) days of Commencement of Works, the Contractor shall supply, for the exclusive use of the Employer and the Engineer or their staff, the following vehicles or similar approved and drivers. These vehicles will, become the property of the Employer at the time of issuance of the Taking-Over Certificate.
   1) Saloon cars, petrol and/or CNG fuelled, air conditioned, fully equipped, to carry four (4) passengers and driver in comfort - 1 No. with driver.
   2) Toyota Land Cruiser (long wheel base) or equivalent, petrol and/or CNG fuelled, air conditioned, fully equipped - 4 No. with drivers.

(2) Four wheel drive vehicles shall have an engine capacity of not less than 4000 cc. The saloon cars shall have an engine capacity of not less than 2000 cc.

(3) All vehicles supplied by the Contractor shall be new and in a fully road worthy condition. The Contractor shall pay all costs including CD-VAT and other payments necessary to allow them to be used freely on all public highways in Bangladesh and shall continue to make such payments throughout the duration of the Contract until the issuance of the Taking-Over Certificate.

(4) The Contractor shall insure all the above vehicles fully comprehensively for any driver and all passengers up to 90 days after the issuance of the Taking-Over Certificate. The insurance company shall be registered in Bangladesh and the policies approved by the

Employer prior to delivery. Receipts of premium payments shall be submitted to the Employer and copied to the Engineer at the time of delivery of the vehicles. Full policy documents shall J be submitted to the Employer and copied to the Engineer within 30 days of delivery.

(5) The Contractor shall provide fuel, oil and other consumables for these vehicles throughout the Contract until the issuance of the Taking-Over Certificate.

(6) The Contractor shall maintain all vehicles supplied by him in fully road worthy condition, including routine maintenance and all repairs and replacements as they become necessary. Should any vehicle be off the road for maintenance purpose for more than 24 hours, the Contractor shall supply an equivalent vehicle at no extra cost for the duration of the period of service. All the conditions in this Clause shall apply to the replacement vehicle.

(7) If any vehicle is lost, damaged or stolen whilst in the possession of the Employer or the Engineer, the Contractor shall immediately provide an equivalent replacement vehicle, at his own expense. The Contractor shall assume responsibility for any legal and insurance procedures resulting from any of the above eventualities.

2.14.8. Vehicle Equipment

(1) The four wheel drive vehicles shall be equipped with the following:
   1) Water carrier of approximately 20 litre capacity
   2) Fuel carrier of approximately 20 litre capacity
   3) Shovel
   4) Hi-lift jack
   5) One spare wheel, with tyre
   6) Sump guard, track guard and front fender grill bars
   7) Seat covers, floor mats and cleaning materials
   8) First aid kit, including blanket
   9) Normal emergency tool kit

(2) In addition, the Contractor shall provide with each vehicle 4 No. new spare tyres at the time of handing over of the vehicles to the Employer.

(3) The saloon car shall be equipped as appropriate as per the four (4) wheel drive vehicles.

2.14.9. Assistance

(1) The Contractor shall render all necessary assistance to the Engineer and his staff in their inspection, evaluation and supervision of the Works.

(2) The Contractor shall also provide such other labour as is required to attend nightly to the office security and cleaning and other requirements and where required to assist the Engineer and his staff in measuring, supervising, testing, checking and examining the Contractor's work whether by day or night.

2.14.10. CD-VAT Charges on Imported Items

(1) The Employer shall be responsible for the payment of CD-VAT charges on items of imported Materials and Plant incorporated in the Permanent Works.

(2) The Contractor shall be responsible for the payment of CD-VAT and other duties and charges of all imported items and consumables provided as required in this section 2.14.

2.15. The Employer's Scope of Work

For smooth implementation of the Project, GTCL shall be responsible to undertake the following items.

(1) Undertakings by GTCL

1) Procedures for lands

In this Project, procured equipment and materials will be installed at the Sites owned by GTCL or other companies who belong to the gas sector and have gas business with GTCL. Therefore, necessary land-use permissions shall been obtained by GTCL so that the Contractor can start their work without any delay.

2) Communication system lease contract between GTCL and BTCL

GTCL has decided to select the communication system provided by BTCL as the communication backbone for the GTCL SCADA System. Accordingly, the lease contract between GTCL and BTCL shall be made within one (1) month of Notice to Proceed to the EPC Contractor.

(2) Works by GTCL

1) Thermo-wells additionally required for the New System shall be installed by GTCL prior to the issuance of “Notice To Proceed”.

2) The soundness of all transmitters, limit switches and/or supply power including related cables and junction boxes at existing RTU sites and other related sites shall be checked and repaired/replaced by GTCL as necessary prior to the issuance of “Notice To Proceed”.

3) For the detection of a gas leakage from the pipelines covered by the Project, the precise measurement of gas flow at whole intake and offtake points shall be indispensable. Therefore, the current situation of the relevant points with respect to the gas flow measuring capability shall be checked by GTCL and necessary countermeasures shall be taken prior to the commencement of the Project.

4) The following information shall be provided by GTCL as a part of the tender document for the EPC Contract:

a) Detailed information, such as the type and exact location of whole intake and offtake points, valve stations, metering stations, etc., on GTCL and other related gas pipeline networks

b) Layout and P&ID drawings of sites to be covered by the New System.

3. Contractor's Key Management Responsibilities

This chapter identifies the requirements of the Employer with respect to how the design, execution and completion of the Works is to be planned, managed and administered by the Contractor. For the most part it sets out detailed requirements that are to be read in conjunction with the more general requirements stipulated in the *Conditions of Contract*, particularly (but not limited to) the requirements of the following subsections:

1) 4.6 [*Co-operation*]
2) 5.2 [*Contractor's Documents*]
3) 5.6 [*As- Built Documents*]
4) 5.7 [*Operation and Maintenance Manuals*]

This chapter also addresses general administrative matters and the coordination thereof between the Employer's Personnel and the Contractor.

3.1. Administrative Matters

3.1.1. Contractor's Documents

(1) Certain Contractor's Documents are specified in the Contract as being required by the Engineer for review. The submission of such documents and the subsequent review thereof shall be carried out under the provisions of *Conditions of Contract* subsection 5.2 [*Contractor's Documents*].

(2) In respect of any of those Contractor's Documents where the Contract is silent on the need for submission, the Contractor is not required to submit such documents unless the Engineer specifically requests the Contractor to do so. This is intended to ensure that the Engineer is not inundated with data that is not critical to the review process, and the Contractor is expected to cooperate with the Engineer to ensure that this intention is realised in practice. The Contractor shall nonetheless provide or provide access to such other documents when so requested, including the following:

1) Administration Documents: these are documents for discussion between the Contractor and the Engineer in order to facilitate the establishment of various management and communication systems, for example, those with respect to Quality Management Systems. Such documents are indicated in the *Employer's Requirements*, and the level of detail required will be agreed between the Engineer and the Contractor.
2) General Records: documents such as those produced by the Contractor to record and document his work and which are to be handed over to the Employer on completion of

the Works. Such documents are to be available for inspection by the Engineer on request and at all times.

3) Particular Records and Reports: documents such as those to be produced by the Contractor to record and document his work or report on particular aspects thereof.

(3) Contractor's Documents shall, except where stated or agreed otherwise, be created in the latest commercially available versions of the software shown in Table 1, as appropriate to the required application.

Table 1 – Software to be Used

Text-based documents	Microsoft Word
Spreadsheets	Microsoft Excel
Drawings	AutoCAD
Graphics	Adobe Photoshop or equivalent
Database	Microsoft Access
Programming	Microsoft Project

(4) Where the Contractor proposes to use software not listed above, then he shall seek the Engineer's approval of his proposal and provide two licensed copies of each type of software and any upgrades thereof for the permanent use of the Employer's Personnel.

(5) Contractor's Documents shall be submitted in a manner that allows for the transmitted data to be stored on a computer server and input into a database for monitoring the subject and status of submissions. Where the editorial integrity of the content of the document is of concern, the document may be provided in a protected format. In such cases, a version of the document that allows the contents to be accessed and used by the Employer's personnel is also to be provided. In addition, paper hardcopies shall be provided where stipulated.

(6) All Contractor's Documents shall be stored and referenced by the Contractor in such a manner as to allow the Employer's Personnel to readily locate, retrieve and inspect any particular document. If the time for submission of a Contractor's Document required for review is not expressly stated, then it shall be submitted in such order and at such times as to allow it to be reviewed properly before implementation is required.

(7) The specific requirements for Contractor's Documents are identified in the relevant parts of the Contract. The following section identifies the broad categories of such documents and the administrative procedure governing their submission.

3.1.2. Design Submissions

(1) The purpose of the Design Submissions is to allow the Employer's personnel to:
   1) Monitor the progress of design
   2) Satisfy themselves that the design is being performed and verified in a competent, professional manner
   3) Satisfy themselves that the design can be effectively and safely built
   4) Satisfy themselves that the Contractor is complying with any other obligation under the Contract.

(2) The Contractor is required to submit the design work required for review, including specifications, in the following order of stages:
   1) Stage 1 - Preliminary Design
   2) Stage 2 - Detailed Design

(3) The Contractor is not authorised to proceed to the next stage of design until he has received from the Engineer a notice of "no objection" for the stage of design under review.

(4) The Design Submissions shall be structured, referenced and presented in a manner that:
   1) Facilitates the achievement of their intended purpose
   2) Allows them to be filed to form part of what will eventually be a comprehensive, integrated and complete record of the design.

(5) A time schedule covering the submission of the Contractor's Documents related to design (the Design Submission Schedule or DSS) shall be incorporated as part of the Programme referred to in the *Conditions of Contract* subsection 8.3 [*Programme*]. The DSS shall identify the attributes of each Design Submission. The minimum attributes shall be:
   1) The Design Stage covered by the submission (either the Conceptual Design, the Preliminary Design or the Detailed Design)
   2) Whether the design work covers Permanent Works or Temporary Works
   3) Where Facility references are applicable, the appropriate code for that part of the Works forming the subject of the submission
   4) The date by which the submission is due
   5) The date for completion of the review.

(6) Except as may otherwise be agreed with the Engineer, the Design Submission for each respective Facility shall be comprehensive and cover the entirety of the design for that

Facility. Partial Design Submissions for a Facility will not be acceptable to the Engineer. The review period for any Facility shall be deemed not to have commenced until such time as the Contractor has submitted the full design according to the requirements as stipulated herein.

(7) Should the Engineer not require a particular aspect of the design to be submitted for review, then this will be identified by the Engineer on a copy of the DSS returned to the Contractor.

3.1.3. As-Built Documents

(1) The As-Built Documents shall be comprised of:
   1) Drawings of the Permanent Works as installed (including a 'family tree' index incorporating all drawings from suppliers and subcontractors), indicating all changes made to the original Drawings issued for construction/installation purposes
   2) Specifications of the Permanent Works as installed, indicating all changes made to the original Specifications issued for construction/installation purposes
   3) A copy of all Variations and Change orders issued by the Engineer during the execution of the Works
   4) A full report on all non-conformities identified and corrective measures taken
   5) A copy of all construction records, including all test results
   6) A copy of all Standards and Codes of Practice applicable to the Works, and
   7) Operation and maintenance documentation, including all; applicable product information, required to operate and maintain the system.

(2) Drafts of the As-Built Documents shall be submitted in paper hard-copy format (5 copies) with the exception of the item (6) stated above. The finally agreed set of As-Built Documents shall be submitted in 1 original and 5 paper copies, together with 2 editable soft copies. For the Standards and Codes as described in item (6) above, 1 original paper hard format or 1 CD-ROM format shall be submitted.

(3) A copy of all indicated software provided for operating and maintaining the completed Works (i.e. software especially written or standard software customized by specialists), together with all supporting documentation relating thereto (including "Help" files and the like), shall be provided by the Contractor to complete the As-Built Documents submission data.

(4) The original design shall be clearly distinguishable from what has been built. On drawings, this may be achieved by layer separation, line colour or line type, or a combination thereof. In the Specifications, this shall be achieved by any changes being identified in red. Where words have been deleted from the Specifications, the deleted words shall remain in view but be struck through with a line.

(5) Each change from the original design shall be referenced to the authorization giving rise to that change.

(6) The documentation of Variations to the Works arising from *Conditions of Contract* subsection 13.2 [*Variations and Adjustments*] shall be in paper hard-copy format. Each variation shall be assigned a unique reference code and shall be contained in a separate file identified with the Variation reference number. The file shall contain all communications and documents related to that variation, filed in chronological order. A table of contents shall be provided at the front of each file.

3.1.4. Operation and Maintenance Manuals

(1) The Contractor is required to prepare an operating and maintenance manual for the System. Specifically, manuals must be prepared to explain how all items of equipment and systems are to be correctly operated and maintained. The manuals are to be written in English, and are to be fully illustrated. They are to be in a consistent format as agreed with the Engineer to facilitate use, and are to form an integrated whole. Except where otherwise identified in detail for specific items of equipment and systems, the manual shall comprise of individual sections on all discrete areas of operations.

(2) The manuals shall contain Maintenance Plans covering all aspects of the Works. Each such plan shall be prepared to ensure that any design life requirements are met in full, and it shall be prepared to maximize the service life. All items that are not considered to be maintenance-free shall be identified, and recommendations shall be given for the frequency and mode of inspection, the means of access, materials, tools and special equipment required, and methods of carrying out the maintenance work. Where proprietary materials and components are incorporated in the Works, details of the manufacturer and supplier, including addresses, telephone numbers and Internet information shall be provided.

(3) Professionally printed and bound copies of each approved manual, in the numbers required,

together with a CD-ROM copy thereof, are to be supplied to the Engineer before a Taking-Over Certificate is issued for that section of the Works in which the relevant equipment or system is required to function. The first drafts in paper hard-copy format of Operation and Maintenance Manuals, illustrating the structure and the nature of the contents, shall be submitted at the Detailed Design Stage.

3.1.5. Provision of Standards

(1) Two copies in English (together with an additional copy of the original if not in English) of all standards, guidelines, codes of practice or similar used by the Contractor are required. The copies are to be provided in advance of, or with, any Design Submission or submission to which they relate and, in general, in advance of when they may be required by the Engineer. Where standards and the like are available from the issuing authority on CD-ROM, they shall be provided to the Engineer in that format. Where the original standard is not in English, an English translation shall be made and certified by a qualified translator.

3.1.6. Drawings and Specifications

(1) The Drawings shall show information that is best or most conveniently presented in a pictorial or tabular form, supplemented by appropriate notes thereon. The Specifications shall provide all other necessary information in text, tables and figures with respect to the materials to be used and the standard of workmanship required to enable the Works to be manufactured, fabricated, constructed, installed, commissioned, tested and operated as designed.

(2) The Works shall be completed in full accordance with all Drawings and Specifications that have been submitted for the Employer's review and against which the Contractor has not received notice from the Employer that such Drawings and/or Specifications fail to comply with the requirements of the Contract.

3.1.7. Method Statements

(1) Method statements describe how particular aspects, parts, stages and elements of the Works are to be executed. The Contractor is required to prepare method statements:

(a) In general terms in response to the *Conditions of Contract* subsection 8.3 [*Programme*]

(b) In detail for all significant elements of work, to comply with the explicit or implicit requirements of the Quality Management System referred to in this Chapter and/or to enable verification that all health, safety and environmental requirements are being complied with.

(2) Where the method of construction influences any stresses (including transient stresses) in a part of the Permanent Works, the method statement shall refer to the design calculations identifying such stresses and demonstrate that they are allowable. Specifically, method-related health, safety and environmental mitigation measures shall be included. The method statement shall also contain an assessment of the risk associated with the method to be used, in terms of safety, cost and time, and the measures to mitigate such risk.

(3) Method statements to satisfy the "type (a)" requirement stated above shall describe the overall method for the construction of a major aspect, part or stage of the Works and in all cases shall be submitted to the Engineer without the need for the Engineer to request them. They shall identify the resources required and the organization and application of those resources. Temporary Works shall be identified, and the method statements shall reference the design of the Temporary Works.

(4) Typical topics that will need to be addressed under "type (a)" method statements are:

- Procurement of major equipment and materials
- Transport, storage and handling procedures for major equipment and materials
- Installation of the System including mechanical completion and pre-commissioning tests, and interface coordination with the other SCADA systems
- Commissioning of the Systems
- Tests after completion.

(5) The method of manufacturing, fabrication and installation (including systems integration, commissioning and testing) is, except where specifically defined in the Contract, at the discretion of the Contractor. Accordingly, the Contractor is required to prepare "type (b)" method statements for all significant work elements, fully describing the methods to be employed. Each such method statement shall describe in detail the process to which it refers, a description of the techniques to be used and the qualification requirements of any specialist personnel that will be needed to apply those techniques. The Contractor shall prepare and submit to the Engineer a list of all such method statements that he proposes to prepare, referencing them to the relevant part of the Employer's Requirements, the Drawings and the

Specifications. The Engineer shall indicate to the Contractor on a copy of such list those method statements that the Engineer wishes to review.

3.1.8. Systems Design Methodology

3.1.8.1. Purpose of System Design

(1) The purpose of the management and validation of the system design by the Contractor is to provide a systematic framework of activities and reporting that confirms the convergence of the system design upon the fulfillment of the performance and programme requirements.

(2) Design Submissions shall be subdivided into the following stages:
   1) Preliminary Design (required prior to commencement of production)
   2) Detailed Design (after completion of Factory Acceptance Tests and prior to shipment)
   3) Acceptance Design (after completion of Site Acceptance Tests and Trial Operations)
   4) Final Design (after expiration of the Defects Notification Period).

3.1.8.2. Methodology

The Employer requires that within the Contractor's methodology for undertaking the design process it can be clearly seen that:

(1) The Contractor understands the complexity and interactive nature of the design task
(2) The implementation plans and procedures are already fully developed and the implementation methodology appears sound
(3) The selection of technologies and subsystem specifications are based upon consistent and coherent analysis
(4) Design freeze(s) will be properly documented and will be fully auditable internally and externally across the Contractor's organisation
(5) Systems assurance disciplines are systematically applied to subsystem specification and design, and to the validation of system integration
(6) Validation, by means of testing and commissioning, training, certification, etc. is systematic, coherent and conclusive.

3.1.9. Meetings

(1) Meetings shall be in either Dhaka or on the Site, as deemed appropriate by the Engineer. Meetings shall be attended by the Contractor's personnel responsible for the subjects under discussion, supported as necessary by the appropriate technical staff. The types of meetings to be arranged and the personnel to be in attendance, including any limitations on numbers in order to ensure that the meetings are productive, shall be agreed between the Engineer and the Contractor from the outset of the Contract. *Ad hoc* Meetings that are not part of the regular schedule of meetings may be convened according to the requirements of the parties, but shall be restricted as far as possible to only those necessary to progress the completion of the Works.

(2) The convening party shall prepare and distribute an agenda by such time before the meeting as is to be agreed between the Engineer and Contractor, together with any information necessary for the proper conduct of the meeting. Progress and coordination meetings shall be held regularly at intervals not exceeding one month, and at such shorter intervals as may be dictated by the rate of progress or the need to resolve matters that might otherwise result in delay to the Works.

3.1.10. Coordination with Other Persons and Organizations

(1) There may be other persons and organizations working on the Site with the permission of the Employer. If so, the requirements of *Conditions of Contract* subsection 4.6 [*Co-operation*] extend to the Contractor being required to accommodate shared possession of the Site and the need to coordinate his activities with those other persons and organizations. Except where otherwise directed by the Engineer, all others working on the Site will be required to attend a coordination meeting on a weekly basis. The purpose of the meeting shall be to resolve any problems arising from the conflict of activities or access. In the event that any such matters cannot be resolved by discussion, the Engineer's wishes or decisions on the matter shall prevail. No claims for delays or additional costs will be considered where arising from (i) shared possession of Site, (ii) failure to coordinate properly with others having the right to be on the Site or (iii) a decision of the Engineer on such matters. The Contractor will be expected to have assessed the risk of such delays and costs, and to have allowed for the same in his bid. Such meetings are to be considered as supplemental to the meetings held solely between the Contractor and other persons and organizations that may be required for daily coordination.

(2) The Contractor shall obtain details of all operations by utilities authorities that may affect the Works, and keep the Engineer advised thereof.

(3) The Contractor shall, at the reasonable request of the Engineer, make available for inspection by other persons and organizations having the right to be on the Site any drawings, specifications or data prepared for the purpose of the Contract, with the exception of those that contain confidential details concerning proprietary methods of construction or design.

3.1.11. Liaison with Authorities

(1) A single person, with a designated deputy in case of absence, shall be appointed by the Contractor to be responsible for liaison and coordination of all communications between the Contractor and those local and national authorities that need to be consulted or advised with respect to the execution of the Works.

3.1.12. Reporting

(1) The Contractor shall prepare such reports as may be required by the Engineer to explain specific situations as they arise from time to time, in addition to the particular requirements for reporting set out hereunder.

(2) The Contractor shall submit a Monthly Progress Report to the Engineer within 7 days following the end of each month. The topics covered shall include but not be limited to the following:

1) Executive Summary –description of highlights and progress achievements (including actual verses planned progress and manpower)
2) Areas of Concern – description of any issue that could have a detrimental effect on the Works and an impact on cost or schedule
3) Progress Summary – narrative description of progress in each phase of the implementation work (Design, Procurement, Fabrication, Construction and Commissioning)
4) Permits and Certification – work permit status, environmental issues, safety, health and MIGAS certification, etc.
5) Quality Management System (QMS) – requirements are as described in section 3.3.4.

herein.

(3) The Monthly Progress Reports shall also include the following:

1) Progress photographs showing evidence of procurement, fabrication and construction progress in key areas, together with schematic drawings to show installation progress of the pipeline and pipeline stations, and the construction of work such as pipe bridges, major and minor pipeline crossings, etc.
2) The Master Time Schedule, showing current schedule status against baseline
3) Manpower Histograms, showing planned and actual manpower status
4) Planned work schedule for the following month
5) Progress 'S' curves for each section of the Works and overall, showing planned and actual percentages.

(4) The Contractor shall also maintain a daily construction report in the form of a diary for each separate working location on the Site, a copy of which shall be delivered on a daily basis to the nearest Site office of the Employer's Personnel.

3.2. Programming and Planning

3.2.1. Planning

(1) The Contractor shall ensure that the scope of work, programme and resource requirements are clearly defined within the Project documentation.

(2) The Project Manager shall break down the Project into manageable, discrete packages of work and define these in a series of documents collectively called the Project Plan.

(3) The Project Plan shall establish a clear and unambiguous understanding of interfaces, responsibilities and standards by which the Project will be managed.

(4) The Project Plan shall provide a resource profile showing the utilization of the staff allocated to the job.

(5) The Project Plan shall provide a single reference document throughout the life of the project and shall be used to monitor the progress of the Project work.

(6) The Contractor shall provide a Project Plan as described above. There are a variety of influences, many particular to Bangladesh and the Project that will impact the Contract. The Contractor shall evaluate and consider these in preparing the Project Plan and reflect them in a realistic and balanced manner. These shall include but not be limited to:

1) The ownership of sites by several Operating Companies and other Third Parties.
2) Approval for site works and access to sites from these Operating Companies and other Third Parties.
3) Minimized disruption to Operating companies and other Third Parties.
4) The geographical spread of sites in relation to Franchise Areas, Operating Company ownership and locations of the MCC and ACC.
5) Staged passing of ownership to the Employer.
6) Staged commissioning of some sites which are not currently operational.
7) On-going development of sites under other projects.
8) Scopes and programme of other gas development projects.
9) Climatic and seasonal factors.

(7) The Contractor shall appoint experienced management staff and proven project management techniques to ensure that projects are completed to specification, programme and cost.

(8) The Contractor shall appoint a Project Manager who shall be responsible for all aspects of the Project and shall act as the single point of contact for all communications with the Engineer and the Employer.

(9) The Project Manager shall be supported by a project team and ancillary staff to ensure the successful execution of the Project.

(10) The Project Manager shall divide his time between his home country and Bangladesh up to and including the end of the Factory Acceptance Test as dictated by the needs of the Contract. Following FAT and commencement of installation works the Project Manager shall be based full time in Bangladesh.

(11) The Contractor shall appoint a full-time deputy to be based in Bangladesh from Award of Contract and whom will act as a point of contact for up to the commencement of installation works whilst the Project Manager is in his home country.

(12) All Contract related correspondence from the Contractor shall be from the Project Manager and addressed to the Engineer.

3.2.2. Programming

(1) This section identifies those Employer's Requirements that are additional to the requirements stipulated in *Conditions of Contract* subsection 8.3 [*Programme*].

(2) The purpose of the Programme required of subsection 8.3 [*Programme]* is to facilitate the Contractor's management of the design, execution and completion of the Works. The purpose of submitting copies of the Programme and related information to the Engineer is to allow the Engineer to:

1) Monitor accurately the progress of the planning, design, procurement, installation, testing, commissioning and Final Taking Over of the Works
2) Monitor accurately the value of work completed
3) Identify demands on the Employer's staff and to arrange staff to meet those demands
4) Identify the impact of events that may give rise to delay to completion of the Works or any part thereof
5) Satisfy the Engineer that all aspects of planning and coordination are being performed in a competent, professional manner
6) Satisfy the Engineer that the methods of installation to be used for the execution of the Works are planned and are in accordance with the Contract
7) Satisfy the Engineer that the Contractor is complying with his obligations.

(3) The Programme shall be structured and presented in a manner that achieves the intended purpose. The Programme shall be developed using the latest version of "Microsoft Project" in such a manner that it can be effectively copied to and legitimately used by the Engineer.

(4) The Contractor shall provide the Programme that details the packages of work against time, key milestones and payment milestones and identifies inter-dependencies between the packages and progress to date.

(5) The Programme shall be multi-leveled containing a high level phased overview and lower level programmes detailing work packages.

(6) The Programme shall identify the following items as a minimum:

1) Project, QA and Test Plans, draft and issue
2) Submission of design drawings and documents for review
3) Delivery of final drawings and documents for major items of equipment
4) Placing of purchase orders for major items of equipment

5) Receipt of materials
6) Fabrication and manufacture
7) Type, Unit and Factory Acceptance Tests (FAT)
8) System support and Installation Manuals, draft and final issues
9) Delivery of major items of equipment and software, including the SCADA System infrastructure, work stations and definite works RTUs
10) Site works commence and end dates by site
11) Site Acceptance Tests (SAT)
12) Final System Test
13) Taking-Over
14) Warranty Period
15) Earliest and latest dates for the requisition of optional items in order to incorporate them in the major item delivery Programme.
16) The Programme shall be reviewed in each monthly report and progress against the original Programme identified. In addition to this the Contractor shall review the Programme in the light of developments and circumstances that have a bearing on it monthly.

3.3. Quality Management System (QMS)

This section contains the details referred to in *Conditions of Contract* subsection 4.9 [*Quality Assurance*].

3.3.1. Principles

(1) The basic principles that the Contractor is required to adhere to with respect to the management of quality are as follows:
1) The quality of (i) the design, execution and completion of the Works and (ii) the management systems necessary to bring the Works into affect are both to be assured through the operation of a QMS designed to monitor those activities.
2) The Contractor shall establish, document, implement and maintain a QMS for use under this Contract, and must continually improve its effectiveness based on ISO 9001:2000 (or such later version as may apply on the Base Date).
3) The Contractor's QMS must embody the principles contained in the ISO 9000 series of international standards such as will provide full documentary evidence that the Works comply with the Contract.

4) The Contractor's QMS shall apply equally to the Contractor and all his Subcontractors, sub-consultants and suppliers, and the Contractor shall be responsible for ensuring that such Subcontractors, sub-consultants and suppliers faithfully adhere to the requirements of the Contractor's QMS.
5) The procedures contained within the Contractor's QMS must have been proven to be effective on projects of a similar nature, size and complexity.

(2) The Contractor's QMS shall identify how:
1) The quality of the Works is to be assured
2) The quality of the work of Subcontractors, sub-consultants and suppliers is to be assured
3) Changes to the manner in which the Works are to be designed, executed and completed are to be assessed, recorded, monitored and controlled.

(3) The Contractor's QMS must cover all aspects of the Contractor's undertakings under the Contract including, but not limited to, the following activities:
1) Management
2) Procurement
3) Design
4) Manufacture
5) Fabrication
6) Installation
7) Construction
8) Testing and verification
9) Pre-commissioning
10) Commissioning
11) Completion
12) Taking Over of the Works.

3.3.2. Quality Control and Verification of the Works

(1) Quality Control and verification systems shall ensure and record conformance of the Works with the Contract requirements and the documented Quality Plans. This shall include, where appropriate, quality monitoring of subcontractors/suppliers, manufacturers, goods, services and workmanship.

(2) Inspection and testing shall be carried out on goods, workmanship, construction, finished

work, functional performance and identification systems, to ensure conformance with the Employer's Requirements.

(3) Where goods are supplied to the Contractor with recommendations or instructions as to how they are to be assembled, handled, installed and/or operated, such recommendations or instructions shall be adhered to.

3.3.3. System Monitoring and Performance Improvement

(1) This tem and its subordinate items identify the requirements with respect to how the Contractor shall monitor the functioning and performance of the QMS, identify problems and initiate corrective action.

(2) The Contractor shall establish documented Procedures for monitoring and analysing his performance in relation to his objectives, product conformity and the satisfaction of interested parties. The Procedures shall identify the issues for measurement and what the needs are, and translate them into requirements. They shall identify what criteria are applicable, what measurements are made and the methods of analysing the data. The issues for assessment shall include both achievement of performance objectives and satisfaction of interested parties.

(3) The Contractor shall identify actions for improvement from the monitoring and analysis of his performance, and implement actions for continual improvement.

(4) The Contractor's monthly progress report shall include a summary of the monitoring activities and results with an analysis of any trends and identification of improvement actions.

(5) The Engineer may at any stage of the Contract verify the correct application of the Contractor's quality system by the application of Quality Audits during build and upon completion of the manufacture of major items of equipment and upon completion of major integration builds of software.

(6) The Engineer may visit both the Contractor's and any of his Subcontractor's premises, at mutually agreed times, in order to gain objective evidence that the level of quality control is adequate to meet the requirements of the Contract. These visits may be in addition to those necessary to undertake inspection and witness tests on completed equipment or software.

3.3.4. QMS Reporting

(1) The Contractor's monthly report to the Employer shall include a section on Quality Management, which shall incorporate the following topics where applicable (not all topics listed are required every month):
   1) A summary of the status of QMS (including the status at the end of the last period, with comments on progress, and the items anticipated during the next period)
   2) Analysis of conformity of product, including a summary of inspection and test activities, results for the month, acceptability of results with reference to NCRs and analysis of any trends
   3) Analysis of conformity with performance objectives, including a summary of outstanding issues relating to the Contractor's QMS
   4) A summary of Non-Conformities and Corrective Actions and their status.

(2) In the regular progress meetings with the Engineer and other Employer's Personnel, the Contractor shall report the status of the above items as appropriate and, in addition, discuss:
   1) Any quality issues causing problems in order to agree on preventative or remedial measures
   2) Items arising from the management review meetings that require revisions to the Contractor's QMS.

3.3.5. QMS Documentation

(1) The Contractor must submit all relevant records to the Employer when the Works or any portions thereof are finally taken over. The specific contents of such records shall be as required by the Engineer. The records shall be suitably indexed and labeled so that records for specific sections or parts of the Works can be readily identified.

(2) The Inspection and Test Plans may be in the Contractor's own format but shall include as a minimum the following:
   1) The series of activities, including the inspections and tests performed in a logical sequence appropriate to the type of work
   2) Reference to the Contractor's procedure/instructions used to control each activity
   3) The Specifications or standard reference
   4) The compliance criteria
   5) The personnel allocation for performing the activities, inspections and tests

6) The frequency of the inspections or tests
7) The type of verification document or check-sheet used to record the result of the activity
8) A facility for the Engineer to indicate his requirements to inspect or witness any activities.

(3) All records are to be made available for inspection by the Engineer. Copies are to be submitted when so requested by the Engineer.

(4) Each major item of equipment shall have a unique Certificate of Conformity, substantiated by detailed results of inspections and tests. Batch-produced items such as RTU enclosures may be covered by a Batch Certificate, providing all serial numbers of equipment are shown and an appendix detailing the acceptance parameter bands within which the controlled parameters have been found to conform.

(5) Records generated to substantiate the attainment of performance and design standards shall be retained for at least 5 years and shall be filed/archived to enable access by the Engineer.

3.4. Health & Safety Management System (HSMS)

(1) The Contractor shall comply in all respects with the requirements of the safe working practices of the Employer, details of which will be provided on requisition in writing to the Engineer.

(2) No explosive or other dangerous substance shall be brought onto any site or used for any purpose unless the Contractor has previously obtained the written approval of the Engineer.

(3) It shall be the Contractor's responsibility during the works to ensure that the handling, storage and use of any dangerous substances follow the safe working procedures to ensure the Health and Safety of all personnel and property.

(4) The Contractor shall ensure, and give written details if so requested by the Engineer, that the materials used in the construction of the works, or those required for operation after take-over, do not in themselves or in any combination lead to the production of other dangerous substances, materials or conditions.

4. Design General Requirements

4.1. System Assurance Requirements

The design life of the system infrastructure shall be 15 years. The electronic equipment shall have an operating life of 10 years minimum.

The SCADA System shall be designed, manufactured and installed such as will ensure that modifications and/or extensions can be executed safely, with no disruption of the operation of the Pipeline System.

Database in the SCADA servers of the MCC and the ACC shall form part of a redundant pair arrangement or the like. The database of the MCC and the ACC shall be synchronized to be maintained as a redundant pair database.

In case of a failure on the SCADA server of the MCC, a switch over to the SCADA server of the ACC shall take place to continue scanning and storing data from the RTUs.

In the event of a communication failure between any RTU and the MCC/ACC, the RTU shall continue scanning and storing data from the field devices and subsystems. After such communication failure is rectified, all missing data at the MCC or the ACC shall be transmitted from the respective RTU.

The MCC and ACC SCADA master computer shall generate reliability reports on demand, including summaries, fault categories, trends and frequency of failure of specific components.

4.2. Reliability and Availability

The reliability of the SCADA System shall ensure that the monitoring and control functions shall not contribute to degradation of operations due to the loss of control of safety-critical functions. The architecture of the SCADA System shall effectively exploit software and hardware redundancy to achieve high operational reliability.

The basic design of the SCADA System shall be based on a 24 hour per day, 365 day per year operation. The availability of the SCADA System will be 99.7%.

4.3. Maintainability

The SCADA System maintainability design shall be consistent with the availability requirements. In particular, diagnostic time, replacement component availability, software loading and validation shall be analyzed and defined in Design Submissions.

The SCADA System shall include comprehensive self-diagnostic checking facilities. The equipment design, including software design, shall incorporate modular or component replacement principles, as appropriate, to minimize downtime.

Equipment requiring routine maintenance shall be able to be maintained without loss of view. Also IO module replacement and I/O tagging shall be maintained with on-line status.

4.4. Expandability

The SCADA shall support a scalable architecture for future expansions. It shall be possible to add additional RTUs and HMI Workstations without the need for additional servers. Expansions to database sizing shall be simple (such as entering a new authorization code) and shall not require additional software installation. In addition, the SCADA shall allow communications with a wide variety of control devices utilizing off the shelf driver packages.

The SCADA System shall be capable of expansion to support 200 RTUs.

GTCL plans to expand their natural gas pipeline network. The other SCADA system dedicated for those planned pipelines will be prepared. The SCADA System shall have an interface with the other SCADA systems and capability to monitor whole pipeline network expanded in the future. An OPC compliant server will be used for the SCADA server.

4.5. Spare Capacity

All parts of the system (I/O, operator stations, RTU interfaces etc) shall have the capability of further expansion by an additional 25% to cater for future expansion. This includes all aspects including hardware, software, firmware and communications.
Sufficient point/tag software licenses shall be furnished to cover the entire initial scope of the Project, including all configuration databases, control modules, I/O points and HMI displays.

Point/tag licenses shall be provided for all spare I/O capacity, specified and included with the system.

All operator stations must be capable of viewing all tags, databases, trends and HMI displays.

5. Procurement and Construction/Installation General Requirements

5.1. Introduction

(1) This section covers the procurement and construction/installation of the system and its components both at the factory and on site.

(2) Detailed requirements for procurement and construction/installation are specified in Chapter 6~10.

5.2. Procurement

(1) The Contractor shall be responsible to the procurement and delivery including all related activities for all equipment and materials to be supplied under this Contract into Bangladesh and onwards to the final locations.

(2) The Contractor shall prepare and submit a Procurement Plan to the Engineer outlining the methods, procedures and schedules for all procurement and related activities required for the Project. The Procurement Plan shall be submitted for the review of Engineer no later than 45 days from the Commencement date, and it shall include a sample of each standard form to be used for such activities.

(3) The Contractor shall provide the Engineer with bi-weekly reports on the procurement status of all equipment and materials, or more frequently when requested by the Engineer. Any deviation from the schedule on any of these items must be reported immediately to the Engineer with an explanation given for each deviation from the schedule and the proposed action plan to correct the situation.

(4) No deliveries to Sites shall be made without prior written approval by the Engineer. The Contractor shall allow in his program a period of two weeks for this permission to be given.

(5) The Contractor shall make visits to site to identify the conditions for delivery and temporary storage prior to installation.

5.3. General Requirement for Construction/Installation

(1) The Contractor shall install all equipment and construct all associated facilities under this Contract.

(2) The Contractor shall be responsible for ensuring that any existing facilities at sites are not damaged by Contractor's activities.

(3) The Contractor shall be responsible for ensuring that any operations of existing gas facilities at Sites are not interrupted by Contractor's activities.

(4) The Contractor shall note that at many locations, new equipment is to be installed alongside existing equipment which is operational and must continue to operate during and after the installation.

(5) The Contractor shall be responsible for the temporary power generation at remote Sites where commercial power supply is not available.

(6) The Contractor shall carry regular inspection of Sites to ensure that installation of equipment and construction of associated facilities are in accordance with the specified requirements.

(7) The Engineer will carry out regular inspection of Sites to verify that installation of equipment and construction of associated facilities are in accordance with the specified requirements.

(8) The Contractor shall rectify any installation or construction work indentified by the Engineer that is not in accordance with the specified requirements.

5.4. Site Access and Cleanliness

(1) The Contractor shall set up the system for requesting access to Sites from the Engineer for all visits required to complete the Contract Works.

(2) Where the Contractor's staff are required to be accompanied by the Employer or the Engineer or the staff from another Operating Company, it shall be assumed that the normal hours of work that they will be available for shall be Sunday to Thursday 09:00 to 17:00 hours inclusive of travel time to the agreed working place.

(3) The Contractor shall ensure that Site is left in a clean, tidy and orderly state and all equipment, materials and tools are stored in the designated location and waste materials are removed on completion of a day of work or particular activity.

5.5. Hazardous Areas and Dangerous Substances

(1) The Contractor shall be responsible to follow the safety procedure and regulation of each Site operated by the Employer or other operating companies.

(2) No explosive or other dangerous substance shall be brought onto any Site or used for any purpose unless the Contractor obtain the written approval of the Engineer.

(3) The Contractor shall be responsible to ensure that the handling, storage and use of any dangerous substances follow the safe working procedures to ensure the Health and Safety of all personnel and property.

(4) The Contractor shall ensure, and give written details if so requested by the Engineer, that the materials used in the construction of the works, or those required for operation after take-over, do not in themselves or in any combination lead to the production of other dangerous substances, materials or conditions.

6. SCADA System

6.1. System Configuration Requirements

The SCADA System shall be based on a network of distributed processor and communication links with multi-level functional tasks incorporating:

(1) Master Control Center (MCC) at Demra as the main control center
(2) Auxiliary Control Center (ACC) at Ashuganj as the hot-standby control center
(3) WAN communication network
(4) Remote Terminal Units (RTUs)
(5) Operating Company Terminal (OCT)
(6) Interfaces to controlled and monitored equipment.

6.1.1. MCC

MCC shall be configured with the following system components as a minimum;

(1) 2 No. SCADA server (redundant application, OPC and ODBC compliant)
(2) 4 No. HMI workstations
(3) 1 No. pipeline application (leak detection and load balancing) console including necessary sub-systems and components
(4) 2 No. laser printers (1 no. color, 1 no. monochrome)
(5) 1 No. Large screen monitor (flat panel LCD monitor with LED backlight type, bigger than 50 inch)
(6) Ethernet LAN (redundant)
(7) Backup or data archiving system.

The SCADA System shall have capability to accommodate the other SCADA system prepared for new pipeline.

6.1.2. ACC

ACC shall be configured with the same equipment as MCC.

6.1.3. RTU

The RTU is a device that is required to be installed at each Site to collect data, code the data into a format that is transmittable and transmit the data to the MCC and the ACC. RTUs shall also collect information from the MCC and ACC and implement processes that are directed by the MCC and ACC. RTUs shall be equipped with input channels for sensing or metering, output channels for control, and a communication port.

88 RTUs shall be prepared as mentioned in RTU list (Appendix-3).

6.1.4. Operating Company Terminal

Operation data can be monitored at the following operating companies. These OCT shall be the same as the HMI workstations to be installed at MCC/ACC to monitor the whole GTCL pipeline network operation accessing to the SCADA server at MCC/ACC through communication backbone prepared by the Project.

Code	Site
20-CML-100T	Comilla Head Office
10-ASH-204T	BGFCL Head Office
10-HOR-300T	Horipur Head Office
30-PBG-500T	TITAS Head Office
10-JAL-600T	Jalalabad Head Office
30-PBG-700T	Petrobangla Head Office
20-FAU-701T	Sanghu Onshore Process Plant
20-FAU-702T	KGDCL Head Office
30-PBG-701T	Chevron Head Office

The following equipment shall be equipped as minimum:

(1) HMI: 1
(2) Color printer: 1
(3) UPS (30 minutes power supply during power failure): 1

The Employer plans to build a new head office. The following equipment shall be prepared for monitoring at the new head office.

(1) HMI workstation: 2

(2) Engineering workstation: 1

6.2. SCADA System Functional Requirements

6.2.1. General

The SCADA System shall be based on a standard SCADA system including hardware and software that must have been proven in use in one or more similar applications for at least 2 years, and which is a “Commercial Off-The-Shelf” (COTS) system. The application history shall include safety-critical systems.

All equipment to be provided for the SCADA System shall be provided with standard interfaces and open system software to communicate with RTUs and other subsystems, to enable system expansion and upgrade interconnection model or similar standard.

Monitoring and controlling the entire Pipeline System shall be a microprocessor based SCADA System with personal computer-based and/or work station based operator consoles configured with HMI software for operator interface.

The SCADA System CPU load shall occupy a maximum of 60% when all programs for the SCADA System are running simultaneously.

6.2.2. Data Acquisition and Control

The SCADA shall provide data acquisition and control facilities to communicate with RTUs using standard software drivers and shall not require any programming to implement. All configurations shall be permissible while the server is on-line without interruption to data acquisition and control on other channels.

The SCADA shall be capable of supporting communication links to networks of RTUs. Each connection shall operate independently of the others and facilities shall be provided by SCADA displays on the Operator Interface to individually place the channels in service or out of service.

Once a RTU is configured and placed in service, the SCADA shall automatically begin background diagnostic scanning of the device to ensure that communications are monitored

independently of any data acquisition scanning.

The SCADA shall support acquisition of data using either:

(1) Periodic Scanning (routine polling)

(2) Report by exception (user request, alarm initiated by RTU, for remote control)

In order to minimize communications traffic, the SCADA shall automatically combine data requests using contiguous addresses and the same scan interval to generate scan packets, optimizing throughput for a given scanning load. The SCADA shall also provide utilities to examine scan packet allocation for each scan interval and compile aggregate statistics on communication channel usage.

The SCADA system shall scan all RTU within less than 15 minutes.

6.2.3. Custom Graphic Display

Custom graphics shall be provided by the Contractor as part of the Detailed Design submission. The custom graphics shall include but not be limited to the following:

(1) Pipeline overview

(2) Schematics for each individual station, with process data and facilities status

(3) Trend graphics

(4) Alarms and events management

(5) Alarm annunciator and SDV operation graphic

(6) Control display for changing set points and control algorism

(7) Failure records and fault category.

6.2.4. Alarms and Event Management

The SCADA System shall provide a display and print alarm messages and eventsas alarm/event logging.

The SCADA System shall support comprehensive alarm management facilities to provide fast and accurate notification to the operating staff of abnormal and/or emergency conditions, and any failure of the SCADA hardware and software.

The alarm and event management system shall be established based on area codes, groups,

alarm/event types, alarm priorities, etc.

Actions such as status changes, setting and resetting of alarms, control operations and operator actions shall be logged as events in the historical database.

6.2.5. Historical Data

A historical database system shall record on hard disk the details of every event and alarm. Analogue data shall be logged to trend records.

Maximum, minimum, average and other statistical values shall be available for operator-definable time periods, to allow further analysis and reporting.

Database displays, including the derived statistics, shall be fully searchable, sortable and reportable, and pre-configured to provide trends and summaries of the data for specific purposes as well as user-configured reports.

All historical data shall be stored in a nominated primary location. After a configurable period of time data can either be moved to a secondary location for long-term storage and analysis or deleted if the data is no longer required. The primary location shall optionally be the local hard disk with the secondary location being a choice of local hard disk, floppy disk, recordable CD/DVD or network disk. The amount of time that archives can be maintained on the primary location before transferal to the secondary location shall only be limited by the size of the hard disk. The SCADA shall allow the user to define the specific intervals of history to be archived to avoid archiving of unnecessary data.

Hard disk storage capacity shall be adequate for the projected demands of the SCADA System. Its sizing shall be fully justified and based on worst case calculations.

The storage shall be capable as for each data type identified in the following table:

CLASS OF DATA	PERIOD	CURRENCY
Plant alarms	Immediate	Until cleared
Plant current values	Immediate	Up to 24 hours
Plant values short-term	Configurable logging period	Up to 40 days

history		
Plant values long-term history	Configurable logging period	Up to 3 months
Plant values archive	Configurable logging period	Indefinite
System alarms/events	Immediate	Until cleared
System parameters history	Configurable logging period	Up to 1 month

6.2.6. Simulation and Training Function

A simulation function shall be provided to assist the operator in checking the safety and feasibility of planned operations.

The function shall include the ability to check the validity of any planned operation and identify any situations where operating constraints may be exceeded.

The training simulator shall be provided for operator training of a wide range of operational scenarios, including emergencies.

At least one of the HMI workstations shall be prepared as the simulation/training console at the MCC.

6.2.7. System Security

The system shall incorporate initial security for all users accessing the system as a first layer of protection of the system from non-designated users.

The system shall support up to 6 levels of the system security providing proper degrees of access to system operation and system configuration works based on the following levels:

(1) Manager level
(2) Engineer level
(3) Supervisor level
(4) Senior operator level
(5) Operator level
(6) Viewer level.

Each operator shall be assigned a user password including single and multi-user passwords and any actions initiated by the operator shall be logged in the Database.

6.2.8. Data Validation

The SCADA System shall statistically check the data integrity of all data acquired from the field.

In the event that an invalid or timeout data or response be received, the data shall be ignored, and the system shall record the transition as an error and signal an alarm to the operator indicating the device or channel that is in error.

6.2.9. Report Generation

The SCADA System shall generate standard operation and maintenance reports including a system alarm log and maintenance alarm log, which will be automatically printed out on the network printers.

Custom operation reports shall be configured and generated including the following;

(1) Shift reports
(2) Daily reports
(3) Monthly reports
(4) Maintenance reports

6.2.10/ System Time Adjustment

A system time adjustment function shall be installed to ensure time accuracy and synchronization of all events and operations covering all the Sites.

6.2.11. Interface to Other System

Chevron, one of the natural gas production companies has its own SCADA system for their gas field operation. Chevron will prepare the web server to disclose their operation data at their own responsibility to GTCL. The SCADA System shall have the function of collecting the data from

Chevron's web server through the secured lease line.

6.2.12. Pipeline Operations Application Software

Pipeline operations application software shall be provided to support "on-line leak detection" and "load balancing and supply scheduling".

The application software shall be based around a real time dynamic model of the gas pipeline network covered by the Project which shall provide a kernel for any additional functionality required.

(1) On-line leak detection
The leak detection method used shall calculate and monitor the line pack, pressure profile and rate of change of pressure of the calculation points on the pipeline.

(2) Load balancing and supply scheduling
Application software shall be provided for load balancing and supply scheduling.
Load balancing software shall allow the monitoring of the gas pipeline network covered by the Project parameters and calculation of line pack and pressure to allow them to be maintained within agreed operational bands.
Supply scheduling shall allow the planning of gas production and consumption based on nominations to enable the requirements of producers and consumers to be met.
Load balancing and supply scheduling shall be carried out on at least an hourly basis.
The load balancing and scheduling software shall assist in the assessment of the effects of nominations in keeping the gas pipeline network covered by the Project in balance.

6.3. SCADA System Equipment Requirements

6.3.1. Server

The SCADA servers to be installed in the MCC and the ACC shall be provided to communicate with each RTU and be capable of performing the following tasks and functions:

(1) Real-time database handling
(2) Event database handling
(3) Ttrending

(4) Hhistorical data archiving
(5) Engineering tool
(6) Alarm management
(7) Reporting

All servers shall form part of a redundant pair arrangement and be equipped with full Human-Machine Interface activities.

The number of servers to be provided shall be such as will achieve maximum availability and reliability of operations, with no single point of failure.

6.3.2. HMI Workstations

The main operator interface of the SCADA System for control, monitoring and shutdown shall be a software application. The application shall operate on personal or desktop computers within local workstations. These workstations shall be 'clients' to the main system communication controllers or 'servers'.

The number of client operator stations shall be such as will be capable of fully controlling and monitoring all likely operating scenarios within the facilities.

6.3.3. Printers

High quality monochrome (black and white) laser printers and color laser printers, with a minimum throughput rate of 20 pages a minute, shall be provided for printing reports at the MCC and the ACC. Each printer shall be accessible from all workstations to provide flexible use of network printers connected to the LAN.

6.3.4. LAN

Interconnection within the SCADA System at the MCC and the ACC shall be supported by a redundant LAN, which shall conform to a recognized international open standard.

6.3.5. Large Screen Monitor

A flat panel large screen monitor which will give an overview of information to all personnel in the MCC and the ACC shall be provided.

The monitor shall have a picture size of no less than 50 inches diagonal with a screen aspect ratio chosen to accommodate both the video formats and graphics resolution selected.

6.3.6. UPS at Operating Company Terminal Site

UPS shall have the capacity of30 minutes power supply during power failure for proposed OCT equipment.

6.4. RTU Equipment Requirements

6.4.1. General

The RTU is a device that is required to be installed at each Site to collect data, code the data into a format that is transmittable and transmit the data to the MCC and the ACC. RTUs shall also collect information from the MCC and ACC and implement processes that are directed by the MCC and ACCS. RTUs shall be equipped with input channels for sensing or metering, output channels for control and a communication port.

RTUs shall be outdoor self-stand type data acquisition and control units, with IP65 enclosure. RTUs shall be installed under the existing sunshades at the Existing Sites and new sunshades shall be prepared by the Project at the Additional Sites for weather protection.

RTUs shall have the following attributes

(1) Backup batteries (24 hours)
(2) IS barrier and lightning protection
(3) Dew condensation prevention
(4) I/O interface,
(5) AGA report standard compatible
(6) Data links to other systems/packages using serial links
(7) Display monitor for process data monitoring at specified site (refer to Section 6.5.8)

(8) Data storage (at least 3 days) during server communication failure
(9) Electric outlet (AC 230V) for maintenance
(10) DC power supply unit for field instruments and radio equipment

6.4.2. Electric Power

The following types of power supply will be applied for RTUs. Applicable power supplies are referred to in the RTU List (Appendix-3).
(1) Existing AC 230V
(2) Replace of existing solar panel
(3) Preparation of new solar power system

All RTUs shall be provided with battery backup systems to supply emergency loads (RTU and radio equipment for communication network) for a period of 24 hours under the condition of loss of AC commercial power.

Detailed specifications for RTU electric power are indicated in Section 9 “Electrical Works Requirements”.

6.4.3. IS Barrier and Lightning Protection

All input signals shall be provided with IS barrier and lightning protection.

6.4.4. Dew Condensation Prevention

The Bangladesh climate during the season of high humidity and high ambient temperature can result in condensation occurring within the RTU. To mitigate this, condensation prevention shall be provided in the RTU.
For the solar powered RTU, condensation prevention may be ignored due to power supply condition.

6.4.5. I/O Interface

I/O interfacing function shall be provided for the RTUs according to the I/O List (Appendix-4).

The number of I/Os for each RTU shall be determined in accordance with the said I/O list and shall have a spare capacity of 25%.

6.4.6. AGA Report Standard Compatible

RTUs installed at orifice metering site and turbine metering site shall calculate the gas volume flow with the use of formula certified by the AGA gas report No.3 and No. 7 respectively.

The following parameters as a minimum for gas volume calculation can be inputted at MCC/ACC and the display mounted on the RTU.

(1) Orifice bore diameter
(2) Pipe bore diameter
(3) Specific gravity
(4) Bas pressure
(5) Base Temperature
(6) Mol% of CO_2
(7) Mol% of Nitrogen
(8) Bas Compressibility

6.4.7. Data Link to Other Systems Using Serial Links

The site “20-BKB-702, Bangura Gas Field” is operated by Tullow Bangladesh Company Ltd. Tullow uses a PLC (Allen-Bradley Model # Control Logic 5562) and HMI software for monitoring and control of this site.
The RTU shall have sufficient interface functionality to communicate with Tullow’s PLC.

6.4.8. Display Monitor for Process Data Monitoring

RTUs at the following sites shall be equipped with display to monitor the process data limited to

the site covered by each RTU respectively. The operator can input the parameters of gas volume calculation through these monitors and from HMI workstations at MCC/ACC.

Code	Site
10-ASH-400	Ashuganj
20-BKB-101	Kutombopur
20-FAU-100	Faujdarhat
20-MIR-401	Barakubundu TBS
30-PBG-401	CGS Aminbazar (out)
30-PBG-402	CGS Ashulia (out)
40-ELE-500	Elenga
40-MHD-500	Monohordi

6.4.9. Data Storage during Server Communication Failure

At each RTU to be installed in the Site, a database storage facility shall be provided to store all acquired data from field, control tuning data and other historical operating data of every 30 minutes as a minimum, for a period of 15 days.

The database of the RTU shall be configured according to the master database to be provided for the MCC and the ACC to enable recovery of missing data at the master database in the event of communication failure between the RTUs and the MCC and the ACC.

6.4.10. Electric Outlet for Maintenance

An AC 230V electric outlet shall be prepared in the RTU for maintenance except solar powered RTUs.

6.4.11. DC Power Supply Unit

The RTUs shall be equipped with 24 VDC power supply system for the field instruments to be designed based on the power load for power system sizing and distribution design.

6.4.12. RTU Maintenance Terminal

The Contractor shall provide four laptop computers suitable for the programming and interrogation of RTUs. These shall be capable of preparing and modifying sequence programs, editing RTU point and alarm configuration and displaying/retrieving historical data and current data from RTU.

The RTU maintenance terminal shall be suitable for use in the environmental conditions of temperature and humidity specified in the general equipment requirements for outdoor Bangladesh.

7. Communication System

7.1. System Configuration Requirements

7.1.1. General

(1) The Communication System shall be connected to the Master Telemetry Stations (20 stations), the Slave Telemetry Stations (81 + 7 upcoming stations), Operating Company Terminal (9 stations), Chevron's server at Chevron Head Office and MCC/ACC. The system shall be composed of the following links and systems:

1) Leased E1 circuits from service provider's network between MCC/ACC and Access Points (AP) of provider's network
2) IP radio link between AP and Master Telemetry Station (MTS)
3) IP radio link between MTS and OCT as well as Chevron's server
4) Telemetry radio link between the MTS and Slave Telemetry Station (STS)
5) IP PBX System

(2) The Communication System shall use IP/Ethernet signal transmission system and has enough capacity for data transmission increase in future.

(3) The Communication System is a closed network, however some port of the network will be connected to WAN. Therefore security measures shall be required.

(4) The Contractor shall be responsible for the following aspects for Communication System design:

1) Network design
2) IP radio path design
3) VoIP(IP PBX) configuration design

(5) The contract for the lease of E1 circuits from service provider's network shall be made between GTCL and the provider (BTCL is recommended). The Contractor shall be responsible to provide GTCL with technical assistance for their Contract agreement as well as necessary coordination during implementation of the Works. The configuration of leased E1 circuits is illustrated in Figure 7.1.

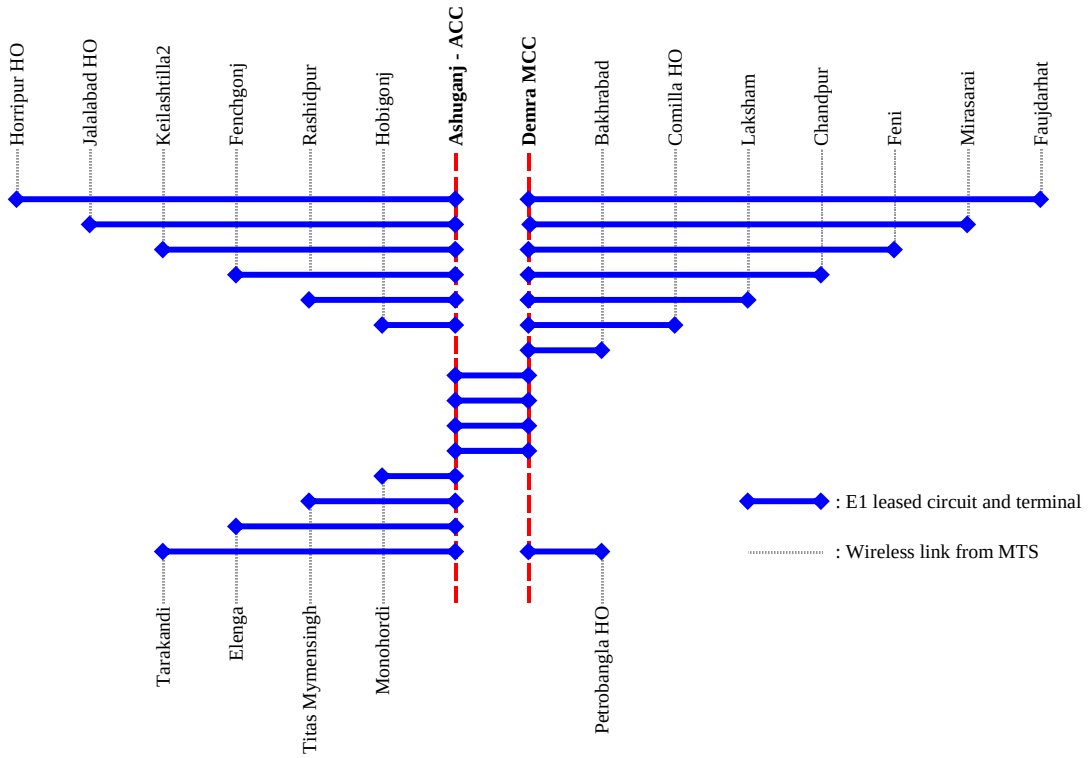
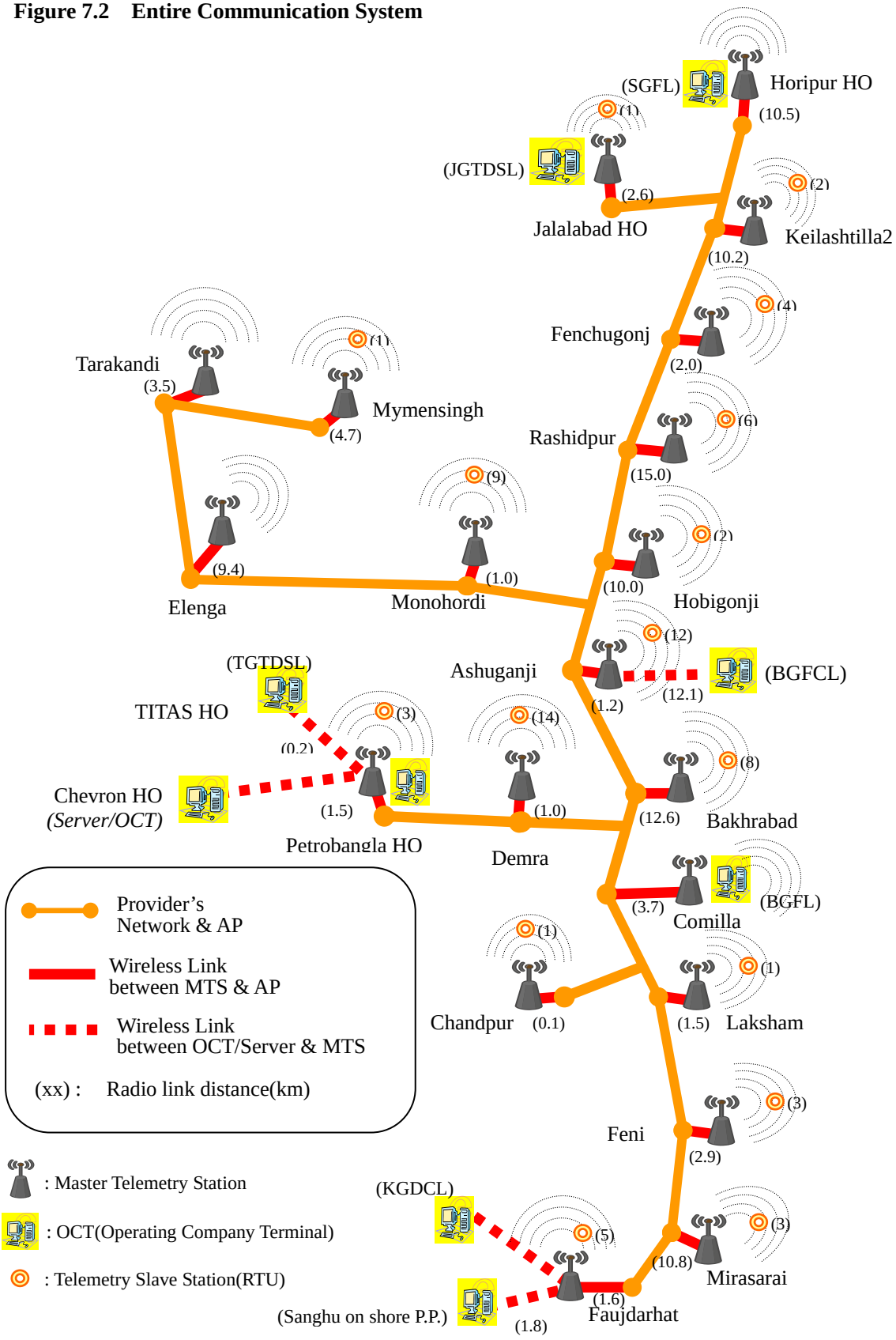


Figure 7.1 Leased E1 Circuits

The configuration of the entire Communication System is illustrated in Figure 7.2

Figure 7.2 Entire Communication System



7.1.2. System Configuration

7.1.2.1. MCC

MCC shall be configured with following system components:

(1) 2 No. IP radio equipment (1 No. IP radio shall be installed BTCL's AP)

(2) 1 No. Master Telemetry Radio equipment

(3) 10 No. VoIP Extension Telephone set

(4) 1 No. Router (installed at BTCL's AP)

(5) LAN material

(6) Spares for IP radio and Telemetry Radio Equipment

7.1.2.2. ACC

ACC shall be configured with following system components:

(1) 3 No. IP radio equipment (1 No. IP radio shall be installed BTCL's AP)

(2) 1 No. Master Telemetry Radio equipment

(3) 1 No. IP PBX Main unit

(4) 10 No. VoIP Extension Telephone set

(5) 1 No. Router (installed at BTCL's Access Point)

(6) LAN materials

(7) Spares for IP radio and Telemetry radio equipment

7.1.2.3. Master Telemetry Station (MTS)

MTS shall be configured with following system components:

For Petrobangla HO and Faujdarhat station

(1) 3 No. IP radio equipment (1 No. IP radio shall be installed at GTCL's Access Point)

(2) 1 No. Master Telemetry Radio equipment

(3) VoIP Extension Telephone set

(4) LAN Materials

For other stations

(1) 2 No. IP radio equipment (1 No. IP radio shall be installed at GTCL's Access Point)

(2) 1 No. Master Telemetry Radio equipment

(3) VoIP Extension Telephone set

(4) LAN Materials

7.1.2.4. Slave Telemetry Station (STS)

STS shall be configured with following system components.

(1) Slave Telemetry Radio Equipment

(2) Antenna Mast with Lightning Protection

The slave telemetry radio equipment shall be installed inside of the RTU enclosure. 75 RTUs shall be equipped with the slave telemetry radio equipment, as shown in the RTU list (Appendix-3).

Antenna masts with lightning protection shall be provided at Additional/Future Sites as shown in the said RTU list.

7.1.2.5. Operating Company Terminal (OCT)

A Communication System shall be required for the following 5 Operating Company Terminals that are located apart from Master Telemetry Station.

Code	Site Name
10-ASH-204T	BGFCL Head Office
30-PBG-500T	TITAS Head Office
20-FAU-701T	Sanghu Onshore Process Plant
20-FAU-702T	KGDCL Head Office
30-PBG-701T	Chevron Head Office

The Communication System shall be configured with following system components:

(1) 1 No. IP radio equipment

(2) 1 No. VoIP Extension Telephone set

(3) LAN materials

7.1.2.6. Chevron's Server at Chevron Head Office

Communication link for the OCT at Chevron Head Office described in Section 7.1.2.5. above shall be used also to interface with Chevron's server at Chevron head office to collect their process data.

7.2. Communication System Equipment Requirements

7.2.1. IP Radio Equipment

(1) The IP radio equipment shall be operated with a 2.4/5.2 GHz non-licenses band. The frequency band shall be selected in accordance with the radio link distance and the required

transmission capacity. However it is preferable that all radio links use the same frequency band for easy maintenance.

(2) The IP radio link shall have 1+1 standby protection.

(3) The antenna size (gain) for the radio link shall have suitable size (gain) to keep the radio link reliability.

(4) The IP radio link shall have security measures for protection from serpents.

(5) At the BTCL's AP, the media converter (E1 to/from IP) shall be installed.

(6) For maintenance purposes, an amount of spare equipment shall be supplied to MCC and ACC. Quantities shall be stated by the Contractor, considering the Equipment MTBF (Mean Time Between Failure).

(7) The IP radio equipment to be installed at MCC/ACC/OCT shall be operated with 230V AC, and the IP radio equipment to be installed at the other stations shall be operated with 24V DC negative ground. If equipment operated by different voltage is adopted, adequate power supply adapter shall be supplied.

(8) The IP radio consists of IDU (Indoor Unit) and ODU (Outdoor Unit). The primary power for the ODU shall be supplied through the cable connected between IDU and ODU.

(9) The IP radio equipment (IDU) shall be installed in the existing 19-inch rack at the existing radio room.

(10) The IP radio equipment shall have the visual indications and terminals for monitoring of the equipment conditions such as operating/fault etc.

(11) The Contractor shall submit the radio path calculation sheets describe following items, but not be limited to:

1) Path profiles for each link
2) Required output power, receiving level, threshold margin, antenna gain, antenna height
3) Transmission speed at normal receiving level
4) Link reliability

IP radio equipment specifications

(1)	Frequency band	:	2.4/5.2 GHz, non-licensed band
(2)	Output power	:	15 dBm maximum
(3)	Modulation method	:	OFDM
(4)	Interface	:	Ethernet (10base-T/100Base-TX)
(5)	Transmission speed	:	12 Mb/s minimum
(6)	Power supply & power consumption	:	24V DC, 10 W or less
(7)	Power feeding of ODU	:	through signal cable connecting ODU and IDU
(8)	Mechanical configuration	:	ODU+IDU
(9)	Antenna size/gain	:	to be designed by the Contractor

7.2.2. Telemetry Radio Equipment

(1) The telemetry radio equipment shall be operated in 400 MHz band.

(2) The master telemetry radio equipment shall have 1+1 standby protection.

(3) The master/slave telemetry radio equipment shall have IP/Ethernet interface port.

(4) To reduce the power consumption, the transmitter output power shall be adjusted depending on the radio link distance.

(5) The rise up time for the transmitter of slave telemetry radio equipment shall be as short as possible for the polling operation method. The contractor shall state the rise up time, and also state whether the master station transmitter can operates intermittently.

(6) As distances of some links between MTS and STS are over 30 km, the Contractor shall select suitable antenna sizes for STS and suitable antenna heights for MTS.

(7) The telemetry radio equipment to be installed at MCC/ACC shall be operated with AC 230V AC. The telemetry radio equipment to be installed at the other stations shall be operated with 24V DC negative ground. If the equipment operated with different voltage is adopted, adequate power supply adapter shall be supplied.

(8) The power consumption of radio equipment shall be as small as possible. The contractor shall state the power consumption of the base/slave radio equipment.

(9) The master telemetry radio equipment shall be installed in the existing 19-inch rack at the existing radio room.

(10) An antenna mast with lightning protection for the slave telemetry radio equipment as well as for RTUs shall be provided. The Contractor shall decide its height in accordance with the radio path calculation.

(11) The Contractor shall submit the radio path calculation sheet for the following 4 links:

1) Jalalabad H.O (MTS) – Devpur DRS (4.5 km)
2) Rashidpur (MTS) - VS M (11.2 km)
3) Mirasarai (MTS) – Semutang Gas Field (21.5 km)
4) Monohordi (MTS) - Joydepur CGS (32.9 km)

The calculation sheets shall include the following items, but not be limited to:

1) Path profiles
2) Required output power, receiving level, threshold margin, antenna gain, antenna height
3) Transmission speed at normal receiving level
4) Link reliability

(12) Telemetry scanning method

1) Each transmitter of master telemetry radio equipment shall be continuously operated to enable the telemetry system to sequentially address the STSs.

2) The slave telemetry radio equipment receives its own address, and the transmitter of master telemetry radio equipment shall be enabled to send data from RTU to the SCADA System.
3) Each transmitter of slave telemetry radio equipment shall be activated only when the slave telemetry radio equipment is addressed.

Telemetry radio equipment specifications

(1)	Operating frequency band	:	400 MHz band
(2)	Operation mode	:	Simplex, half-duplex
(3)	Protection	:	1+1 Standby protection (Master)
		:	1+0 standby protection (Slave)
(4)	Output power	:	5W max.
(5)	Modulation method	:	Digital, CPFSK
(6)	Interface	:	Ethernet (10Base-T/100Base-TX)
(7)	Transmission speed	:	4.8 kb/s minimum
(8)	Power supply & power consumption	:	24V, 40W or less (continuous operation TX/RX), 2W or less (RX only)
(9)	Transmitter rise up time	:	5 ms typical, (the contractor shall design the rise up time of the transmitter to be offered)
(10)	Antenna size/gain	:	Omni-directional at master, directional at slave station. The gain of antennae shall be designed by the Contractor.
(11)	Antenna mast at Additional Sites		
	1) Height, strength and material	:	to be designed by the Contractor
	2) Foundation	:	to be designed and constructed by the Contractor
	3) Lightning system	:	Lightning rod shall connect to RTU's earthing system.

The configuration of telemetry radio link is illustrated in Figure 7.3.

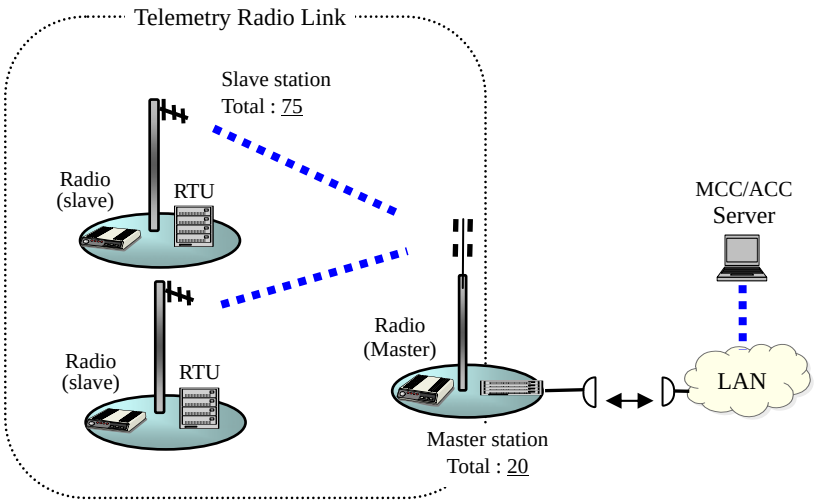


Figure 7.3. Telemetry Radio Link

7.2.3. Telephone System

The telephone system shall employ VoIP technology and shall provide voice communication through the network.

The telephone system shall consist of IP PBX, extension telephone sets and associated cabling in the buildings of the master telemetry stations and in the MCC/ACC room. At ACC, uninterrupted power supply (UPS) is available, so a standby power supply system for IP PBX is not required. The telephone system configuration is shown in Figure 7.4.

7.2.3.1. IP PBX Equipment

(1) The IP PBX shall be located at the ACC Ashuganj.

(2) Access to the public switched telephone network (PSTN) shall be provided at ACC.

(3) The capacity of IP PBX shall be as follows:

1) PSTN line : 6 lines
2) Extension line : 81 lines (maximum capacity shall be 512 lines)
3) Trunk line : 5 lines (in future, partner PBX will be installed at GTCL new Head Office which is currently being planned for future construction.)

(4) The IP PBX shall be modular construction and designed to have 100% expansion

capability.

(5) The IP PBX shall be non blocking digital switches, operating under stored program control.

(6) All common control equipment shall be duplicated.

(7) PSTN connection

1) In the case where the PSNT connection is a digital circuit, the interface condition shall be compliant with relevant ITU-T Rec. and other regulations.

2) The IP PBX shall have facilities to restrict dialing access from any telephone extension to the PSTN.

3) Access to the PSTN shall be done through direct dialing where configured, and shall be permitted to the selected extension lines.

(8) Supervisory function

1) A supervisory system shall be provided for IP PBX that allows the performance to be analyzed as well as providing configuration facilities and fault information and diagnostics.

2) The IP PBX shall prepare, store and collate information on call logging, traffic analysis and fault analysis. A hard copy printout shall be available at IP PBX installation on dedicated printers.

(9) The exact quantities and locations of the VoIP extension telephone set are shown in Figure 7.4.

IP PBX equipment specifications

(1)	Outside lines	: 16 minimum
(2)	Extension lines	: 512 maximum
(3)	Applications	: to be designed by the Contractor (Voice mail, Automated call, Distribution, Group hunting etc.)
(4)	Power supply	: AC 230V, single phase
(5)	Backup battery	: Not required
(6)	Mechanical construction	: to be equipped on 19 inches rack, the Contractor shall design the height of the rack.

Extension Telephone set specifications

(1)	Operation	: VoIP on LAN
(2)	Interface	: RJ-45 (10Base-T/100Base-TX)
(3)	Line key	: 6 lines maximum
(4)	Speaker phone	: required
(5)	Display	: LED's display
(6)	Applications	: to be designed by the Contractor

(7) Power supply : AC 230V, power adapter shall be provided

7.2.3.2. Telephone cabling

The contractor shall be responsible for the installation of telephones and associated cabling inside of the room at MCC/ACC and also inside the radio building at MTS. The telephone cabling shall be made of Ethernet cable.

7.2.3.3. Maintenance PC

The PC for the maintenance purpose shall be supplied. It shall be able to interface with IP PBX in order to upgrade or renew the programs installed in IP PBX memory.

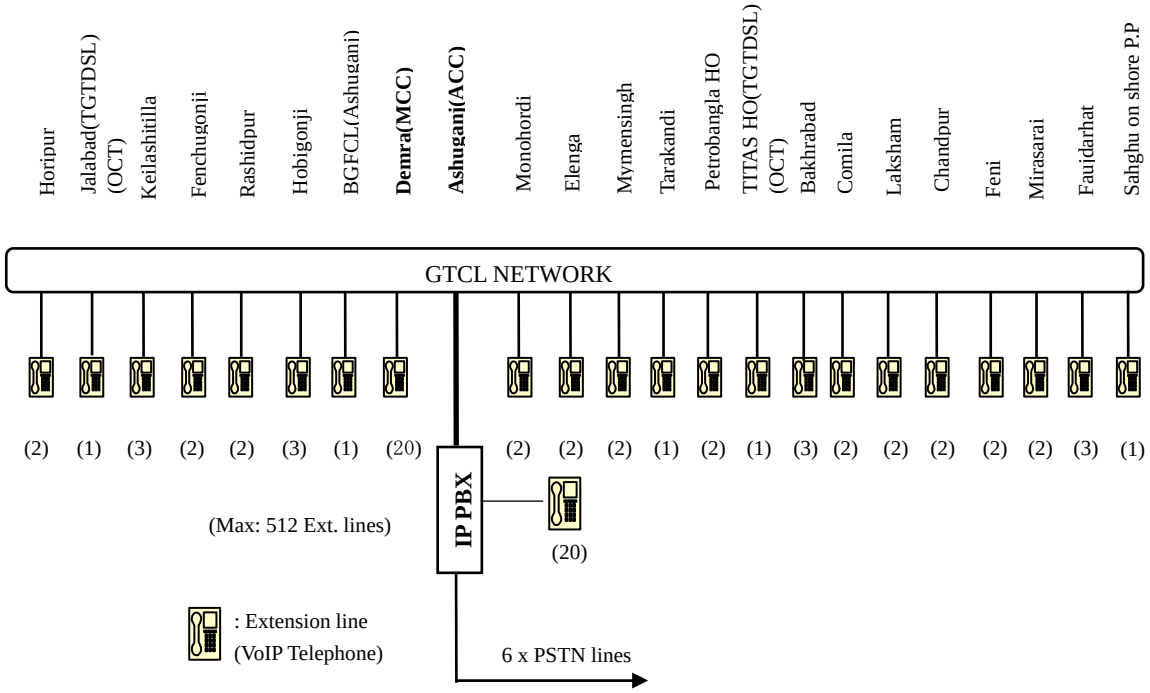


Figure 7.4 IP PBX System

7.2.4. Network system

7.2.4.1. Media converter

(1) A media converter (IP/Ethernet to/from E1) shall be installed at BTCL's AP.

(2) The media converter shall be operated with 24V DC negative ground. If the equipment operated with different voltage is adopted, a DC/DC converter shall be supplied.

(3) A Router or HUB which converts IP/Ethernet to/from E1 can be offered.

Media converter specifications

(1)	Converting signal protocol	: IP/Ethernet to/from E1(2Mb/s)
(2)	Number of required port	: For MCC's AP
		3 nos. IP/Ethernet: 12 nos. E1 Min.
		: For ACC's AP
		3 nos. IP/Ethernet: 14 nos. E1 Min.
		: For other 18 AP
		1 no. IP/Ethernet: 1 no. E1 Min.
(3)	E1 signal format	: HDB-3
(4)	Interface connector	: RJ-45 for IP/Ethernet side
		BNC-R for E1 side
(5)	Power supply	: 24V DC negative ground
(6)	Power consumption	: to be designed by the Contractor
(7)	Mechanical construction	: to be installed on a 19-inch rack

7.2.4.2. HUB/Router

(1) To connect with the branching network, a HUB or Router shall be provided to each MTS and MCC/ACC.

(2) The Contractor shall select an adequate branching device from the HUB or Router to get the best performance of the network.

(3) The HUB/Router to be installed at MCC/ACC shall be operated with 230V AC. The HUB/Router to be installed at the other stations shall be operated with 24V DC negative ground. If the equipment operated with different voltage is adopted, an adequate power supply adapter shall be supplied.

HUB specifications

(1)	Number of port	: 5 minimum
(2)	LAN interface	: 10Base-T, 100Base-TX, 1000Bae-T
(3)	Switching data transfer method	: Store and forward
(4)	Access method	: CSMA/CD
(5)	Address table	: MAC address, 1,000 (min) address, self learning
(6)	Interface connector	: RJ-45
(7)	Power supply	: 24V DC, negative ground
(8)	Power consumption	to be designed by the Contractor

Router specifications

For WAN side

(1)	Number of port	: 1 minimum
(2)	WAN interface	: 10Base-T, 100Base-TX
(3)	Access Method	: CSMA/CD
(4)	Interface connector	: RJ-45
(5)	Transmission speed	: 10 Mb/s, 100Mb/s, auto sense
(6)	IP Address acquisition	: Manual/DHCP/PPPoE/IPUnnumberd

For LAN side

(7)	Number of port	: 4 minimum
(8)	Switching data transfer method	: Store and forward
(9)	Address table	: MAC address, 1,024 (min) address, self learning
(10)	Interface connector	: RJ-45

Router function

(11)	Number of registry of packet filter	: 32 minimum
(12)	Number of registry interchangeable address (port)	: 20 minimum
(13)	Number of IP masquerading session	: 800 minimum
(14)	Number of registry routing table	: 20 minimum
(15)	Number of MAC address filtering	: 32 minimum
(16)	Number of Subnet	: /24 - /30
(17)	Power supply	: 24V DC, negative ground
(18)	Power consumption	: to be designed by the Contractor

7.2.4.3. Monitor PC for Network Monitoring System (NMS)

The PC with software for NMS shall be provided at MCC and ACC.

Monitor PC for NMS specifications

(1)	Type of PC	: Laptop type
(2)	Display size	: 15 inches or more
(3)	OS	: Windows 7 or latest version
(4)	CPU	: Core_2_Duo, mobile processor or better
(5)	HD capacity	: 500GB or more
(6)	Media Drive	: Built-in, CD/DVD

7.2.4.3. LAN Cable

The Contractor shall provide the LAN cable with category-5 or higher category cable for 10Base-T, or 100Base-TX for LAN cabling.

The equipment composition of each station is illustrated in Figure 7.5.

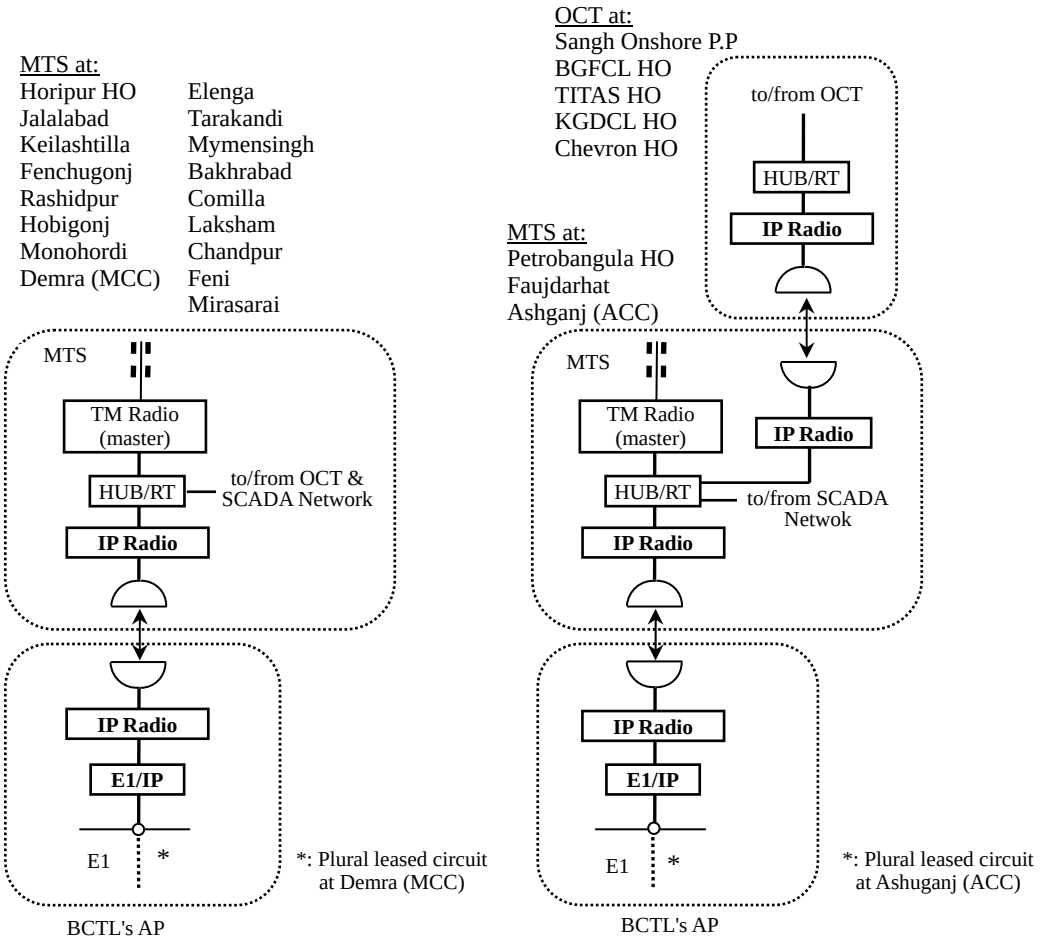


Figure 7.5 Equipment Composition of Each Station

8. Instrumentation Requirements

The Contractor shall design, supply and install the following instruments:

(1) Pressure Transmitter (PT): 71

(2) Temperature Transmitter (TT): 58

(3) Differential Pressure Transmitter (PdT): 82

(4) Limit switch for valve status monitoring: 11

Instrument installation sites are shown in the RTU List (Appendix-3).

In addition to the above, the following instruments shall be supplied for spares of existing instruments.

(1) Pressure Transmitter (PT): 15

(2) Temperature Transmitter (TT): 15

(3) Differential Pressure Transmitter(PdT): 20

8.1. General

All electronic instruments requiring separate power supply, shall generally operate on 24V DC.

Electronic transmitters shall generally be two-wire type. These shall have transmission/output signal of 4-20 mA DC and shall be capable of delivering rated current into external load of at least 600 ohm when powered with 24 V DC nominal voltages.

8.2. Pressure Transmitters

The Contractor shall verify the process connection for pressure instruments at the sites. As a reference, process connections for pressure instruments are normally 1/2” NPT.

At some sites, the Contractor shall make a branch on the existing impulse tubing as a tapping point for pressure instruments. The Contractor shall survey the installation condition, make hook-up drawings and install the pressure transmitters.

Pressure transmitters shall be electronic SMART type, two wire, loop powered at 24VDC with 4-20 mA output and an integral digital indicator meter in both MKS and FPS engineering units.

Transmitters shall have HART protocol for digital communication.

Material for construction for wetted parts shall be SS 316L as a minimum, except where process conditions require more stringent materials. Materials for construction shall be suitable for the process media and based upon the piping specification.

Pressure transmitters shall have minimum accuracy ± 0.075% of the calibrated span. Transmitters shall have independent external screws for zero and span adjustment.

8.3. Temperature Transmitters

Thermo Wells

Temperature measuring instruments shall be provided with thermo well. The boss on the pipeline as a process connection for thermo well will be prepared by the Employer. The Contractor shall verify the information of process connection and design suitable thermo well.

Thermo wells shall be constructed from one-piece bar stock, and machined to get a smooth and tapered profile with no sharp edges. All insertion type temperature instruments and indicators shall be provided with a thermo well. The thermo well immersion depth in the pipe shall be between one-third and two-thirds of the internal diameter of the pipe.

Temperature Transmitter

Resistance temperature detectors (RTDs) shall be used for centralized and multi-point indication. The RTDs shall be grade II, Platinum 100 ohms at 0 °C (32 °F).
A detector with head mounted transmitters shall be used. The 4-20 mA output signal must be directly proportional and linear to temperature.

8.4. Limit Switch

Limit switches for open/close valve position indication shall be of proximity type. The switch enclosure shall be copper free cast aluminum, weather proof (NEMA 4X) and it shall be intrinsically safe.

8.5. Pick up Signal from the Existing Turbine Meter

The Contractor shall supply and install a dual pulse output pickup head in place of the single pulse output pickup in the existing turbine flow meter sensor head at sites specified in Site Information & Scope of Work (Appendix-2). The output signal from the existing turbine flow meter shall be cabled via junction box to RTU.

8.6. Tubing System

Stainless steel ANSI 316 tubing and fittings shall be used for the instrument gas supply distribution system. Double compression fittings shall be used. Pneumatic devices shall be stainless steel. Tubing shall be protected so that no galvanic corrosion will occur.

The tubing system shall be capable of continuously withstanding the design pressure and temperature.

All materials for pressure lead pipe including valves, regulators and accessories, shall be stainless steel. Pressure lead pipes and fittings shall be 316 SS with double compression fittings.

8.7. Junction Box

Junction boxes shall be of intrinsically safe types. Material for construction of junction boxes shall be LM-6 cast aluminum.

Terminals shall be vibration proof, clip-on types mounted on nickel-plated steel rails complete with end covers and clamps for each row. All terminals shall be suitable for accepting a minimum 2.5 mm^2 copper conductor in general. Sizing shall be done with due consideration for accessibility and maintenance.

Plugs shall be of Nickel plated brass.

Cable glands shall be double compression type for use with armored cables. They shall be made of Nickel plated brass. All cable glands shall be provided with rubber cable hood. All cable glands shall be supplied to suit the cable dimensions. Various components like rubber rings, metallic rings, metallic cones and the outer/inner nuts, etc. shall be capable of being adjusted according to the

cable tolerances.

8.8. Instrument Cabling

Cables for instruments are referred to in Section 9.3.7 and 9.3.8.

8.8.1. Serial Link or Control Bus Cable

Shielded Twisted Pair (STP) cables, RS 232 for serial link, RS 485 or IEC 1158-2 for control bus. The cables shall have mechanical protection, be isolated from electromagnetic interference and be routed separately from power cables.

8.9. Cable Glands

The Contractor shall supply all cable glands required for glanding the above mentioned cables both at field instrument and local control panel locations, junction box locations and at control room locations.

All cables glands shall be made of nickel-plated brass and they shall be double compression type suitable for armored cables.

Flameproof glands shall be supplied wherever required with EXd certification.

9. Electrical Works Requirements

9.1. General

The Contractor shall design and provide AC power and backup power supply for the New SCADA System and New Communication System equipment. The existing rated power supply is 230V single phase 2 wire, 50 Hz.

9.2. Power Supply from Existing/New Power Source

9.2.1. MCC and ACC

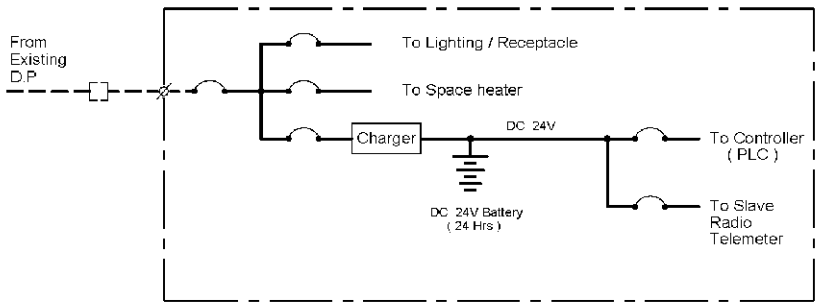
The Contractor shall install a UPS at each site to provide 8 hours backed-up power supply for the New SCADA and Communication Systems, and 4 hours backed-up power supply for building emergency lighting in the event of a failure or outage of the incoming main AC power. The capacity of the respective UPSs shall be of 15 kVA.

At least one distribution board shall be provided for all the equipment provided at MCC and ACC respectively, all cabling including conduit/raceway from existing distribution board to the distribution board, and all cabling from the distribution board to each piece of equipment shall be designed and installed by the Contractor.

9.2.2. RTUs

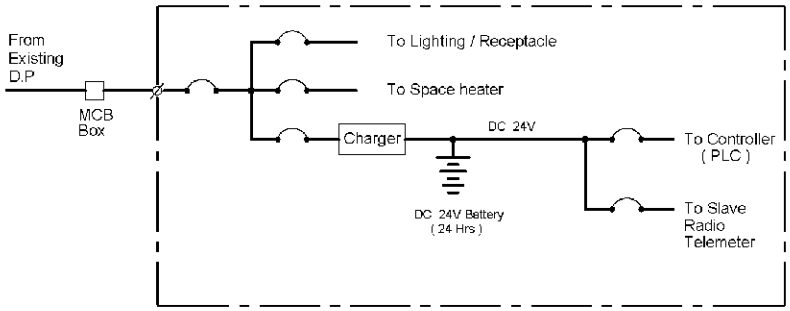
(1) Existing RTU

All Existing RTUs that are currently installed at Original Sites shall be replaced with New RTUs. At the Original Sites, complete RTU set including the battery shall be replaced by the New RTU. However, the existing primary power supply feeder (single phase AC 230V) is to be used.



(2) New RTU

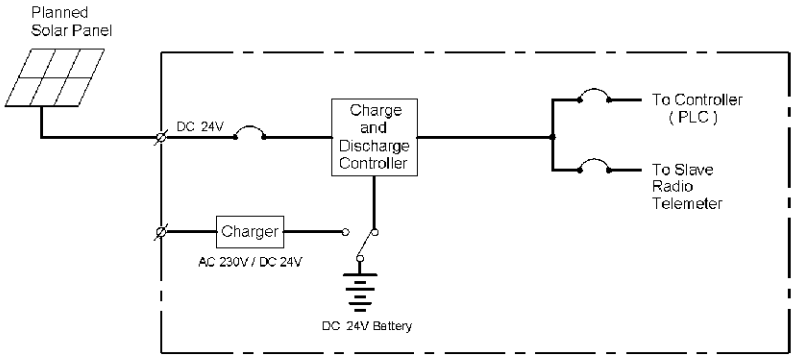
Currently no RTUs are installed at the Additional Sites. New RTU and a new primary AC power supply for the New RTU shall be provided. The Contractor shall install one MCB (Molded Case Circuit Breaker) Box adjacent to an existing distribution board and the primary cable of MCB Box shall be connected to the existing distribution board by using existing spare breaker/fuse. The secondary cable from MCB Box to the New RTU shall be installed.



(3) Non Powered Sites

1) Existing Non Powered Sites

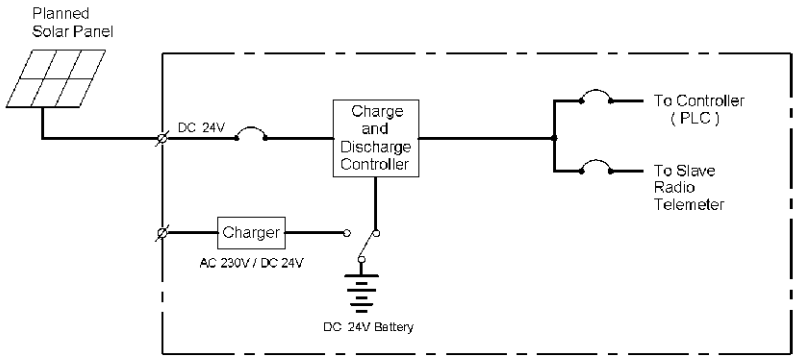
Currently there is no AC power supply at the smaller Original Sites, and solar panels are installed to feed electric power to the Existing RTUs. The existing solar panels shall be replaced with new solar panels for the New RTUs, and cabling from the solar panel to the New RTU, and the solar controller shall be replaced by new ones.



2) Non Powered Additional Sites

A solor driven power supply shall be provided for the New RTUs at the Additional Sites where AC power is not available.

Solar panels shall be installed on the roof of RTU shed, and cabling from the solar panel to the New RTU shall be installed. The Contractor shall provide a solar controller, charging unit and all required devices.



3) Battery provided with New RTU

In the event of the battery voltage drops below a certain level, a signal shall be sent to MCC and ACC to protect batteries against over discharge.

9.2.3. UPS for the Operating Company Terminal

The Contractor shall install a UPS at the Operating Company to provide 30 minutes of power supply for the equipment in the event of a failure of the incoming main AC power.

9.2.4. Communications Equipment

(1) Slave Telemetry Radio Equipment

The slave telemetry radio equipment installed in the RTU shall be powered from the backup battery installed in the RTU.

(2) Master Telemetry Stations

The Contractor shall provide a backup battery (48V) for the communication equipment installed in the Master Telemetry Stations. In addition to the above backup battery, an emergency generator shall be provided at the following Mater Telemetry Stations:

1) Monohordi
2) Eleng
3) Mirasara
4) Feni
5) Laksham
6) Chandpur

The generator shall be of manual start/stop, 3 phase 4 wire, 400/230 V and output capacity of the generator shall be 15 kVA.

9.3. Technical Specifications

9.3.1. Uninterruptible Power Supply (UPS) for MCC and ACC

(1) General

The UPS shall be manufactured in accordance with IEC 439 and BS 800 or equivalent standards. The capacity of each UPS shall be designed by the Contractor based on the proposed equipment's power consumption.

(2) Components of UPS

The UPS shall comprise the following major components:

1) Battery charger
2) Static inverter
3) Bypass switch
4) Battery
5) Status monitoring panel

(3) Rating

Output

Nominal Output Voltage : AC 230V

Input

Input Voltage : Single Phase AC 230V or 3 Phase 4 wire 400/230 V

Capacity : min. 15kVA

(4) Battery Charger

1) The battery charger shall be automatic solid state type, capable of rated output with an input voltage tolerance of +10% to -l5% and input frequency ±l0%.
2) The battery charger shall be capable of automatic recharge, equalizing and floating operations to suit the battery type.

(5) Static Inverter

1) The inverter shall be static type, capable of supplying full load, continuously with overload capability, performance characteristics shown below are for 0 to 100% load at 80% power factor, and for input variations from battery discharged value to charger maximum output value:
   - ±2% voltage steady rated
   - ±1 Hz frequency when operating on internal frequency
   - Wave shape: Less than 5% harmonic distortion for all possible operating conditions.

(6) Bypass Switch

1) A static bypass switch shall provide no-break transfer of AC loads from the inverter to the alternative supply and back to the inverter, and have performance characteristics equal to those of the inverter.
2) A manual bypass shall be provided and be mounted in the same cubicle/section as the static switch to allow manual transfer in the event of maintenance or failure of equipment.

(7) Batteries

1) Maintenance free sealed lead acid batteries shall be employed and the guaranteed life of battery shall be a minimum of 10 years.
2) The battery capacity shall be 20% in excess of what is required to achieve the specified emergency discharge duty.
3) The battery back-up power supply duration is 8 hours for SCADA and Communication Systems, and 4 hours for building emergency lighting.

9.3.2. Backup Battery

(1) General

1) The Contractor shall provide a battery backup for the New RTUs and Master Telemetry Stations.
2) The backup duration of the batteries for the RTU and Master Telemetry Stations is 24 hours and 48 hours, respectively. The Contractor shall design the capacity (kVA) of the batteries based on the power consumption of the relevant equipment.
3) The batteries for the RTUs shall be housed in RTUs however the batteries for the Master Telemetry Stations shall be mounted on a steel rack. The steel rack shall be painted to resist the corrosive properties of the electrolyte.
4) Batteries and chargers shall be complete with control panels. The battery charger panel shall incorporate an input switch and an output switch to allow the charger to be readily isolated for maintenance.

(2) Batteries

1) Maintenance free sealed lead acid batteries shall be used and the guaranteed life of each battery shall be a minimum of 10 years.
2) The battery capacity shall be 20% in excess of what is required to achieve the specified emergency discharge duty.

(3) Battery Charger

1) The charger shall be suitable for supplying the initial charging requirements, boost charging a battery subsequent to an emergency discharge, supplying the maximum DC load whilst float charging both batteries and providing 20% spare capacity.
2) DC out put shall be suitable for DC 24/48V nominal load voltage with float and boost charging.
3) A changing over switch for float/boost charging shall be provided.
4) The charger shall be provided with protection devices such as over-voltage and under-voltage cut relays to protect the equipment against fluctuation in voltage.

9.3.3. Solar Panel with Battery

At sites where no AC 230V power is available, the Contractor shall provide solar power supplies consisting of solar panels, a charging and discharging controller and batteries. The specifications for the batteries are referred to in Section 9.3.2.

(1) Solar Panels

1) General

Solar panels are to be installed in a very limited space (on the roof of the RTU shed). The Contractor shall design a solar panel that has the smallest solar panel footprint.

2) The solar panel shall be of a durable construction and designed for use in a tropical environment.

3) The Contractor shall design the exact number of solar panels required based on the solar radiation of Bangladesh and required power consumption of the equipment in the RTU to keep continuous operation of the RTU. Regarding tentative battery capacity, 24 hours as specified, the Contractor shall review the specified capacity based on the solar panel output and power consumption, and all calculation data shall be submitted to the Engineer prior to install the equipment.

(2) Charge and Discharge Controller

A charging and discharging controller together with overcharging protection, and a low voltage disconnector to protect the battery from over discharge shall be provided. This controller shall be equipped with back-flow (battery to solar panel) prevention device.

The charging and discharging controller shall be provided with an AC 230V input terminal for boost charge of the battery. The boost charge will be carried out by using a potable type AC 230 V generator.

9.3.4. UPS for Computers installed at the Operating Company

The Contractor shall provide the UPS for the HMI installed in the Operating Company.

The capacity of the battery shall be calculated by the Contractor based on the electrical demand of the HMI.

(1) Output

Nominal Output Voltage	: AC 230V
Output Voltage Distortion	: Less than 5% at full load
Output Frequency	: 47 Hz – 53 Hz

(2) Input

Input Voltage	: Single Phase AC 230V ±20%
Input Frequency	: 50 Hz ± 3 Hz
Serge Protection	: to be provided

(3) Capacity : min. 30 minutes operation of HMI in the event failure/outage of the incoming mains supply

(4) Battery : Maintenance free sealed Lead-Acid battery

(5) Unattended shutdown

Provision of an unattended shutdown device for HMI.

A software interface shall provide automatic, unattended shutdown when the battery voltage drops below a certain level.

9.3.5. Emergency Generator

Frequency	: 50 Hz
Out put	: 15 kVA
Rated Voltage	: 400/230 V, 3 phase 4 wire
Power Factor	: 0.8 (lagging)
Voltage Regulation	: ±2% of nominal from no-load to full load
Excitation	: Brushless, Rotating Exciter (with AVR)
Engine	: Diesel engine including all required accessories.

9.3.6. Portable Generator for Maintenance

A portable generator shall be provided for maintenance of the battery for the RTUs located where AC power is not available.

Frequency	: 50Hz
Output	: 1kVA
Rated Voltage	: 230V single phase

7 sets of generators shall be provided and will be kept at the Master Telemetry Stations monitoring RTUs without AC power supply.

9.3.7. MCB Box

The Contractor shall provide a MCB Box for feeding AC 230V to the New RTU.

Rated MCB	: Molded Case Circuit Breaker 2 pole 50 AF/ 20 AT
Box	: The MCB shall be installed in an IP55 enclosure

9.3.8. Cables

(1) General

The cables shall be made of flame retardant cable and shall have stranded copper conductors with minimum cross section area shall be as follows:

1) Power Cable : 2.5 mm^2
2) Control Cable : 1.5 mm^2

(2) Power Cable/Control Cable

0.6/1kV XLPE/PVC/SWA/PVC flame retardant cable

Conductor	: copper
Insulation	: XLPE
Armour	: Galvanized steel wire
Outer Sheath	: Blue colored PVC, compound having flame retardant properties as per IEC 60332-3 Category A
Cable Identification	: 3 cores Red, Yellow, Blue

(3) Control Cables (Screened Pair Cable)

0.6/1kV XLPE/PE/SWA/PVC-SLA, overall screened flame retardant cable (control cable)

Conductor	: copper
Insulation	: XLPE
Screen	: Laminated aluminum polyester tape with tinned copper drain wire of 0.5 mm^2
Armour	: Galvanized steel wire
Outer Sheath	: Blue colored PVC, compound having flame retardant properties as per IEC 60332-3 Category A
Cable Identification	: 1 pair - Red, Black

(4) Control Cables (Multi Screened Pair Cable)

0.6/1kV XLPE/PVC/PSLA/PE/SWA/PVC (control cable), individual pair screened flame retardant cable

Conductor	: copper
Insulation	: XLPE
Screen	: Laminated aluminum polyester tape with tinned copper drain wire of 0.5mm^2
Armour	: Galvanized steel wire
Outer Sheath	: Blue colored PVC, compound having flame retardant properties

as per IEC 60332-3 Category A

Cable Identification : Manufacturer's standard

9.3.9. Cable Laying and Cable support

(1) Cables laid directly in the ground shall have the following depth of cover:

Power cable :500 mm

Control cable : 500 mm

Cable markers shall be provided to indicate where cables have been laid.

(2) Cable Tray

1) All tray work and accessories shall be heavy duty and sized to provide 25% additional free space.
2) The minimum clearance behind the tray shall be sufficient to allow for fixing of cables, which shall relate to tray width, but shall not be less than 25 mm.
3) The galvanized cable tray shall be perforated, heavy-duty return flange type, hot dipped galvanized after manufacturing. All cut ends shall be made good to equal protection as uncut lengths, using "galvanized" paints.
4) The plastic coated cable tray shall be diamond pattern, and covered with heavy duty, black PVC. It shall only be used where, for reasons of corrosion, galvanized tray work is impracticable.
5) The rigid PVC cable tray shall be manufactured from rigid un-plasticized PVC having a thickness of not less than 3 mm. It shall be perforated and have provision for a cover. The manufacturing material shall be self extinguishing or non flammable and suitable for use in ambient temperatures of 0℃ to +80℃.

(3) Conduit

1) The steel conduit shall be heavy duty, welded, screwed and galvanized to Class 4 of the relevant British Standard.
2) They shall be sized to enable satisfactory accommodation of the cables required for the contract with a further 25% free space for future installations.
3) Conduit systems shall be completely installed before commencing cable installations.
4) They shall be securely fixed by means of distance saddles to give not less than 6 mm clearance between the conduit and the building.

9.3.10. Lightning Protection

A one-meter long lightning rod complete with a down conductor and earthing system shall be provided. The earthing resistance for the lightning protection shall be less than 10 obm.

The lightning rod shall be installed at the top of the antenna mast.

9.3.11. Earthing

(1) All new power cables from the existing distribution board to the MCB Box and the MCB Box to the New RTU shall be of 3 cores; Live, Neutral and Earth. The earth core shall be terminated at the SCADA earth star point.

(2) All equipment enclosures to which an electrical power supply is connected shall have a main earth connection point suitable for a l0 mm^2 wire. The exposed metal cases of all electrical apparatus shall be connected to the SCADA star point earth unless the apparatus is nearer to the system earth point, in which case the connection shall be to the system earth point. The protective and non-live metalwork of the panel shall have a maximum resistance not exceeding l0 milliohms to the SCADA earth star point. An earth cable shall then be taken from the SCADA star point earth to the system earth point within the building containing the SCADA equipment. The maximum resistance between the SCADA star point earth and the system earth shall not exceed l0 milliohms.

(3) All equipment to be earthed shall be connected to the SCADA earth star point using green/yellow PVC insulated cable of the appropriate size.

(4) The steel wire armoured power cable shall not be used as the earthing conductor.

(5) Equipment shall not be earthed to its chassis but shall have the earth points brought to an insulated point from which the connection to a special logic earth can be made.

(6) Provision shall be made for the termination of signal screens, or to maintain the continuity of isolated screens as required.

(7) The minimum earthing conductor shall be 2.5 mm^2.

9.3.12. Cable Terminals

(1) A steel wire armoured (SWA) cable shall be terminated by using a cable gland. The cable gland shall be suitable for the environment in which they are to be used, and shall be complete with PVC shrouds, back nuts and bonded earth tags.

(2) AC/DC power cables shall be terminated in a screw clamp/clamp terminal.

(3) Instrument cable cores and internal connection cores shall be terminated with polyamide type terminals, having socket screw clamp connections with a knife-edge switch disconnection.

10. Civil Works Requirements

10.1. General Information

10.1.1. Introduction

(1) This part provides a general description of the civil works required for the Project.

10.1.2. Scope of Work

(1) The Contractor shall carry out pre-installation civil works to provide foundations or to prepare sites and buildings for the installation of the New System.

(2) The Contractor shall remove and dispose of unnecessary existing equipment for the installation of the New System.

(3) The Contractor shall design and construct foundations and sunshades for new RTUs at Additional Sites.

(4) The Contractor shall refurbish existing foundations and sunshades for the replacement of existing RTUs at Original Sites, if necessary.

(5) The Contractor shall design and construct the instrument stands with foundations and sunshades at sites where new instruments are installed.

(6) The Contractor shall refurbish existing instrument stands with foundations and sunshades, if necessary, for the continuous use of existing instruments.

(7) The Contractor shall refurbish existing equipment rooms to accommodate new SCADA and Communication equipment according to the requirement.

(8) The Contractor shall carry out soil investigation if it is required for the design of foundations mentioned above.

(9) The Contractor shall provide temporary facilities required for the execution of the works described herein.

(10) All other works as described and/or implied in the Tender Documents to complete the Contract.

10.1.3. General Requirements

(1) All designs and constructions shall be prepared and carried out in accordance with British Standards and codes of practice or other equal national standards approved by the Engineer. Any departure from these standards and codes shall be subject to approval by the Engineer.

(2) All works shall be carried out in accordance with recognized standards of safety. The Engineer shall have the power to instruct the Contractor to comply with the safety requirements. This shall not relieve the Contractor of any of his obligations under the Contract.

(3) All design documents shall indicate the referred standard and codes of practice, and the Contractor shall be able to present the copies of the referred standard and codes of practice at the request of the Engineer.

(4) Foundations shall be designed to suit the ground conditions.

(5) The Contractor shall be responsible for the complete design and design check of the Works which shall be submitted to the Engineer for approval.

(6) The Contractor shall ensure that the submitted design is adequate in all respects for proper functioning of the System.

(7) The Contractor shall submit the Method Statement for the works that describes the method & sequence of the construction, working program, quality assurance, referred standards and codes of practice, etc. for the approval of the Engineer.

(8) For any deviation from the approved specification and quality, the Engineer will have the authority to instruct the Contractor to reinstate such work to the required standard.

(9) The Contractor shall arrange suitably qualified competent civil engineers on site to supervise the work and ensure the quality and progress of the civil works is achieved and maintained.

The site engineers shall be responsible for liaising with the Engineer.

(10) The Contractor's engineers shall inspect and test the works to ensure that all works are done as per approved design, standard and specification, and shall submit the records of such inspections and tests to the Engineer for approval.

(11) The Contractor shall carry out all geotechnical investigations necessary and submit the reports to the Engineer for approval. The Contractor shall use the approved Geotechnical Reports for designing all foundations.

(12) The Contractor shall also ensure that progress is maintained in accordance with the contracted program of work.

(13) The Contractor shall coordinate with operating companies of existing gas facilities where Contractor’s works shall be carried out, and ensure no disturbance to the operations of existing gas facilities, and also ensure no damage to the existing gas facilities.

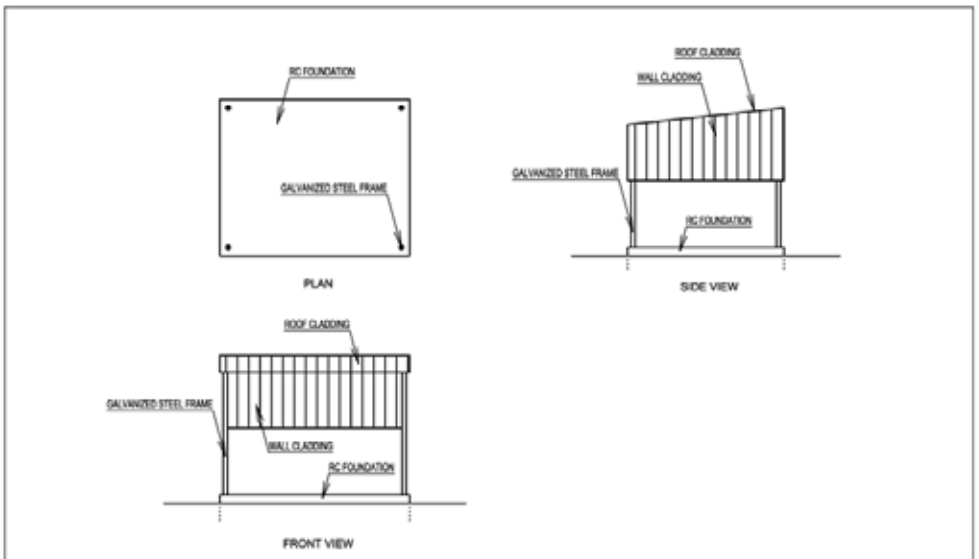
10.2. Foundations & Sunshades for Equipment

10.2.1. General

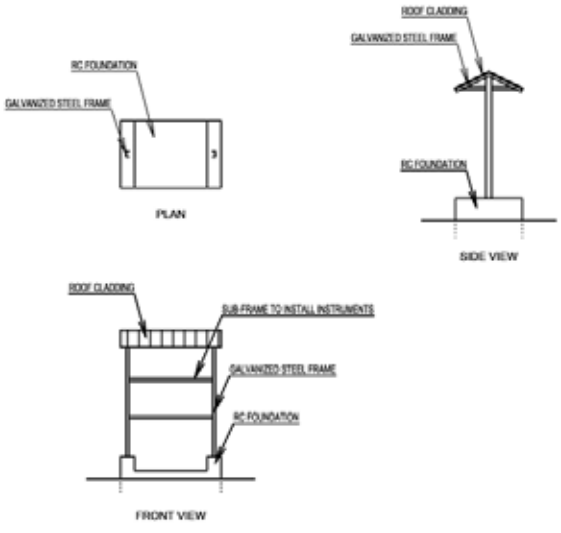
(1) New stands, foundations and sunshades shall be designed and constructed for the installation of new RTUs and instrument for the Project at Additional and Original Sites.

(2) Existing stands, foundations and sunshades shall be refurbished at Original Sites, if necessary.

(3) A typical indicative plan and elevation for new stand, foundation and sunshade are shown in Figure 10.1.



FOUNDATION AND SUNSHADE FOR RTU



INSTRUMENT STAND WITH FOUNDATION AND SUNSHADE

Figure 10.1

10.2.2. Requirements

(1) The Contractor shall design and construct reinforced concrete foundation with sunshade for New RTU at Additional Sites.

(2) The Contractor shall remove and dispose the existing RTU, and refurbish the existing foundation and sunshade of existing RTU, if necessary, in order to install New RTU at Original Sites.

(3) The Contractor shall design and construct new Instrument Stand with reinforced concrete foundations and sunshades for new instruments installation at Original and Additional Sites.

(4) The Contractor shall refurbish the existing Instrument Stand with foundation and sunshade for the existing instrument(s), if necessary for the continuous use of the existing instrument(s).

(5) The new foundation shall be designed to suit ground conditions and to resist possible loads on the structure.

(6) New sunshades shall be designed to adequately house the RTUs and instruments to provide ample protection against sunlight and rain.

(7) Ducts for cables shall be properly embedded into reinforced concrete foundations.

(8) At remote sites without commercial power supply, new sunshades for RTUs shall be designed to support solar power panels on the roof.

10.3. Refurbishment of Radio Rooms/Buildings

10.3.1. General

(1) There are a total of 20 existing radio rooms/buildings at Master Telemetry Stations to be refurbished for the installation of new communication equipment collecting natural gas process data from RTUs and sending it to Control Centers through BTCL's leased network.

(2) The existing radio rooms/buildings are listed in Table 10.1. with further details.

Table 10.1. Radio Rooms and Buildings at Master Telemetry Stations

Old Site Code	New Site Code	Master Station	State of the Radio Rooms/Buildings	Approximate Size of Rooms/Buildings for Refurbishment		
				Radio Room	Battery Room	Entire Building
306	10-HOR-300M	Horipur Head Office	This is GTCL's radio building entirely dedicated to the telecommunication system for the exsiting SCADA system. Entire building shall be refurbished to accommodate new equipment.	4.1m x 3.5m	3.1m x 2.9m	10.6m x 4.6m
405	10-KAI-400M	Kailashtilla2 Radio	Ditto	Ditto	Ditto	Ditto
608	10-JAL-600M	Jalalabad Head Office	Radio equipment is installed at penthouse of the commercial building at Sylhet city. Since this building is not owned by GTCL, refurbishment is not necessary and only cleaning is required.	Not Applicable but cleaning is required	Not Applicable but cleaning is required	Not Applicable
604	10-FCH-600M	Fenchugonj Radio	This is GTCL's radio building entirely dedicated to the telecommunication system for the exsiting SCADA system. Entire building shall be refurbished to accommodate new equipment.	4.1m x 3.5m	3.1m x 2.9m	10.6m x 4.6m
302	10-RAS-300M	Rashidpur Gas Field	Ditto	Ditto	Ditto	Ditto
203	10-HOB-200M	Hobigonj Gas Field	Ditto	Ditto	Ditto	Ditto
400	10-ASH-400M	Ashuganj New Radio	Ditto	Ditto	Ditto	8.5m x 4.6m
120A	20-BKB-100M	Bakhrabad New Radio	Ditto	4.1m x 3.5m	3.0m x 2.9m	10.6m x 4.6m
114	20-CML-100M	Comilla Head Office	Ditto	4.3m x 3.0m	2.9m x 2.5m	9.6m x 6.7m
115	20-LAK-100M	Laksham Radio	Ditto	4.2m x 3.0m	2.8m x 2.3m	12.7m x 5.0m
116	20-CHA-100M	Chandpur	Ditto	3.0m x 2.8m	3.0m x 1.5m	9.0m x 3.0m
102	20-FEN-100M	Feni	Ditto	4.2m x 3.0m	2.9m x 2.5m	6.6m x6.3m
118	20-MIR-100M	Mirasarai	Ditto	3.0m x 3.0m	3.1m x 1.8m	10.7m x 4.7m
105	20-FAU-100M	Faujdarhat	Ditto	3.5m x 2.4m	3.0m x 2.0m	7.8m x 4.1m
109	30-DMR-100M	Demra	Ditto	3.0m x 2.7m	3.5m x 2.8m	5.0m x 4.9m
702	30-PBG-700M	Petrobangla Head Office	Radio equipment is installed in the room located at 9F of the commercial building in Dhaka city. Since this building is not owned by GTCL, refurbishment is not necessary and only cleaning is required.	Not Applicable but cleaning is required	Not Applicable but cleaning is required	Not Applicable
510	40-MHD-500M	Monohordi	A part of GTCL's office building is currently used for the telecommunication system of the existing SCADA system. Cleaning and refurbishment are required only for the rooms used for the telecommunication system and no refurbishment is required at other part of the building.	6.3m x 3.9m	3.3m x 3.0m	Not Applicable
508	40-ELE-500M	Elenga	Ditto	3.6m x 3.2m	1.7m x 1.5m	Not Applicable
-	40-MYM-500M	TITAS Mymensing Office	A part of TGTDCL's office building is currently used for the telecommunication system of the existing SCADA system. Cleaning and refurbishment are required only for the rooms used for the telecommunication system and no refurbishment is required at other part of the building.	6.5m x 2.7m	3.0m x 2.0m	Not Applicable
511	40-TRK-500M	Tarakandi	Ditto	4.7m x 4.0m	3.2m x 2.0m	Not Applicable

10.3.2. Requirements

(1) The Contractor shall remove and dispose of the existing radio equipment that is no longer required for the new Communication System.

(2) The Contractor shall examine the condition of the existing radio room and repair defects if they are found.

(3) The Contractor shall clean and neatly touch-up the external and internal finish of existing radio rooms/buildings to accommodate new radio equipment.

10.4. Refurbishment of Control Centers

10.4.1. General

(1) There are two existing Control Centers for the Existing System. One is the Main Control Center located at Demra and the other is the Auxiliary Control Center located at Ashuganj. Existing equipment of these control centers shall be replaced with new equipment. Therefore the existing equipped rooms shall be refurbished for the installation of new equipment after the removal of existing equipment.

10.4.2. Requirements

(1) The Contractor shall remove and dispose of existing SCADA equipment that is no longer required for the new SCADA System.

(2) The Contractor shall examine the present condition of the following existing rooms at both Control Centers and repair defects if they are found.
- System Management Room
- Equipment Room
- Battery Room

(3) The Contractor shall clean and neatly touch-up the internal finishes of these rooms at both Control Centers to accommodate the new SCADA equipment.

11. Inspection and Testing

11.1. General

At stages throughout the Contract, formal tests shall be carried out and all test result shall be submitted by the Contractor. These test procedures shall be designed to show that the System meets the requirements of the Specifications, and shall be completed to the satisfaction of the Engineer before subsequent stages can proceed.

The procedures shall define detailed test method and procedures, measuring items, testing equipment to be used and recording forms for test results, and shall contain design values and tolerances which will be treated as the criteria for evaluation of each test. The test procedure shall be submitted to the Engineer for approval prior to respective test.

The Factory Acceptance Test (FAT), Site Acceptance Test (SAT), Commissioning Test and the Final System Test to be carried out by the Contractor shall include but are not limited to the following:

- Visual check
- Name plate check
- Dimensional check
- Cabling, wiring, and grounding check
- Protective and safety system function check
- Functional test
- Operation test
- Performance test

11.2. Test Equipment and Facilities

(1) The Contractor shall provide for the purpose of the tests all equipment and services required for testing, including but not limited to:
   1) Laboratory test instruments
   2) Special test equipment, simulators and test software
   3) Other items of equipment and software specified elsewhere as part of the Contractor's supply, or required for the purpose of conducting a test
   4) Consumables

5) Payment of all communications charges during the Factory Acceptance Test including local and international telephone calls.

(2) 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 Engineer, and if required by the Engineer shall be calibrated at the expense of the Contractor by an approved standards laboratory.

11.3. Test

The following tests shall be carried out by the Contractor

(1) Factory Acceptance Test (FAT)

(2) Site Acceptance Test (SAT)

(3) Commissioning Test

(4) Final System Test

11.3.1. Factory Acceptance Test (FAT)

Before any item of the equipment is packed or delivered from the manufacturer's factory, all tests itemized in the relevant sections of these Technical Specifications shall be carried out by the Contractor as far as practicable to prove compliance with the requirements of the Specifications.
All parts of the SCADA and Telecommunication System shall be assembled in the manufacturer's factories prior to shipment and tests shall be performed by the Contractor as may be required to demonstrate the adequacy of the systems and its component parts. All tests should simulate normal operating conditions as closely as possible.
The Contractor shall give the call regarding FAT well in advance with a minimum of 30 days notice of the date at which the system is ready for testing.

11.3.2. Site Acceptance Test (SAT)

After the equipment has been fully assembled/installed, the Contractor shall carry out the Site Acceptance Test.

(1) The SAT shall be carried out on all equipment and software supplied under the Contract.

(2) The SAT shall be carried out after the equipment has been installed at the site.

(3) The SAT shall be performed with equipment at the locations in which they will eventually operate, or in a typical location in the case of portable equipment.

(4) The SAT shall demonstrate that the overall design of the System meets the requirements of the Specification in the field, using the actual communications network, including equipment supplied by others.

(5) The installation shall be inspected to ensure compliance with the installation manual and cable drawings and to verify satisfactory condition of all equipment.

11.3.3. Commissioning Test

The Commissioning Tests shall be performed following completion of the installation of equipment at each site. The Commissioning Test shall be carried out under the conditions of connecting all the equipment.

(1) The Contractor shall carry out the Commissioning Tests in the presence of the Employer's Personnel and the Engineer to demonstrate that all guarantees and technical particulars as listed in the Contract Documents are satisfied and that all the equipment is properly installed.

(2) The Commissioning Test shall be conducted on all equipment and software supplied under the Contract in accordance with the SAT document approved by the Employer.

(3) The Commissioning Test shall establish all aspects of functionality, including proving of all types of communication link.

(4) The Commissioning Test shall include both polling of the RTU by the SCADA Server and generating an alarm in the RTU to ascertain it can initiate a call to the Server. The necessary test software/configuration to perform the above shall be supplied by the Contractor

11.3.4. Final System Test

The Final System Test shall be carried out to confirm continuous functional operation of the systems with the required system reliability and availability. This test aims at keeping the complete integrated system operating for 24 hours a day for a period of 14 days.

In case of failure, the tests shall be restarted till the system operates without failure of any system functionality for 14 days.

The Final System Test shall be carried out in accordance with a test plan and procedures approved by the Employer.

The test result obtained during the Final System Test shall be documented in the form of report and submitted to the Employer for approval.

12. Operation and Maintenance Support and Spare

12.1. Introduction

The New System is required to provide full operational facilities for a minimum of fifteen (15) years. The Contractor shall ensure that supplier is able to provide spares for 15 years.

12.2. Operation Support

12.2.1. General

In addition to or as part of the staff required for maintenance support and training, the Contractor shall provide two engineers in Bangladesh for the 24 months period from System Take-over to Contract Completion. The two engineers shall be a SCADA engineer and a communication engineer

The engineers shall be based between Demra MCC, Ashuganj ACC and GTCL Head Office. In addition they will be required to travel to all sites covered by the Contract as and when required.

The engineers shall work under the direction of the Engineer and/or as directed by the Employer.

Each engineer shall work a minimum of 42 working weeks per year in Bangladesh. At all times at least one engineer shall be working in Bangladesh.

12.2.2. Qualifications and Experience

The said two engineers shall be degree qualified with a minimum of five years practical experience in the relevant area.

The SCADA engineer shall have experience in SCADA systems configuration and maintenance, and shall advise and assist the Employer in configuring and maintaining the System.

The Communication engineer shall have experience in communication systems configuration and maintenance, and shall advise and assist the Employer in configuring and maintaining the System.

12.3. Maintenance Philosophy

The Contractor shall provide all maintenance services for the System during the two years warranty period following System Taking-Over.

On completion of the warranty period, the Employer will enter maintenance contracts for all maintenance activities for the System and the provision of spare parts.

The Contractor shall support these maintenance contracts through the vendor and/or relevant maintenance service provider for the following services:

(1) Routine maintenance
(2) First level hardware maintenance
(3) Repair of all items replaced under first level maintenance
(4) Emergency call-out
(5) Software maintenance

First level maintenance and support shall include identification of faults down to module or card level and on-line replacement of faulty equipment.

Notwithstanding this requirement to maintain the System, the Contractor shall provide documentation and training of the Employer's staff during the Contract period, to a level that would allow first level and routine maintenance to be performed.

12.4. Design to Facilitate Maintenance

The System shall have remote and local diagnostic facilities to allow for identification of faults necessary for first level maintenance.

Equipment shall be designed to allow the on-line replacement of modules or cards without affecting System operation.

Peripheral equipment shall be easily removable from service and either replaced by standby equipment or spare equipment without affecting System operation.

12.5. Spare Parts

During the two years warranty period, the Contractor shall provide all spare parts and consumables required for the support of the System appropriate to maintaining the System within the specified availability. These spare parts shall be stored on the Employer's premises, and at the end of the Contract period all spare parts that have been used shall be replaced.

All spare parts shall be identical, electrically and mechanically, to the corresponding parts in the equipment provided and shall be suitably packed and clearly marked, ready for storage.

Spare or replacement parts shall be fully compatible with and necessarily similar to items previously

supplied.

The Contractor shall furnish full contact address of all the equipment suppliers with their (supplier's) commitment letter to support spares provision to the Employer, the local associate or any other party undertaking maintenance contracts with the Employer to maintain the System availability for its lifetime.
The suppliers shall maintain the availability of spares or replacement parts for the System lifetime.

If the supplier intends to discontinue the manufacture of spare or replacement parts for the works during the maintenance Contract with the Employer, the supplier shall supply such spare or replacement parts required to maintain the System availability for the remainder of the maintenance Contract to the local associate. This shall include any repair service that may be discontinued.

If the supplier intends to discontinue the manufacture of spare or replacement parts for the works, the supplier shall either:

(1) Forthwith give notice to the Employer of such intention and afford the Employer the opportunity of ordering all spare or replacement parts required to maintain the System availability for its lifetime.
(2) Or sell to the Employer such drawings, patterns, specifications and other information as he may have in his possession to enable him to make or have made such spares or replacement parts.

12.6. Maintenance Contracts

12.6.1. General

The maintenance Contractor shall provide maintenance contracts for all System hardware and software.
Hardware maintenance contracts shall conform to the Model Form of Conditions of Contract for the Servicing (Maintenance) of Computer Equipment of The Institute of Purchasing and Supply, 1988. The Contract shall provide for both preventive and remedial maintenance to a specified standard of service.
Software maintenance contracts shall be to the Model Form of License Agreement for the use of Computer Software Products of the Institute of Purchasing and Supply, IPS Model L 1987, The Contract shall provide remedial maintenance to a specified standard of service.

12.6.2. Routine Maintenance

Routine maintenance on the System shall be based on the recommendations of the maintenance Contractor to maintain the System availability. The maintenance shall be performed at no additional charge, at a time agreed with the Employer, but only during normal working hours (Sunday to Thursday, 09:00 to 17:00).

The maintenance Contractor shall be responsible for detailing the necessary procedures to be carried out to fully comply with the Manufacturers' recommended preventive maintenance requirements.

During routine maintenance visits, the maintenance Contractor shall replace or repair any defective equipment at his own expense.

The maintenance Contractor shall provide a detailed report on all findings within seven calendar days of a routine maintenance visit.

12.6.3. Hardware Remedial Maintenance

A remedial maintenance service that takes the form of fault diagnosis and repair or replacement of defective parts of the System shall be provided

The coverage and response time period shall be 7 days a week 24 hours a day, however the contract shall provide different call out charges for weekdays, weekends and visits outside of normal working hours. The Contractor shall attend to the site within 24 hours or as directed by the Employer of the report of a fault.

The Contractor shall be responsible for attending sites with all relevant spare parts and test equipment to enable a speedy and effective repair.

If a replacement unit is supplied under the maintenance contract it will remain in the equipment under normal circumstances. In such cases the original unit in the equipment shall be vested in the Contractor and become his absolute property at the time of replacement, and the replacement unit shall be vested in the Employer and become their absolute property at that time.

The Contractor shall not have access to the Employer's system manuals and or drawings.

The Contractor shall make repairs within an MTTR (Mean Time To Repair) specified in the maintenance contract.

The Contractor shall provide a detailed written report of the visit, which shall only be certified by the designated maintenance engineer.

12.6.4. Software Remedial Maintenance

A software remedial maintenance service that takes the form of fault diagnosis and correction of software shall be provided.

The coverage and response time period shall be 7 days a week 24 hours a day however the contract shall provide different call out charges for weekdays, weekends and visits outside of normal working hours. The Contractor shall attend to site within 24 hours of the report of a fault.

The Contractor shall be responsible for attending sites with all relevant equipment to enable a speedy and effective repair.

The Contractor shall not have access to the Employer's system manuals and or drawings.

The Contractor shall make repairs within an MTTR specified in the maintenance contract.

The Contractor shall provide a detailed written report of the visit, which shall only be certified by the designated maintenance engineer.

In the case of non-critical software errors or faults, the Employer will agree with the Contractor on a mutually convenient time for the Contractor to attend the site and be granted access to the System.

All successful Software Remedial Maintenance will be documented and included on all system working and back-up copies of the software.

12.6.5. Consumables

The Contractor shall offer to provide all consumables such as printer paper, floppy disks, printer ribbons, plotter pens, streamer tapes etc., as with spare parts.

13. Training

13.1. Introduction

The Contractor shall provide a program of training courses and training to enable the installation, operation, management and maintenance of the System to be effectively carried out.

13.2. General Course Requirements

Courses shall consist of lectures, discussions, demonstrations and experience of the equipment involved. Courses shall be prepared in advance and printed sets of course notes shall be provided to all attendees.

All courses shall be held in English and all course notes shall be written in English.

All equipment to be used for training shall be provided by the Contractor, and its use shall not interfere with any other use of the System, or with the program or time schedules for commissioning or testing.

The training staff of the Contractor shall have experience in giving training. The Contractor shall provide evidence of the training experience and appropriate accreditation of proposed staff six weeks prior to the start of the first course.

The program of training courses shall be arranged to comply with the program for implementation of the System and by arrangement with the Engineer.

Courses shall provide attendees with sufficient skills to achieve a level of in-house support required for the successful operation of the System.

13.3. Categories of Personnel Requiring Training

13.3.1. General

Training shall be provided making due provision for the abilities and needs of the attendees. To this end the following categories of user should be noted by the Contractor.

13.3.2. Managers

This group of personnel are those charged with responsibility for the safe and efficient running of

the plant. Knowledge on the System operation is needed to enable appreciation of the benefits and limits of the information available and assist the decision making process. Their involvement is essentially at an executive level.

13.3.3. Engineers

Engineers will require detailed knowledge of the supplied System to ensure that it becomes a sustainable and supportable system.

Training in both software and hardware shall be given to cover both the maintenance function and to deliver the capability for effecting future enhancements.

13.3.4. Operators

Operators have knowledge of gas transmission operations and use of the System as their main operational tool based at a control centre.

Their responsibility is continuous supervision of the National Gas Grid in a safe and efficient manner and typical duties include:

(1) Reporting the performance of the pipeline operations, for example how much gas is available, and from where.
(2) Monitoring maintenance operations, e.g. on valves.
(3) Carrying out appropriate actions when alarms are activated.

13.3.5. Technicians

Technicians perform maintenance and modification duties under the direction of an engineer. Training should be given in all aspects of system support including planned maintenance and minor configuration changes.

13.3.6 Trainers

In order to ensure effective in service training and to ensure sustainability of training after the Contractor's warranty period is over, staff will be identified who in addition to other duties will be designated as trainers and undergo a 'Training to the Trainers' program. These trainers will then be

assigned to provide in-service training to new staff.

13.4. Training Requirements

13.4.1. Location and Methodology

The Contractor shall provide training in suitable premises at locations of their choice. It is envisaged that the majority of the training will take place within Bangladesh.

The Contractor shall provide all accommodation, travel costs and subsistence for the Employer's staff, except for Dhaka based training where only travel and subsistence costs shall be provided.

The Contractor shall maintain records of topics covered, records of who has carried out training and who has attended.

13.4.2. Training Course during Installation and Commissioning

The Contractor shall provide technology transfer training course to demonstrate and lecture the installation and commissioning of equipment at site for three months.

13.4.3. Training Course Structure for Operation & Maintenance

The Contractor shall provide technology transfer training where ten members of the Employer's staff visit an overseas gas transmission company with an established SCADA system in use. The visit shall consist of seminars, site visit and time spent within control rooms viewing operations. The course shall demonstrate the benefits and problems encountered when operating a complex gas transmission grid. The period of the visit shall be four weeks.

The following course structure and guidelines are provided as typical examples of the content and duration required and the attendees experience. The list shall not be deemed comprehensive and the Contractor shall devise courses that are appropriate to the System provided and the scope required.

Code	Title/Content/Outcome	Attendees	Experience
1	System Safety [1 day duration] This course shall cover the safe working of the SCADA system and necessary precautions. Upon completion participants shall be aware of the essential safety requirements.	All Staff	None
2	Introduction to SCADA Systems [14 days duration] This course shall familiarize participants with the fundamentals of SCADA systems. It shall describe the history of SCADA systems applications, and explain the elements of the technology that has been developed. The course shall also introduce participants to the technology that is used. Upon successful completion, the participants shall be able to identify the basic elements of a SCADA system and the function which each performs. Participants shall be able to describe how the SCADA system enable them to supervise and control the plant. Participants shall also be able to explain the roles of the personnel involved in operating and maintaining the system.	Operators, Engineers, Maintenance Technicians & Instrument Technicians	Engineering Degree Qualified. Gas Industry experience
3	Overview of SCADA System [7 days duration] This course shall provide an overview of the SCADA system and its functionality for those not practically involved in the operation or maintenance of the system. It shall familiarize those personnel with responsibilities for managing plant operations or using the data which is provided by the SCADA system. Upon successful completion, participants shall be able to describe how the SCADA system improves the supervision and control of plant. Participants shall also be able to understand the activities required for planning, specifying and supervising the operations and maintenance of the plant. Participants shall also know how to make further personal research into SCADA systems using the documentation provided with the system.	Managers, Support Service Personnel	Sufficient experience in the gas industry, particularly gas transmission.
4	SCADA Software Engineering This course shall consist of three separate courses covering: Mimic Creation [1 week] Software Engineering [2 weeks] System Administration [2 weeks] Upon completion participants shall be able to make some modifications to the SCADA system software for expansion or simple variations to the system.	Software Engineers	Attendance at Course 2 Engineering Degree Qualified. Gas Industry experience
5	SCADA Hardware Maintenance [4 weeks duration] This course shall be designed for technicians and engineers who are responsible for hardware maintenance and troubleshooting of the SCADA system. Hardware configuration shall be covered. Upon completion participants shall be able to repair and maintain SCADA equipment and commission new equipment.	SCADA Hardware Technicians and Engineers	Attendance at Course 2 Degree qualified in electronics / electrical engineering

6	Instrument Technicians Course [4 weeks duration] This course shall be designed to familiarize technicians with equipment such as energy metering, gas analysis and intrinsic safety devices. Upon completion technicians shall be able to carry out calibration and simple maintenance operations.	Instrument Technicians	Attendance at Course 2 Electrical Engineering Diploma
7	Material control - Handling [1 week duration] This course shall cover the essential materials control and handling activities such as inventory control, safe handling and custody of materials. Handling of equipment and stock keeping. Upon completion participants could be given control of area store.	Store keepers	Experience in store keeping and security
8	Communications Software Engineering [4 weeks duration] This course shall cover configuration, diagnostics and performance monitoring. Upon completion participants shall be able to make some modifications to the communications systems software for expansion or simple variations to the system.	Comms Engineers	Degree qualified in comms related subjects
9	Communications Hardware Maintenance [4 weeks duration] This course shall be designed for technicians and engineers who are responsible for hardware maintenance and troubleshooting of communications systems. Hardware configuration shall be covered. Upon completion participants shall be able to repair and maintain communications equipment and commission new equipment.	Comms Hardware Technicians and Engineers	Degree qualified in comms related subjects
10	Basic Quality Control & Management [2 weeks duration] This course shall cover the basic elements of calibration, preparation of work instructions and basic auditing techniques. Upon completion participants shall carry out basic quality audits, manage the calibration process and prepare simple work instructions.	Inspectors	Experience gained within the gas sector at the supervisor level.
11	Leak Detection [2 weeks duration] This course shall cover the Leak Detection application software. Upon completion of the course participants shall be able to use the application software and the SCADA system in general to monitor for leak detection and to implement operational procedures for dealing with the leak.	Operators	Attendance in course 2. Engineering Degree Qualified. Gas industry experience.
12	Load Balancing and System Scheduling [2 weeks duration] This course shall cover the Load Balancing and System Scheduling application software provided with particular emphasis on the Employer's existing operational and organizational involvement in this area. Upon completion the participants shall be able to use the application software to implement load balancing and system scheduling.	Operators Supervisors & Managers	Attendance in course 2. Engineering Degree Qualified. Gas industry experience.

13	Training the trainers [2 weeks duration] This course shall cover basic training skills necessary for providing on the job training. Upon completion the participants shall be able to train new and existing staff in the main tasks for their area of work.	Supervisors & Managers	Attendance in course 2 Extensive experience of work within the gas industry.

TECHNICAL SPECIFICATIONS

APPENDICES

Appendix-1	Site List
Appendix-2	Site Information & Scope of Work
Appendix-3	RTU List
Appendix-4	I/O List

Appendix-1 Site List

Site List

Area	Covered by	New Code	Old Code	SITE	Operator	Site Category	Site Status	Coordinates	
								Latitude	Longtitude
North-East Leg [Ashuganj - Horipur H/O]		10-ASH-400M	400	Ashuganj New Radio	GTCL	MTS	Original	N 24° 01' 48.60"	E 90° 59' 52.40"
		10-ASH-400C	400	ACC at Ashuganj	GTCL	CC	Original	colocated with 10-ASH-400M	
	Ashuganj	10-ASH-201	205	Titas Gas Filed 1	BGFCL	GF	Original	N 23° 59' 49.20"	E 91° 06' 41.90"
		10-ASH-202	206	Titas Gas Filed 3	BGFCL	GF	Original	N 24° 00' 55.70"	E 91° 07' 20.40"
		10-ASH-203	N400-4	TITAS Location 7	BGFCL	GF	future	N 23° 56' 54.40"	E 91° 06' 48.90"
		10-ASH-204T	205	BGFCL Head Office	BGFCL	OCT	Additional	N 23° 58' 59.10"	E 91° 06' 00.00"
		10-ASH-400	400	Ashuganj	GTCL	GMS	Original	colocated with 10-ASH-400M	
		10-ASH-401	409	VS R	GTCL	VS	Original	N 24° 02' 22.20"	E 91° 10' 01.90"
		10-ASH-402	410	VS T	GTCL	VS	Original	N 24° 02' 55.70"	E 91° 06' 55.70"
		10-ASH-403	417	VS 1 A-B	GTCL	VS	Original	N 23° 58' 13.60"	E 91° 02' 55.80"
		10-ASH-404	N400-X	VS Chandura R-A Line	GTCL	VS	Additional	N 24° 02' 24.80"	E 91° 13' 58.10"
		10-ASH-501	500	Ashganj PS	TGTDCL	PS	Original	N 24° 02' 28.60"	E 91° 00' 40.00"
		10-ASH-502	502	Ashganj FF	TGTDCL	FF	Original	N 24° 01' 28.50"	E 90° 59' 27.20"
		10-ASH-503	514	TITAS VS3	TGTDCL	VS	Original	N 24° 02' 11.80"	E 91° 00' 25.70"
		10-ASH-504	516	Daulatkandi VS0	TGTDCL	VS	Original	N 24° 01' 18.70"	E 90° 57' 08.60"
		10-ASH-505	N400-2	MS Ghatura	TGTDCL	MS	Additional	N 23° 59' 50.30"	E 91° 06' 29.70"
		10-HOB-200M	203	Hobigonj Gas Field	BGFCL	MTS	Original	N 24° 14' 00.00"	E 91° 22' 38.80"
	Hobigonj	10-HOB-200	203	Hobigonj Gas Field	BGFCL	GF	Original	colocated with 10 HOB-200M	
		10-HOB-401	416	VS P	GTCL	VS	Original	N 24° 13' 51.00"	E 91° 22' 30.60"
		10-HOB-501	513	Hobigonj TITAS DRS	TGTDCL	DRS	Original	N 24° 14' 03.60"	E 91° 22' 23.40"
		10-RAS-300M	302	Rashidpur Gas Field	SGFL	MTS	Original	N 24° 18' 43.20"	E 91° 36' 26.30"
	Rashidpur	10-RAS-300	302	Rashidpur Gas Field	SGFL	GF	Original	colocated with 10 RAS-300M	
		10-RAS-401	403	VS L	GTCL	VS	Original	N 24° 17' 42.20"	E 91° 36' 42.30"
		10-RAS-402	412	VS H	GTCL	VS	Original	N 24° 29' 58.70"	E 91° 44' 32.10"
		10-RAS-403	414	VS K	GTCL	VS	Original	N 24° 22' 19.60"	E 91° 44' 10.90"
		10-RAS-404	415	VS M	GTCL	VS	Original	N 24° 16' 09.00"	E 91° 30' 09.60"
		10-RAS-405	N302-3	Rashipdur/Muchai Compressor Station	GTCL	CS	future	N 24° 17' 42.90"	E 91° 35' 09.00"
		10-RAS-406	N302-X	VS Chunarughat R-A Line	GTCL	VS	Additional	N 24° 15' 37.60"	E 91° 28' 58.80"
		10-FCH-600M	604	Fenchugonj Radio	JGTDSL	MTS	Original	N 24° 41' 16.90"	E 91° 55' 16.50"
	Fenchugonj	10-FCH-401	406	VS E	GTCL	VS	Original	N 24° 41' 24.00"	E 91° 55' 13.20"
		10-FCH-402	413	VS D	GTCL	VS	Original	N 24° 41' 40.80"	E 91° 55' 12.60"
		10-FCH-600	604	Fenchugonj 90MW PS	JGTDSL	PS	Original	colocated with 10 FCH-600M	
		10-FCH-601	602	Fenchugonj NGF	JGTDSL	FF	Original	N 24° 39' 39.00"	E 91° 56' 13.80"
		10-FCH-701	N604-1	Fenchugonj Gas Field	BAPEX	GF	Additional	N 24° 36' 58.20"	E 91° 57' 09.20"
		10-JAL-600M	608	Jalalabad Head Office	JGTDSL	MTS	Original	N 24° 53' 00.80"	E 91° 53' 04.90"
	Jalalabad HO	10-JAL-600T	608	Jalalabad Head Office	JGTDSL	OCT	Original	colocated with 10-JAL-600M	
		10-JAL-601	N608-X	Devpur DRS	JGTDSL	DRS	Additional	N 24° 54' 13.80"	E 91° 55' 15.70"
		10-KAI-400M	405	Kailashtilla 2 Radio	GTCL	MTS	Original	N 24° 51' 58.90"	E 92° 01' 44.00"
	Kailashtilla2	10-KAI-301	303	Benibazar Gas Field	SGFL	GF	Original	N 24° 47' 42.80"	E 92° 09' 58.90"
		10-KAI-400	405	Kailashtilla GTCL Compound	GTCL	GMS	Original	colocated with 10-KAI-400M	
		10-KAI-601	600	Kailashtilla DRS	JGTDSL	DRS	Original	N 24° 51' 16.80"	E 92° 00' 48.00"
		10-HOR-300M	306	Horipur Head Office	SGFL	MTS	Original	N 24° 58' 04.30"	E 92° 01' 41.80"
	Horipur HO	10-HOR-300T	306	Horipur Head Office	SGFL	OCT	Original	colocated with 10-HOR-300M	
		10-HOR-300	300	Horipur Gas Field	SGFL	GF	Original	colocated with 10-HOR-301M	
South-East Leg [Bakhrabad - Faujdarhat]		20-BKB-100M	120	Bakhrabad Radio	BGSL	MTS	Original	N 23° 38' 04.20"	E 90° 52' 24.70"
	Bakhrabad	20-BKB-100	120	Bakhrabad	BGSL	GF	Original	colocated with 20-BKB-100M	
		20-BKB-101	100	Kutombopur	BGSL	TBS	Original	N 23° 30' 11.50"	E 90° 54' 42.80"
		20-BKB-102	128	VS3 BKB-Demra	BGSL	VS	Original	N 23° 31' 48.40"	E 90° 43' 01.40"
		20-BKB-201	200	Meghna Gas Field	BGFCL	GF	Original	N 23° 50' 16.30"	E 90° 47' 18.10"
		20-BKB-401	418	VS2 A-B	GTCL	VS	Original	N 23° 45' 34.70"	E 90° 59' 44.30"
		20-BKB-501	N120-2	TBS Gazaria	TGTDCL	TBS	Additional	N 23° 34' 32.20"	E 90° 38' 32.90"
		20-BKB-701	703	Salda Nadi Gas Field	BAPEX	GF	Original	N 23° 40' 31.00"	E 91° 10' 15.40"
		20-BKB-702	N120-1	Bangura Gas Field	Tullow	GF	Additional	N 23° 42' 38.60"	E 90° 58' 59.30"
		20-BKB-703	N120-5	Srikail Gas Field	BAPEX	GF	future	N 23° 45' 14.60"	E 90° 58' 13.40"
		20-CML-100M	114	Comilla Head Office	BGSL	MTS	Original	N 23° 26' 53.20"	E 91° 12' 49.50"
	Comilla HO	20-CML-100T	114	Comilla Head Office	BGSL	OCT	Original	colocated with 20-CML-100M	
		20-LAK-100M	115	Laksham Radio	BGSL	MTS	Original	N 23° 15' 04.50"	E 91° 07' 20.60"
	Laksham	20-LAK-101	101	Laksham TBS	BGSL	TBS	Original	N 23° 16' 18.60"	E 91° 07' 21.80"
		20-CHA-100M	116	Chandpur	BGSL	MTS	Original	N 23° 14' 02.80"	E 90° 41' 00.60"
	Chandpur	20-CHA-101	112	Chandpur TBS	BGSL	TBS	Original	N 23° 14' 22.90"	E 90° 40' 55.60"
		20-FEN-100M	102	Feni	BGSL	MTS	Original	N 23° 01' 02.00"	E 91° 22' 10.50"
	Feni	20-FEN-100	102	Feni TBS	BGSL	TBS	Original	colocated with 20-FEN-100M	
		20-FEN-701	N102-1	Feni Gas Field	NIKO	GF	Additional	N 22° 56' 29.30"	E 91° 24' 08.00"
		20-FEN-702	N102-2	Sundalpur Gas Field	BAPEX	GF	future	N 22° 51' 28.40"	E 91° 14' 39.00"
		20-FEN-703	N102-3	Begumgonj Gas Field	BAPEX	GF	future	N 22° 59' 17.00"	E 91° 10' 03.00"
		20-MIR-100M	118	Mirasarai	BGSL	MTS	Original	N 22° 42' 15.80"	E 91° 36' 46.60"
	Mirasarai	20-MIR-101	103	Mitachara	BGSL	TBS	Original	N 22° 48' 16.20"	E 91° 33' 20.60"
		20-MIR-401	N118-X	Barakubundu TBS	GTCL	TBS	Additional	N 22° 34' 58.00"	E 91° 39' 58.20"
		20-MIR-701	N118-1	Semutang Gas Field	BAPEX	GF	future	N 22° 49' 59.30"	E 91° 46' 01.20"
		20-FAU-100M	105	Faujdarhat	BGSL	MTS	Original	N 22° 23' 00.00"	E 91° 46' 07.00"
	Faujdarhat	20-FAU-100	105	Faujdarhat	BGSL	CGS	Original	colocated with 20-FAU-100M	
		20-FAU-101	122	CUFL	BGSL	FF	Original	N 22° 13' 22.30"	E 91° 49' 48.30"
		20-FAU-102	123	KAFCO	BGSL	FF	Original	N 22° 13' 51.00"	E 91° 49' 37.20"
		20-FAU-103	124	Sikalbaha	BGSL	PS	Original	N 22° 19' 26.80"	E 91° 51' 59.10"
		20-FAU-104	125	Raujan PS	BGSL	PS	Original	N 22° 27' 32.00"	E 91° 58' 32.40"
		20-FAU-701	706	Sanghu Onshore Process Plant	CAIRN	GF	Original	N 22° 23' 44.80"	E 91° 45' 10.10"
		20-FAU-701T	706	Sanghu Onshore Process Plant	CAIRN	OCT	Original	colocated with 20-FAU-701T	
		20-FAU-702T	-	KGDCL Head Office	KGDCL	OCT	Additional	Not available, but in Chittagong City	
Around Demra & Dhaka		30-DMR-100M	109	Demra	BGSL	MTS	Original	N 23° 42' 40.10"	E 90° 30' 25.20"
	Demra	30-DMR-401C	401	MCC at Demra	GTCL	CC	Original	colocated with 30-DMR-100M	
		30-DMR-100	109	Demra CGS	BGSL	CGS	Original	colocated with 30-DMR-101M	
		30-DMR-101	107	Sonargaon	BGSL	TBS	Original	N 23° 38' 23.20"	E 90° 36' 08.10"
		30-DMR-102	108	Dewanbagh	BGSL	TBS	Original	N 23° 41' 33.90"	E 90° 32' 31.20"
		30-DMR-103	126	VS7 BKB-Demra	BGSL	VS	Original	N 23° 42' 38.60"	E 90° 31' 27.20"
		30-DMR-104	127	VS5 BKB-Demra	BGSL	VS	Original	N 23° 36' 01.80"	E 90° 36' 52.70"
		30-DMR-501	N109-1	Siddirganj 210 MW PS	TGTDCL	PS	Additional	N 23° 40' 55.10"	E 90° 31' 16.20"
		30-DMR-502	N109-10	Horipur IPP 350 MW PS	TGTDCL	PS	future	N 23° 41' 05.50"	E 90° 31' 46.90"
		30-DMR-503	N109-2	Horipur IPP 360 MW PS	TGTDCL	PS	Additional	N 23° 40' 44.80"	E 90° 32' 05.60"
		30-DMR-504	N109-3	Horipur SBU 100MW	TGTDCL	PS	Additional	N 23° 41' 04.10"	E 90° 31' 54.10"
		30-DMR-505	N109-4	VS 14 Madhabdi	TGTDCL	VS	Additional	N 23° 51' 23.00"	E 90° 39' 20.40"
		30-DMR-506	N109-5	VS 15 Tarabo	TGTDCL	VS	Additional	N 23° 43' 03.90"	E 90° 30' 26.90"
		30-DMR-507	N109-6	VS Dighibarabo	TGTDCL	VS	Additional	N 23° 43' 25.70"	E 90° 31' 00.90"
		30-DMR-508	N109-7	VS Horipur	TGTDCL	VS	Additional	N 23° 41' 11.60"	E 90° 32' 10.30"
		30-DMR-509	N120-3	VS Meghnaghat	TGTDCL	VS	Additional	N 23° 36' 49.20"	E 90° 36' 19.60"
		30-DMR-510	N120-4	Meghnaghat IPP 450 MW PS	TGTDCL	PS	Additional	N 23° 36' 47.60"	E 90° 36' 02.20"
		30-DMR-701	N302-1	Moulavibazar Gas Field	Chevron	GF	Original	N/A	
		30-DMR-702	N302-2	Bibiyana Gas Field	Chevron	GF	Original	N/A	
		30-DMR-703	N405-1	Jalalabad Gas Field	Chevron	GF	Original	N/A	
		30-PBG-700M	702	Petrobangla Head Office	Petrobangla	MTS	Original	N 23° 44' 59.30"	E 90° 23' 50.30"
	Petrobangla HO	30-PBG-401	N702-2	CGS Aminbazar (out)	GTCL	CGS	Additional	N 23° 47' 18.80"	E 90° 19' 04.60"
		30-PBG-402	N702-3	CGS Ashulia (out)	GTCL	CGS	Additional	N 23° 53' 13.70"	E 90° 19' 48.90"
		30-PBG-500T	509	TITAS Head Office	TGTDCL	OCT	Original	N 23° 45' 02.30"	E 90° 23' 37.00"
		30-PBG-501	N702-1	Tongi 80 MW P.S. (out)	TGTDCL	PS	Additional	N 23° 53' 47.40"	E 90° 24' 41.50"
		30-PBG-700T	702	Petrobangla Head Office	Petrobangla	OCT	Original	colocated with 30-PBG-700M	
		30-PBG-701T	-	Chevron Head Office	Chevron	OCT	Additional	Not available, but in Gulshan, Dhaka	
North-West Leg [Monohordi - Tarakandi]		40-MHD-500M	510	Monohordi	TGTDCL	MTS	Original	N 24° 07' 55.00"	E 90° 42' 09.00"
	Monohordi	40-MHD-201	201	Narsingdi Gas Field	BGFCL	GF	Original	N 24° 01' 23.20"	E 90° 49' 00.50"
		40-MHD-500	510	Monohordi	TGTDCL	GMS	Original	colocated with 40-MHD-500M	
		40-MHD-501	503	GUFF/PUFF	TGTDCL	FF	Original	N 23° 59' 11.00"	E 90° 38' 28.60"
		40-MHD-502	504	Ghorasal PS	TGTDCL	PS	Original	N 23° 58' 50.50"	E 90° 38' 40.40"
		40-MHD-503	505	Joydevpur CGS	TGTDCL	CGS	Original	N 24° 00' 31.80"	E 90° 24' 55.80"
		40-MHD-504	515	Poladi VS3	TGTDCL	VS	Original	N 24° 12' 49.20"	E 90° 32' 00.00"
		40-MHD-505	517	Uzilab VS1	TGTDCL	VS	Original	N 24° 04' 26.40"	E 90° 49' 34.00"
		40-MHD-506	518	Khirti VS2	TGTDCL	VS	Original	N 24° 09' 06.90"	E 90° 40' 50.30"
		40-MHD-507	519	Dhanua VS4	TGTDCL	VS	Original	N 24° 14' 39.70"	E 90° 24' 11.10"
		40-MHD-508	N510-2	VS-12 Narsingdi	TGTDCL	VS	Additional	N 23° 55' 56.20"	E 90° 42' 06.60"
		40-ELE-500M	508	Elenga	TGTDCL	MTS	Original	N 24° 20' 18.50"	E 89° 55' 34.20"
	Elenga	40-ELE-500	508	Elenga	TGTDCL	GMS	Original	colocated with 40-ELE-500M	
		40-MYM-500M	NMW1	TITAS Mymensing Office	TGTDCL	MTS	Original	N 24° 43' 17.60"	E 90° 24' 37.60"
	Titas Mymensingh	40-MYM-501	NMW1-1	RPCL PS Mymensing	TGTDCL	PS	Additional	N 24° 45' 47.90"	E 90° 25' 06.40"
		40-TRK-500M	511	Tarakandi	TGTDCL	MTS	Original	N 24° 41' 03.50"	E 89° 49' 42.20"
	Tarakandi	40-TRK-500	511	Tarakandi (JFCL RMS)	TGTDCL	DRS	Original	colocated with 40-TRK-500M	

Control Centre	2
Master Station	20
Existing RTU to be replaced	58
New RTU to be supplied & installed	23
New RTU to be supplied for future site	7
Operation Company Terminal	9

CC : Control Center
CGS : City Gate Station
CS : Compressor Station
DRS : District Regulating Station
FF : Fertilizer Factory
GF : Gas Field
GMS : Gas Manifold Station
MS : Metering Station
MTS : Master Telemetry Station
OCT : Operating Company Terminal
PS : Power Station
TBS : Town Bordering Station
VS : Valve Station

Appendix 2 Site Information & Scope of Work

Site Information & Scope of Work

Site Information

Site Name : Ashuganj
Site Code : 10-ASH-400/400M/400C

Site Address : To be provided later.

Coordinates : N 24° 01' 48.6 " : E 90° 59' 52.4 "
** Coordinates are surveyed by handy type GPS and might be inaccurate.*

Site Type

☑	Control Center	☑	Master Telemetry Station
☐	Gas Field	☐	Operating Company Terminal (OCT)
☐	CGS (City Gas Station)	☐	Power station/Fertilizer Factory
☐	Compressor Station	☐	TBS (Town Bordering Station)
☐	Pig Station	☐	DRS (District Regulating Station)
☐	MS (Metering Station)	☑	GMS (Gas Manifold Station)
☐	VS (Valve Station)		

Site Status
- ☑ Originally covered by The Existing System and shall be covered by The New System.
- ☐ Currently not covered by The Existing System but shall be covered by The New System.
- ☐ Upcoming site which will be covered by The New System after the completion of the Project.

Operating Company : GTCL

Remarks : Additional instruments are required at this site.

Scope of Work

Works checked off hereinafter shall be carried out for the Project

1. SCADA System

■ : Control Center

☑ Design, supply and install following equipment as a minimum configuration of SCADA control room.
- 2 SCADA servers (redundant)
- 4 HMI work stations
- 1 color printer
- 1 monochrome printer
- 1 Large screen monitor (flat panel)

■ : RTU

☐ RTU without display monitor
Design, supply and install a self-standing IP65 enclosure equipped with following items:
- RTU
- Instrumentation and communication equipment
- Backup battery system with charger for 24 hours
- Lighting
- Anti-condensation heater
- Earthing and lightning protection
- All internal wiring
- Other equipment to satisfy the functional requirements

☑ RTU with display monitor
Design, supply and install a self-standing IP65 enclosure equipped with following items:
- RTU
- Display monitor
- Instrumentation and communication equipment
- Backup battery system with charger for 24 hours
- Lighting
- Anti-condensation heater
- Earthing and lightning protection
- All internal wiring
- Other equipment to satisfy the functional requirements

☐ RTU (design & supply only)
Design and supply self-standing IP65 enclosure equipped with following items:
- RTU
- Instrumentation and communication equipment
- Backup battery system with charger for 24 hours
- Lighting
- Anti-condensation heater
- Earthing and lightning protection
- All internal wiring
- Other equipment to satisfy the functional requirements

☑ Interface with flow computer
Make provision for:
- Installation of the flow computer which shall be prepared by GTCL in the enclosure
- Interface between RTU and the said flow computer

☐ Interface with receiver for turbine meter
Install the existing receiver for turbine meter(s) in the RTU enclosure and interface it (them) via communication (MODBUS) cable.

☐ Interface with other system
Provide the interface between RTU and other system such as PLC or PC operated by the operating company including all communication cables between RTU and other system.

☑ Cable between RTU and Master Telemetry Station
Design, supply and install the cable between RTU and Master Telemetry Station in case RTU and Master Telemetry Station are located in the same site.

■ : Instruments

☑ Existing instruments
Re-use the existing instruments and cables.

Note:
Existing instruments and cables shall be serviced by the Employer.

☑ New Instruments
Design, supply and install the following instruments.
Output signals from instruments are to be cabled via field junction box to the RTU.

■ : Pressure transmitters Q'ty

☑ Design, supply and intall: [1]
- Pressure transmitter on the existing spare tapping point
- Tubing between tapping point and transmitter

☐ Prepare the tapping point for the pressure transmitter, and design, supply and install:
- Pressure transmitter on the prepared tapping point
- Tubing between tapping point and transmitter

■ : Differential pressure transmitters Q'ty

☐ Design, supply and install:
- Differential pressure transmitter on the existing spare tapping point
- Tubing between tapping point and transmitter

☐ Prepare the tapping point for the differential pressure transmitter, and design, supply and install:
- Differential pressure transmitter on the tapping point
- Tubing between tapping point and transmitter

■ : Temprature transmitters Q'ty

☐ Design, supply and install:
- Thermowell in the spare boss on the pipe
- Resistance temperature detector complete with a head mounted transmitter into the thermowell

■ : Limit switch Q'ty

☑ Design, supply and install the limit switch on the existing shutdown valve for valve position monitoring. [1]

☐ Pick up Signal from the Existing Turbine Meter Q'ty
Supply and install a dual pulse output pickup head in place of the single pulse output pickup in the existing turbine flowmeter sensor head. The output signal from the existing turbine flowmeter to be cabled via junction box to RTU.

☑ Local Field Instrument Junction Box Q'ty
Design, supply and install an Intrinsic safety junction box. The junction box to be suitable for glanding appropriate cables. [1]

☑ Instrument Cables
Design, supply, install the instrument cables from the field instruments to RTU via junction box including each cable termination with gland.

2. Communication System

■ : Master Telemetry Station (Former Microwave Radio Station)

☑ Removal of existing communication system
Remove and dispose following existing items used for microwave transmission system:
- Microwave equipment/facilities in the radio equipment room
- Antenna mounted on the existing tower
- Cables between radio equipment room and existing tower

☑ Radio equipment to connect Master Telemetry Station with Provider's Access Point
Design, supply and install IP radio equipment at existing radio equipment room to connect Master Telemetry Station with nearest Provider's Access Point (BTCL's AP), including all necessary cables, accessories and the antenna to be mounted on the existing tower.

☑ Master telemetry equipment
Design, supply and install master telemetry equipment at existing radio equipment room to connect with slave telemetry equipment, including all necessary cables, accessories and the antenna to be mounted on the existing tower.

☐ Radio equipment to connect Master Telemetry Station with OCT
Design, supply and install IP radio equipment at radio equipment room to connect Master Telemetry Station with Operating Company Terminal (OCT) at another site, including all necessary cables, accessories and the antenna to be mounted on the existing tower.

☑ Radio equipment to connect Provider's Access Point with Master Telemetry Station
Design, supply and install IP radio equipment at nearest BTCL's access point to connect BTCL's AP with Master Telemetry Station, including all necessary cables, accessories and the antenna with monopole.

☑ Network equipment
Design, supply and install all necessary Network equipment at radio equipment room of Master telemetry station as well as at nearest BTCL's access point.

☐ Network cable to OCT
Design, supply and install network cable between Master Telemetry Station and OCT which shall be installed within the same site.

■ : IP PBX System

☑ IP PBX main unit
Design, supply and install IP PBX main unit with necessary accessories and spare parts.

☑ Extension telephone set Q'ty
Design, supply and install extension telephone set(s) with required cables. [20]

3. Electrical Works

■ : Power Supply to RTU

☑ Electrical power shall be supplied to RTU from existing PDB, and existing power cable shall be re-used.

☐ Design, supply and install MCB box for the power supply to RTU including all cables from existing PDB to MCB box and from MCB box to RTU.

☐ Design, supply and intall power controller and power cable to RTU at remote site where electrical power is supplied from existing solar panel.

☐ Design, supply and install new solar panel, power controller and power cable to RTU.

■ : Backup Batteries for Radio Equipment at Master Station

☑ Remove and dispose existing backup batteries for radio equipment.
Supply & install new backup batteries with charger suitable to backup new radio equipment for 48 hours.

■ : Replacement of Air conditioner at Radio room of Master Station

☑ Remove and dispose existing window type air conditioner at raido room, and Supply & install new air conditioner suitably selected to maintain the specified temperature and humidity of radio room.

■ : Supply of Portable Engine Generator Q'ty

☑ Supply of the petrol and/or diesel driven 1 kVA portable engine generator for the maintenance of remote site(s) without commercial power supply. [1]

4. Civil Works

■ : Foundation & Sunshade for RTU

☑ Re-use existing foundation & sunshade for RTU
Examine the condition of existing foundation and sunshade for RTU and repair the defects, if any.

☐ Provide new foundation & sunshade for RTU
Design and construct the foundation and sunshade for new RTU at suitable location. The foundation and sunshade should be designed to suitably accommodate new RTU.

■ : Instrument Stand with Foundation & Sunshade

☑ Re-use existing Instrument stand(s) with foundation & sunshade
Examine the condition of existing Instrument stand(s) with foundation & sunshade and repair the defects, if any.

☑ Provide new Instrument stand(s) with foundation & sunshade
Design and construct the Instrument stand(s) with foundation & sunshade at suitable location. It should be designed to suitably accommodate the required number of instruments and explosion proof instrument field junction box.

■ : Refurbishment of Existing Radio Building/Radio Equipment Room

☑ Refurbishment of Radio Building
Examin the condition of the whole existing radio building and repair the defects if any.
Clean and touch-up the external and internal finish of the whole existing radio building.

☐ Refurbishment of Radio Equipment Room
Examine the condition of existing rooms where radio equipment and backup batteries are installed and repair the defects if any.
Clean and touch-up the internal finish of the said rooms.

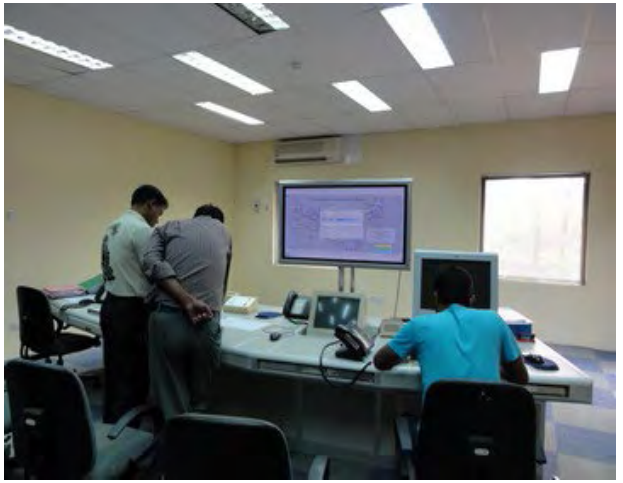
☐ Cleaning of Radio Equipment Room
Clean and tidy up the existing rooms where radio equipment and backup batteries are installed.

■ : Refurbishment of Rooms at Existing Control Center

☑ Examine the condition of following existing rooms at Main/Auxiliary Control Center and repair the defects, if any:
- Equipment Room (GF)
- Battery Room (GF)
- System Management Room (1F)

Clean & touch-up the internal finish of these rooms.

5. Site Photo

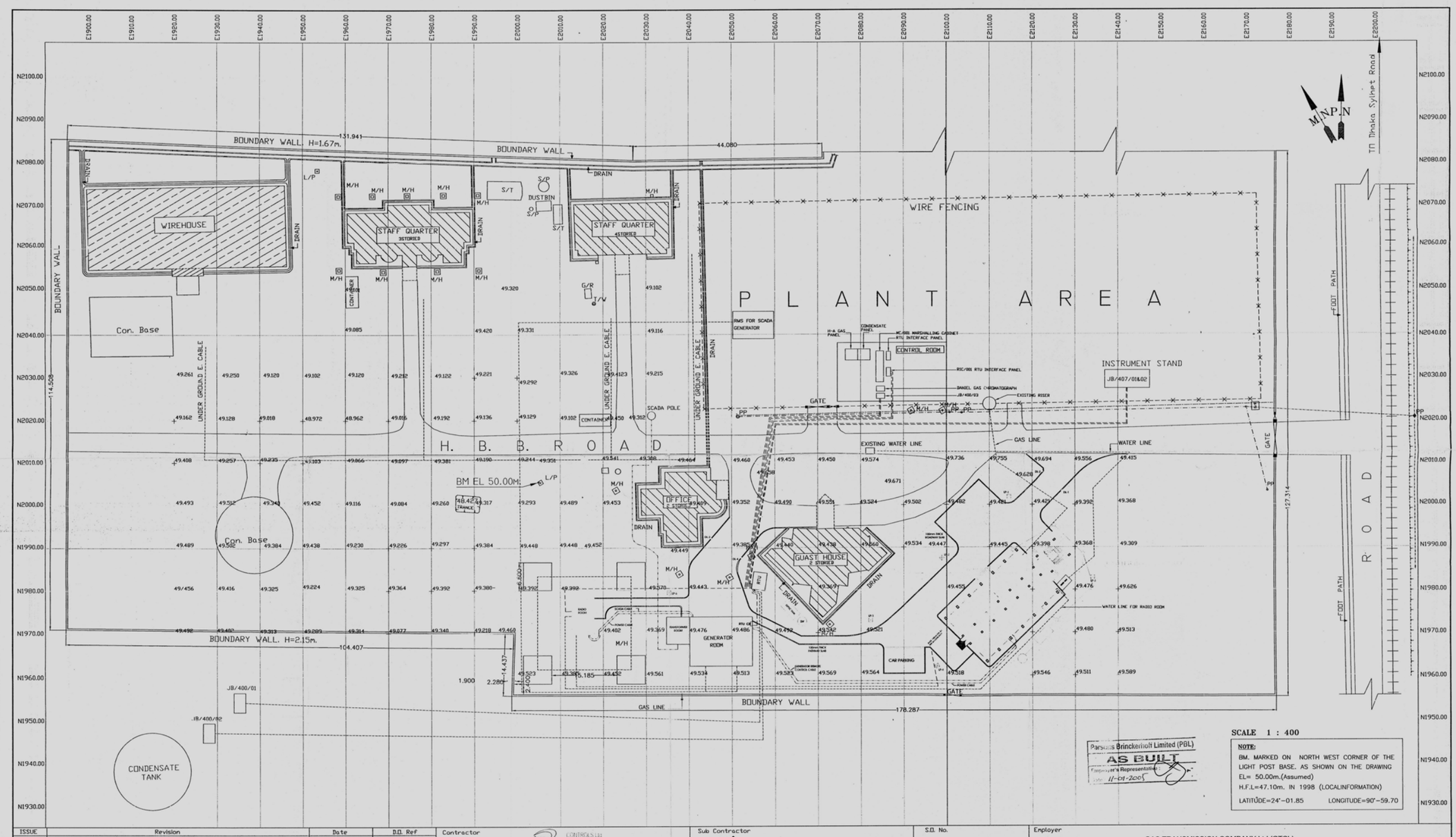


System Management Room

Existing Radio Building

6. Site Layout

See attached Layout Plan.



Parsons Brinckerhoff Limited (PBL)
AS BUILT
Engineer's Representative
11-01-2005

SCALE 1 : 400

NOTE:
BM. MARKED ON NORTH WEST CORNER OF THE LIGHT POST BASE, AS SHOWN ON THE DRAWING
EL= 50.00m.(Assumed)
H.F.L=47.10m. IN 1998 (LOCALINFORMATION)
LATITUDE=24°-01.85 LONGITUDE=90°-59.70

ISSUE	Revision	Date	D.O. Ref
A	ISSUED FOR DESIGN APPROVAL	-	-
B	ISSUED FOR DESIGN APPROVAL	08-11-04	-

Contractor: CONTROLS Ltd

CONTRACT DRAWING APPROVAL
Drawing Status: DESIGN APPROVAL
REDLINED CHANGES | APPROVED NO CHANGES
PRINT NAME:
SIGNED: DATE:

Sub Contractor: SURVEY CORPORATION
S.O. No.

Drawing Title: SITE CODE : 400, 400A & 407
SITE NAME : ASHUGANJ STANDBY CONTROL ROOM & SCRAPER TRAP STATION

Drawing No.	Rev	Sheet	Orig. Size
400-60-72			A1

	Drawn	Checked	Approved
BY	HASHEM	M. A. HAYAT	M. A. HADAYET
Date	25-04-99	25-04-99	25-04-99

Employer: GAS TRANSMISSION COMPANY Ltd (GTCL)

THE BANGLADESH GAS INFRASTRUCTURE DEVELOPMENT PROJECT. SUPERVISORY CONTROL, DATA ACQUISITION AND TELECOMMUNICATIONS SYSTEMS.

Consultant: PB Technologies Ltd.

Employer Contract No: GTCL/RL-1109/C2

Site Information & Scope of Work

Site Information

Site Name : Titas Gas Field Location 1
Site Code : 10-ASH-201

Site Address : To be provided later.

Coordinates : N 23° 59' 49.2 " : E 91° 06' 41.9 "
** Coordinates are surveyed by handy type GPS and might be inaccurate.*

Site Type

☐	Control Center	☐	Master Telemetry Station
☑	Gas Field	☐	Operating Company Terminal (OCT)
☐	CGS (City Gas Station)	☐	Power station/Fertilizer Factory
☐	Compressor Station	☐	TBS (Town Bordering Station)
☐	Pig Station	☐	DRS (District Regulating Station)
☐	MS (Metering Station)	☐	GMS (Gas Manifold Station)
☐	VS (Valve Station)		

Site Status
- ☑ Originally covered by The Existing System and shall be covered by The New System.
- ☐ Currently not covered by The Existing System but shall be covered by The New System.
- ☐ Upcoming site which will be covered by The New System after the completion of the Project.

Operating Company : BGFCL

Remarks : Additional instruments are required at this site.

Scope of Work

Works checked off hereinafter shall be carried out for the Project

1. SCADA System

■ : RTU

☑ RTU without display monitor
Design, supply and install a self-standing IP65 enclosure equipped with following items:
- RTU
- Instrumentation and communication equipment
- Backup battery system with charger for 24 hours
- Lighting
- Anti-condensation heater
- Earthing and lightning protection
- All internal wiring
- Other equipment to satisfy the functional requirements

☐ RTU with display monitor
Design, supply and install a self-standing IP65 enclosure equipped with following items:
- RTU
- Display monitor
- Instrumentation and communication equipment
- Backup battery system with charger for 24 hours
- Lighting
- Anti-condensation heater
- Earthing and lightning protection
- All internal wiring
- Other equipment to satisfy the functional requirements

☐ RTU (design & supply only)
Design and supply self-standing IP65 enclosure equipped with following items:
- RTU
- Instrumentation and communication equipment
- Backup battery system with charger for 24 hours
- Lighting
- Anti-condensation heater
- Earthing and lightning protection
- All internal wiring
- Other equipment to satisfy the functional requirements

☐ Interface with flow computer
Make provision for:
- Installation of the flow computer which shall be prepared by GTCL in the enclosure
- Interface between RTU and the said flow computer

☐ Interface with receiver for turbine meter
Install the existing receiver for turbine meter(s) in the RTU enclosure and interface it (them) via communication (MODBUS) cable.

☐ Interface with other system
Provide the interface between RTU and other system such as PLC or PC operated by the operating company including all communication cables between RTU and other system.

☐ Cable between RTU and Master Telemetry Station
Design, supply and install the cable between RTU and Master Telemetry Station in case RTU and Master Telemetry Station are located in the same site.

■ : Instruments

☑ Existing instruments
Re-use the existing instruments and cables.

Note:
Existing instruments and cables shall be serviced by the Employer.

☑ New Instruments
Design, supply and install the following instruments.
Output signals from instruments are to be cabled via field junction box to the RTU.

■ : Pressure transmitters Q'ty

☑ Design, supply and intall: [1]
- Pressure transmitter on the existing spare tapping point
- Tubing between tapping point and transmitter

☐ Prepare the tapping point for the pressure transmitter, and design, supply and install:
- Pressure transmitter on the prepared tapping point
- Tubing between tapping point and transmitter

■ : Differential pressure transmitters Q'ty

☑ Design, supply and install: [2]
- Differential pressure transmitter on the existing spare tapping point
- Tubing between tapping point and transmitter

☐ Prepare the tapping point for the differential pressure transmitter, and design, supply and install:
- Differential pressure transmitter on the tapping point
- Tubing between tapping point and transmitter

■ : Temprature transmitters Q'ty

☑ Design, supply and install: [1]
- Thermowell in the spare boss on the pipe
- Resistance temperature detector complete with a head mounted transmitter into the thermowell

■ : Limit switch Q'ty

☐ Design, supply and install the limit switch on the existing shutdown valve for valve position monitoring.

☐ Pick up Signal from the Existing Turbine Meter Q'ty
Supply and install a dual pulse output pickup head in place of the single pulse output pickup in the existing turbine flowmeter sensor head. The output signal from the existing turbine flowmeter to be cabled via junction box to RTU.

☑ Local Field Instrument Junction Box Q'ty [1]
Design, supply and install an Intrinsic safety junction box. The junction box to be suitable for glanding appropriate cables.

☑ Instrument Cables
Design, supply, install the instrument cables from the field instruments to RTU via junction box including each cable termination with gland.

2. Communication System

■ : Slave Telemetry System

☑ Removal of existing slave telemetry equipment
Remove and dispose the existing slave telemetry system including antenna and cable.

☑ Slave Telemetry Equipment
Design, supply and install new slave telemetry equipment in the RTU enclosure, including cables and antenna.

☐ Slave Telemetry Equipment (design & supply only)
Design and supply new slave telemetry equipment in the RTU enclosure, including cables and antenna.

☑ Existing monopole
Re-use existing monople to mount new antenna.

☐ New monopole
Design, supply and install new monopole with foundation to mount new antenna.

☐ New monopole (design & supply only)
Design and supply new monopole to mount new antenna.

3. Electrical Works

■ : Power Supply to RTU

☑ Electrical power shall be supplied to RTU from existing PDB, and existing power cable shall be re-used.

☐ Design, supply and install MCB box for the power supply to RTU including all cables from existing PDB to MCB box and from MCB box to RTU.

☐ Design, supply and intall power controller and power cable to RTU at remote site where electrical power is supplied from existing solar panel.

☐ Design, supply and install new solar panel, power controller and power cable to RTU.

4. Civil Works

■ : Foundation & Sunshade for RTU

☑ Re-use existing foundation & sunshade for RTU
Examine the condition of existing foundation and sunshade for RTU and repair the defects, if any.

☐ Provide new foundation & sunshade for RTU
Design and construct the foundation and sunshade for new RTU at suitable location. The foundation and sunshade should be designed to suitably accommodate new RTU.

■ : Instrument Stand with Foundation & Sunshade

☑ Re-use existing Instrument stand(s) with foundation & sunshade
Examine the condition of existing Instrument stand(s) with foundation & sunshade and repair the defects, if any.

☑ Provide new Instrument stand(s) with foundation & sunshade
Design and construct the Instrument stand(s) with foundation & sunshade at suitable location. It should be designed to suitably accommodate the required number of instruments and explosion proof instrument field junction box.

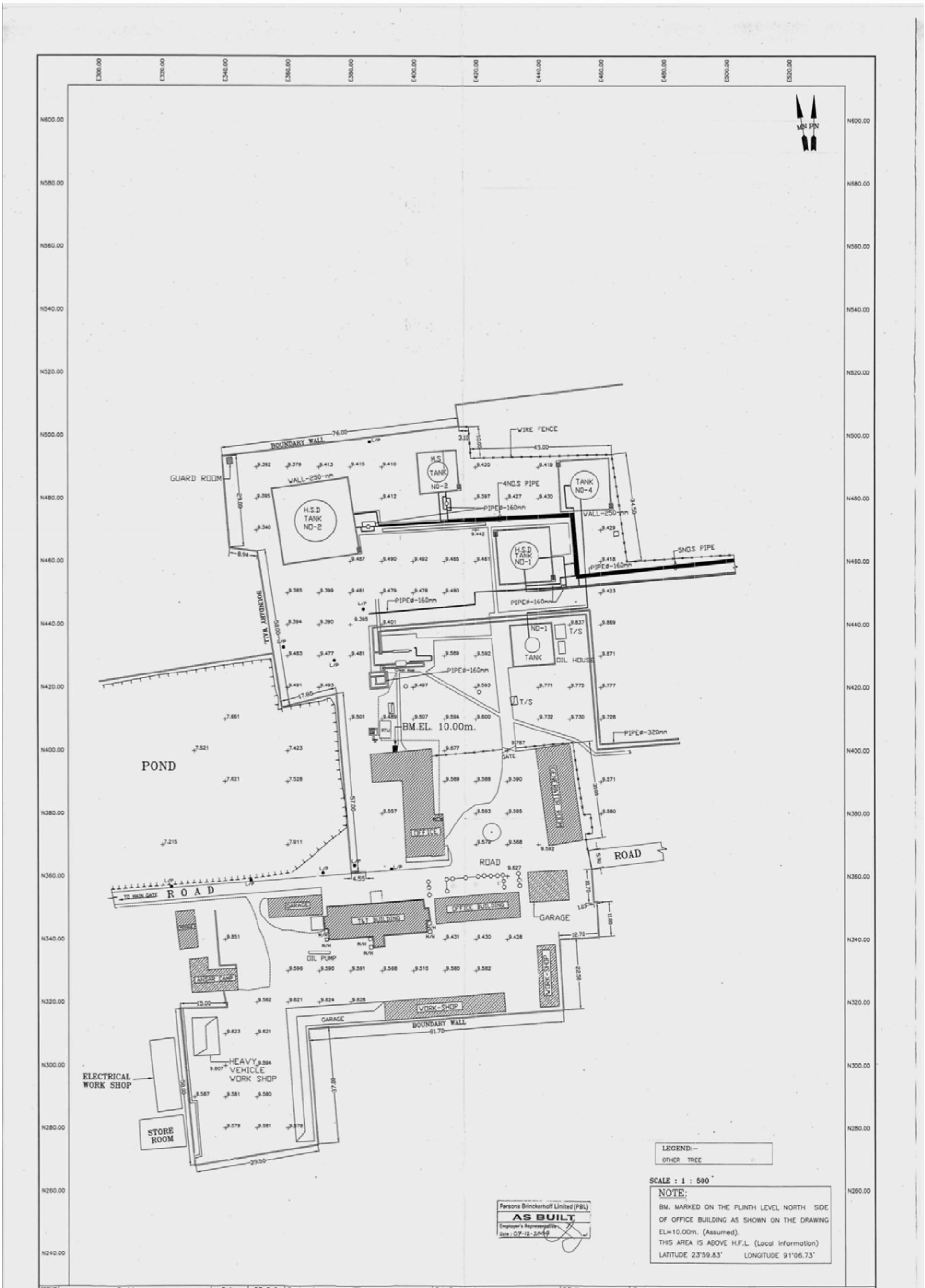
5. Site Photo

Existing RTU

Existing Instrument Stand

6. Site Layout

See attached Layout Plan.



ISSUE	Revision	Date	S.O. Ref
A	ISSUED FOR DESIGN APPROVAL		-
B	ISSUED FOR DESIGN APPROVAL	27-05-99	-
C	ISSUED FOR DESIGN APPROVAL	01-11-04	-

Contractor

CONTRACT DRAWING APPROVAL

Drawing Status: DESIGN APPROVAL

REDLINED CHANGES | APPROVED NO CHANGES

PRINT NAME:

SIGNED: DATE:

Sub Contractor: SURVEY CORPORATION

S.O. No.

Employer: GAS TRANSMISSION COMPANY Ltd (GTCL)

Drawing Title:
SITE CODE : 205
SITE NAME : TITAS GAS FIELD, LOCATION-1

THE BANGLADESH GAS INFRASTRUCTURE DEVELOPMENT PROJECT. SUPERVISORY CONTROL, DATA ACQUISITION AND TELECOMMUNICATIONS SYSTEMS.

Drawing No.	Rev	Sheet	Orig. Size
205-60-72			A1

	Drawn	Checked	Approved
BY	HASHEM	M.A. HAYAT	M.A. HADAYET
Date	27-05-99	27-05-99	27-05-99

Consultant: PB Technologies Ltd.

Employer Contract No: GTCL/RL-1109/C2