ANALYSIS AND DESIGN OF AN IDEAL GAS DISTRIBUTION SYSTEM

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RECOMMENDATION OF THE BOARD OF EXAMINERS

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DECLARATION

It is hereby declared that this project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

.....

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Dedicated

To

My

Beloved

Mother

Invocation of who might be the source for the blessings of God in completion this study.

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ABSTRACT

Exploration, development and production activities for natural gas are technology-driven. These difficult and complex activities will not bring economic prosperity of the country unless the gas is properly utilized. Gas distribution plays a pivotal role in appropriate use of natural gas. It is the vital interface between the industry and the end users. Revenue is brought in by the distribution companies. So for a healthy business, it is imperative that the distribution system runs at the highest efficiency.

Performance of all the distribution companies in Bangladesh is ruined by a phenomenon called 'System loss'. It accounts for 8% of the total gas. Apart from very little system requirement of gas (less than 2%) the rest of it is stolen. Technical and administrative flaws in system design, along with improper and old equipment use worsens the problem. Before embarking new network expansion, identification of the existing problems are very important. Titas Gas Transmission and Distribution Company, which is the largest with highest system loss is chosen for the case study.

Identification of the drawbacks in the existing distribution system, suggestions for development of an ideal distribution system and meaningful evaluation of the suggested system are the main objectives of this study. Financial and economic evaluation of the suggested distribution system is mainly conducted to attract private entrepreneurs for investment in the gas sector. Positive reforms both technical and administrative will enhance that possibility even further. Recommendations of these changes are suggested at the end of this study.

TABLE OF CONTENTS

CHAPTER I: Introduction 1

CHAPTER II: Statement of the Problem 3

2.1 Objectives 3

2.2 Methodology 4

CHAPTER III: Investigations 6

3.1 Study of an Existing System 6

3.1.1 System loss 7

3.1.2 Problems in the network 10

3.1.3 Weaknesses of existing controlling system 14

3.1.4 Administrative drawbacks 14

3.1.5 Maintenance system 15

3.1.6 Sufferings to the users 16

3.2 Surveys on The Proposed Area 18

3.2.1 Bogra 20

3.2.2 Naogaon 22

3.2.3 Joypurhat 22

3.2.4 Environment 23

3.3 Surveys on The Probable Customers 24

3.3.1 Domestic connections 24

3.3.2 Commercial and Industrial connections 25

CHAPTER IV: Distribution System Design 29

4.1 Network Analysis 29

4.1.1 Hardy cross method 29

4.1.2 Gasworks analysis 37
4.2 SCADA System 45

CHAPTER V: Reform and System Adoption 53
5.1 Administrative Reforms 53
5.1.1 The organogram 53
5.1.2 Wage fixation 61

5.2 Monitoring and Evaluation 62
5.2.1 Monitoring 63
5.2.2 Evaluation 63
5.3 Strategic Business Unit (SBU) 65
5.3.1 Concept of SBU 66
5.3.2 Basic works 66
5.3.3 Classification of works 67
5.4 Customer Supporting Proposals 73
5.4.1 Existing gas connection systems 73
5.4.2 New proposals 77
5.4.3 Proposals on Gas Billiug 85

CHAPTER VI: The Project Pro-forma 86
6.1 Calculation of Cost and output values 86
6.2 Project Analysis 99

CHAPTER VII: Conclusions and Recommendations 110

References 112

Appendix: A 113

Appendix: B 116

Appendix: C 121

LIST OF TABLES

Table-1.1: Short descriptions of four distribution companies 1

Table-3.1: Year wise system loss 8

Table-3.2: Four days pressure variation 11

Table-3.3: Data's of the selected region 18

Table-3.4: Existing industries of Bogra 21

Table-3.5: Population Distribution of the Area 24

Table-3.6: Probable Domestic Customers 25

Table-3.7: Probable Industrial and commercial Customers 26

Table-3.8: Gas Load Forecasting 27

Table-3.9: Area wise Gas Load Forecasting 28

Table-4.1: Constant A for Spitzglass formula 33

Table-4.2: Hardy Cross Analysis 34

Table-4.3: Value of pressure drop (Hardy Cross) 37

Table-4.4: Flow rate scenarios 38

Table-4.5: Calculated load and corresponding pressures 38

Table-4.6: Comparison of Hardy Cross and Gas Works 45

Table-4.7: Cost Estimation for SCADA 50

Table-5.1: Salary structure 62

Table-6.1: Costing of pipes 87

Table-6.2: Costing for Manpower 88

Table-6.3: Length of pipeline 90

Table-6.4: Area wise connections and consumptions 90

Table-6.5: Investment cost 91

Table-6.6: Operating/ Recurring cost 94

Table-6.7: Annual value output 98

Table-6.8: Financial NPV & BCR 103

Table-6.9: Financial IRR 104

Table-6.10: Economic investment cost 105

Table-6.11: Economic operating/ recurring cost 106

Table-6.12: Annual value of output 108

Table-6.13: Economic analysis of NPV, BCR & IRR 109

LIST OF FIGURES

Figure-3.1: Graph on 35 year system loss	7
Figure-3.2: Hourly pressure on 01-06-2002	12
Figure-3.3: Hourly pressure on 30-06-2002	12
Figure-3.4: Hourly pressure on 01-12-2002	13
Figure-3.5: Hourly pressure on 30-12-2002	13
Figure-3.6: Position of three proposed town	19
Figure-4.1: Main routs of Bogra town	31
Figure-4.2: Assumed load and pressure	32
Figure-4.3: Final load dist. (Hardy Cross)	35
Figure-4.4: Gas works load dist. (50 psig.)	39
Figure-4.5: Gas works load dist. (45 psig.)	40
Figure-4.6: Gas works load dist. (40 psig.)	41
Figure-4.7: Gas works load dist. (35 psig.)	42
Figure-4.8: Gas works load dist. (30 psig.)	43
Figure-4.9: Location of CGS, TBS and DRS	44
Figure-4.10: SCADA System overview	49
Figure-4.11: Diagrammatic view of SCADA	52
Figure-5.1: The organized organogram	55
Figure-5.2: Organogram of planning and purchase dept.	56
Figure-5.3: Organogram of Mrktg.1 and Mrktg.2 dept.	57
Figure-5.4: Organogram of opn. and Engg. dept.	58
Figure-5.5: Organogram of Service and Admn. dept.	59
Figure-5.6: Organogram of Finance dept.	60
Figure-5.7: Flow diagram of monitoring and evaluation	64
Figure-6.1: Net cash position curve-showing payout	100

ABBREVIATIONS

BARD	Bangladesh Academy for Rural Development
BCR	Benefit Cost Ratio
BGFCL	Bangladesh Gas Field Company Limited
BGSL	Bakhrabad Gas Systems Limited
CGS	City Gate Station
DRS	District Regulation System
DTMF	Duel Tone Multi Frequency
EOW	Engineers Order Wire
GOB	Government of Bangladesh
IMED	Implementation Monitoring and Evaluation Division
IOC	International Oil Company
IRR	Internal Rate of Return
JGTDSL	Jalalabad Gas Transmission and Distribution Systems Limited
LAN	Local Area Network
LCD	Liquid Crystal Display
MMCM	Million Million Cubic Meter
MSCFH	Million Standard Cubic Foot per Hour
NPV	Net Present Value
PCM	Pulse Coded Modulation
PGCL	Pachhimanchal Gas Company Limited
PTA	Performance Target Achievement
RMS	Regulator and Metering System
RTU	Remote Terminal Unit
SBU	Strategic Business Unit
SCADA	Supervisory Control And Data Acquisition
SGFL	Sylhet Gas Fields Limited
TBS	Town Border Station
TGTDCL	Titas Gas Transmission and Distribution Company Limited
TMS	Transmission Management System
UPS	Uninterrupted Power Supply

CHAPTER I

বাংলাদেশ জাতীয় গ্রন্থাগার
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INTRODUCTION

Bangladesh, a transition zone between Southwest and Southeast Asia consists of largest delta in the world, which is blessed with a good reserve of Natural Gas. At present total natural gas producing from 10 (ten)-gas fields under Bangladesh Gas Fields Company Limited (BGFCL), Sylhet Gas Fields Limited (SGFL) and International Oil Companies (IOC), are about 28.35 MMCM/Day. Country's Gas consuming sectors are, Power plants, Fertilizer factories, Industries, Commercial and Domestic sectors etc. Under 'Petrobangla' a corporate body under the ministry of petroleum and mineral resources, there are four separate distribution companies in the country.

Distribution companies are very important in the entire gas value chain, as they are the one who collect the revenue from the consumers. The four distribution companies were formed on the basis of the region they serve. The details of these companies are shown in the Table-1.1.

Table-1.1: Short descriptions of existing four distribution companies.

Name of the company and covering districts	Date of Establishment	Franchise area in Sq. km.	Daily use of gas in MMCM/Day	% Of Consump.	No of Consumers
Titas gas T&D Co. Ltd.: Gr. Dhaka, Gr. Mymensing, Tangail & B. Baria	20th Nov. 1964	26,050	19.03	67.13	8,33,797
Bakhrabad gas Systems Ltd.: Chand pur, Comilla, Gr. Noakhali & Ctg.	7th June, 1980	16,100	6.07	21.41	2,43,887
Jalalabad gas T&D System Ltd.: Greater Sylhet.	1st Dec. 1986	12,600	1.99	7.02	68,079
Pashchimanchal Gas Co. Ltd.: Serajganj and Pabna.	29th Nov. 1999	4,875	1.26	4.44	1,558

Franchise areas with transmission lines of the four distribution companies are shown in the Figure-A1 (Appendix-A).

Presently the distribution companies are facing crisis and major public anger due to as high as 8% so called 'System loss'. The internationally accepted system loss for some leakage and own use by the system is not more than 2%. The major portion of the system loss is due to theft. Illegal consumers along with some corrupt employees of the distribution company are depriving the nation a large amount of revenue every year (estimated 500 crore taka). This corruption process is aided by faulty system design, lack of control and monitoring, poor organizational and pay structure of the companies and unplanned growth.

To resolve some of these problems, a detailed study of the existing system is essential. If all the problems can be identified, only then a new and ideal gas distribution network can be designed. Among the four distribution companies in Bangladesh, Titas is the largest, oldest and with the highest system loss. A thorough study of its system loss, technical problems in the distribution network, controlling system, administrative bottlenecks, maintenance procedures and most importantly customer handling, will reveal the measures that need to be taken for a better system design.

The west zone of Bangladesh did not get the privilege of using gas. After the completion of Jamuna Bridge, gas has now reached the west zone. Completion of TGTDCL system study, a new area in the west zone (Bogra, Naogaon and Joypurhat) can be used for a comprehensive new system design.

CHAPTER II

STATEMENT OF THE PROBLEMS

Natural gas sector is very important for the development of a growing country like Bangladesh. Significant problems existing in gas exploration, development, production, transmission and distribution are deterring the expected developments. This study concerns only with the distribution system, the core part of gas marketing. Country's existing distribution networks are full of faulty design, poor controlling and lot of drawbacks in administration and customer services. To overcome these problems, selected objectivity and methodologies are described bellow.

1.1 Objectives

Although Bangladesh is endowed with natural gas, the demand is growing rapidly. Conservation and judicious use of this only primary energy resource is equally important as finding new reserves in meeting the future gas demand. Through the so-called 'System loss' the gas distribution companies are being financially hit and at the same time the national economic growth is being retarded. Old systems are flawed that helps this nexus of corruption. To mitigate this problem, the objective of the present study is

- To identify all technical shortcoming in the distribution system of TGTDCL.
- To identify the weaknesses in planning implementation and monitoring of the TGTDCL distribution system

- To locate administrative, organizational and occupational problems in the system

- To design an ideal distribution system for a new area based on the learning of TGTDCL system study.

1.2 Methodology

Completion of the Jamuna multipurpose bridge has opened the door for the natural gas into the northern region of the country. Already two town of the area have been connected to the national grid of natural gas. Bogra is one of the most important, old and prosperous industrial towns of Bangladesh. Naogaon and Joypurhat are other two important district towns close to Bogra. Connection of these three towns to the national gas grid, would give a boost to the development of the region. Thus for an ideal gas distribution network, the central region of the north Bengal has been chosen and to design an ideal gas distribution system to create sustainable gas market in the selected area, the methodologies followed are:

1. By adopting the findings of the study of an existing gas distribution system and conducting an elaborate survey of the selected area (data collection).

2. Prediction of probable numbers of customers separately in the heads of industrial, commercial, domestic, seasonal and bulk etc.

3. Outlines of the proposed network, including probable position of transmission line, locations of City Gate Station (CGS), Town Border Station (TBS) and District Regulating Stations (DRS)

4. Design of the network with the help of latest software available, to confirm adequate pressure and supply of gas

5. Installation of Supervisory Control and Data Acquisition (SCADA) system to establish a modernized communication system

6. Administrative reforms considering human resource management and introduction of some customer supporting programs

7. Financial and economic evaluation of the designed distribution system.

CHAPTER III

INVESTIGATIONS

In order to assess the feasibility of a gas distribution system in any region, it is imperative to conduct a thorough investigation of the selected region. The investigation should cover some key parameters such as the socioeconomic condition, communication, infrastructures, future growth potential, geographical features and the environment. Details of the investigations conducted are described in the following paragraphs.

3.1 Study of An Existing System

A pragmatic approach to design an improved distribution system is to avoid the known problems in the existing distribution systems. Therefore a study on the Titas Gas T&D Co. Ltd. (Figure A2) was conducted aiming to identify the key problem areas such as, a) System loss, b) Network problems, c) Weaknesses in the controlling system, d) Bottlenecks in the administration, e) Problems in the maintenance system and f) Sufferings of the consumers.

<u>The company at a glance:</u>

Name of the company	: Titas Gas Transmission and Distribution Co. Ltd.
Date of incorporation	: 20 November 1964.
Yearly Gas Sales	: 6945.32 MMCM (2001-2002 Audited Report)
Yearly Revenue	: Tk. 2009.83 crore (2001-2002 Audited Report)
Payment to the National Exch	: Tk. 194.46 crore
Foreign currency savings	: About Tk. 1600.00 crore
Number of customer	: Total-833978 (Power-8, Private Power-6, Fertilizer-4, Industry-2516, Seasonal-152, Commercial-7029 and Domestic-824263) up to June 2002.
Constructed Pipeline	: 7841.19 km. Up to June 2002.

Sources of Gas Supply	: Titas (Brahmmanbaria), Habiganj, Rashidpur, Bakhrabad Bianibazar, Kailashtila, Jalalabad and Narshingdi Gas Fields.
Manpower	: Total-2748 (Officer-710, Staff-2038) as on June 2002.
Chief Executive	: Engr. Md. Abdullah

The present study is concerned only with its drawbacks as mentioned above.

3.1.1 System loss

'System Loss' is an acute problem of the 'Titas Gas T&D Co Ltd', now going on relentlessly. During 2001-2002 fiscal year, the total system loss on sales value stands at Tk. 274.00 crore. The matter is disappointing not only to the authority, but also embarrassing for its employees. Already the government has directed the authority to curtail its system loss to a sensible level, otherwise it threatened for stern actions. During the study, observations on 35-year figure of system loss as shown in Table-3.1 and Figure-3.1, is enough to understand the severity of the problem (System loss, Titas-2002).

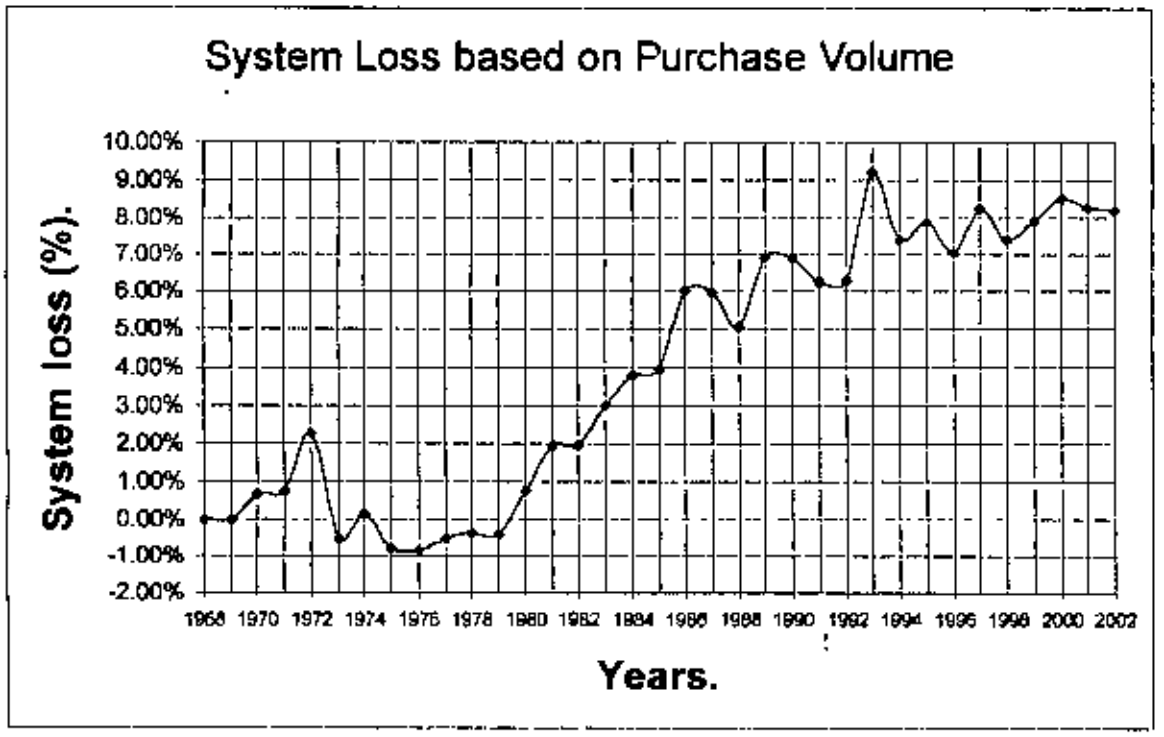


Figure-3.1: Graphical representation of 35 years system loss.

Table-3.1: Year wise system loss, from beginning of TGTDCL.

Unit: MMSCM.

Financial Year	Gas Purchase (Net)	Gas Sales	System Loss based on Purchase Volume
1967-68	6.37	6.37	0.00 %
1968-69	29.27	29.27	0.00 %
1969-70	89.62	88.99	0.69 %
1970-71	227.18	225.45	0.76 %
1971-72	118.65	115.98	2.25 %
1972-73	426.99	429.29	0.54 (+)%
1973-74	558.70	557.86	0.17 %
1974-75	292.26	294.57	0.79 (+)%
1975-76	579.53	584.51	0.86 (+)%
1976-77	631.15	634.57	0.54 (+)%
1977-78	649.62	652.07	0.38 (+)%
1978-79	771.89	775.17	0.42 (+)%
1979-80	896.17	889.40	0.76 %
1980-81	1003.72	984.12	1.95 %
1981-82	1458.00	1429.43	1.96 %
1982-83	1619.16	1570.70	2.99 %
1983-84	1900.37	1828.16	3.80 %
1984-85	2216.92	2129.14	3.96 %
1985-86	2273.67	2134.24	6.00 %
1986-87	2688.12	2527.04	5.99 %
1987-88	2977.88	2827.32	5.06 %
1988-89	3171.63	2951.66	6.94 %
1989-90	3474.70	3225.00	6.90 %
1990-91	3669.04	3439.67	6.25 %
1991-92	4092.32	3834.97	6.29 %
1992-93	4749.82	4312.26	9.21 %
1993-94	4661.89	4316.71	7.40 %
1994-95	4877.94	4493.31	7.89 %
1995-96	5280.57	4907.59	7.06 %
1996-97	5447.51	4999.31	8.23 %
1997-98	5534.29	5123.68	7.42 %
1998-99	6106.15	5622.72	7.92 %
1999-00	6658.01	6091.51	8.51 %
2000-01	7191.67	6594.82	8.30 %
2001-02	7568.12	6946.67	8.21 %

Causes of system losses are-

i) Gas piracy by dishonest customers and officials.

ii) Inadequate logistic supports.

iii) Absence of appropriate management strategies.

iv) Lack of efficient manpower.

v) Inappropriate monitoring works.

vi) Weak legal supports.

vii) Irregularities in billing.

viii) Installations of the network without input-output analysis.

ix) Injunctions by honorable courts on some disconnection encouraging the delinquent customers to continue their misdeeds.

x) Delay in disposal of court cases.

xi) Wrong calculation of bills.

xii) Random leakage in the networks.

xiii) Absence of congenial atmosphere in the companies.

xiv) Meter-less domestic customers, as per test result consuming minimum of 86.65 m^3 and 110.05 m^3 of gas per month, rather pay only for 76.40 m^3 and 87.64 m^3 for single and double burner respectively (a major uncounted factor, actually recurring 35% of the total system loss).

The mischief acts normally applied in gas piracy are-

i) Meter tampering.

ii) Meter by-pass lines.

iii) Unauthorized reconnections to disconnected risers.

iv) Unauthorized connections.

v) Pressure tampering for excess load than sanctioned once.

vi) Copying of the meter/ regulator saving seals.

vii) Ledger tampering.

viii) Lump-sum bill without meter reading and adjustment after hiding a complete cycle of a meter.

3.1.2 Problems in the network

At the beginning of the company, the city of Dhaka had a population of about 1 million and the network was designed on the basis of this population with a twenty-year forecasting period. Today the mega-city is facing a tremendous population pressure on it. At present, population of the Metropolitan Dhaka stands at over 10 million.

The gas network constructed during 70's in the old part of the city became undersized in its capacity in the context of the increased gas demand in the residential, commercial and industrial units. Unplanned growth of the area of the city resulted in unplanned growth of the gas network as well. Consequently increase of production, development of human resources, socioeconomic and infrastructural developments of the country faced a strong setback. This study finds that at present main problems in the distribution networks are-

i) Inconsistent pressure to the inlets of each distribution network is due to tremendous pressure variations in the national transmission grid as shown in the Figure-3.2 to Figure-3.5.

ii) Severe pressure depression in various part of the gas network.

iii) Pressure depression during pick hours.

iv) In many cases, the supplies are not complying with the demands.

v) It is very difficult to categorize (either grid or loop) the existing distribution system.

vi) There are random leakages, at most of the valves on the distribution network.

vii) Random growing of the industrial units causing interruptions in the uniform gas flow.

viii) In many places ¾" dia service lines are acting as a low-pressure distribution line!

ix) In many cases, at the junctions of the mains or at the junctions between the mains and the services were not purged properly.

To see the extent/range of pressure variations, hourly reading of two days from the month of June and December 2002 are presents in Table-3.2. These readings were taken during the study at the inlet of Demra (Titas) City Gate Station (CGS)-1. The same data are shown graphically in Figures-3.2 to Figure-3.5 (Hourly log book, Titas gas-2002).

Table-3.2: Four days pressure variations.

Time in Hour.	Pressure (psig).			
	June-2002		December-2002	
	1st.	30th.	1st.	31st.
08.00	720	590	690	710
09.00	720	580	675	680
10.00	710	560	660	660
11.00	700	550	650	650
12.00	680	550	645	630
13.00	640	530	640	625
14.00	630	500	635	655
15.00	630	495	630	660
16.00	640	485	620	665
17.00	630	490	610	650
18.00	610	495	600	640
19.00	600	480	580	620
20.00	580	470	580	590
21.00	575	440	570	560
22.00	560	420	565	555
23.00	570	445	560	570
24.00	590	470	580	590
01.00	600	500	600	640
02.00	610	540	625	665
03.00	625	580	640	690
04.00	650	600	645	720
05.00	675	630	645	740
06.00	700	660	660	740
07.00	680	630	680	730

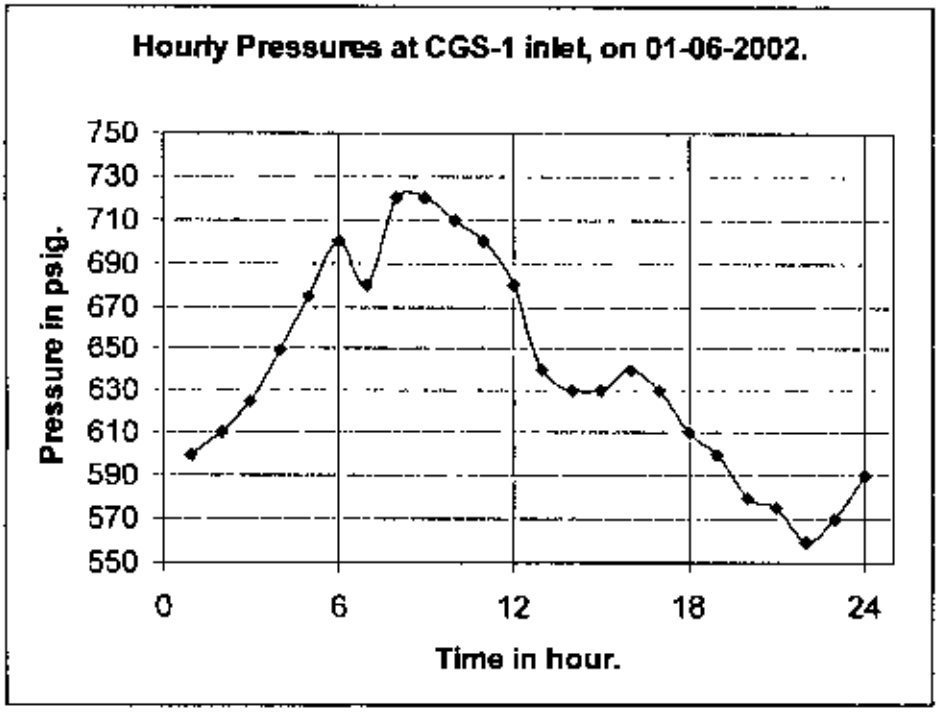


Figure-3.2: Hourly pressure readings at CGS-1, on 01-06-2002.

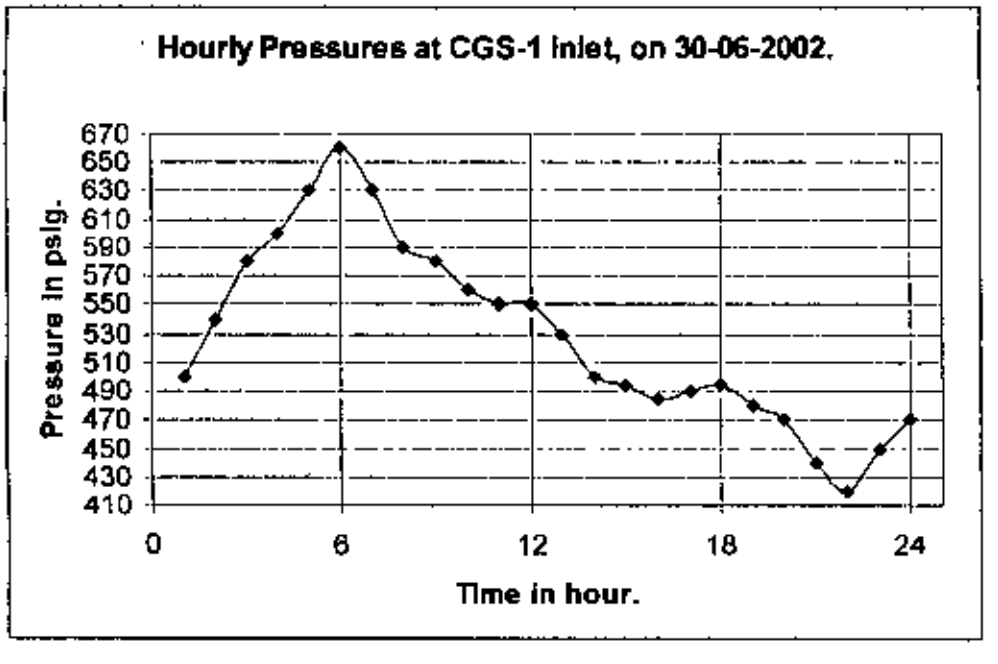


Figure-3.3: Hourly pressure readings at CGS-1, on 30-06-2002.

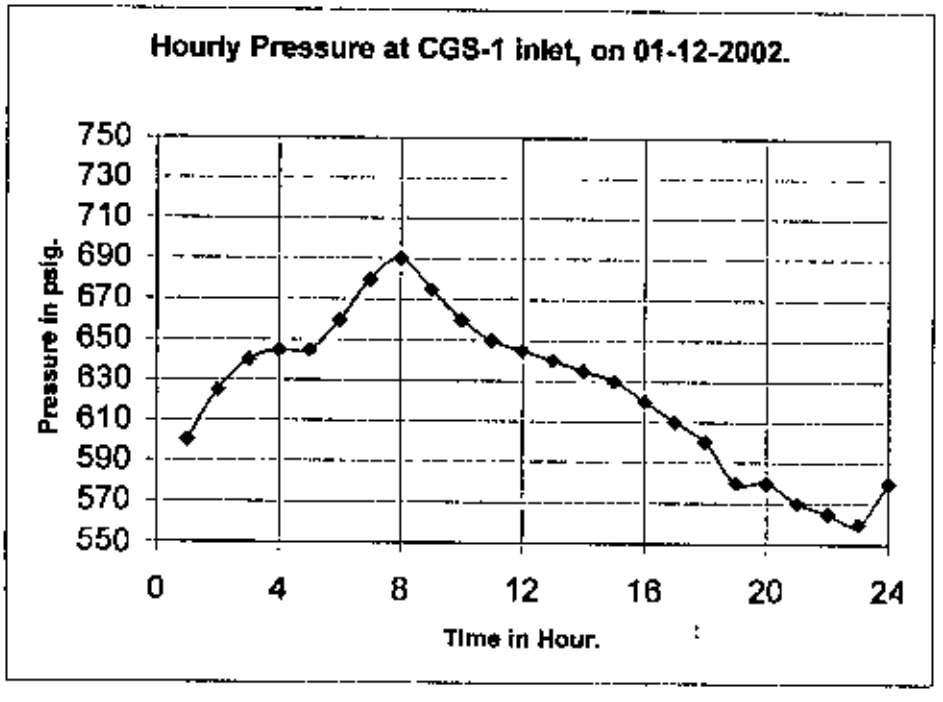


Figure-3.4: Hourly pressure readings at CGS-1, on 01-12-2002.

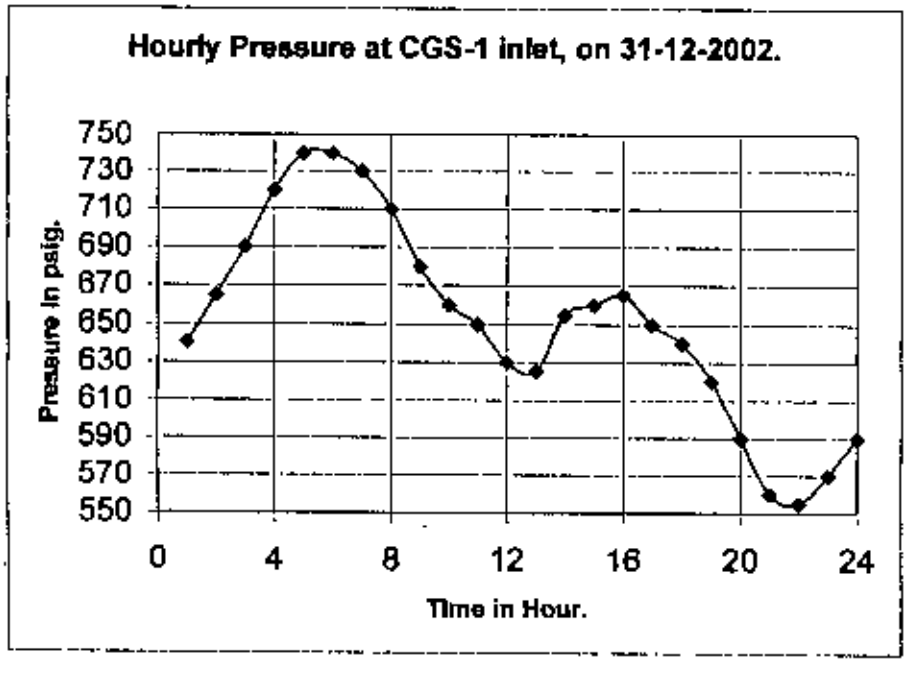


Figure-3.5: Hourly pressure reading at CGS-1, on 31-12-2002.

3.1.3 Weaknesses of existing controlling systems

i) Existence of manual system of operations at different controlling stations like CGS/ TBS/ DRS/ RMS etc.

ii) Positions of most of the control valves are on the main roads. Usual damage of the valve pits by medium/heavy vehicles traffic cause obstacles in controlling gas distribution through the valves.

iii) Inaccurate readings and bills prepared by some unscrupulous persons cause increase in system loss. In some cases this type of mistakes hurt the customers also by imposing negative (!) system loss. This must not be a desirable situation. Inaccurate reading is mainly due to faulty calculations of the pressure factors.

iv) There is no zonal control system in the existing distribution networks.

v) Absence of adequate measures of keeping records of the newly extended distribution lines simultaneously.

vi) Outdated radio operating system for transmission of the messages.

3.1.4 Administrative drawbacks

i) Existing companies are now running with unqualified administration with loose administrative control.

ii) Excessive inefficient staffs and officers with heterogeneous distribution.

iii) Poor evaluations for obedient, efficient and devoted workers and officers.

iv) Nepotism is a common practice.

v) Clear conflict between different cadres, like General versus Technical versus Accounts, BSc. Engineers versus Diploma Engineers versus promoted technical officers and staffs versus officers etc.

vi) Parallel but superior control on administration by CBA.

vii) Nexus between management and CBA.

viii) Intermediary control by Petrobangla added needless complexity to the overall administration process.

ix) Poor inter departmental staffing system.

x) Training and motivational works are full of discrepancy rife with nepotism.

xi) Discrimination during promotion.

3.1.5 Maintenance systems

Distribution lines: In the existing distribution system maintenance of distribution lines are very weak. There is lot of problems in the existing maintenance system as mentioned bellow-

i) At present most of the patrolmen, responsible for reporting on running condition of the distribution lines are non-trained and hence irresponsible.

ii) Follow up controlling over patrol duties are very poor.

iii) In most cases the patrolman hardly perform any other duties besides signing the attendance registrar.

iv) Existing valve pits at the junctions of the distribution lines are mostly in worse condition. The pits are not watertight and full of garbage and water.

v) Painting and greasing of valves is a rare practice.

vi) As well as the poor patrol reports, corresponding follow up remedial actions are also negligible.

vii) Lack of coordination between patrolmen and maintenance team results in endangered exposed gas distribution pipes/valves throughout the year.

viii) Existence of unskilled persons in the distribution line maintenance team.

TBS, DRS and valve stations: These most important establishments of the distribution networks are situated at different part of the network area. The main drawbacks in the maintenance of TBS, DRS and valve stations are-

i) Some are unprotected, grass covered and inaccessible to the pressure/ meter recorders and maintenance team.

ii) Valve stations (for river crossing, rail crossing etc.) are functionally situated at remote areas. Thus they have additional problems of access ways.

iii) Some TBS/ DRS have broken fencing or unlocked gate, giving free access to the cattle and any other trespassers. It poses danger to the people, cattle and the equipments.

Customer RMS: Accessible, spacious and workable customers RMS area give comforts to the metering and regulating (M&R) teams. Problems relating RMS maintenance are-

i) Most of the RMS rooms are less spacious, dark, backward and unsuitable for access of maintenance/ working teams.
ii) In many cases the rooms have only one door and no other openings or ventilations are disgusting for visitors.
iii) The rooms are full of soot and filth.
iv) In some cases customer RMS rooms are not well protected.

Moreover there are many bottlenecks in the maintenance systems of civil engineering department, electrical and mechanical engineering department, transmission department, metering and regulating department, transport department, store department, common service department and all sales departments.

3.1.6 Suffering of the users

The main objective of this study is to provide the customers with smooth and uniform service during gas connections and billing. The main sufferings to the existing customers are-

i) Existing gas connection (domestic, commercial and industrial) system is full of complexity.
ii) For its complex nature, the interested customers remain in the dark about the system of gas connection.

iii) In spite of scheduled time frame one may get a connection soon and other may face difficulty due to nexus of the groups with vested interests.

iv) The tasks for existing gas connection system are very complicated. Initial survey team, sales team and connection team etc. are the different forms of malpractice persons.

v) The customers are suffering, as corrupted workers/ officers and intermediaries (broker in the name of contractor), did not help them without any interest.

vi) Most of the brokers in the name of contractor are the main media for corruptions, in gas sales activities.

vii) An interested customer may get a gas connection at last. But still there are more scope for sufferings during billing, riser shifting, load extension, temporary disconnection/ reconnection etc. as per requirements.

viii) Most of the domestic customer cannot light their burners due to lack of supply and low pressure of gas at the pick hours.

ix) Every domestic customer had to pay their fixed gas bills; even if they did not get proper service from the gas companies.

x) Low pressure or lack of gas in the pick hours causes extreme anguish for the industrial/commercial customers. It results serious losses for the customers due to disturbance or discontinue or in some cases shutting down of the production of their industries or factories.

xi) Unscrupulous and opportunist staffs/officers are often collect ransom in the name of 'RMS visiting' and giving undue facilities to the evil customers.

xii) From July 4, 2004, a new revised gas marketing rules for commercial and industrial customers has been enacted. But any substantial improvement in customer satisfaction has not been noticed yet.

3.2 Survey on the Proposed Area

The selected region for the proposed network includes the district towns of Bogra, Naogaon and Joypurhat, as shown in the Figure-3.6. These three district-towns in the selected region form a large bilateral triangle, as the air distances of both Naogaon and

Joypurhat from Bogra are 52 kilometer and the air distance between Naogaon and Joypurhat is 39 kilometers. The region is situated in the east central part of the Barind tract of Bengal basin, one of the several terraces of Pleistocene age of Cenozoic era. This tract is characterized by its comparatively high elevation, reddish and yellowish clay soils. In local terminology the selected region is termed as the Khiyar (H.E. Rashid, Geography of Bangladesh-1991).

The main rivers of this terrain are: the Karatoa, the little Jamuna. the Bangali, the Atrai, the Tulshiganga and the Chhiri nadi. Bogra town is situated on the west bank of the river Karatoa, Naogaon town is situated on the bank of the river little Jamuna and Joypurhat district sadar is situated on the bank of the river Chhiri.

Total area of the region is 7321 square kilometer and has a population of 55,82,351 according to the 2001 census (Survey of BD-2001). A brief description of the proposed area is explained in Table-3.3

Table-3.3: Detailed data (Land, Population, Agriculture etc.) of the selected region.

Name of the districts.	Land		No of upazilla's	Population	Main crops.
	Acre	Sq. Km.			
1. Bogra	7,21,523	2920	11	26,69,287	Rice, Jute, Wheat, Potato, Chili, Pulbul etc.
2. Naogaon.	8,48,973	3436	11	21,48,053	Rice, Jute, Sugar cane, Potato, Chili, Pulbul etc.
3. Joypurhat	2,38,566	965	5	7,65,011	Rice, Jute, Sugar cane and vegetables etc.
Total.	18,09,062	7321	27	55,82,351	

Communication: Presently the three towns are connected with both roads and railways. Each town is also connected to waterways, as every town is situated on riverbanks. The longest and continuous Teknaff-Tentulia highway through port city Chittagong and the capital city Dhaka also passed through Bogra town. Naogaon and Joypurhat are connected to Bogra by direct highway links, through Dhaka-Bogra-Naogaon and Dhaka-Bogra-Joypurhat routs.

Scale 1" = 62 mile.

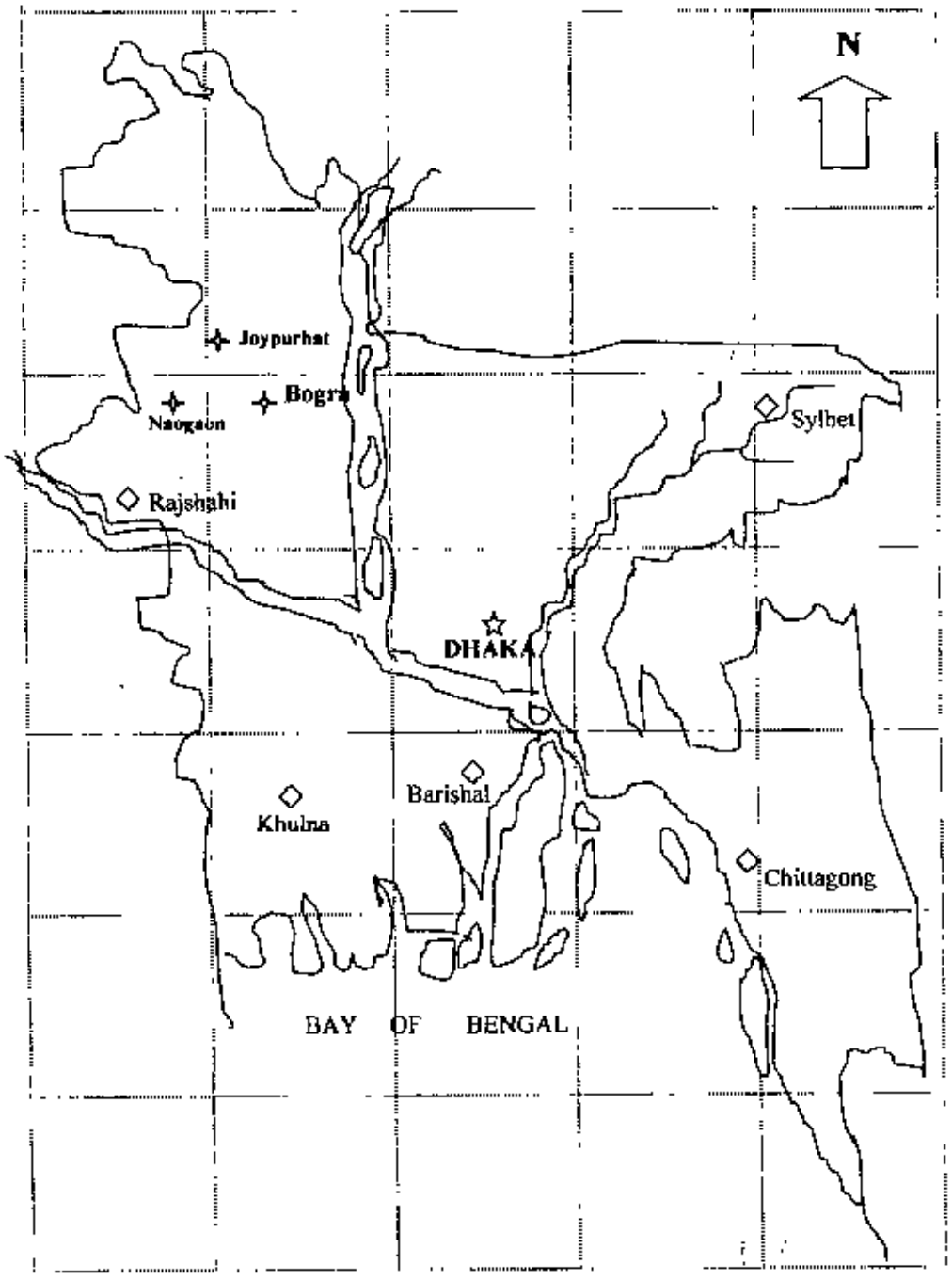


Figure-3.6: Position of proposed three district towns.

The western Ishwardi- Shantahar-Parbatipur-Saidpur broad gauge railway rout touches both Naogaon and Joypurhat. The Shantahar-Bonarpara-Gaibanda-Rangpur-Kurigram-Lalmanirhat meter gauge rail line passes through Bogra town, and the proposed Serajganj-Bogra rail link will bring the dream of Dhaka-Bogra railway connection to reality (H.E. Rashid, Geography of BD-1991).

3.2.1 Bogra

Bogra is one of the most important towns in nor-western part of the country. The town is situated at a pleasant area on the west bank of the river Karatoa. After completion of the Jamuna Multipurpose bridge, the road distance between the Capital city Dhaka and Bogra is only three and half hours. This is an oldest town, famous for its historic establishment the 'Mahastan Garh'. The ancient name of Mahastan Garh was 'Pundranagar' the capital city of the dynasties of Sen, Mourga, Gupta and Paul (Tabibur Rahman, Mohastan garer itihash-2002).

Both on regional and geographical point of view, Bogra is the most important town, for its industrial, commercial and cultural developments in the northern region. The position and existing communication network of the beautiful town, evidently defining it, as the heart of the Rajshahi division.

Establishments:

Educational Institutions: Government Azizul Haque University college, Shahid Ziaur Rahman Medical college and hospital, Shah Sultan government college, Women's college, Polytechnic Institute, Commerce college and number of famous high schools including the Bogra Zilla school.

Industries: A short description about existing industries is given in the Table-3.4

Markets: Fateh Ali market, Raza Bazaar, Shath matha etc.

Cantonments: Aria Bazaar Cantonment and Zahangirabad Cantonment.

BSCIC estate: Situated at Fulbari mouza of Bogra paurashava. Area covered by the estate is 33.17 acre of land with 234 no of different type plots.

Air Port: Kumira Airport (under construction).

Others: Bangladesh Academy for Rural Development (BARD), a modern parjatan motel, a large inter-district bus terminal, a branch of Bangladesh Bank and a railway station that will be transformed into junction after completion of Bogra-Jamuna bridge railway link soon (Geography of Bogra, St. Add.-2002).

Table-3.4: Existing industries of Bogra.

Industry	Types	Numbers
Cotton Industry	Cotton Spinning, Specialized (cotton & synthetic), Twisting and readymade garments.	6
Jute Industry	Jute bag, Jute belling and Jute handicrafts.	8
Paper & Packaging Industry	Paper converting and packaging, Printing and publishing.	10
Forest Industry	Saw mills.	25
Leather Industry	Leather shoes and leather goods.	1
Chemical Industry	Soap and detergent, Plastics etc.	5
Metal Industry	Cast iron foundry, Metal container and Steel utensils.	15
Engineering Industry	Light engineering factories, Automobile servicing, Body building (bus & truck) etc.	120
Electrical & Electronic Industry	Electrical appliances.	4
Food Industry	Flour mill, Rice mill, Bakery & confectionary, Oil mill, Dairy/Poultry firms etc.	80
Servicing Industry	Hotels, Restaurants, Hospitals and Clinics.	225

3.2.2 Naogaon

Situated on the bank of the river little Jamuna, Naogaon is a beautiful town. The air distance between Bogra and Naogaon is only 52 kilometers and has a direct link through both road and railway. Naogaon is an old and commercially important business center.

Municipality: Naogaon was declared as a paurashava during 1963. It has three wards; they are i) Chak Enaet, ii) Khash Naogaon and iii) Par Naogaon. Area of the municipality is 46 square kilometer.

Educational Institutions: There are three colleges, 29 high schools, 102 primary schools, 4 madrasha, one primary teachers training college and one under construction polytechnic institute at Naogaon sadar upazilla.

Commercial importance: Near nor-western border of the country, the strongly communicated (rail, road and water ways) district head quarter is the center of the region and is acting as an important business point. There is huge possibility of industrial development (Geography of Naogaon, St. Add.-2002).

3.2.3 Joypurhat

Joypurhat is famous for its sugar mill and trading center for rice, potato, parbal etc. The air distance between Bogra and Joypurhat is also 52 kilometer and from Naogaon it is 39 kilometer. The well-communicated (rail, road and waterway) district head quarter has a 22 square kilometer paurashava on the bank of the river Chiri.

Commercial importance: Groups of culturally developed inhabitants, numbers of different educational institutions, mineral ore containing calcium carbonate and pit coal, an under construction cement industry and the existing sugar mills etc. are announcing the future commercial prospect of the town. The historic Paharpur near Joypurhat also increases the importance of the town for tourism prospects (Geography of Joypurhat, St. Add.-2002).

3.2.4 Environment

Gas distribution projects have little effects on environment. Even then the environmental **parameters** are briefly explained below-

Physical Resources:

Water resources: Though all three towns are situated on riverbank, hydrology and quality for both surface water and ground water will have no such effects on gas distribution network. Because rivers in this region are calm and less erosive in nature and water pollutions are not very high. During survey in the region, there was no evidence of arsenic pollution physically or as reports in the contemporary newspapers.

Air resources: Overall climate of the area is mostly fare. Due to the fair weather pattern, rich vegetation and clay type topsoil, possibility of air pollution by smog, noise, radiation, odors etc. is less. Hence environmental tolerance for gas linkage and simultaneous industrialization in the area is feasible.

Land resources:

Most of the soils of the area are very fertile for rice, potato, chili, jute wheat, vegetables etc. Possibility of land erosion and sedimentation is unlikely. The main mineral resources of the area are lime stone and pit coal in Jamalganj area of Joypurhat district.

Ecological Resources:

Ecological resources including aquatic resources (Fisheries, Aquatic biology), terrestrial resources (Forests, Terrestrial wild life, Endangered species) etc. are hardly affected by a gas distribution project. Once maximum portion of the area under consideration were covered with dense forests, termed as 'Borendra Bhumi'. At present existence of such jungles are not visible. Thus there is no threat to ecological imbalance due to the proposed project.

Human Use Values:

The parameters including human use values are water supply, transportation (highways, railways and navigation), agricultural development (aquaculture, livestock, irrigation and reforestation), flood control and drainage, power generation, mining and industrialization (manufacturing, agro-based and mineral processing). Existing conditions of all these parameters are extremely favorable for proposed gas distribution project.

Quality of Life Values:

Socio-economic parameters like human ecology, public health, public safety, institutional, resettlement, economic and social structures are promising. Both historical and archaeological culture of the area is jealousy. Mohastan gahr, Pahar pur, modern tourism motel at Bogra and presence of random ancient monuments all over the area are bearing the sign of recreation and aesthetic condition of the area (Dr. M. Rahman, BUET-2003).

3.3 Survey On Probable Customers

According to the annual report (2001) of the survey of Bangladesh, population and family numbers of the three-sadar upazillas are given in the Table-3.5

Table-3.5: Population distribution of the proposed area.

Upazilla	Population	No of Family
Bogra sadar	5,88,783	1,07,224
Naogaon sadar	3,27,632	60,753
Joypurhat sadar	2,25,271	45,484

3.3.1 Domestic connections

It is assumed that 50% families of Bogra upazilla sadar and 40% families of Naogaon and Joypurhat sadar upazilla's are urbane. Study on existing gas connected district head quarters like Mymensiug, Brahmmanbaria, Tangail, Narshindi and Manikganj under Titas Gas T&D Co. Ltd. shows that 2.50% to 3.50% of total families of the district sadars are interested to obtain domestic gas connection at the starting year. The study also shows that in the second year domestic connections increased by 80% of the previous year, third year by 50%, fourth year by 35%, fifth year by 25% of previous cumulative totals and so on as shown in the Table-3.6 (TGTDCL sales reports).

3.3.2 Commercial and industrial connections

Considering existing study, economic and infrastructure development, socioeconomic condition and other environmental situations, probable numbers of commercial and industrial connections in the area are given in the Table-3.7

After completion of customer approximations, total and area wise gas load forecasting (probable off take/ consumption) is computed for this study, as explained in the Table-3.8 and Table-3.9 respectively (Sales report, Titas gas-2002).

Table-3.6: Probable distribution of the domestic customers for designed 20 year period.

Year	Increasing trend % (previous year)	Number of domestic connections		
		Bogra (Holding = 53,000)	Naogaon (Holding = 24,000)	Joypurhat (Holding = 18,000)
1	-	2,000	700	500
2	80 %	3,600	1,250	900
3	50 %	5,400	1,900	1,350
4	35 %	7,300	2,550	1,800
5	25 %	9,100	3,100	2,200
6	15 %	10,400	3,550	2,500
7	12 %	11,600	4,000	2,800
8	11 %	12,800	4,350	3,100
9	10 %	14,000	4,750	3,400
10	9 %	15,200	5,150	3,700
11	8 %	16,400	5,550	4,000
12	7 %	17,600	5,900	4,300
13	7 %	18,800	6,350	4,600
14	6 %	20,000	6,750	4,900
15	6 %	21,200	7,150	5,200
16	6 %	22,400	7,550	5,500
17	5 %	23,600	7,950	5,800
18	5 %	24,800	8,350	6,100
19	5 %	26,000	8,750	6,400
20	5 %	27,200	9,150	6,900
Total		43,250		

Table-3.7: Probable distribution of industrial and commercial customers.

Year	Commercial connections			Industrial connections		
	Bogra	Naogaon	Joypurhat	Bogra	Naogaon	Joypurhat
1	20	5	4	11	2	2
2	33	10	8	19	3	3
3	46	14	11	27	3	4
4	59	19	15	34	4	5
5	72	24	18	39	4	6
6	85	29	22	44	6	6
7	98	33	25	49	6	7
8	111	38	29	53	7	8
9	124	42	32	57	8	9
10	137	47	36	60	9	9
11	150	51	40	63	9	10
12	163	56	43	67	9	11
13	176	60	47	70	10	12
14	189	65	50	74	11	14
15	202	69	54	79	13	16
16	215	74	57	83	14	17
17	228	78	61	87	15	17
18	241	83	64	90	15	18
19	254	87	68	95	16	19
20	267	92	71	103	18	20
Total	430			141		

Table-3.8: Gas load forecasting (Probable Gas Off-take/ Consumption).

Year	Domestic		Commercial		Industry		Others (Power/ Fert.)		Total No. of Connections	Total Gas Consumption (MMSCM)
	Connect.	Consumption (MMSCM)	Connect.	Consumption (MMSCM)	Connect.	Consumption (MMSCM)	Connect.	Consumption (MMSCM)		
1	3200	2.74	29	0.30	15	5.37	0	0	3244	8.41
2	5760	4.92	51	0.54	25	8.95	0	0	5836	14.41
3	8640	7.39	71	0.75	34	12.17	0	0	8745	20.31
4	11660	9.97	93	0.98	43	15.39	0	0	11796	26.34
5	14400	12.31	114	1.20	49	17.54	1	250	14564	281.05
6	16450	14.06	136	1.43	56	20.05	1	250	16643	285.54
7	18350	15.69	156	1.64	62	22.20	1	250	18569	289.53
8	20250	17.31	178	1.87	68	24.34	1	250	20497	293.52
9	22150	18.94	198	2.08	74	26.49	1	250	22423	297.51
10	24050	20.56	220	2.31	78	27.92	1	250	24349	300.79
11	25950	22.19	241	2.53	82	29.36	1	250	26274	304.38
12	27850	23.81	262	2.75	87	31.15	1	250	28200	307.71
13	29750	25.44	283	2.97	92	32.94	1	250	30126	311.35
14	31650	27.06	304	3.19	99	35.44	1	250	32054	315.69
15	33550	28.69	325	3.41	108	38.66	2	450	33985	520.76
16	35450	30.31	346	3.63	114	40.81	2	450	35912	524.75
17	37350	31.93	367	3.85	119	42.60	2	450	37838	528.38
18	39250	33.56	388	4.07	125	44.75	2	450	39765	532.38
19	41150	35.18	409	4.29	130	46.50	2	450	41691	535.97
20	43250	36.98	430	4.52	141	50.48	2	450	43823	541.98

Note:

1) Each double burner domestic customer consumes 0.855 MCM/ Year.
2) „ Commercial „ „ 10.50 „ „
3) „ Industrial „ „ 0.358 MMCM/ Year.
4) „ Power „ „ 364.50 „ „

As per existing Titas Gas study.

Table-3.9: Gas loads (Area wise probable yearly Customer and Gas Off-take/ Consumption), excluding powerhouses.

Year	No of customer									Gas Load (MMSCM)		
	Bogra			Naogaon			Joypurhat			Bogra	Naogaon	Joypurhat
	Dom.	Com.	Ind.	Dom.	Com.	Ind.	Dom.	Com.	Ind.			
1	2000	20	11	700	5	2	500	4	2	5.858	1.367	1.186
2	3600	33	19	1260	10	3	900	8	3	10.227	2.256	1.928
3	5400	46	27	1890	14	3	1350	11	4	14.766	2.837	2.702
4	7290	59	34	2550	19	4	1820	15	5	19.024	3.812	3.504
5	9100	72	39	3100	24	4	2200	18	6	22.499	4.335	4.218
6	10400	85	44	3550	29	5	2500	22	6	25.537	5.130	4.517
7	11600	98	49	3950	33	6	2800	25	7	28.489	5.872	5.163
8	12800	111	53	4350	38	7	3100	29	8	31.084	6.624	5.819
9	14000	124	57	4750	42	8	3400	32	9	33.678	7.366	6.465
10	15200	137	60	5150	47	9	3700	36	9	35.915	8.119	6.764
11	16400	150	63	5550	51	9	4000	40	10	38.151	8.503	7.420
12	17600	163	67	5950	56	9	4300	43	11	40.746	8.897	8.066
13	18800	176	70	6350	60	10	4600	47	12	42.982	9.639	8.723
14	20000	189	74	6750	65	11	4900	50	14	45.577	10.392	9.727
15	21200	202	79	7150	69	13	5200	54	16	48.529	11.492	10.741
16	22400	215	83	7550	74	14	5500	57	17	51.124	12.244	11.387
17	23600	228	87	7950	78	15	5800	61	17	53.718	12.986	11.686
18	24800	241	90	8350	83	15	6100	64	18	55.955	13.381	12.332
19	26000	254	95	8750	87	16	6400	68	19	58.907	14.123	12.988
20	27200	267	103	9150	92	18	6900	71	20	62.934	15.233	13.805

Note:

1) Each double burner domestic customer consumes 0.855 MCM/ Year.
2) " Commercial " " 10.50 " "
3) " Industrial " " 0.358 MMCM/ Year.
4) " Power " " 364.50 " "

As per existing Titas Gas study.

CHAPTER IV

DISTRIBUTION SYSTEM DESIGN

Designing a distribution system to meet increased gas demand may involve two major considerations: i) reinforcement of the system to meet increased demands, and ii) extension of mains into new areas as per requirements. Both problems are basically similar, requiring provisions for adequate gas supply and adequate pressure to customers at all times. Both manual and software system analyzes the proposed network to confirm adequate pressure and supply, and finally the network is equipped with a latest SCADA (supervisory control and data acquisition) system.

4.1 Network Analysis

This study conducted network analysis for the proposed area. Network analysis refers to solution of network problems regarding load calculation, pressure variation, capacity calculation, pipe sizing, calamity simulation etc. Other than computer solutions, there are varieties of network analysis. For example: Rout book billing data method, Temperature-Pressure drop method and Hardy cross method etc. The present study, which is a small and simple network, employs 'Hardy cross' method for the analysis before venturing a software analysis (Gas Engg. Hand book, NY-10016).

4.1.1 Hardy cross method

The principles applied to this method for calculating network pressure drops and flow rates are

i) Total gas flow arriving at a junction equals to the total gas leaving it.

ii) The sum of pressure drops along any closed path must be zero for the network to be in balance.

iii) Flow formula is expressed in the form $h = AL_f Q^n$, where h is pressure drop in inch of water column, Q flow rate in MSCFH, L_f length of main in feet, A is resistance to flow per unit length and coefficient n (ranges between 1.75 to 2).

iv) Resistance to change in gas flow in pipe equals approximately $nAL_f Q^{(n-1)}$.

Data required to solve a network problem include

i) Diameter and length of mains, locations of main connections, and locations of supply sources.

ii) Volume of gas flowing into network at each source of supply, and estimated load distribution from network.

iii) Maximum allowable pressure drops in network, and minimum or maximum allowable pressure.

iv) A gas flow formula best fitting the type of distribution system.

Main layout:

As per main routs of Bogra town shown in Figure-4.1, a network grid of 10" dia, 8" dia and 6" dia distribution network is shown in Figure-4.2. The network has four loops with thirteen legs of distribution main with respective pipe lengths, directions of gas flow, load distribution and diameters as shown in Figure-4.2. Categorically it is a two dimensional network. A map of Bogra municipality is presented in Figure-A2 (Appendix-A).

Using Hardy cross method in this study, it is desirable to calculate the equivalent length of each main of the proposed network, in terms of a single reference diameter. The equivalent length is obtained by multiplying the actual length of pipe by the appropriate factor. In this network, factors for corresponding equivalent length is calculated as per formula and factors shown in Table-4.1.

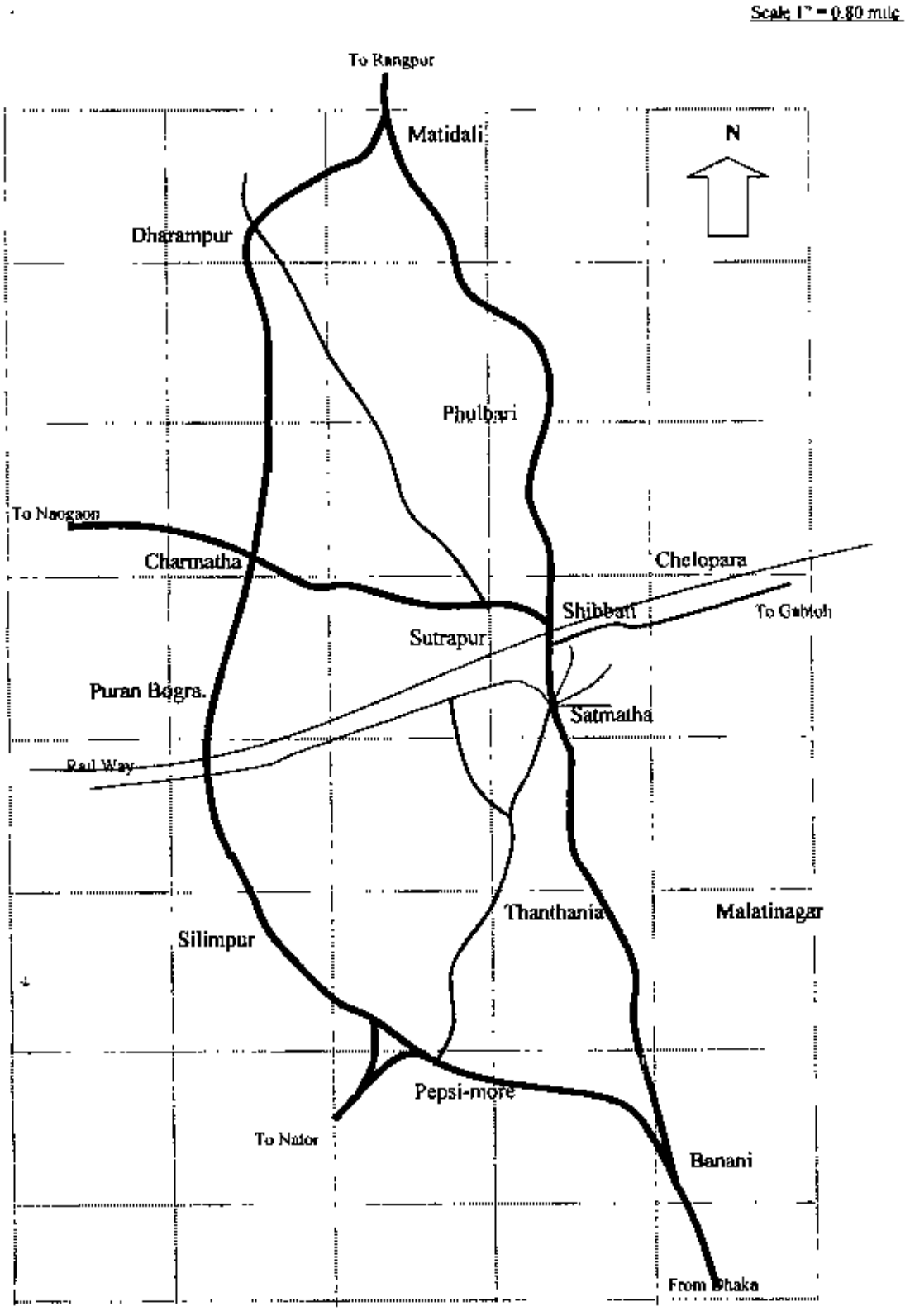


Figure-4.1: Main routs of Bogra town.

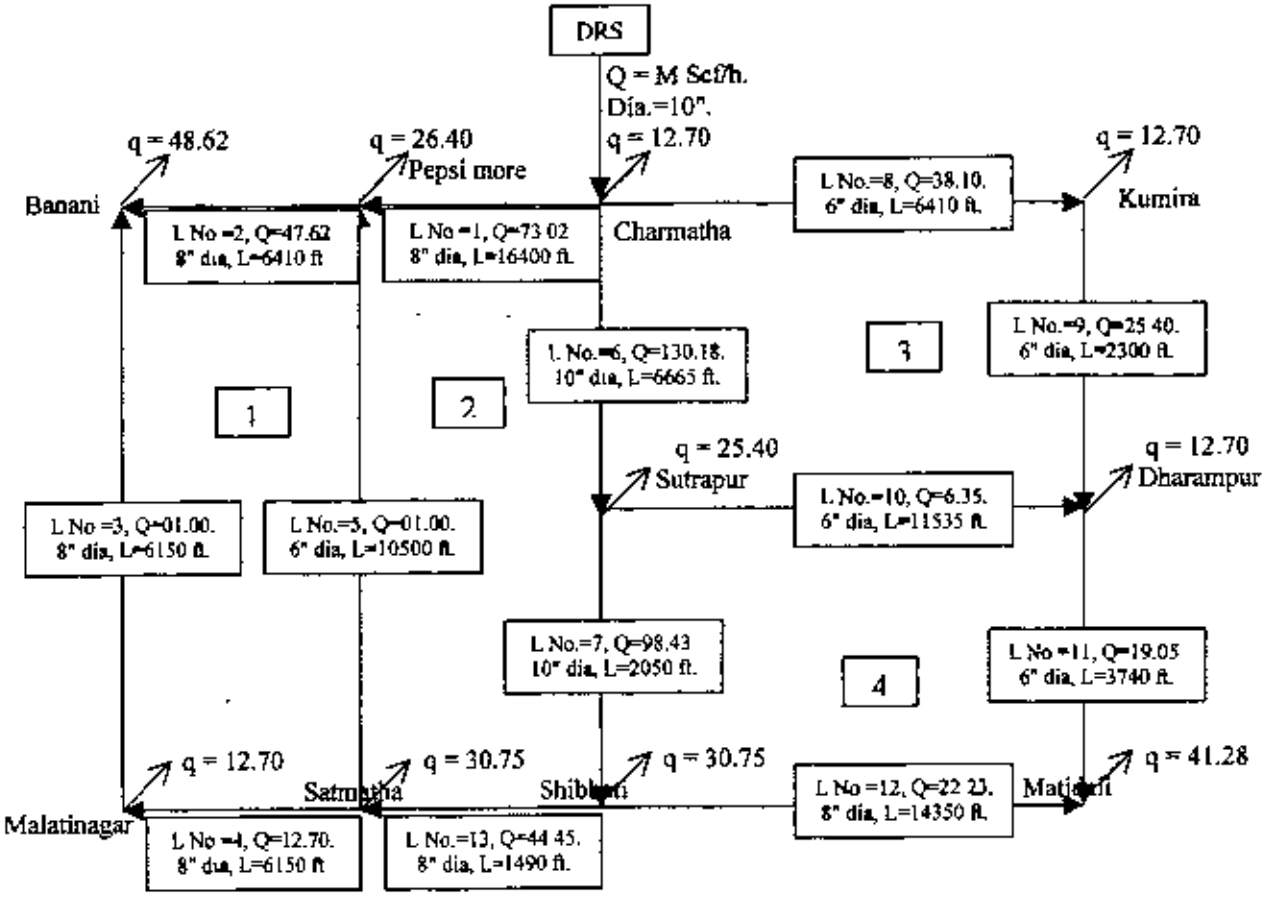


Figure-4.2: Assumed Load Distribution, Pressure and flow (both Q and q are in MSCF/Hour and pressure in psig).

Table-4.1: Constant A for Spitzglass low-pressure formula and factors for computing equivalent lengths of pipe.

Nominal size of pipe in inch.	Constant A.	Equivalent factors (A/A_e).	
		6 inch pipe	16 inch pipe
4	9.036×10^{-11}	8.78	1169
6	1.029×10^{-11}	1.00	133
8	2.482×10^{-12}	2.41×10^{-1}	32.10
10	7.818×10^{-13}	7.59×10^{-2}	10.10
12	3.170×10^{-13}	3.08×10^{-2}	4.10
16	7.728×10^{-14}	7.51×10^{-3}	1.00
20	2.651×10^{-14}	2.57×10^{-3}	3.43×10^{-1}

Note: Where gas flow is in MSCFH, A_e=Constant for desired equivalent diameter and sp. gr. of gas = 0.60 (DMC-55-1).

In this study the low-pressure gas distribution system, composed of four loops with thirteen mains (Fig. 4.2), has been analyzed by Hardy Cross method to determine the individual main flow rates and pressure drops. Gas flow into the network from the proposed DRS is 254 MSCFH. Points of delivery are at junctions of mains, with the arrows pointing to volumes delivered (summations of these deliveries equals 254 MSCFH). Assumed gas flow and its direction, also indicated by an arrow, appears either to the right or bellow the main for the first trial, and the corresponding pressure drop is to the left or above the main. The diameters, length of mains, and equivalent length of 6" main for the large diameter mains are also shown in the Figure-4.2.

Four trials are presented in Table-4.2. Results of the fourth trial, after the network has been brought into approximate balance are also shown in Figure-4.3. Loops and main numbers are listed in the first and second column of the table, respectively. Main length, expressed as equivalent length of 6 inch main, is listed in the third column of the table. The assumed gas flow in each main for trial-1 is listed in the fourth column. The plus or minus preceding the flow Q, indicates the direction of the main flow for the particular loop. A

Table-4.2: Hardy Cross Analysis of the network (Constant A = ± 1.029 × 10^{-5} for Spitzglass formula).

Loop No.	Main No	Length (ft)	Trial-1					Trial-2					Trial-3					Trial-4			
			Q in mscfh	ALQ	ALQ^2 (h")	Correction 1	Correction 2	Q in mscfh	ALQ	ALQ^2 (h")	Correction 1	Correction 2	Q in mscfh	ALQ	ALQ^2 (h")	Correction 1	Correction 2	Q in mscfh	ALQ	ALQ^2 (h")	P in Psi.
1	2	1546	- 47.62	0.7576	-36.07	- 15.72		- 31.90	0.5075	- 16.19	+ 0.27		- 32.17	0.512	- 16.46	- 0.08		- 32.09	0.511	- 16.38	0.59
1	3	1483	+1.00	0.0153	+0.02	- 15.72		+ 16.72	0.2551	+4.27	+ 0.27		+ 16.45	0.251	+4.13	- 0.08		+ 16.53	0.252	+ 4.17	0.15
1	4	1483	+ 12.70	0.1938	+2.46	- 15.72		+ 28.42	0.4337	+ 12.33	+ 0.27		+ 28.15	0.430	+ 12.09	- 0.08		+ 28.23	0.431	+ 12.16	0.43
1	5	10500	-1.00	0.1080	-0.11	- 15.72	± 12.94	+1.78	0.1923	+0.34	+ 0.27	= 0.84	+ 0.67	0.072	+0.05	- 0.08	= 0.53	+ 0.22	0.024	+ 0.01	0
				1.0747	-33.70				1.3886	+0.75				1.265	-0.19					-0.04	
			Δ = -33.70 / 2(1.0747) = -15.72					Δ = +0.75 / 2(1.3886) = +0.27					Δ = -0.19 / 2(1.2648) = -0.08								
2	1	3956	- 73.02	2.9724	- 217.05	- 12.94		- 60.08	2.4457	- 146.9	- 0.84		- 59.24	2.412	- 142.9	- 0.53		- 58.71	2.390	- 140.3	5.07
2	5	10500	+1.00	0.1080	+0.11	- 12.94	= 15.72	-1.78	0.1923	-0.34	- 0.84	‡ 0.27	- 0.67	0.072	-0.05	- 0.53	± 0.08	- 0.22	0.024	- 0.01	0
2	13	360	+ 44.45	0.1647	+7.32	- 12.94		+ 57.39	0.2126	+ 12.20	- 0.84		+ 58.23	0.216	+ 12.56	- 0.53		+ 58.76	0.218	+ 12.79	0.46
2	6	507	+ 130.18	0.6792	+88.41	- 12.94	∓ 1.96	+ 145.08	0.7569	+ 109.8	- 0.84	∓ 2.55	+ 143.4	0.748	+ 107.2	- 0.53	= 0.10	+ 143.8	0.750	+ 107.9	3.90
2	7	156	+ 98.43	0.1580	+15.55	- 12.94	= 2.95	+ 108.42	0.1740	+ 18.87	- 0.84	= 0.26	+109.5	0.176	+ 19.25	- 0.53	= 1.14	+ 108.9	0.175	+ 19.04	0.69
				4.0823	-105.6				3.7815	-6.40				3.623	-3.86					-0.61	
			Δ = -105.66 / 2(4.0823) = -12.94					Δ = -6.40 / 2(3.7815) = -0.84					Δ = -3.86 / 2(3.6234) = -0.53								
3	8	6410	+ 38.10	2.5130	+95.75	+1.96		+ 3.14	2.3838	+ 86.15	- 2.55		+ 38.69	2.552	+ 98.73	- 0.10		+ 38.79	2.559	+ 99.25	3.58
3	6	507	+ 130.18	0.6792	-88.41	+1.96	± 12.94	- 145.08	0.7569	- 109.8	- 2.55	± 0.84	- 143.4	0.748	- 107.2	- 0.10	± 0.53	- 143.8	0.750	- 107.9	3.90
3	9	2300	+ 25.40	0.6011	+15.27	+1.96		+ 23.44	0.5548	+13	- 2.55		+ 25.99	0.615	+ 15.99	- 0.10		+ 26.09	0.618	+ 16.11	0.58
3	10	11535	-6.35	0.7537	-4.79	+1.96		- 11.26	1.3365	- 15.05	- 2.55	‡ 0.26	- 8.45	1.003	- 8.48	- 0.10	± 1.14	- 9.49	1.126	- 10.69	0.39
				4.5470	+17.82				5.032	-25.7				4.918	-1.00					-3.21	
			Δ = +17.82 / 2(4.5470) = +1.96					Δ = -25.71 / 2(5.032) = -2.55					Δ = -1.00 / 2(4.918) = -0.10								
4	7	156	- 98.43	0.1580	-15.55	-2.95	± 12.94	- 108.42	0.1740	- 18.87	+ 0.26	± 0.84	- 109.5	0.176	- 19.25	- 1.14	± 0.53	- 108.9	0.175	- 19.04	0.69
4	10	11535	+6.35	0.7537	+4.79	-2.95	∓ 1.96	+ 11.26	1.3365	+ 15.05	+ 0.26	= 2.55	+ 8.45	1.003	+ 8.48	- 1.14	= 0.10	+ 9.49	1.126	+ 10.69	0.39
4	11	3740	+ 19.05	0.7331	+13.97	-2.95		+ 22.00	0.8467	+ 18.63	+ 0.26		+ 21.74	0.837	+ 18.19	- 1.14		+ 22.88	0.881	+ 20.15	0.73
4	12	3462	- 22.23	0.7919	-17.60	-2.95		- 19.28	0.6868	- 13.24	+ 0.26		- 19.54	0.696	- 13.60	- 1.14		- 18.40	0.656	- 12.06	0.44
				2.4367	-14.39				3.044	+1.57				2.712	-6.18					-0.26	
			Δ = -14.39 / 2(2.4367) = -2.95					Δ = +1.57 / 2(3.044) = +0.26					Δ = -6.18 / 2(2.7116) = -1.14								

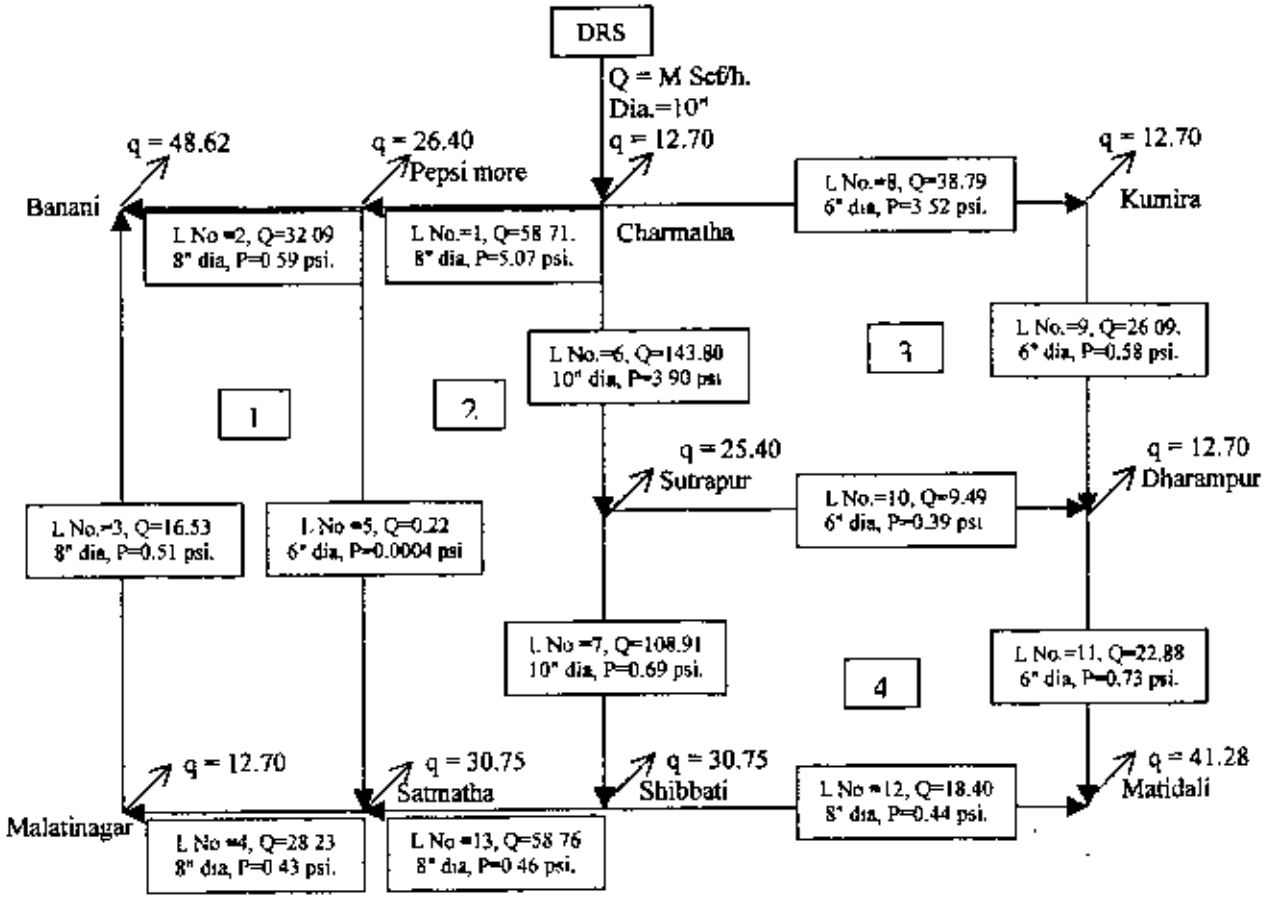


Figure-4.3: Final Load Distribution, Pressure and Flow after fourth trial of the Hardy Cross analysis.

plus sign denotes clockwise flow in the main within the loop; a *minus sign, counterclockwise*.

The first computation-resistance (AL_fQ) to change in gas flow in each main is listed in Table-4.2. The pressure drop (AL_fQ^2) in each main, is listed, and carries the same sign as the gas flow. Column AL_fQ is added *arithmetically* for each loop. Column AL_fQ^2 is added *algebraically* for each loop. A flow correction Δ, equal to $(\Sigma + AL_fQ^2)/2\Sigma AL_fQ$ when n = 2, is computed for each loop. This correction must be *subtracted algebraically* from the assumed gas flow. A main common to two loops receives two corrections, and a main common to three or more loops receives three or more corrections.

The upper plus or minus sign shown indicates direction of flow in that main in these two loops and is obtained from Q for trial 1. The upper sign is the sign in front of Q if the flow direction in each loop coincides with the assumed flow direction in the particular loop under consideration, and opposite if it does not.
The flow Q, and corrections are totaled across to obtain the Q listed under trial 2 according to the following rules:

i) The algebraic operation for correction 1 should be the opposite of its sign; i.e., add when the sign is minus.
ii) The algebraic operation for corrections 2 and 3 should be the opposite of their lower signs when their upper signs are the same as the sign in front of Q, and as indicated by their lower signs when their upper signs are opposite to the sign in front of Q.

The calculation procedure is repeated for trial 2 and for successive trials until the net pressure drop around each loop, $\Sigma \pm AL_fQ^2$, is as close to zero as the degree of precision demands. In addition to Table-4.2 of this analysis, final pressure drops (AL_fQ^2), in inch of water column and in psig at nearly balanced condition after the 4th trial, is shown in

Table-4.3. Values of pressure drops after assumed increase of Q, by 50% and 100%, are also shown in Table-4.3.

Table-4.3: Values of pressure drops after imaginary increment of flow by 50% and 100%.

Main No.	Trial-4				150% of Q		200% of Q	
	Q in Mscfh	ALQ	ALQ^2 h" wc	P. Drop In psig	ALQ^2 h" wc	P. Drop In psig	ALQ^2 h" wc	P. Drop In psig
2	-32.09	0.5105	-16.38	0.59	36.86	1.33	65.53	2.37
3	+16.53	0.2522	+4.17	0.15	9.38	0.34	16.68	0.60
4	+28.23	0.4308	+12.16	0.43	27.36	0.99	48.65	1.76
5	+0.22	0.0238	+0.01	0.00	0.01	0.00	0.02	0.00
		$\Sigma ALQ^2 = -0.04$						
1	-58.71	2.3899	-140.31	5.07	315.70	11.40	561.25	20.26
5	-0.22	0.0238	-0.01	0.00	0.01	0.00	0.02	0.00
13	+58.76	0.2177	+12.79	0.46	28.78	1.04	51.16	1.85
6	+143.80	0.7502	+107.88	3.90	242.73	8.76	431.52	15.58
7	+108.91	0.1748	+19.04	0.69	42.83	1.55	76.15	2.75
		$\Sigma ALQ^2 = -0.61$						
8	+38.79	2.5885	+99.25	3.58	223.30	8.06	396.98	14.33
6	-143.80	0.7502	-107.88	3.90	242.73	8.76	431.52	15.58
9	+26.09	0.6175	+16.11	0.58	36.25	1.31	64.44	2.33
10	-9.49	1.1264	-10.69	0.39	24.05	0.87	42.76	1.54
		$\Sigma ALQ^2 = -3.21$						
7	-108.91	0.1748	-19.04	0.69	42.83	1.55	76.15	2.75
10	+9.49	1.1264	+10.69	0.39	24.05	0.87	42.76	1.54
11	+22.88	0.8805	+20.15	0.73	45.33	1.64	80.59	2.91
12	-18.40	0.6555	-12.06	0.44	27.14	0.98	48.24	1.74
		$\Sigma ALQ^2 = -0.26$						

4.1.2 'Gas works' analysis

Recently Titas Gas T&D Co. Ltd. authority installed an automated software system to analyze gas transmission and distribution system on design built and turnkey basis. The system automatically creates and registrars new facilities in the real world coordinate system appropriate for the organization. It is important for users to be familiar with the rules for digitizing gas network. The system provides facilities to assign consumption data to gas mains. This feature enables users to perform analysis and planning on the network.

In this study, as per calculated consumptions, the sizes of the distribution mains were assumed. The transportation mains of the Bogra town and corresponding symbolic gas network are shown in Figure-4.2 and Figure-4.3 respectively. The DRS as the starting node, was considered having outlet pressures of 50 psig, 45 psig, 40 psig, 35 psig and 30

psig at different times. Details of the section wise pressure and flow rates calculated by the Gas Works method are explained in Tables-4.4 and Table-4.5. Load distribution, pressure and flow at different source pressures are diagrammatically shown in Figure-4.4, Figure-4.5, Figure-4.6, Figure-4.7, and Figure-4.8.

Table-4.4: Discharge or flow rate scenarios (pipe report) of the distribution mains.

Sl.	Node		Eqn.	Size	Dia	Rough	Length		Effcy	Flow Rate
	From	To			inch	nes	L.	Unit	Decim.	In Mcfh.
1	DRS	Charmatha	IGT	10	10	0.0007	3	Km.	0.95	254.000
2	Charmatha	Kumira	IGT	6	6	0.0007	6410	Feet	0.95	38.452
3	Charmatha	Pepsi	IGT	8	8	0.0007	16400	,,	0.95	59.143
4	Pepsi	Banani	IGT	8	8	0.0007	6410	,,	0.95	32.438
5	Banani	Malatingr	IGT	8	8	0.0007	6150	,,	0.95	16.182
6	Maltingr.	Satmatha	IGT	8	8	0.0007	6150	,,	0.95	28.882
7	Pepsi	Satmatha	IGT	6	6	0.0007	10500	,,	0.95	0.305
8	Satmatha	Shibbati	IGT	8	8	0.0007	1490	,,	0.95	59.327
9	Shibbati	Sutrapur	IGT	10	10	0.0007	2050	,,	0.95	108.896
10	Sutrapur	Charmatha	IGT	10	10	0.0007	6665	,,	0.95	143.705
11	Sutrapur	Dharampur	IGT	6	6	0.0007	11535	,,	0.95	9.409
12	Kumira	Dharampur	IGT	6	6	0.0007	2300	,,	0.95	25.752
13	Shibbati	Matidali	IGT	8	8	0.0007	14350	,,	0.95	18.819
14	Dharampur	Matidali	IGT	6	6	0.0007	3740	,,	0.95	22.461

Calculated distribution of loads and corresponding pressures at different source point, as a node report, are explained in Table-4.5.

Table-4.5: Calculated load distribution and corresponding pressures.

SL	Node Name	Consumptions (Base load)	Source (DRS) Pressures				
			50 psig	45 psig	40 psig	35psig	30 psig
1	DRS	254.00 mscfh.	50.00	45.00	40.00	35.00	30.00
2	Charmatha	12.70 ,,	45.65	40.25	34.77	29.18	23.43
3	Kumira	12.70 ,,	44.71	39.22	33.63	27.89	21.93
4	Pepsi	26.40 ,,	44.37	38.84	33.21	27.41	21.37
5	Banani	48.62 ,,	44.21	38.68	33.02	27.19	21.12
6	Malatinagar	12.70 ,,	44.25	38.72	33.06	27.24	21.18
7	Satmatha	30.75 ,,	44.37	38.84	33.21	27.41	21.37
8	Shibbati	30.75 ,,	44.48	38.97	33.35	27.57	21.56
9	Sutrapur	25.40 ,,	44.66	39.17	33.57	27.82	21.85
10	Dharampur	12.70 ,,	44.56	39.05	33.44	27.68	21.68
11	Matidali	41.28 ,,	44.37	38.85	33.21	27.41	21.38

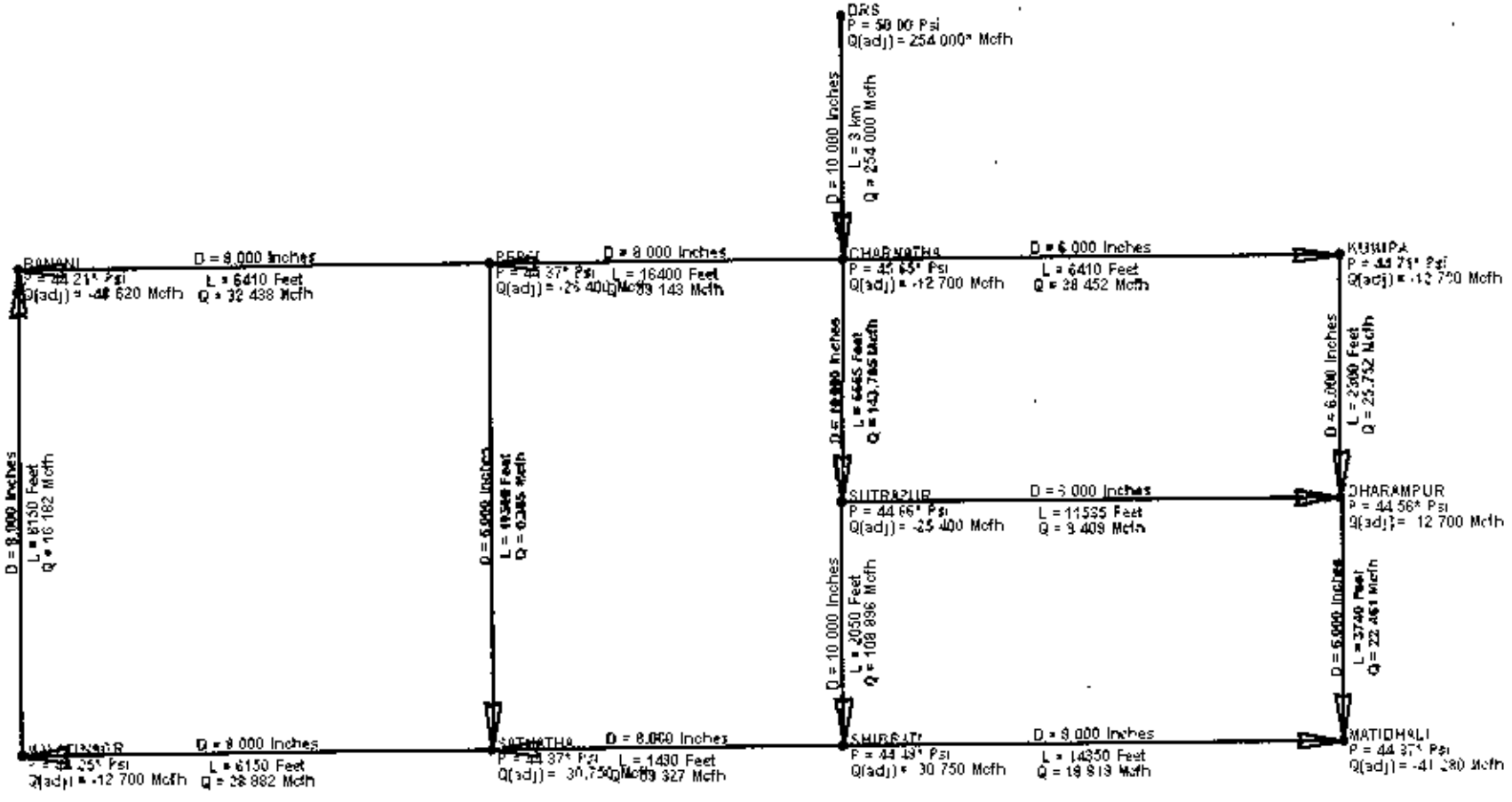


Figure-4.4: Load Distribution, Pressure and Flow as per Gas Works analysis at a source (DRS outlet) pressure of 50 psig.

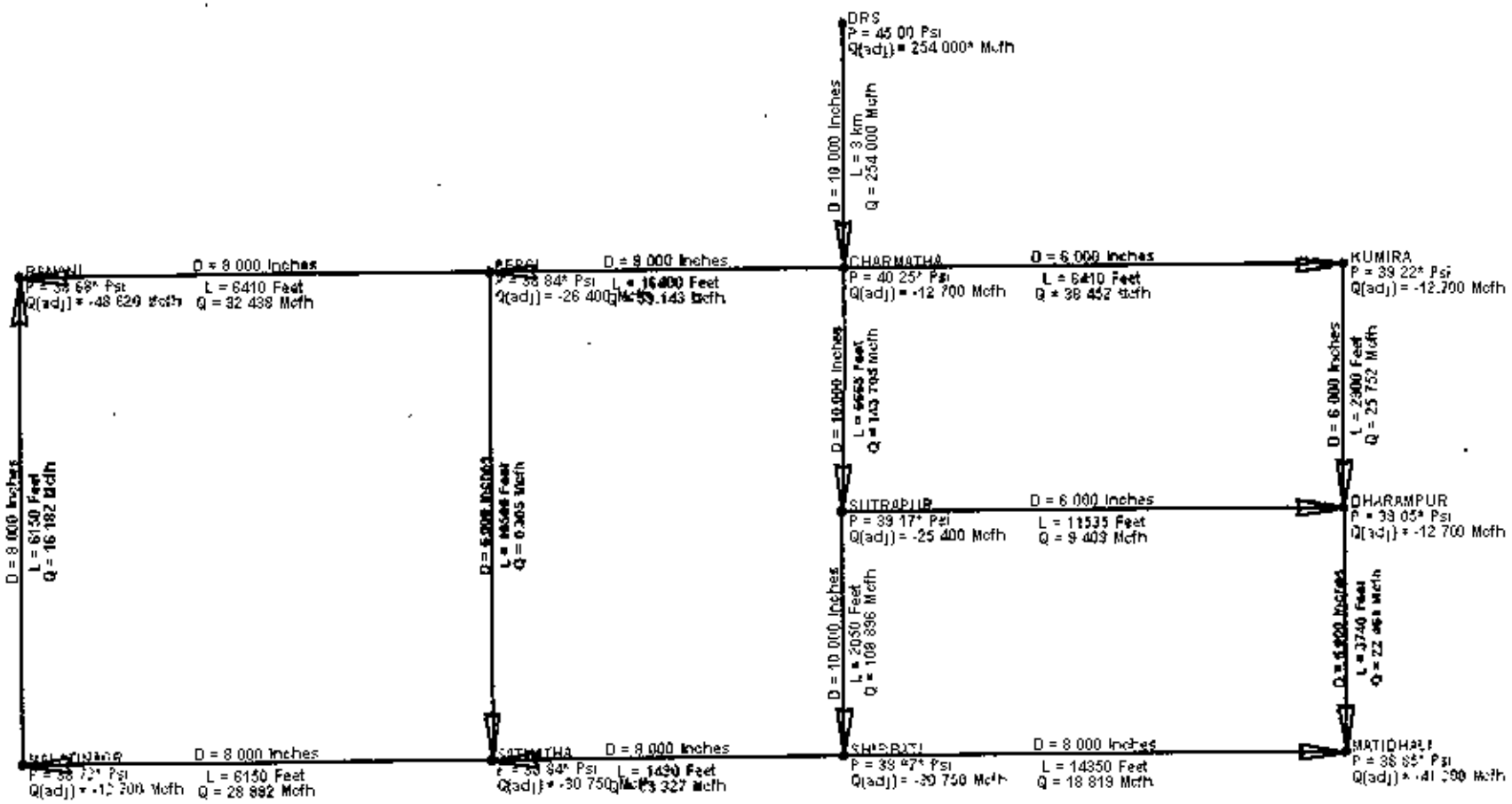


Figure-4.5: Load Distribution, Pressure and Flow as per Gas Works analysis at a source (DRS outlet) pressure of 45 psig.

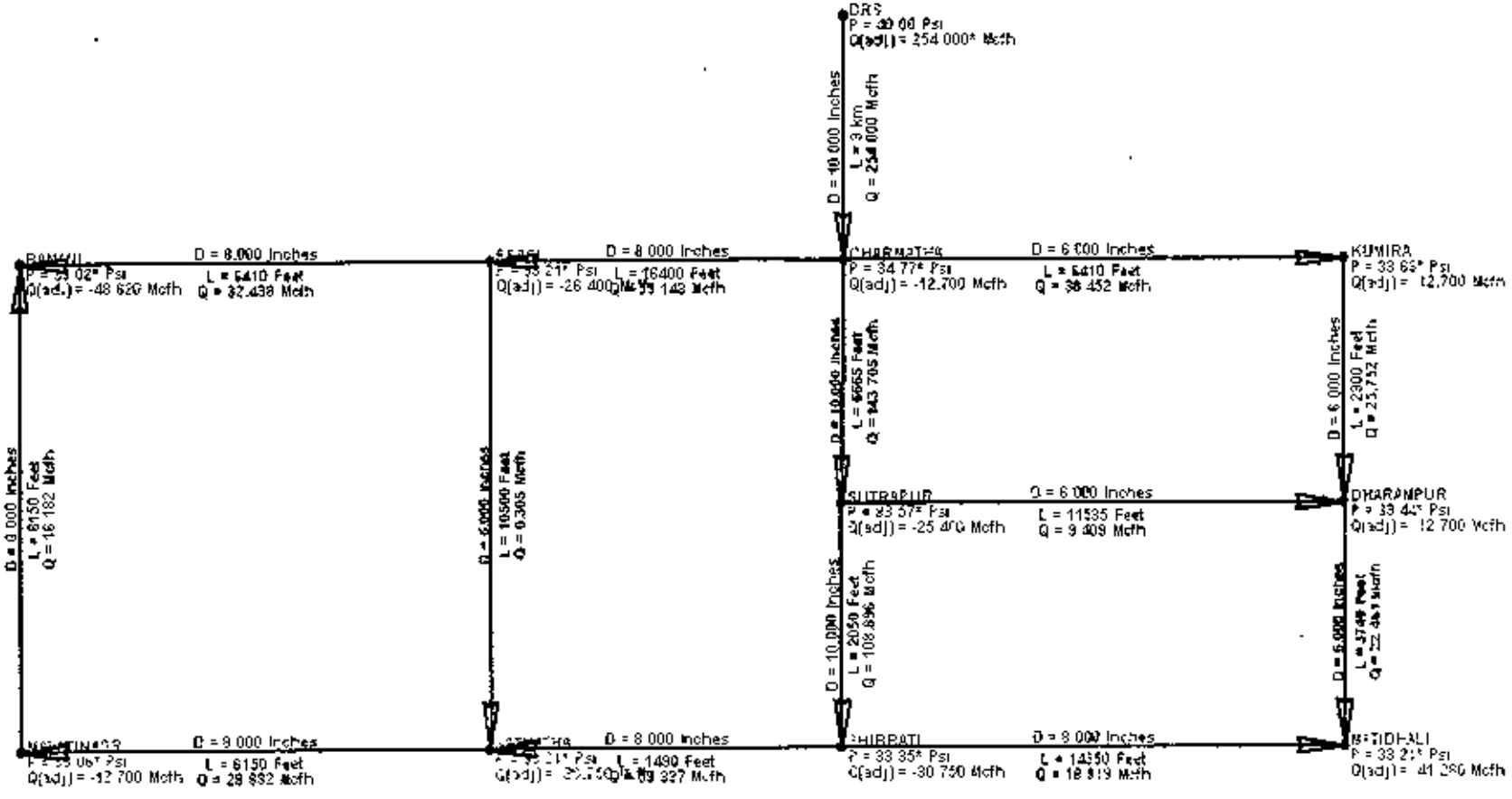


Figure-4.6: Load Distribution, Pressure and Flow as per Gas Works analysis at a source (DRS outlet) pressure of 40 psig.

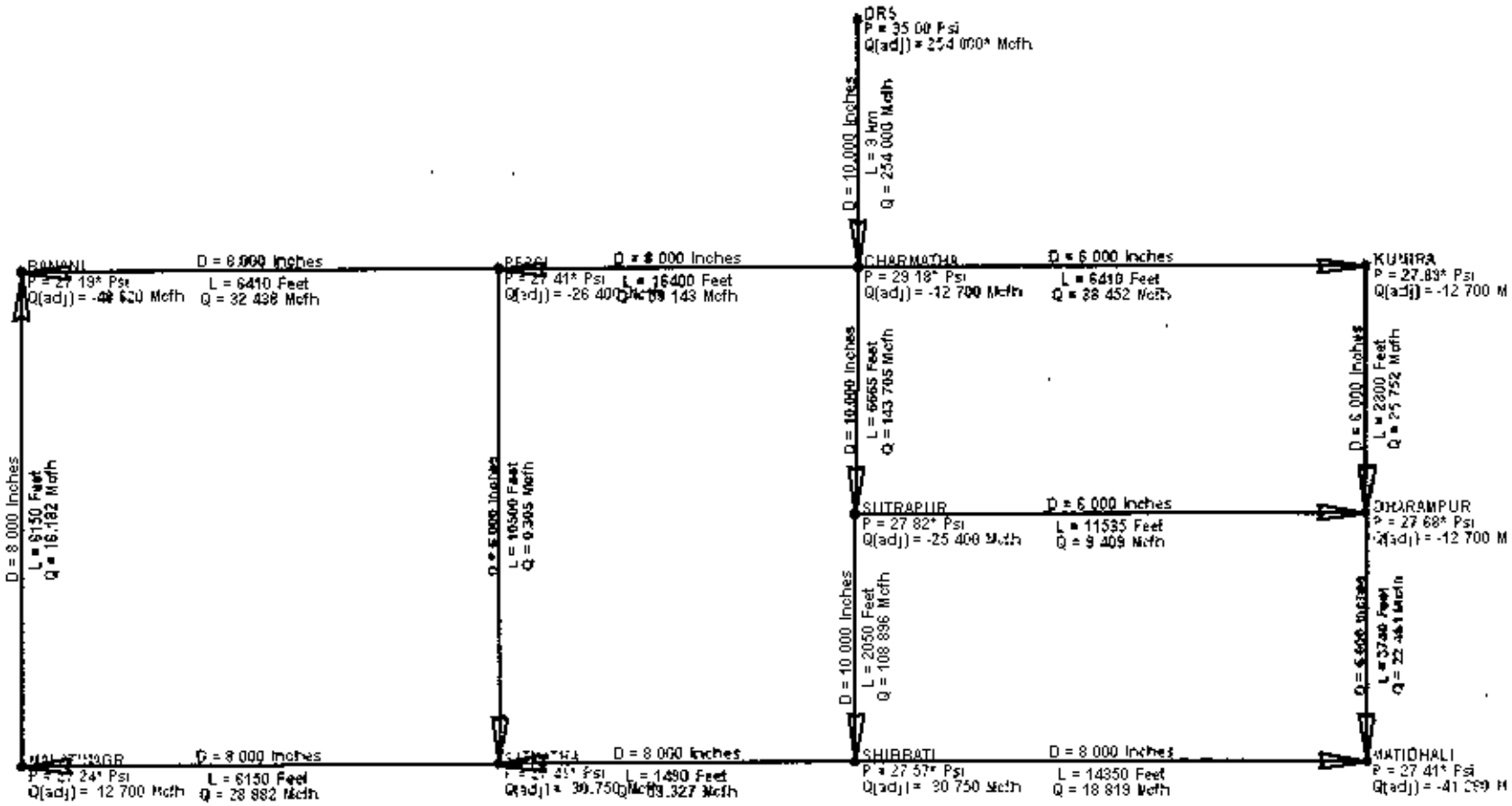


Figure-4.7: Load Distribution, Pressure and Flow as per Gas Works analysis at a source (DRS outlet) pressure of 35 psig.

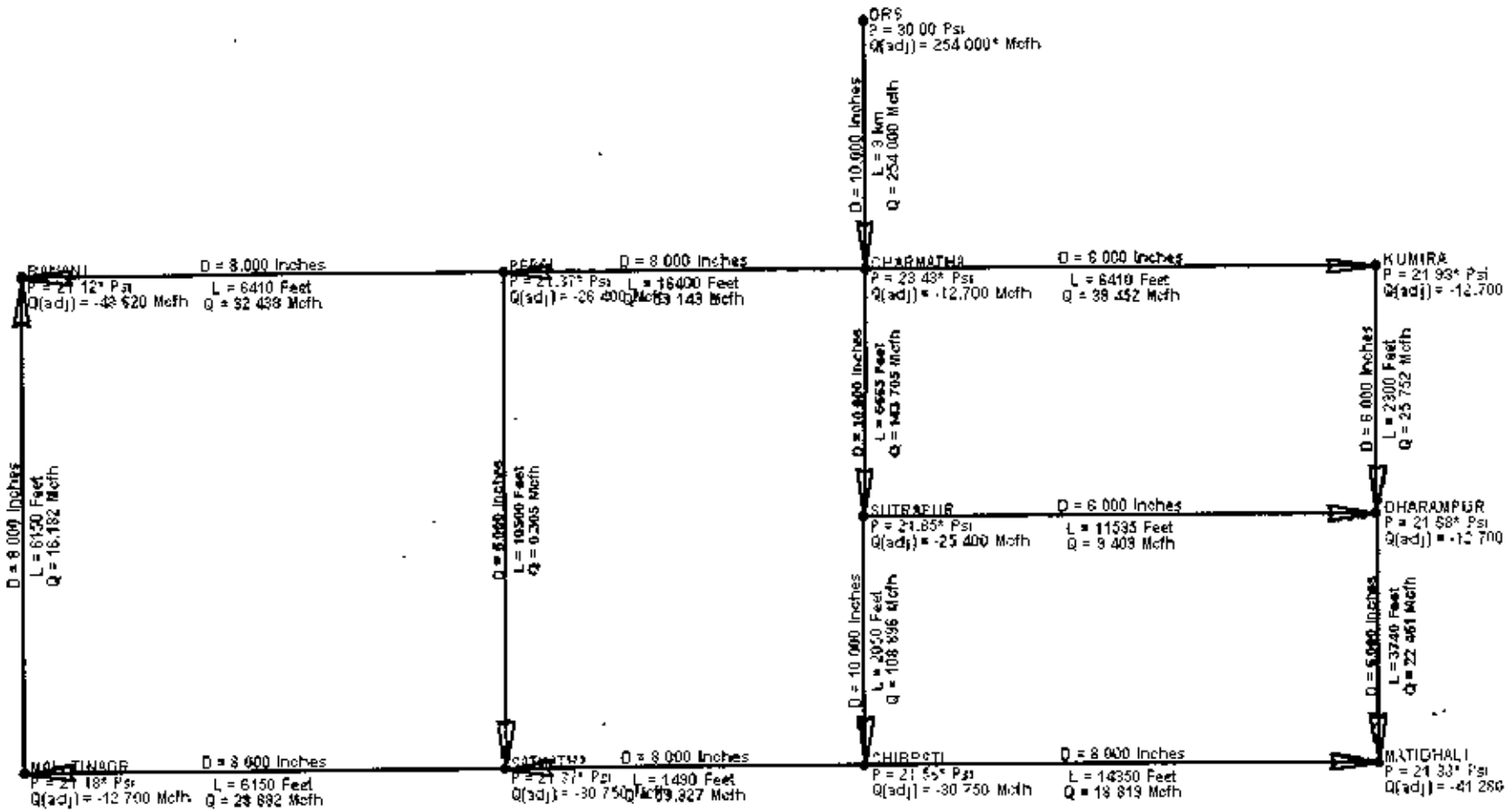


Figure-4.8: Load Distribution, Pressure and Flow as per Gas Works analysis at a source (DRS outlet) pressure of 30 psig.

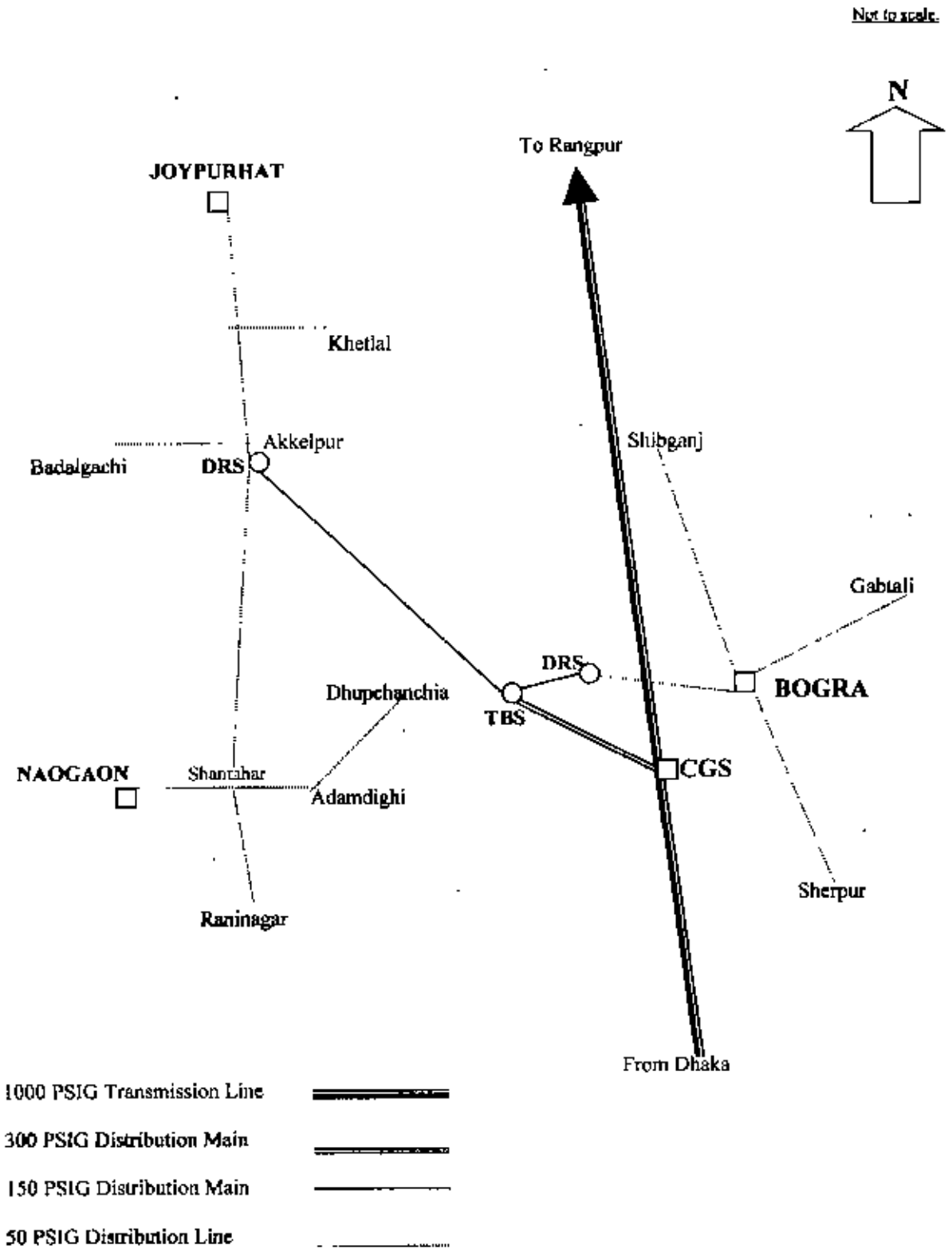


Figure-4.9: Probable location of CGS, TBS and DRS on the proposed network.

After completion of both the systems of network analysis, a comparison of pressure drops for Hardy Cross and Gas Works method is explained in Table-4.6 and an imaginary transmission and distribution network including positions of CGS, TBS and DRS's are shown in the Figure-4.9.

Table-4.6: Comparison of pressure drops for both Hardy Cross and Gas Works method.

SL	Node Name	Consumptions (Base load)	Pressure drops.	
			Hardy Cross	Gas Works.
1	DRS	254.00 mscfh.	50.00	50.00
2	Charmatha	12.70 „	45.65	45.65
3	Kumira	12.70 „	42.13	44.71
4	Pepsi	26.40 „	40.58	44.37
5	Banani	48.62 „	39.99	44.21
6	Malatinagar	12.70 „	40.33	44.25
7	Satmatha	30.75 „	40.59	44.37
8	Shibbati	30.75 „	41.06	44.48
9	Sutrapur	25.40 „	41.75	44.66
10	Dharampur	12.70 „	41.20	44.56
11	Matidali	41.28 „	40.55	44.37

4.2 Supervisory Control And Data Acquisition (SCADA)

Today the supervisory control and data acquisition (SCADA) system is the latest technology supported popular controlling instrument and is the heart of gathering transmission and distribution data. Everybody who uses the systems information can benefit in operation, maintenance and control of the system. A short summary of SCADA system is mentioned bellow (A. S. Labovitch, Pipeline & Gas Journal-1998).

Purpose: The SCADA system controls gathering operations and gas flow in transmission mainlines and laterals. For local distribution companies, SCADA:

- Manages flows from various suppliers
- Controls the flow and direction of gas within the distribution network
- Can manage flow to interruptible customers.

Control is accomplished through operator-initiated directions to motor operated valves and remotely controlled compressors and regulators. SCADA ensures flows throughout the system are balanced and gas is available to all firm customers and to interruptible customers, as appropriate. When third party excavators damage a line or there is any leakage in the line, SCADA gives information on system impact, allowing intelligent decisions.

Database: The database is the information structure of the entire computer system. It is a collection of several integrated databases, including:

Communication: The communications database contains records that describe the data acquisition lines. These are telephone lines, microwave links, satellite links, fiber optic cable drops, local area network (LAN) nodes, or radio transceivers.

Real-time data: All information from field transmitters requires unique records in the appropriate database. Typical measurements described by an analog record include temperature, pressure, height and weight. Field devices described by digital or status records include pumps, motors and valves.

Historical data: This information can help recreate software simulations of gas system conditions and perform post event analysis. It also is used for on-screen trending and peak period determinations. The historical database subsystem contains analog, digital and accumulator databases sized at purchase to customer needs. Space can vary from several days to several years, limited only by the hard disk space purchased.

SCADA functions

Data acquisition: In the data acquisition function, whenever an analog value, such as pressure, flow rate or temperature and alarm status, is measured in the field, the transmitter sitting on the pipeline sends a signal to the remote terminal units (RTU) for transmission to the SCADA master station. When the master station requests data, the RTU transfers that information. System controllers and SCADA application programs may also request RTU data.

Data processing: In the data processing function, values come to the master station from the RTUs on the defined communications line via the data acquisition databases. If any

limit is violated, a message that must be acknowledged is displayed on the operator's display, the data highlighted on the screen, and a message is stored in historical data.

Supervisory control: In the supervisory control function, the system operator remotely controls valves, compressors and regulators to ensure proper pipeline operation. There are several basic varieties of remote control:

- On/off
- Open loop
- Closed loop.

System redundancy: For most companies, the SCADA system is so critical to pipeline operation that it never can be out of service. To ensure uninterrupted communication system, all the equipment must be configured in hot standby mode. A SCADA system can become inoperative from:

- Component failure
- Master station AC power failure
- RTU AC power failure
- Communications failure.

To minimize component failures impact, redundancy is the key. Communications failure at an individual field site usually is not critical, but to minimize complete failure, at least two different paths and two different media should rout communications circuits. Since telephone, microwave, satellite links, fiber optics, ether net and radio all can fail, the best way to ensure continuous communications is to install backup circuit from each site. A SCADA system overview, also two different controlling stations are shown in Figure-4.10.

Control center security: These recommendations are based on observed philosophies of different companies

i) Secrecy about the location of the control room

ii) The room should be beyond sets of secure doors

iii) Commercial metal keys usually offer no protection

iv) If remote door opener is used, a status point on a local RTU is better than a push button

v) Multiple security zones are desirable.

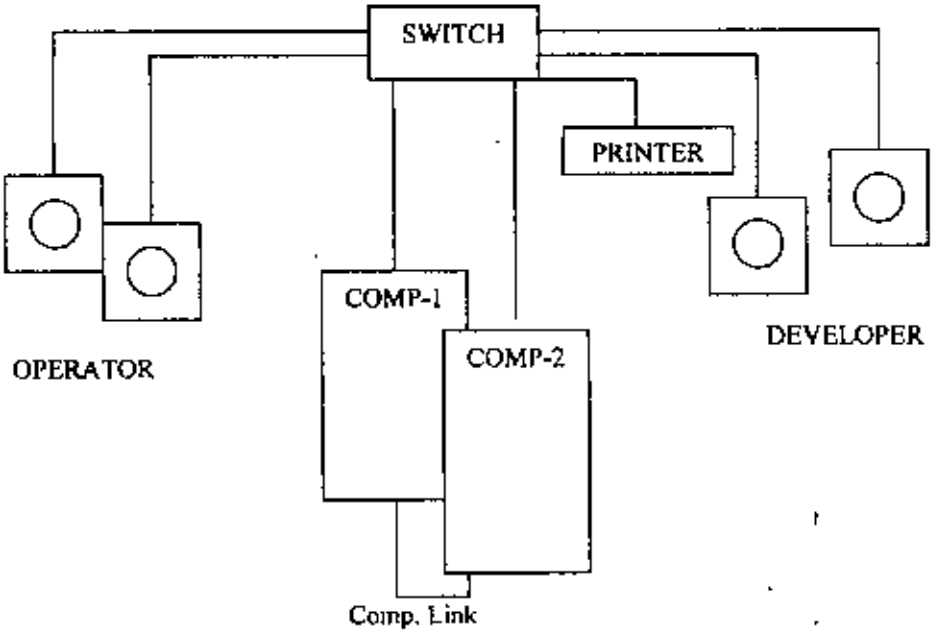
Hacker security: Ways to protect against unauthorized remote access are

- Keep the modem powered down except when dial up access is required
- Install a password encryption program with access control modules between the modem and host computer.

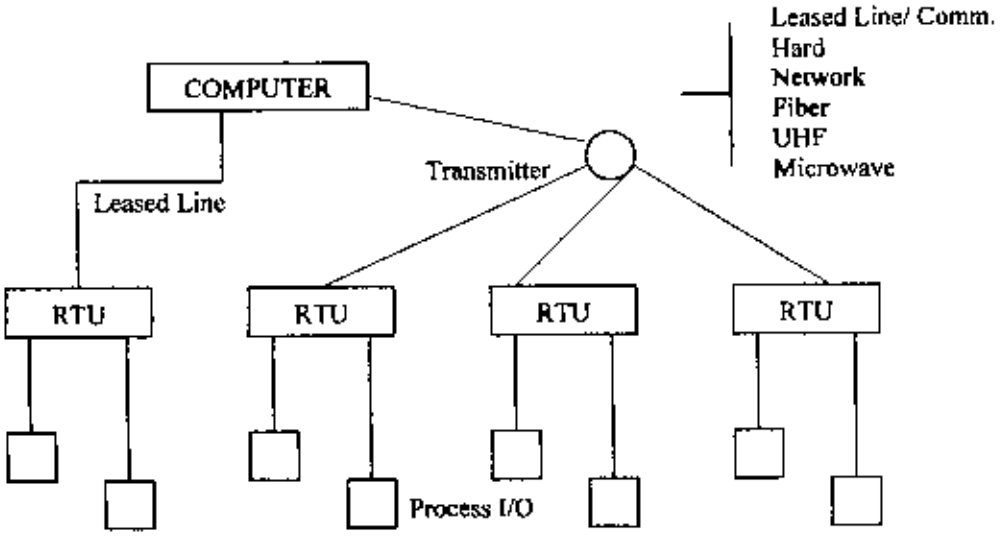
Proposed SCADA system: On the basis of above mentioned components, a latest SCADA system has been chosen for the proposed area. In this study, a 'GEC Fenaue USA' type SCADA system is recommended for the proposed distribution network and main control room is considered at Bogra.

The main control room contains, a 2+2 mega bit radio, MUX, RTU, TMS, VHF, Plasma screen, PC, power supply and a 3 leg tubular type SS tower (100 meter). Both Naogaon and Joypurhat control rooms are adorned with 2 mega bit radio, MUX, RTU, VHF, power supply and 3 leg tubular type SS towers (100 meter). Diagrammatic representation of the recommended SCADA system is shown in Figure-4.11. A detailed cost estimation of the SCADA system for the proposed network is described in Table-4.7 (GEC Fenaue USA-2002).

The proposed SCADA system for Titas Gas Transmission and Distribution Co. Ltd. is shown in Figure-A3 (Appendix-A). The various components are in different stages of completion.



Master/ Sub-master to RTU communication.



RTU to process I/O device communication

Figure-4.10: SCADA System overview.

Table-4.7: Estimation of cost for proposed telecom SCADA system.

Sl. No.	Description	Quantity distribution				Unit price In US$	Total price In US$
		Bogra	Naogaon	Joypurhat	Total Qty.		
1.	**Microwave system:**						
	2+2 M bit radio.	2	1	1	4	11000	44000
	PCM Multiplexer.	2	1	1	4	4000	16000
	48 volt DC power (UPS), 8 hour backup	1	1	1	3	6000	18000
	6 feet grid antenna	2	2	2	6	400	2400
	7/8" foam heliax cable	250 rm	250 rm	250 rm	750 rm	3	2250
	Engrs. Order Wire (EOW)	1	1	1	3	1600	4800
2.	**Transmission mgt. System (TMS):**						
	Personal computer (PC)	1	-	-	1	1200	1200
	Modem	1	-	-	1	3500	3500
3.	**SCADA System:**						
	Remote terminal unit (RTU)	1	1	1	3	9000	27000
	Modem	1	1	1	3	3500	10500
	PC	2	-	-	2	1200	2400
	56" LCD plasma screen	1	-	-	1	5000	5000

PCM = Pulse Coded Modulation.
UPS = Uninterrupted Power Supply.
EOW = Engineers Order Wire.
TMS = Transmission Management System.
LCD = Liquid Crystal Display.
DTMF = Duel tone multi frequency.

Table-4.7 continued (Estimation of cost for proposed telecom SCADA system).

Sl. No.	Description	Quantity distribution				Unit price In US$	Total price In US$
		Bogra	Naogaon	Joypurhat	Total Qty.		
3. contd.	Network management system (NMS)	1	-	-	1	15000	15000
	Server	1	-	-	1	6000	6000
	SCADA software	1	-	-	1	100000	100000
	Router	1	1	1	3	3000	9000
	3 leg tubular type SS tower (100 meter)	1	1	1	3	200000	600000
	PABX	1	-	-	1	2000	2000
	VHF repeater	1	1	1	3	4000	12000
	DTMF hand held radio	10	5	5	20	12000	240000
4.	**Accessories:**						
	Lesser printer	1	-	-	1	1000	1000
	Fax cum telephone set	1	1	1	3	100	300
	Cable tray	LS	LS	LS	1 lot	1000	1000
	Aviation warning light	2	2	2	6	150	900
	Air cooler	2	2	2	6	1000	6000
	Earthing system	1	1	1	3	1500	4500
	Total						11,34,750

Total SCADA cost in US$ 11,34,750
Contractors profit, 10% „ 1,13,475
Vat, tax etc. 8% „ 90,780
Total US$ 13,39,005 ~ TK. 8,00,00,000/= (800 lac)

Company Identity:

SCADA = GEC Fenaue USA.
Digital microwave radio = MDS, USA.
PCM Mux = Buley Mux, Canada.
Repeater = Motorolla, USA.
Antenna = Mark grid system, USA.
Cable = Foam Haliex cable.

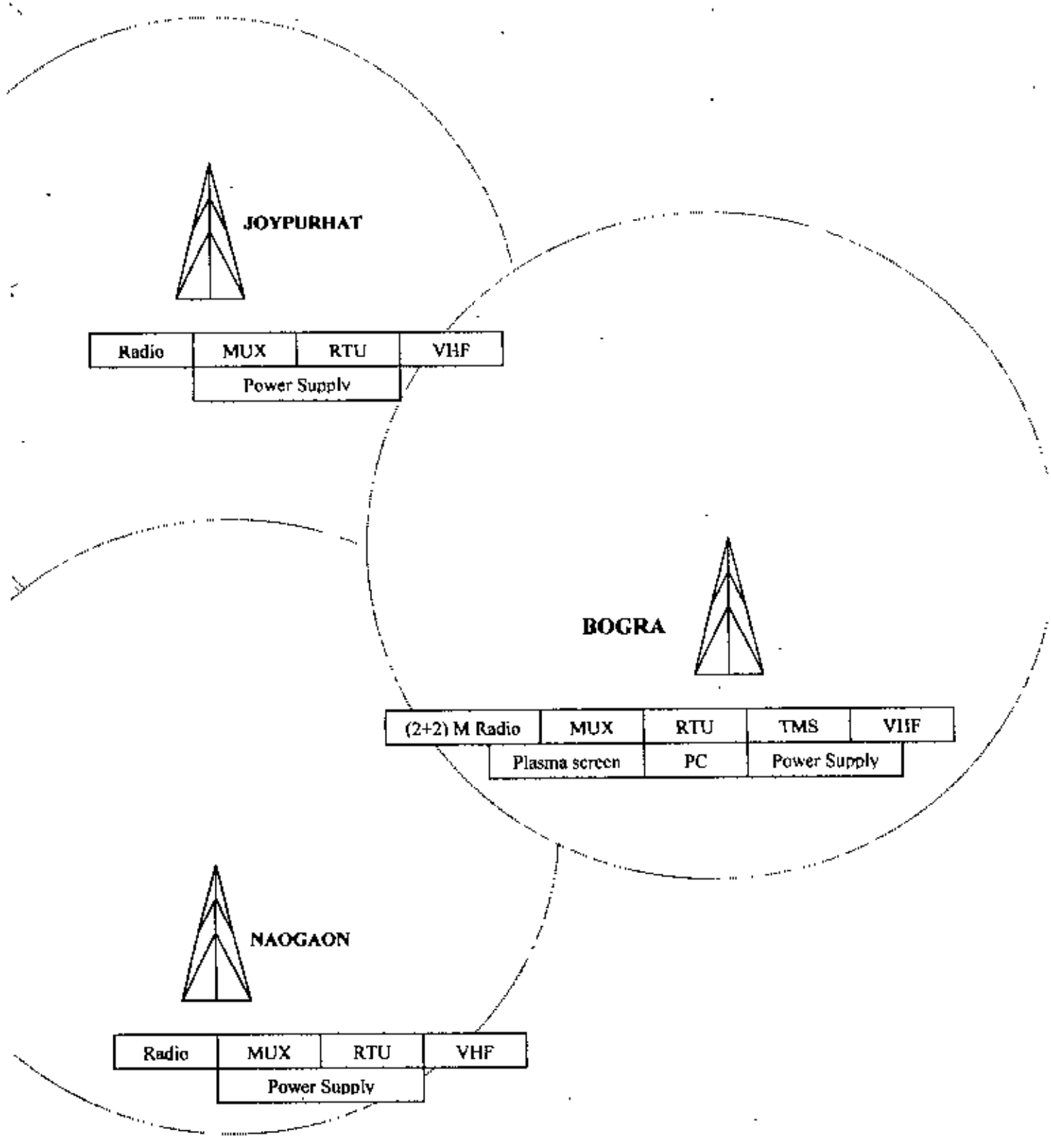


Figure-4.11: Diagrammatic representation of SCADA system in the proposed area.

CHAPTER V

REFORM AND SYSTEM ADOPTION

Completion of the study on existing distribution system marked a lot of bottlenecks in planning, system design, administration, gas connection, gas sales and revenue collection of the distribution companies. Proper planning and system design have been discussed in Chapter-III and Chapter-IV. Reforms and system adoption in administrative control, gas connection, gas sales and revenue collection are explained below.

5.1 Administrative Reforms

After discussion of all the administrative drawbacks of the existing system, the new system should be free from such bureaucratic hindrances. A private company may be established on the basis of Companies' Act, 1913, and it must be controlled by different government regulations like the payment of wages Act, 1936, the industrial relations (regulation) ordinance, 1975, the employer's liability Act, 1938 etc. But to overcome the existing drawbacks, some applicable suggestions are summarized bellow (Prof. A.A. Khan, Labour and Ind. Law-1996).

5.1.1 The organogram

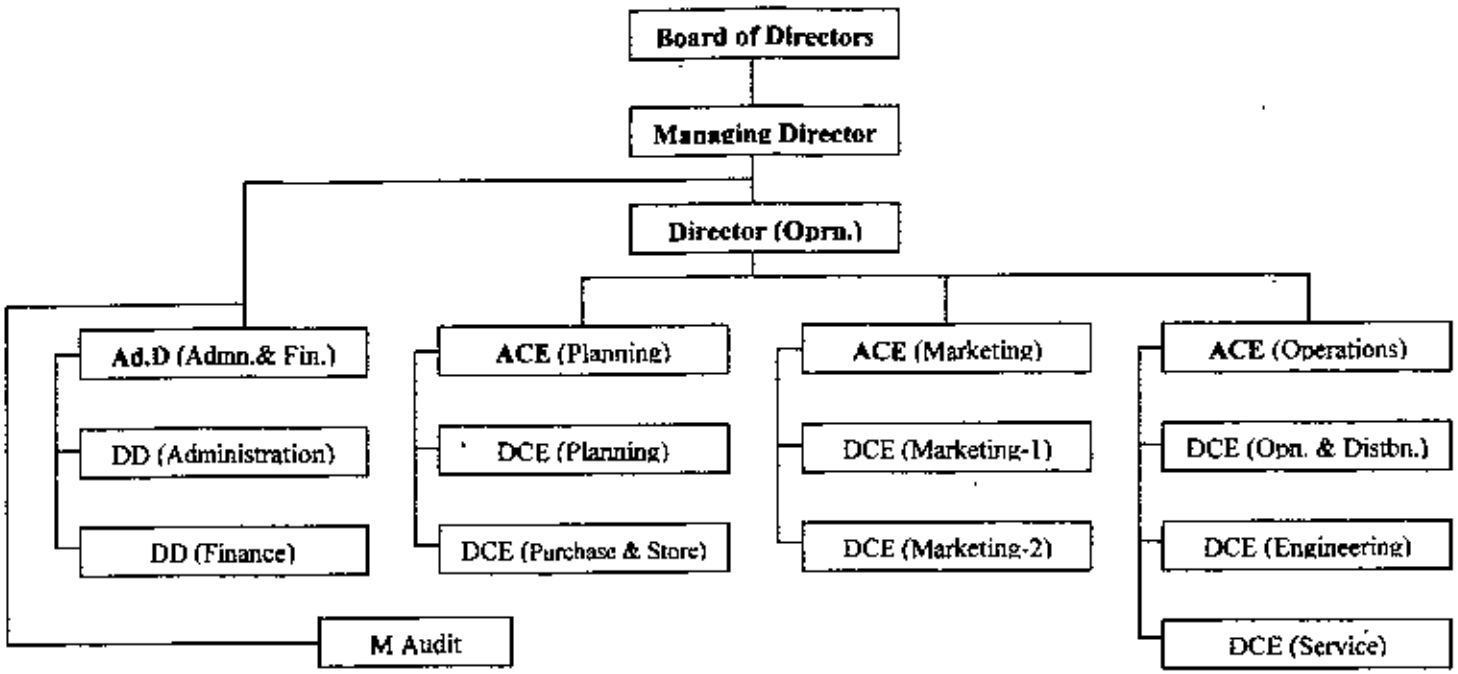
Most of the organograms of different organizations of the country still exist as they were conceived during the colonial times. During the study, a number of bottlenecks were observed in the existing natural gas distribution systems. Bureaucratic complexity is one of them. Existing monumental organograms of the gas related companies are the citable examples of the bureaucratic tangles. For example, a large gas distribution company has eight divisions, each headed by a general manager (GM). Moreover the technology-based company comprises 4 (four) general GMs against 4 (four) technical GMs, where secretary of the company is also a GM level officer!

There is also another general division in the name of Service Division with departments like Common Service Department, Store Department, Transport Department, Medical Department and Security Section. But for better service, the Service Department and the Transport Department could be included in the Operations Division, with medical as a section under Service Department and the Store Department under Planning Division. The rest Security Section should be under the Administrative Division. Other discrepancies are not explained here.

Considering all anomalies explained in the above paragraph, an organized organogram is shown in Figure-5.1 to Figure-5.6.

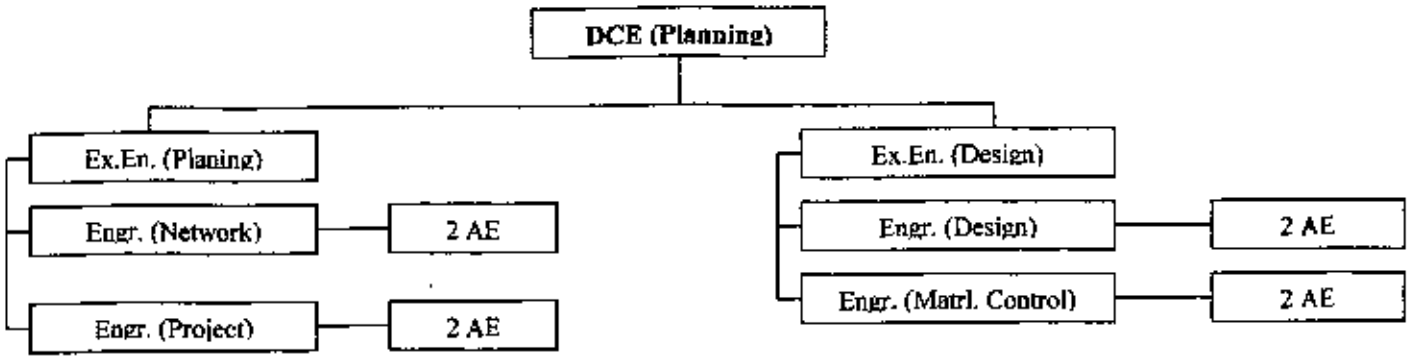
Advantages of the proposed organogram are,

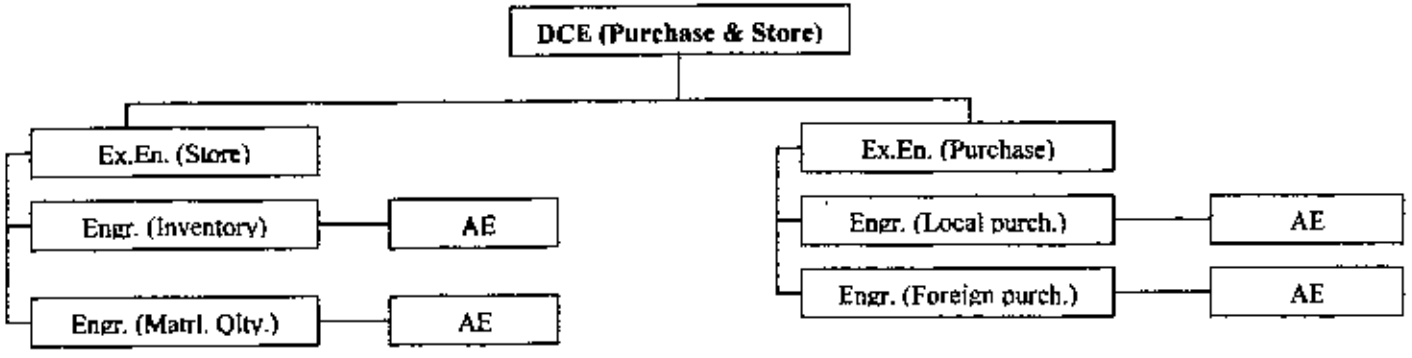
i) As a technology oriented organization, predominance of technical staffs and officers
ii) This is a complete work oriented organogram
iii) Qualification, merit, performance and only acceptable experiences are the main criteria for evaluation of the employees
iv) To avoid unionism, higher intensity of officers than staffs
v) Tried to avoid bureaucratic tangles
vi) There is no scope for inter-cadre conflicts
vii) Jobs are distribnted evenly and carefully
viii) Scope for surplus manpower is avoided totally
ix) Tried to eliminate possibility of idle times during working hours
x) Highly skilled, qualified and dedicated persons are more preferred as per proposed organogram.



Ad.D = Additional Director.
ACE = Additional Chief Engineer.
DCE = Deputy Chief Engineer.
DD = Deputy Director.
M = Manager.

Figure-5.1: An organized organogram of the proposed gas distribution system.

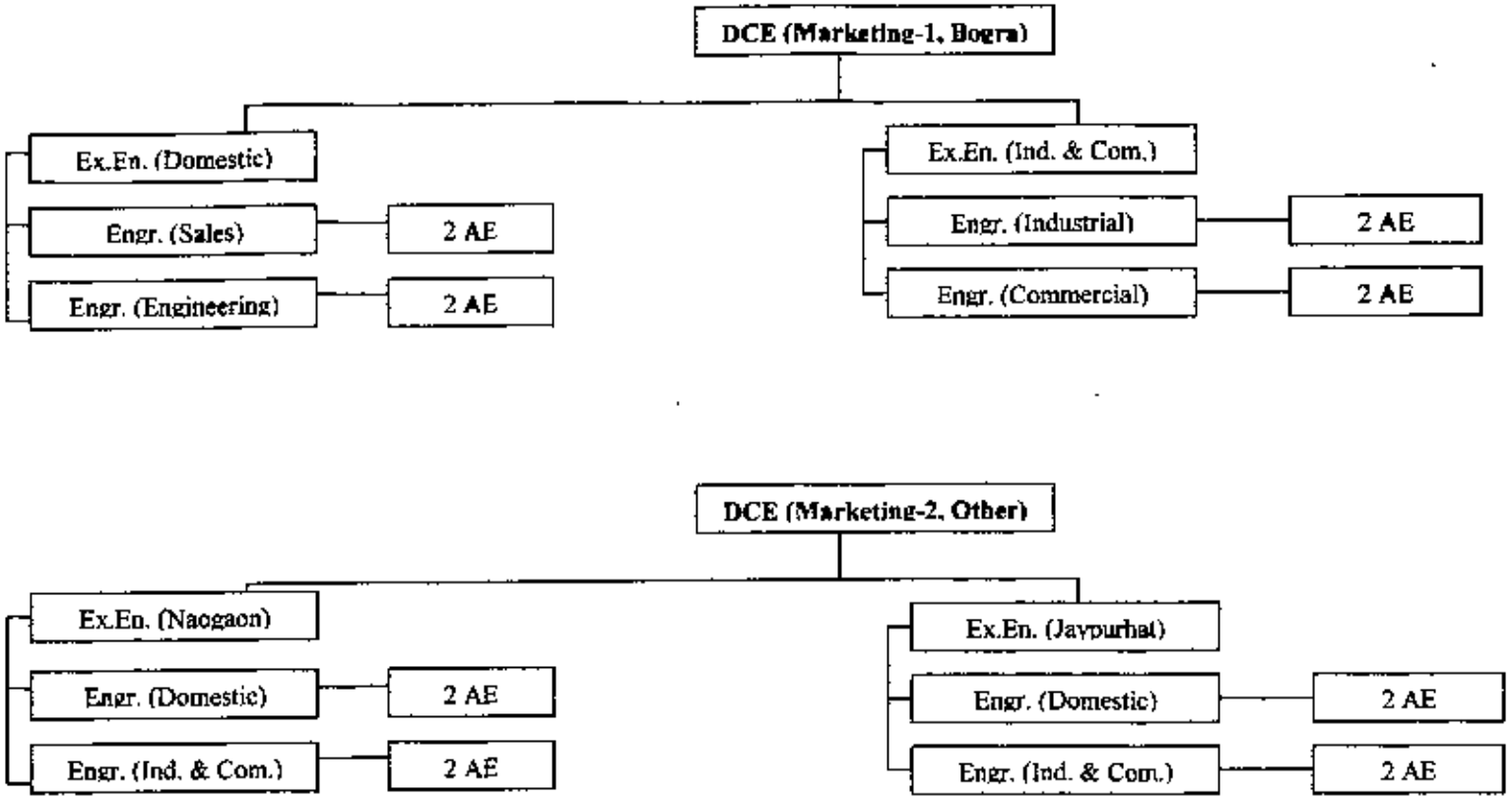




AD = Assistant Director.
AM = Assistant Manager.
PR = Personal Relations.
CD = Central Dispatch.

Ex.En. = Executive Engineer.
E = Engineer.
AE = Assistant Engineer.
PCD = Pipeline Construction Department.

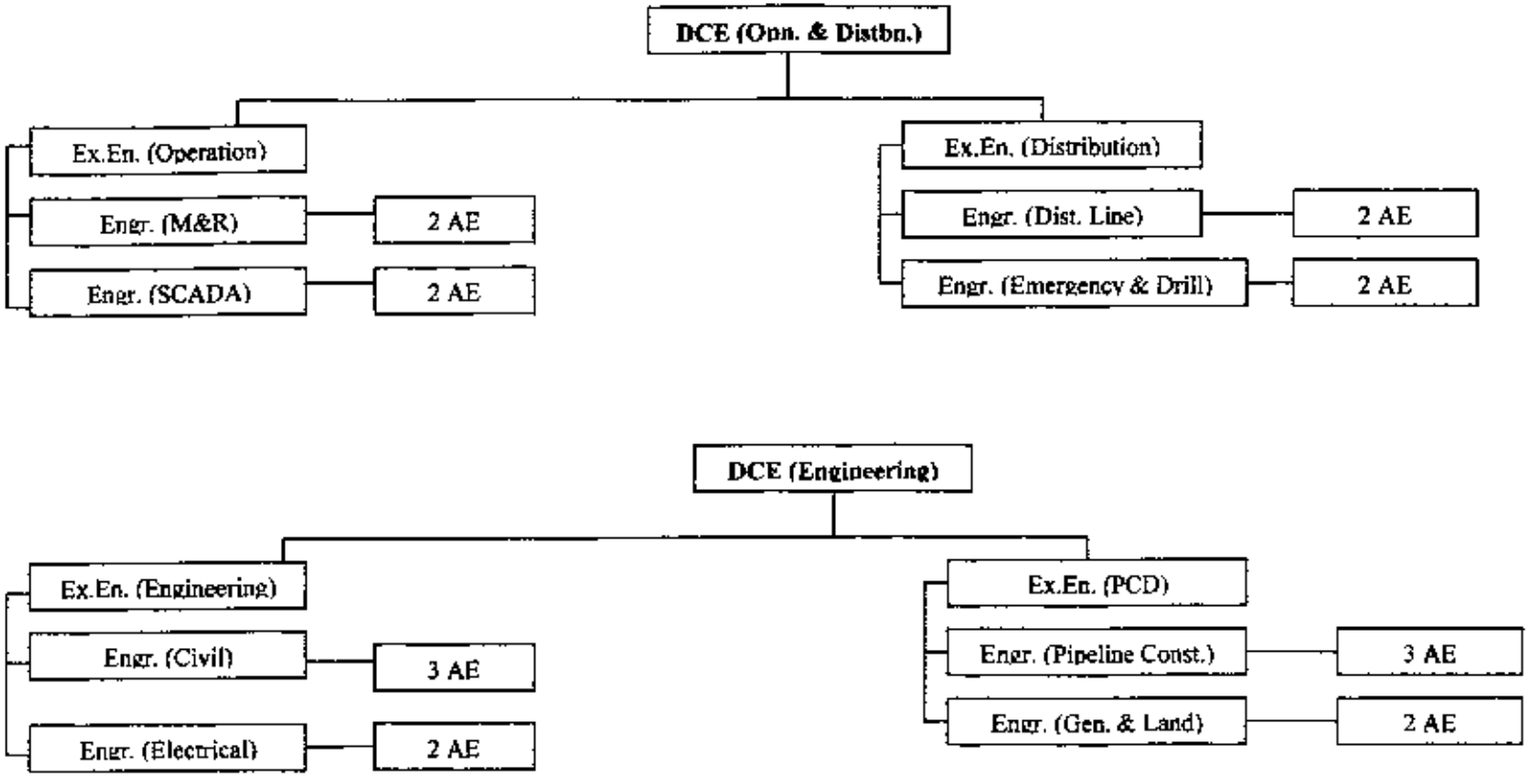
Figure-5.2: Organogram of Planning department and Purchase & Store department.



AD = Assistant Director.
AM = Assistant Manager.
PR = Personal Relations.
CD = Central Dispatch.

Ex.En. = Executive Engineer.
E = Engineer.
AE = Assistant Engineer.
PCD = Pipeline Construction Department.

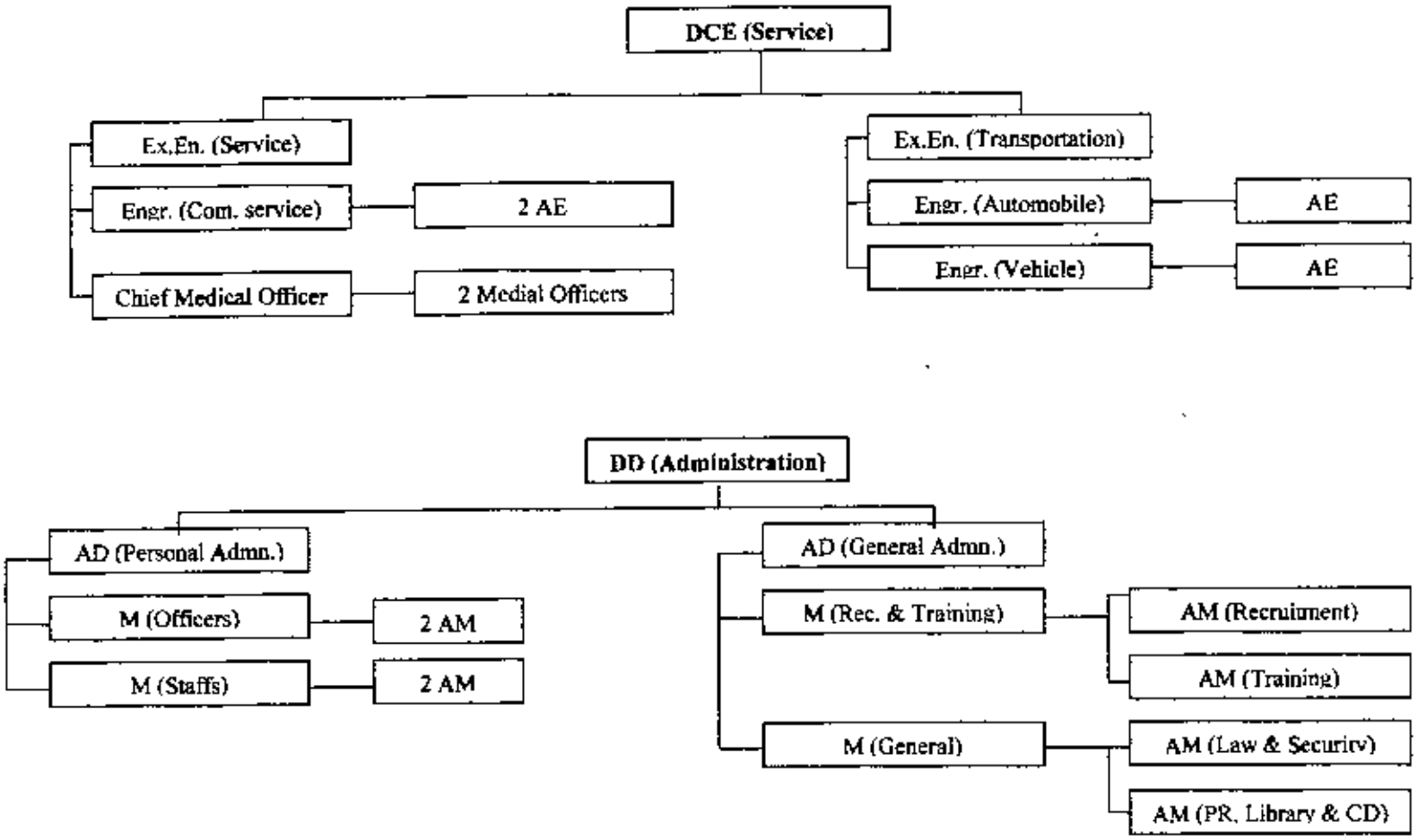
Figure-5.3: Organogram of Marketing-1 (Bogra) department and Marketing-2 (Naogaon and Joypurhat) department.



AD = Assistant Director.
AM = Assistant Manager.
PR = Personal Relations.
CD = Central Dispatch.

Ex.En. = Executive Engineer.
E = Engineer.
AE = Assistant Engineer.
PCD = Pipeline Construction Department.

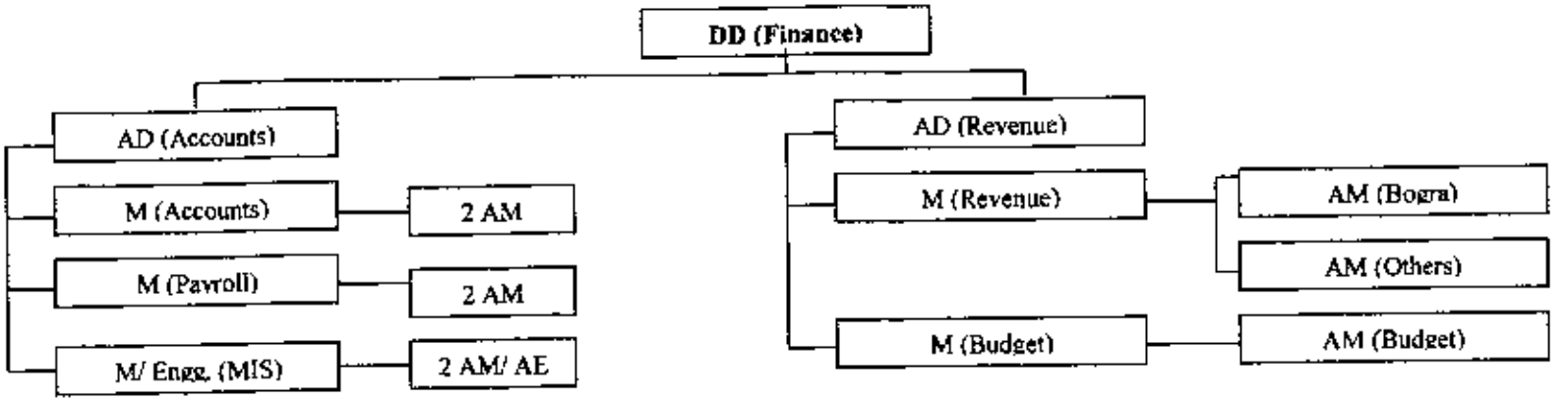
Figure-5.4: Organogram of Operation and Distribution department and Engineering department.



AD = Assistant Director.
M = Manager.
AM = Assistant Manager.
PR = Personal Relations.
CD = Central Dispatch.

Ex.En. = Executive Engineer.
E = Engineer.
AE = Assistant Engineer.
PCD = Pipeline Construction Department.

Figure-5.5: Organogram of Service department and Administration department.



AD = Assistant Director.
M = Manager.
AM = Assistant Manager.

Figure-5.6: Organogram of Finance department.

5.1.2 Wage fixation

'The payment of wages Act, 1936', 'The minimum wages Act, 1957' and 'The minimum wages ordinance, 1969' etc. are the Government tools for wage fixation. But to attain the goal of the organization and for the sake of the company employee's interest, a criterion depends on basic needs for lump sum salary is explained below.

Assumed monthly basic needs for the four-member family of a fourth class employee:

a) Coarse rice 60 kg, @ Tk.15/= per kg.	= Tk. 900/=
b) Coarse flour 30 kg, @ Tk.15/= per kg.	= Tk. 450/=
c) Pulse (symbolic for vegetable costs) 20 kg, @ Tk.45/= per kg.	= Tk. 900/=
d) Oil 5 kg, @ Tk.50/= per kg.	= Tk. 250/=
Total	= Tk. 2500/=

Considering other essential needs like, habitation, wearing, movements etc. costs as 100% of basic needs. Then the lump sum monthly pay for a fourth class employee will be stands at,

Tk. 2500/= × 2 = Tk. 5000/= (Taka five thousand only).

Considering monthly salary for a third class employee, as three times the calculated basic need of a fourth class employee, five times for a second class employee and 7.50 times for a starting executive.

Therefore,

A third class employee salary = Tk. 2500/= × 3 = Tk. 7500/= ≈ Tk. 7000/= (Taka seven thousand only).

A second-class employee salary = Tk. 2500/= × 5 = Tk. 12500/= ≈ Tk. 12000/= (Taka twelve thousand only).

A first class executives salary = Tk. 2500/= × 7.50 = Tk. 18750/= ≈ Tk. 18000/= (Taka eighteen thousand only).

Using the salary structure, mentioned above, the manpower cost for the project period is calculated in Table-5.1.

Table-5.1: Salary structure for 4 years project period.

Type of Personnel	Gross pay per Month.	Year-1		Year-2		Year-3		Year-4		Compare with NPS
		No.	Annual Remun.	No.	Annual Remun.	No	Annual Remun.	No.	Annual Remun.	
1.OFFICERS:										
a) Project Director.	40,000	1	4 80	1	5.28	1	5.81	1	6.40	12,900/=
b) Deputy Chief Engg	32,000	1	3.84	1	4 23	1	4.66	1	5.13	11,600/=
c) Ex. Engg./ DM	25,000	2	6.00	3	9.90	3	10.89	4	15.98	9,500/=
d) E / AM.	18,000	4	8.64	5	11.89	6	15.70	7	20.15	7,200/=
e) AE / Officer.	12,000	4	5.76	5	7.92	6	10.46	7	13.43	4,300/=
Total.		12	29.04	15	38.74	17	47.52	20	61.09	.
2. STAFFS:										
a) Skill Tec./Operator.	7,000	3	2.52	5	4.63	7	7.13	7	7.85	2,375/=
b) MLSS/ Sec. Guard	5,000	9	5.40	14	9.24	17	12.35	17	13.60	1,625/=
Total.		12	7.92	19	13.87	24	19.48	24	21.45	
Grand Total.		24	36.96	34	52.61	41	67.00	44	82.54	

Manpower costs in the investment table were considered roundly as 37, 53, 67 & 83 lacs respectively, for 4 years project period.

5.2 Monitoring and Evaluation

Monitoring and evaluation is a relative recent addition to the scientific management. Project management, seen as a scientific management discipline, rather than an ad-hoc master builders activity is, by itself, a rather newcomer.

5.2.1 Monitoring

Monitoring is the faculty of continuous or periodic reviews or overseeing by management at different levels of the hierarchy of any activity or project. During implementation of an activity /project, monitoring ensure that input deliveries, work schedules, targeted outputs and other required actions are proceeding according to designed plans and budgets. The

purpose of monitoring is to achieve efficient and effective project performance by providing feedback to project management at all levels. This enables management to improve operational plans and to take timely corrective action in case of shortfalls and /constraints.

The management of more complex projects and programmes will require a monitoring system to keep an overview of implementation and operation and to identify issues that are general to the project.

5.2.2 Evaluation

Evaluation is an analytical process for systematically and objectively perceiving the relevance, efficiency, effectiveness and impact of activities in the light of their objectives. It is an organizational process for improving activities still in progress and for aiding management in future planning, programming and decision-making.

From the government's point of view, a project may evaluate in terms of:

a) The total effect on the balance of trade
b) The employment opportunities offered
c) The contribution to the developments of the particular geographical area measured, for instance, in terms of social costs and benefits.
d) The degree of technological independence achieved in the country.

100880

If we look at the project implementation as an input and output system, we are mainly dealing with the management control cycle, whereby corrective action is initiated to improve upon subsequent results. A flow diagram of monitoring and evaluation process is shown in the Figure-5.7.

For better monitoring and evaluation, a separate section/ department under direct control of the head of the organization, like Implementation Monitoring and Evaluation Division (IMED) can be design.

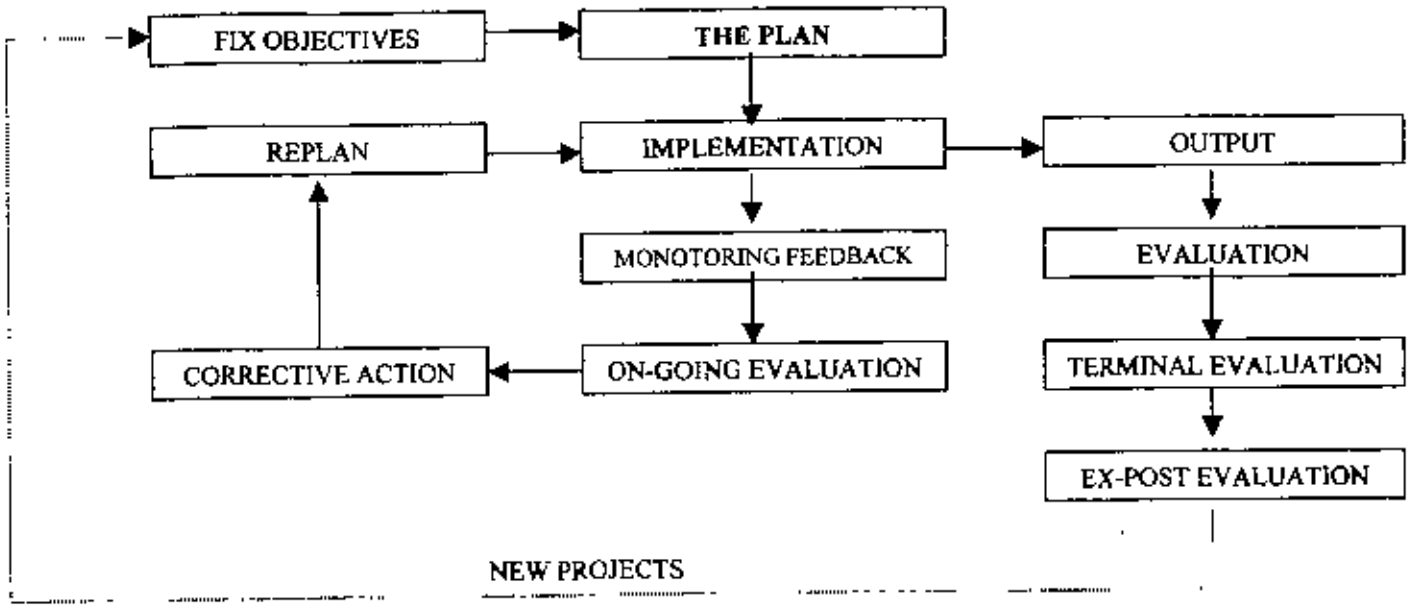


Figure-5.7: A flow diagram of monitoring and evaluation system.

The functions of the IMED may be-

i) Evaluation of the implementation of development projects, schemes and programmes.

ii) Collection and compilation of data for preparing monthly, quarterly, annual and periodical reports and statements for the information of the head of the organization and concerned other agencies.

iii) Supervision and field inspection of project and such other co-ordination work, as may be necessary for the removal of problems/ bottlenecks, if any, in consultation with the agencies concerned.

iv) To render such advisory or consultancy services to the agencies concerned, as and when necessary for the implementation of the projects according to schedule.

v) To submit inspection reports to the head of the organization and advisors concerned after the inspection of the projects, highlighting the problems bottlenecks etc. and suggesting remedial measures where necessary.

vi) Any other function as may be assigned to the IMED by the head of the organization and agencies concerned from time to time.

5.3 Strategic Business Unit (SBU)

The work of Strategic Business Unit (SBU) core monitoring team is to motivate the people to stand up against the tide. The members of this team are to work with zeal and motivated attitude in a sense that they are to mix with the staff of the unit as well as with any class of consumers without any reservation. A member should be free of feudal mentality, commanding attitude or lordship behavior. Moreover each member would be polite, gentle and sober and at the same time hard rocked, disciplined, sincere and honest (Guide line, SBU-2001).

5.3.1 Concept of SBU

Strategic Business Unit (SBU) is a commercial terminology. Outside of Bangladesh SBU concept has been implemented in Japan, mostly in private organizations. The Apex body of a group of industries set targets for each industry under them and give responsibility to the Chief Executives of the industries to set target with full autonomy. If they achieve the targets they get bonus, if not as per agreement get punishment. So SBU emphasizes to implement commercial views in any utility or in any complex. The basic philosophy of SBU concept is that the defined quality product is to be exchanged against properly priced value. Considering the bitter experience of the past in different utilities and precarious condition of the gas sector in Bangladesh it has been conceived that one has to pay properly for buying gas and one has to earn properly for selling gas. This is how SBU structures should be conceived in gas distribution systems of Bangladesh. To make distribution of natural gas financially viable and run it on SBU's standard, it needs to be structured in such a way so that each and every output of SBU activities can be measured as per standard set of indicators. At the same time quality of service and product should be compared by standard specification. In SBU concept it is desired that a definite incentive/ punishment package will keep the concept alive and drive forward.

Few things should be considered exceptionally in the context of Bangladesh. The social points considering poor economy of the country would get some concession, which would be estimated and calculated properly considering socio-economic condition of the specific area in each SBU in fixing the parameters. The details of all these have been covered in Performance Target Achievement (PTA) system. Under this PTA the declared set of standards to be fixed for each SBU of the sector.

5.3.2 Basic works

To begin the work each member of SBU team should have and carry during tour,

a. A permanent well bound notebook.
b. A plastic clip file
c. A computer note book
d. Company's Distribution and maintenance manual

e. Company's Consumers Operation Procedures (COP)
f. Company's Service Rule
g. Company's Ordinance
h. Energy Policy of Bangladesh
i. Pocket calculator, pencil, pen, papers etc.
j. Some written instructions, publications and format published by SBU team
k. Company's Mode Of Development (MOD) / Executive Summary
l. Some standard statistics on gas distribution system
m. Any other item thought to be required by any member.

To start the work as per SBU concept, the core SBU team authority should

a. Know the specific area
b. Collect all statistics of that area as mentioned below
    i) MOD of the unit for last one year beginning from starting month
    ii) Category wise no of consumers for last one year
    iii) Peak demand of gas of that area for last one year
    iv) Staff strength including salary, wages and O&M expenses
    v) Quantity of pipeline, TBS, DRS and diagram of the distribution network
    vi) An updated material inventory report
    vii) Existing work order for consultant and contractor
    viii) Supply quality such as pressure variation, interruptions etc.

c. Make group from the core team who will be responsible for specific job in different unit and accordingly tour program should be prepared
d. Recruit people from the unit to assist the core group
e. Nominate team leader from core group and vice team leader from the unit for each group.

5.3.3 Classification of works

The SBU activities to be done for the unit shall be divided in two groups and these will be completed in two phases

1) 1st phase
2) 2nd phase

The work should start after motivation lectures given by senior members of SBU core team to all other members stating the purpose of the job. Existing status of gas sector along with an estimated picture of benefit achieved after completion of different phases shall also be described.

1st phase: The 1st phase works comprises the following activities are

Promotional activities: A leaflet from central team will be distributed with the help of the unit head. The unit will also arrange for canvassing about the program. The slogans conveying the motto of the company and its objectives should be given in the leaflets. Local press coverage and advertisement through posters should be done as well.

Meter checking and sealing: Each group will comprise of either 3 or 4 members of divisional staff engaged for RMS checking, sealing and filling up of the prescribed format. Each team should seal minimum of 5 RMS per day. In all cases, RMS premises should be established at open places. In filling up the consumer survey format the most important item is "likely monthly consumption". Consumption of any establishment mainly for industrial and commercial customer should be calculated on spot and noted accordingly.

Legalization of illegal consumers: As there are enormous problem to get the gas connection and new consumer service connection has gone to worse, a new change in the service culture is urgently need to be brought. On this conception, the SBU team at the assistance of the unit will apply a 'spot consumer connection methodology'. This means, standard facilities to give connection will be developed. Consumers will be invited in the spot and should be regularized as per Consumer Operation Procedures (COP). This will give manifold benefit to the program.

Reporting on transmission and distribution lines and control points: Thorough study on the existing transmission and distribution lines with its CGS, TBS, DRS etc. will confirm, a)

an updated and unexposed condition of gas pipelines and b) uninterrupted and smooth supply of gas.

Installing of programmable meters and digitizing: For large (mainly industrial and commercial) customers the SBU core team members with the assistance of local unit and consultant people shall start installing programmable meter and data loggers and make preparation for digitizing the system including load and flow analysis. This group will prepare a time bound program and this will be helpful for making accountability and transparency for sustenance of the system. In case of domestic customers prepaid billing system should be applicable.

Computer billing: The logistics for computer billing activities shall be well thought by the SBU team and the consultant team leader and these shall be procured timely for computer billing.

Accounts receivable: The SBU core team shall assign a group of the team for recovery of outstanding payments. The group shall discuss with the outstanding consumers along with the unit staff and submit a recommendation to the team leader. However an incentive package for the group for recovery of outstanding can be structured.

2nd phase: The SBU core-monitoring team will complete the 2nd phase work with in next 90 (ninety) days in each unit and with the assistance of divisional staff and local consultant the team will perform the following functions.

Identification of standard performance indicators are:

i) Technical and non-technical loss
ii) Pressure factor
iii) Accounts receivable
iv) Quantity of gas in
v) Quantity of gas sale
vi) Administration expenses
vii) Personal condition of the unit

Introduction of Performance Target Achievement (PTA) system: Keeping the existing management of distribution unit intact, monitoring should be introduced as per following system.

As per proposed organogram (Figure-4.1 to Figure-4.6), keeping distribution unit as it is, executive engineer working under deputy chief engineer (DCE) as sectional head will be considered pivotal chief of the utility. All activities such as construction, operation, maintenance and monitoring of the set of performance indicator of all Executive Engineers will be monitored by the respective DCE and finally by the additional chief engineer (ACE). The area under each DCE (the departmental head) will be monitored through defined standard criterion, which as per new definition can be termed as SBU area.

So, the standard smaller and independent unit under SBU will be section, on which gas accounts, management and audit will be done on division basis. Normally the Executive Engineer will be held responsible for operation, maintenance, gas import and export etc. in that specific area. So, the Executive Engineer for section including DCE for a single SBU and ACE for all the SBUs under the division will be responsible for maintaining standard set indicators. For any construction or extension of pipeline and other infrastructure, for distribution business of its own jurisdiction can be done as per set criteria, which of course is to be as per allocated in ADP. However the parameter of those will be decided by a standard committee and will be yardstick for performance monitoring of the section, SBU or of division.

SBU can structure a punishment and incentive bonus package, so that this scheme may be implemented in divisions, SBUs or on sections, to ensure sustained improvement by the system. For obvious reason and on technical ground the incentive and punishment scheme naturally be applicable on a standard unit that is on section headed by Executive Engineer. Ultimately each piecemeal division be added and will create one defined SBU.

The committee will set the indicators of each section. The Executive Engineer is to agree on these parameters. These all calculations and measurement will do jointly by the committee, sectional people and appointed local consultant. However DCE and ACE will participate in the discussion. So Executive Engineer has to agree with those otherwise he is

to quit. These parameters depend on the socio-economic condition and load quantum of the area. So these parameters may vary from unit to unit.

Some times, a punishment scheme also needs to be introduced. Like structural reforms, the targeted goals in gas sector can be achieve by slight policy reforms. Lack of reward or punishment, for good and bad performance respectively; promote apathy among the employees, which in tern cause inefficiency and malpractice in the company. So that punishment could be imposed for not achieving the target. That is the only way to commercialize the gas distribution unit successfully and achieve the target and thus ultimately make natural gas distribution system financially and technically viable.

Remuneration of the proposed unit: It can be noted here that the existing salary structure of the country has partially contributed to the current level of corruption. This ultimately made almost all revenue-earning sectors into non-viable areas. It can be anticipated that if people get proper remuneration vis-à-vis efficiency and accountability are maintained all the sectors, especially the gas sector would become much more profitable.

Modification of service structure: In contemporary times it is reflected that accountability and transparency were absent almost in all sectors that resulted an undesired irregularities in the society. Scaling the over all performance of the units against agreed indicators the sections and SBUs accountability and transparency can be surfaced. If so, in going forward for achieving the specific target, a competitiveness can be brought by the SBUs and divisions within themselves in macro scale and individual performance in micro scale for each specific job. No need to be privatizing for so-called "competitiveness" is required. This program of privatization by the donors has been landed for the benefit of the "out tracked" beneficiary of the society at the cost of the peoples interest.

So Additional Chief Engineers, Deputy Chief Engineers and Executive Engineers down to MLSS need to sign a contract with gas sector against specific job they are assigned to maintain the improved system and to go forward to attain the agreed target. That will be structured in such a way so that for achievement they will get a bonus that is fixed through PTA or if they fail as agreed in PTA they are to quit. All these needs to be structured immediately and accordingly SBU core monitoring team will take immediate action for that.

Conclusion: Programs for system improvement and reduction of losses have never been very successful for various reasons such as:

i) Lack of knowledge on the total sector
ii) Absence of command to fight against ill motivated people
iii) Lack of patience to continue till success is achieved
iv) Lack of knowledge on methodology for improvement of system
v) It is often wrongly presumed that a new project would bring more benefits as opposed to upgrading an existing system for improvement.

The vital parts of the program are more administrative and financial than technical. Actually it is an ongoing conflict between honesty and dishonesty. But to establish honest and transparent mechanism all work force must know the technicality of the distribution system. Otherwise present drawbacks will continue. So all SBU team members should be well conversant with the technicality of the gas distribution system. Books and literatures should be available in the SBU library. The proposed SBU report forms are shown in Appendix-B. These were adopted from Power Development sector.

People working in SBU concept must realize that complexities in gas distribution system have direct impact over gas transmission and production systems. Varieties of consumer dictating load curves and resulting various gas-measuring factors tend to evolve in to a differential tariff and revenue structure. These complexities along with unspecified public relation and end use appliances efficiency depend upon the quality service of a distribution engineer. To meet the requirements skills must be combined with good working ethics.

5.4 Customer Supporting Proposals

Before going to establish any customer supporting proposals, short description of existing gas connection systems and other customer services are necessary.

5.4.1 Existing gas connection systems

Domestic:

a) Collection of application form with a copy of prescribed gas connection rules, after depositing application price to the company account of scheduled banks.

b) Applicant should be the proprietor of the holding (s) and the application must accompanied with,

- Attested copies of ownership documents including holding number.
- Two copies of attested photo.
- Four copies of line diagram of the house/ holding, showing proposed house wiring and gas service lines.
- An estimate of costs.

c) Feasibility survey by an officer nominated by the authority with in 5 days of submission of the application.

d) Approval for load sanction or any decision after convey of the feasibility survey should be reached to the customer with in 15 days.

e) After giving consent to the consumer, a demand note should be issued with in 3 days and it will include connection fee, security deposit and service line charge etc.

f) Drawing should be approved with in 5 days after deposition of the demand note amount to approved scheduled banks. After approval of drawing, establishment of house wiring and its pressure testing should be completed with in 5 consecutive days respectively. Anthority should give a written note on internal house wiring costs (except material costs) to the customer.

g) Completion of 'Gas sales' contract.

h) Submission of road cutting permission by the customer.

i) Laying of the service line, riser installation and commissioning of the service line should be performed with in 15 days of getting road cutting permission and completion report.

j) Establishment of the regulator and RMS by the concerned authority, with in 3 and 10 days respectively.

k) Internal line commissioning (gas supply), connection card and bill book (in case of non-metered customer) supply etc. should completed with in 3 days of regulator and RMS establishment.

Probable time required to perform 11 stages of gas connection system may be about 100 days (over three months), if everything runs normally.

Commercial:

a) Collection of application form, from office, designated banks or from the website etc. and a copy (on payment) of prescribed gas connection rules from any gas office. Application must accompanied with,

   1) Crossed cheque or pay order of Tk. 200/= (renewable), in favor of the company as the value of application form.
   2) Two attested copies of passport size photo of the applicant.
   3) Trade license.
   4) Attested copies of ownership documents including holding number.
   5) In case of hiring, a deed of contract between the owner (land) and the applicant. In this case security deposit should be equal to 6 (six) months probable gas bill.
   6) Four copies of drawing of the internal wiring.
   7) Catalogue of the gas equipments (burner, boiler, dryer, oven etc.).

b) After obtaining the application, the procedural steps are

   1) Customer will communicate to the respective sales zone/ regional offices.
   2) Feasibility survey by an officer nominated by the zone/regional authority with in 5 days of submission of the application.
   3) As per justification survey, feasible customer will be entitled with the grant letter with in 14 days and the demand note will be issued with in 7 day after submission of signed grant letter by the customer. The demand

note will contain connection fee, security deposit, service line, regulator, RMS etc. costs.

4) Lists of the enlisted fourth or third class (1.1 or 1.2) contractors, required for gas connection, can be obtained from zone/ regional offices.
5) Approval of the drawing performed by the appointed contractor with in 5 days after depositing credited demand note to the respective office and pressure test for internal line should be completed with in 5 days of submission of the internal liue completion report. Actual cost (without the material cost) should be calculated and supplied by the zone/ regional offices to the customer.
6) Submission of road cutting permission by the customer and if required, clearance from environmental authority.
7) Sign of the 'Gas Sales' stipulation, after submission of all mandatory documents.
8) Zone/ regional offices will finish all necessary proceedings including gas supply, with in 15 days of obtaining the work completion report. Commissioning card and meter card should be handed over to the customer during gas commissioniog.

Probable time required to perform above stages of commercial connection system may be about 120 days (four months), if everything runs normally.

Industrial:

a) Collection of application form, from office, designated banks or from websites etc. Copy (on payment) of prescribed gas connection rules can also be collect from respective gas offices. Application must accompanied with,

1) Crossed cheque or pay order of Tk. 300/= (renewable), in favor of the company as the value of application form.
2) Two attested copies of passport size photo of the applicant.
3) Trade license.
4) TIN certificate.
5) Memorandum of Articles & Association and Certificate of incorporation in case of Registered Company.

6) Attested copies of ownership documents including holding number.
7) In case of hiring, a deed of contract between the owner (land) and the applicant. In this case security deposit should be equal to 6 (six) months probable gas bill.
8) Four copies of drawing of the internal wiring.
9) Technical Catalogue of the gas equipments (burner, boiler, dryer, oven etc.).

b) Thorough inspection and feasibility survey by an officer nominated by the zone or regional authority with in 5 days of submission of the application. During the visit the concern officer should confirm on following matters:

i) Accuracy in load calculation.
ii) Confirmation on suitable RMS position as per existing rules.
iii) Consideration of standby gas equipment/ burner during load calculation.
iv) Customers willing to use fuels other than gas simultaneously will not be choose.
v) Separate RMS or a central RMS with different sub-meters for more than one factories/ industries under single ownership/ management and in the same premise.
vi) Different contracts and different run/ sub-meter for different kinds of gas connections (industry, captive power, domestic etc.) including an undertaken of Tk. 150/= in non-judicial stamp, attested by a Notary Public.

c) As per report on feasibility survey, approval of load by the authority within 20 days.
d) Allotment letter with in two days of obtaining approval list and issue of demand note (security money and commissioning fee) with in 5 days of signing the allotment letter by the customer.
e) Drawing approval with in 3 days of getting receipt of security demand note and issue of 2nd demand note for distribution line, service line and related materials by concern department/ zone offices.

f) Supply of estimated materials from concern offices to the customer with in 5 days crediting of the demand note.

g) Completion of service line, valve pit construction and internal lines, as per working schedule jointly signed by the contractor and the customer in the supervision of the authorized official.

h) Purging & testing in presence of authorized officer with in 3 days of submission of work completion report by the contractor.

i) Building of a suitable RMS room with chain-link fencing (partially) and supply of 'as built drawing' by the appointed 1st/ 2nd class (1.2/ 1.3 category) contractor.

j) Delivery environmental clearance as per existing rules.

k) Completion of gas contract with the customer.

l) Collection of road cutting permission from respective authority by the customer.

m) Gas commissioning within 15 days of completion of respective construction and contract sign.

Probable time required to perform above stages of industrial connection system may be about 150 days (five months), if everything runs normally.

5.4.2 New proposals

<u>One point Connection System</u>: To change the present notion of public about confusing and complex gas connection system and to motivate customers, the company can go after the following simplified systems.

Domestic: Requirements of a deserving domestic customer are-

a) Owner of a holding with standard kitchen room(s).

b) Willing to get domestic connection(s) and have the ability to pay the corresponding charges and bills.

c) Whose premise is within the reach of a distribution line*.

A selected customer will obtain a final demand note containing cost of materials (distribution and service line, RMS etc.), commissioning fee, security deposit, application fee etc. with in 10 working days of submission of his simple application, accompanied with

i) Ownership documents including mutation certificate, holding number etc.

ii) A pay order amounted to Tk. 10000/= (Taka ten thousand only), in favor of the organization**.

iii) Two copies of passport size photo.

iv) Four copies of line drawing of the premise showing riser position, internal line, kitchen room(s) etc. prepared by a minimum of 1.1 category enlisted contractor.

v) A stipulation form signed by the customer, committing compensation for not taking connection or any dilly-dully, after application.

* Service line length: Up to 20 meter for 3/4"dia pipe, 60 meter for 1"dia pipe and above 60 meter 2"dia pipe should be procured by the customer if such situation arise. Provided rout for 1"dia and 2"dia pipe should be a walkway not less than 2 meter and 2.5 meter wide respectively. Lines laid by owners cost will named after him/her. But company will be the solo owner of the laid line. As a founder of the line by own cost, he/his successor will be honored by a one-time bonus amounted to two months existing double burner bill for every domestic riser connected from the line. Total procedure should be conducted under the jurisdiction of the company by collecting the said amount through demand note and offer to the valid person(s) with in stipulated time. Riser shifting, load increase or decrease, disconnection reconnection and any 2"dia line linkage should not be considered in this regard. Distribution lines named after various persons should be blue marked in the as-laid drawing. Company have the unique right to resolve any discrepancy arise in this regard.

** The pay order will be adjusted during issuance of the final demand note and monthly bills (if required). For any discrepancy in giving gas connection due to unavoidable circumstances, the company will bound to return the pay order with in shortest possible

time. In this situation the desired customer can stay away from returning his/ her pay order seeking normal connection. Any dilly-dally by customer will result in forfeit of 20% of the deposited pay order. Moreover the company will have the right to curtail the already-expended amount (material plus implementation cost), from the pay order of the derailed and refuted customer. The company will re-fix its domestic pay order amount time to time, as per cost of connection and gas price.

Finally the kitchen of the deserving customer will be commissioned by natural gas with in next 10 working days from the date of submission of the report accompanied with road cutting permission, completion of house wiring, pressure-testing result etc. and payment of the demand note money, as per company regulation. Provided an effective contract between the authority and the customer should be signed before gas commissioning. The company have the right to extend its stipulated 10 days time, in case of any situation, arise due to unavoidable circumstances. On the other hand, if the situation permits, a fortunate customer may get a demand note/ connection in less than stipulated 10 days.

Thus the domestic billboard of the company office will take the shape as shown bellow.

DOMESTIC CONNECTION.

A deserving customer:

i) **Owner of a good holding.**
ii) **Have the ability and will force for gas connection.**
iii) **A gas reached premise.**

APPLY through a simple prescribed form accompanied with

i) **A Tk. 10,000/= pay order.**
ii) **Ownership documents.**
iii) **Two copies of passport size photo.**
iv) **Four copies of line sketch of the premise.**
v) **Signed stipulation form.**

Obtain the final Demand Note with in 10 working days of submission of the application and Gas Commissioning with in 10 working days of pay back of the demand note and submission of the complete final report on house wiring.

*** Strictly follow the detailed gas rules.**

Commercial: Requirements of a deserving commercial customer are-

i) Owner of a factory/ enterprise with standard gas equipments (burner, boiler et.).

ii) Willing to get commercial connection and have the ability to pay relative charges and bills.

iii) Whose factory/ enterprise is with in the reach of a standard distribution line/ main*.

A preferential commercial customer will obtain a final demand note containing cost of materials (distribution and service line, RMS etc.), commissioning fee, security deposit, application fee etc. with in 10 working days of submission of his simple application, accompanied with

i) Ownership documents including mutation certificate, holding number etc and in case of hiring, a deed of contract between the landowner and the entrepreneur (applicant).

ii) A pay order amounted to Tk. 25000/= (Taka twenty five thousand only), in favor of the company**.

iii) Two copies of passport size photo.

iv) Trade license.

v) Four copies of line drawing of the factory and the premise showing RMS position, internal line, burner/ boiler etc. prepared by a minimum of 1.2 category enlisted contractor.

vi) Catalogue of the gas equipments (burner, boiler, dryer, oven etc.).

vii) Environmental clearance.

viii) A stipulation form signed by the customer, committing compensation for not taking connection after application.

*Service line length: For commercial gas connections, there is no limitation for service lines. But approach road is the conditionality and customer should pay the cost of service/ distribution line between the factory and existing main. If the company desired to install a larger size of the pipe than the required one, should be exempt the customer from

additional payment. For such a case the company may have the right to demand a surcharge, not exceeding 10% on total connection cost (except security money), from the commercial customers taking connections from outside of the gate valve of the described customer financed pipeline.

** The pay order will be adjusted during issuance of the final demand note and monthly bills (if required). For any discrepancy in giving gas connection due to unavoidable circumstances, the company will bound to return the pay order with in shortest possible time. In this situation the desired customer can stay away from returning his/ her pay order seeking normal connection. Any dilly-dally by customer will result in forfeit of 20% of the deposited pay order. Moreover the company will have the right to curtail the already-expended amount (material plus implementation cost), from the pay order of the derailed and refuted customer. The company will re-fix its commercial pay order amount and security money time to time, as per cost of connection and gas price.

Finally the gas equipments of the deserving commercial customer will be commissioned (including RMS establishment) by natural gas with in next 20 working days from the date of payment of the demand note money or with in 10 days of submission of the complete final report accompanied with road cutting permission, completion of internal wiring, pressure-testing result etc. which one is suitable for the situation. The company has the right to extend its stipulated 10 and 20 days time, in case of any situation arise due to unavoidable circumstances. On the other hand, if the situation permits, a fortunate customer may get a demand note/ connection in less than stipulated 10 and 20 days respectively.

Thus the commercial billboard of the company office will take the shape as shown in the next page.

COMMERCIAL CONNECTION.

A deserving customer:

i) Owner of a good commercial enterprise.
ii) Have the ability and will force for gas connection.
iii) A gas reached premise.

APPLY through a prescribed form accompanied with

i) A Tk. 25,000/= pay order.
ii) Ownership documents and deed in case of hiring.
iii) Trade license.
iv) Equipment details (boiler, burner ect.).
v) Two copies of passport size photo.
vi) Four copies of systematic line sketch of the factory/ premise.
vii) Environmental clearance.
viii) Signed stipulation form.

Obtain the final Demand Note with in 10 working days of submission of the application and Gas Commissioning with in 20 working days of pay back of the demand note or with in 10 days of submission of the complete final report on internal wiring.

*** Strictly follow the detailed gas rules.**

Industrial: An intent industrial customer, after learning about his/ her industries nearest distribution main/ line and approach road, may apply in black and white, accompanied with

i) Ownership documents including mutation certificate, holding number etc and in case of hiring, a deed of contract between the landowner and the entrepreneur (applicant).

ii) Description of load and standard gas equipments (burner, boiler et.).

iii) A non refundable pay order amounted to Tk. 1000/= (Taka one thousand only)

Then the entrepreneur will obtain a letter of consent containing, a fresh application form, calculations for probable connection cost, amount of probable security etc. with in 7 working days of submission of his application or he/she will be informed through a regret letter explaining drawbacks for the refuted connection. After obtaining the assent letter the industrial customer will apply finally, which will contain

i) Memorandum of Articles and Association and Certificate of incorporation in case of Registered Company.
ii) A refundable pay order amounted to Tk. 1,00,000/= (Taka one lac only) or 2/3rd of the probable connection cost, which one is the maximum, in favor of the company*.
iii) Two copies of passport size photo.
iv) Trade license.
v) TIN number.
vi) Four copies of line drawing of the industry/ factory and the premise showing RMS position, internal line, burner/ boiler etc. prepared by a minimum of 1.2 category enlisted contractor.
vii) Catalogue of the gas equipments (burner, boiler, dryer, oven etc.).
viii) Environmental clearance.
ix) A stipulation form signed by the customer, committing compensation for not taking connection after application or any procrastination.

An approved industrial customer will earn a final demand note containing cost of materials (distribution and service line, RMS etc.), commissioning fee, security deposit, etc. with in 15 working days from the date of submission of the complete application as described above.

Service line length: For industrial gas connections, there is no limitation for service lines. But approach road is the conditionality and customer should pay the cost of service/ distribution line between the industry and existing main. If the company desired to install a larger size of the pipe than the required one, should be exempt the customer from

additional payment. For such a case the company may have the right to demand a surcharge, not exceeding 10% on total connection cost (except security money), from the industrial and large commercial customers taking connections from outside of the gate valve of the described customer financed pipeline.

* The pay order will be adjusted with the final demand note and monthly bills (if required). For any discrepancy in giving gas connection due to unavoidable circumstances, the company will bound to return the pay order with in shortest possible time. In this situation the desired customer can stay away from returning his/ her pay order seeking normal connection. Any dilly-dally by customer will result in forfeit of 20% of the deposited pay order. Moreover the company will have the right to curtail the already-expended amount (material and implementation cost), from the pay order of the derailed/ refuted customer. The company will re-fix its industrial pay order amount and security money time to time, as per cost of connection and gas price.

Finally the gas equipments of the deserving industrial customer will be commissioned by natural gas with in next 25 working days from the date of payment of the demand note money. Provided the complete final report accompanied with road cutting permission, completion of internal wiring (including RMS installation), pressure testing result etc. as per company regulation should be reached to the concern office with in 15 working days from the date of submission of the demand note. Moreover an effective contract between the authority and the customer should be signed before gas commissioning. The company has the right to extend its stipulated 15 and 25 days time, in case of any situation arise due to unavoidable circumstances. On the other hand, if the situation permits, a fortunate customer may get a demand note/ connection in less than stipulated 15 and 25 days respectively.

Thus the industrial billboard of the company office will take the shape as shown in the next page.

INDUSTRIAL CONNECTION.

A deserving customer:

- **i) A gas reachable industry.**
- **ii) Have the consent letter in return of black and white application containing ownership documents, Tk. 1000/= pay order (non refundable) and equipments (burner) details.**

APPLY through a prescribed form accompanied with-

- **i) A Tk. 1,00,000/= pay order or 2/3rd of the security (max^m one).**
- **ii) Company Registration (MAA).**
- **iii) Trade license.**
- **iv) TIN number.**
- **v) Two copies of passport size photo.**
- **vi) Four copies of systematic line sketch of the factory/ premise.**
- **vii) Environmental clearance.**
- **viii) Signed stipulation form.**

Obtain the final Demand Note with in 15 working days of submission of the application and Gas Commissioning with in 25 working days of pay back of the demand note and with in 10 days of submission of the complete final report on internal wiring.

*** Strictly follow the detailed gas rules.**

For easy new connectivity and effective inspection of existing connections, a number of simplified forms have been developed. They are presented in Appendix-C.

5.4.3 Proposals on Gas Billing

To improve present gas billing system, following steps can be proposed.

- i) Rebate on regular/ advance payment
- ii) Pre-paid metering system
- iii) Updating of billing through banks.

CHAPTER VI

THE PROJECT PROFORMA

Evaluation is the analytical process for systematically and objectively perceiving efficiency and effectiveness. Project pro-forma is the standard form of project evaluation mainly based on a) investment costs, b) operating recurring costs and c) annual value output. Finally outputs of the evaluation are net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR).

6.1 Calculation of Costs and Output Values

To make a standard output of the study as per objectivity, a four years length project is considered for the selected region. Project evaluation process performs on three inputs, these are: investment costs, operating recurring costs and annual value output.

6.1.1 Detailed break-up of investment costs

The investment costs required during project period (initial four year), includes pre-construction expenditure, construction cost, machineries and equipment costs, transport vehicles costs and manpower costs. Head wise detailed break-up both in local currency (LC) and foreign currency (FC) are explained bellow.

(Tk. In lac.)

I. PRE-CONSTRUCTION EXPENDITURE:	LC	FC	Tot.
a. Advance expenditure.(Rout survey, Design, Drawing etc.)	60	-	60
b. Land acquisition (10 acres of land, @ Tk. 60 lac/ acre)	600	-	600
c. Land requisition for pipelines (605, 000 rm @ Tk. 65 /rm.)	394	-	394
d. Land development.	60	-	60
e. Others (Soil investigation, Right of way demarcation etc.).	100	-	100

II. CONSTRUCTION WORKS:

a. Functional Buildings (2500 m^2 @ Tk. 13000/= per m^2)	325	-	325
b. Residential buildings (3500 m^2 @ Tk 13000/= per m^2)	455	-	455
c. Other Constructions.			
i) TBS, DRS (Two Nos.) & SCADA	480	160	640
ii) Pipeline Construction (485 km @ Tk. 250/= per rm. 120 km. @ Tk. 1200/= per rm.)	2653	-	2653
iii) ¾" dia riser pipe (55 km @ Tk. 135/= per rm.)	75	-	75
iv) Miscellaneous (Boundary walls, internal roads, cp, etc.)	150	-	150

[Where construction costs for 1 TBS & 2 DRS are, 320 in LC and 60 in FC. Construction costs for SCADA are, 160 in LC and 100 in FC.]

III. MACHINERIES, EQUIPMENTS & MATERIALS:

Table-6.1: Cost calculation for required quantity of pipes (Pipe rates, Titas-2002).

Sl. No.	Dia (inch)	Length (rm.)	Rate Per rm.(Tk)	Tot. Taka (Lac).
1.	12"	40,000	810/=	324
2.	10"	80,000	590/=	472
Total		1,20,000		796 (FE).
1.	8"	55,000	1550/=	853
2.	6"	60,000	1100/=	660
3.	4"	1,00,000	630/=	630
4.	3"	30,000	405/=	122
5.	2"	2,00,000	270/=	540
6.	1"	40,000	135/=	54
7.	¾"	55,000	95	52
Total		5,40,000		2911 (LC)

- Cost of pipes (Table-6.1)	2911	796	3707
- Cost of TBS, DRS & SCADA Equipment & Spares.	-	960	960
- Cost of line fittings.	200	300	500
i) CIF Cost (2.50%) on FE.	52	-	52
ii) Pre-shipment Inspection.(2%) on FE.	-	41	41
iii) Duties and Taxes (50%) on FE.	1028	-	1028
iv) Handling & Transportation Charges (7.5%) on FE.	155	-	155

[Where material cost for 1 TBS & 2 DRS are 420 in FC and material cost for SCADA is 540 in FC.]

Extra costs on Local Currency.

i) Ex-factory costs.	-	-	-
ii) CD/VAT (20%) on LC.	622	-	622
iii) Transportation cost (7.5%) on LC.	234	-	234
iv) Office Equipments and Furniture.	75	-	75

IV. TRANSPORT VEHICLES:

Jeep 5 each @ 22 Lac. = 110 Micro 4 „ „ 12 „ = 48 Pick-up 4 „ „ 8 „ = 32 Motor cycle 10 „ 1 „ = 10	200	-	200

V. MANPOWER:

Table-6.2: Cost calculation for project period manpower.

Type of Personnel	Gross pay per Month.	Year-1		Year-2		Year-3		Year-4		Compare with NPS
		No.	Annual Remun.	No.	Annual Remun.	No.	Annual Remun.	No.	Annual Remun	
1.OFFICERS:										
a) Project Director.	40,000	1	4.80	1	5.28	1	5.81	1	6.40	12,900/=
b) Deputy Chief Engg.	32,000	1	3.84	1	4.23	1	4 66	1	5.13	11,600/=
c) Ex. Engg./ DM	25,000	2	6.00	3	9.90	3	10.89	4	15.98	9,500/=
d) E / AM.	18,000	4	8.64	5	11.89	6	15.70	7	20.15	7,200/=
e) AE / Officer.	12,000	4	5.76	5	7 92	6	10 46	7	13.43	4,300/=
Total.		12	29.04	15	38.74	17	47.52	20	61.09	
2. STAFFS:										
a) Skill Tec./Operator.	7,000	3	2.52	5	4.63	7	7.13	7	7.85	2,375/=
b) MLSS/ Sec. Guard	5,000	9	5.40	14	9.24	17	12 35	17	13.60	1.625/=
Total.		12	7.92	19	13 87	24	19 48	24	21 45	
Grand Total.		24	36.96	34	52 61	41	67.00	44	82.54	

Manpower costs in the investment table were considered roundly as 37, 53, 67 & 83 lacs respectively, for 4 years project period.

Pre-construction expenditure: based on the value of standard quantity of acquirable land for offices and residential buildings, quantity of land required for rout of distribution line laying, land development, survey, design, drawing, soil investigation, right of way demarcation etc.

Costs for construction works: include probable expenditure for office and residential buildings, distribution line lying, boundary walls, internal road, installation of TBS, DRS and SCADA. Area wise pipeline lengths are explained in Table-6.3. Pipe lying costs are taken from Titas Gas and costing of civil works is as per PWD rates.

Machineries equipments and material costs: are calculated on costs of pipes, costs of TBS, DRS and SCADA equipments and spares with import duties, transportation costs, VAT/ Tax etc. Detailed calculation of cost for probable quantity of pipe is shown in the Table-6.1.

Transport vehicle costs: are calculated on basic requirements avoiding dissipation.

Manpower: Detailed description with standard salary structure for the project period manpower is explained in the Table- 6.2.

6.1.2 Operating recurring cost

All costs related to final running of gas distribution activities including raw materials and supplies, duties and taxes, fuel and power, manpower, maintenance and repair are termed as operating recurring cost. Operating cost is calculated on yearly basis. In this study, initially a period of 20 (twenty) years is considered, for the proposed distribution network. Detailed description of operating recurring costs for 20 years period is explained in the Table-6.6.

6.1.3 Annual value output

Annual value output concerns with total revenue earned per year. As per customer survey report (Table-3.9, Ch-III), assumed no of customer and corresponding consumption of gas has been calculated. As a part of the study, calculation of annual value output (financial) including well head price of gas, excise, BAPEX charge and end users price are described in Table-6.7.

Table-6.3: Total and area wise probable pipeline length (meter).

(In Meter)

Sl. No.	Area	12"	10"	8"	6"	4"	3"	2"	1"	¾"	Total
1.	BOGRA	25,000	50,000	35,000	40,000	70,000	20,000	1.50,000	30,000	40.000	4,60,000
2.	NAOGAON	5,000	10,000	11,000	11,000	18,000	6,000	30,000	6,000	9.000	1,06,000
3.	JOYPURHAT	10,000	20,000	9,000	9,000	12,000	4,000	20,000	4,000	6,000	94,000
	TOTAL.	40,000	80,000	55,000	60,000	1,00,000	30.000	2,00,000	40,000	55.000	6,60,000

Table-6.4: Description of probable connection and respective gas consumption (After 20 Years).

Sl. No.	Area	Customer Connections					Gas Consumption (MMCM).				
		Power	Industrial	Commer.	Domestic	Total	Power	Industrial	Commer.	Domestic	Total
1.	BOGRA	2	103	267	27,200	27572	450	36 88	2 81	23 26	512.95
2.	NAOGAON	-	18	92	9,150	9260	-	6.44	0 97	7.82	15.23
3.	JOYPURHAT	-	20	71	6,900	6991	-	7.16	0 74	5.90	13.80
	TOTAL.	2	141	430	43,250	43,823	450	50.48	4.52	36.98	541.98

Table-6.5: Calculation of investment cost.

(Figures in Lac Taka.)

Sl. No.	Items of work	Total			Year-1			Year-2			Year-3			Year-4		
		LC	FC	TOT	LC	FC	TOT.	LC	FC	TOT.	LC	FC	TOT.	LC	FC	TOT
I.	**Preconstruction Expenditure:**															
	a. Advance Expenditure	60	-	60	60	-	60	-	-	-	-	-	-	-	-	-
	b. Land Acquisition.	600	-	600	300	-	300	200	-	200	100	-	100	-	-	-
	c Land Requisition.	394	-	394	94	-	94	150	-	150	150	-	150	-	-	-
	d. Land development.	60	-	60	15	-	15	15	-	15	15	-	15	15	-	15
	e. Others.	100	-	100	20	-	20	30	-	30	30	-	30	20	-	20
	Sub total.	1214	-	1214	489	-	489	395	-	395	295	-	295	35	-	35
	Cost escalation.	61	-	61	25	-	25	20	-	20	15	-	15	1	-	1
II.	**Construction Works:**															
	a. Functional Building (all cost)	325	-	325	75	-	75	100	-	100	100	-	100	50	-	50
	b. Residential Building.	455	-	455	100	-	100	200	-	200	100	-	100	55	-	55
	c. Other Constructions:															
	i) Installation of TBS, DRS & SCADA.	480	160	640	240	-	240	240	160	400	-	-	-	-	-	-
	ii) Pipe line const.	2653	-	2653	400	-	400	1000	-	1000	1000	-	1000	253	-	253
	iii) ¾" dia pipe.	75	-	75	-	-	-	-	-	-	25	-	25	50	-	50
	iv) B. walls. Int. roads etc.	150	-	150	50	-	50	75	-	75	25	-	25	-	-	-
	Sub total.	4138	160	4298	865	-	865	1615	160	1775	1250	-	1250	408	-	408
	Cost escalation.	207	8	215	43	-	43	81	8	89	63	-	63	20	-	20

Table-6.5: Continued (investment cost).

(Figures in Lac Taka.)

Sl. No	Items of work.	Total			Year-1			Year-2			Year-3			Year-4		
		LC	FC	TOT.	LC	FC	TOT.	LC	FC	TOT.	LC	FC	TOT.	LC	FC	TOT.
III.	**Machineries & Equipments:**															
	a. Imported Machineries, Equipments & Spares.	-	2056	2056	-	900	900	-	900	900	-	256	256	-	-	-
	i) CIF costs.	52	-	52	22	-	22	22	-	22	8	-	8	-	-	-
	ii) Pre-shipment Inspection.	-	41	41	-	18	18	-	18	18	-	5	5	-	-	-
	iii) Duties & Taxes.	1028	-	1028	450	-	450	450	-	450	128	-	128	-	-	-
	iv) Handling & transportation Charges.	155	-	155	68	-	68	68	-	68	19	-	19	-	-	-
	b. Locally produced Machineries, Equipment & Spares.	3111	-	3111	1000	-	1000	1000	-	1000	800	-	800	311	-	311
	i) Ex-factory cost.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ii) CD/VAT.	622	-	622	200	-	200	200	-	200	150	-	150	72	-	72
	iii) Transprtn. Cost.	234	-	234	75	-	75	75	-	75	60	-	60	24	-	24
	iv) Furniture & off. equipments.	75	-	75	25	-	25	25	-	25	15	-	15	10	-	10
	Sub total.	5277	2097	7374	1840	918	2758	1840	918	2758	1180	261	1441	417	-	417
	Cost escalation.	264	105	369	92	46	138	92	46	138	59	13	72	21	-	21
IV.	**Transport vehicles:**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	a. Imported															
	i) CIF cost.															
	ii) Duties & Taxes.															
	iii) H Charges.															
	b. Local procured.	200	-	200	50	-	50	50	-	50	50	-	50	50	-	50
	i) Exfeury cost															
	ii) CD/VAT.															
	iii) Transprt. Cost															
	Sub total	200	-	200	50	-	50	50	-	50	50	-	50	50	-	50
	Cost escalation.															

Table-6.5: Continued (investment cost).

(Figures in Lac Taka.)

Sl. No.	Items of work.	Total			Year-1			Year-2			Year-3			Year-4		
		LC	FC	TOT	LC	FC	TOT	LC	FC	TOT.	LC	FC	TOT.	LC	FC	TOT.
V.	**Manpower:**															
	a. Managerial/ Officers.	160	-	160	25	-	25	35	-	35	45	-	45	55	-	55
	b. Staff/ Skilled worker.	80	-	80	12	-	12	18	-	18	22	-	22	28	-	28
	Sub total.	240	-	240	37	-	37	53	-	53	67	-	67	83	-	83
	Cost escalation.															
VI.	**Others:**															
	a. Cost of Engineering & design	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b. Interest during construction.	1032	-	1032	220	-	220	440	-	440	300	-	300	72	-	72
	c. Miscellaneous.	100	-	100	25	-	25	25	-	25	25	-	25	25	-	25
	Sub total.	1132	-	1132	245	-	245	465	-	465	325	-	325	97	-	97
	Cost escalation.	57	-	57	12	-	12	23	-	23	17	-	17	5	-	5
A.	Total of Sub-totals.	12201	2257	14458	3526	918	4444	4418	1078	5496	3167	261	3428	1090	-	1090
B	Total of cost escalations.	589	113	702	172	46	218	216	54	270	154	13	167	47	-	47
C.	Total of investment cost (A+B).	12790	2370	15160	3698	964	4662	4634	1132	5766	3321	274	3595	1137	-	1137
D.	Total of CD/VAT.	1028	-	1028	450	-	450	450	-	450	128	-	128	-	-	-
	Investment cost for financial analysis (NPV, BCR etc).			14128			4442			5326			3295			1065

Table-6.6: Operating/ Recurring cost.

Sl. No.	Items of Work	Year-1			Year-2			Year-3			Year-4			Year-5		
		LC	FC	Tot.	LC	FC	Tot	LC	FC	Tot	LC	FC	Tot	LC	FC	Tot.
I.	Raw Materials & Supplies															
	a) Imported Materials	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Locally Proc. Raw Materials.															
	i) Cost of Gas	18.50	-	18 50	31 70	-	31.70	44 68	-	44 68	57.95	-	57.95	618.31	-	618 31
	ii) Duties & Taxes	222.56	-	222 56	380 38	-	380.38	533 42	-	533.42	689.69	-	689 69	4012 90	-	4012.90
	Sub Total	241 06	-	241 06	412 08	-	412.08	578 10	-	578.10	747.64	-	747 64	4631.21	-	4631.21
II.	Fuel and Power.															
	a) Electricity															
	b) Oil,	10	-	10	10	-	10	10	-	10	10	-	10	10	-	10
	c) Others															
	Sub Total	10	-	10	10	-	10	10	-	10	10	-	10	10	-	10
III.	Manpower.															
	a) Foreign Personnel.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Local Personnel															
	i) Officers.	45	-	45	55	-	55	61	-	61	67	-	67	73	-	73
	ii) Staffs	22	-	22	28	-	28	31	-	31	34	-	34	37	-	37
	Sub Total	67	-	67	83	-	83	92	-	92	101	-	101	110	-	110
/IV.	Other Costs															
	a) Depreciation Costs.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Maintenance ,,	-	-	-	-	-	-	10	-	10	10	-	10	10	-	10
	c) Interests	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	d) Miscellaneous (LS) ,,	2	-	2	2	-	2	2	-	2	2	-	2	2	-	2
	e) Tax if any	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sub Total	2	-	2	2	-	2	12	-	12	12	-	12	12	-	12
	Total operating cost	253 06	-	253 06	424 08	-	424.08	692 10	-	692.10	870 64	-	870.64	4763 21	-	4763 21
	Net operating cost			253 06			424 08			692.10			870 64			4763 21

Table-6.6: Continued (Operating/ Recurring cost).

Sl. No.	Items of Work	Year-6			Year-7			Year-8			Year-9			Year-10		
		LC	FC	Tot.	LC	FC	Tot	LC	FC	Tot	LC	FC	Tot	LC	FC	Tot.
I.	Raw Materials & Supplies.															
	a) Imported Materials.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Locally P Raw Materials.															
	i) Cost of Gas	628 19	-	628 19	636.97	-	636 97	645.74	-	645 74	654 52	-	654.52	661 74	-	661.74
	ii) Duties & Taxes	4130.94	-	4130 94	4235 47	-	4235 47	4340 30	-	4340 30	4444 84	-	4444 84	4529 88	-	4529 88
	Sub Total	4759 13	-	4759.13	4872.44	-	4872.44	4986 04	-	4986.04	5099.36	-	5099.36	5191.62	-	5191.62
II.	Fuel and Power.															
	a) Electricity.															
	b) Oil.	10	-	10	10	-	10	10	-	10	10	-	10	10	-	10
	c) Others.															
	Sub Total	10	-	10	10	-	10	10	-	10	10	-	10	10	-	10
III.	Manpower															
	a) Foreign Personnel.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Local Personnel															
	i) Officers	79	-	79	85	-	85	91	-	91	97	-	97	103	-	103
	ii) Staffs.	40	-	40	43	-	43	46	-	46	49	-	49	52	-	52
	Sub Total	119	-	119	128	-	128	137	-	137	146	-	146	155	-	155
IV.	Other Costs															
	a) Depreciation Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Maintenance ,,	10	10	20	10	10	20	10	10	20	10	10	20	10	10	20
	c) Interests	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	d) Miscellaneous (1 %) ,,	2	-	2	2	-	2	2	-	2	2	-	2	2	-	2
	e) Tax if any	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sub Total	12	10	22	12	10	22	12	10	22	12	10	22	12	10	22
	Total operating cost	4900.13	10	4910.13	5022.44	10	5032.44	5145 04	10	5155 04	5267 36	10	5277.36	5368 62	10	5378 62
	Net operating cost			4910.13	-		5032 44			5155 04			5277.36			5378.62

Table-6.6: Continued (Operating/ Recurring cost).

Sl. No.	Items of Work	Year-11			Year-12			Year-13			Year-14			Year-15		
		LC	FC	Tot	LC	FC	Tot	LC	FC	Tot	LC	FC	Tot	LC	FC	Tot.
I.	Raw Materials & Supplies															
	a) Imported Materials	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Locally P. Raw Materials.															
	i) Cost of Gas.	668 98	-	668 98	676.96	-	676 96	684.97	-	684.97	694 52	-	694 52	1145 67	-	1145 67
	ii) Duties & Taxes	4615 02	-	4615.02	4709.69	-	4709 69	4804.59	-	4804 59	4919.06	-	4919.06	7615.82	-	7615 82
	Sub Total	5284 00	-	5284 00	5386.65	-	5386.65	5489.56	-	5489 56	5613.58		5613 58	8761.49	-	8761.49
II	Fuel and Power															
	a) Electricity.															
	b) Oil.	10	-	10	10	-	10	10	-	10	10	-	10	10	-	10
	c) Others.															
	Sub Total	10	-	10	10	-	10	10	-	10	10	-	10	10	-	10
III.	Manpower															
	a) Foreign Personnel.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	c) Local Personnel															
	i) Officers.	109	-	109	115	-	115	121	-	121	127	-	127	133	-	133
	ii) Staffs.	55	-	55	58	-	58	61	-	61	64	-	64	67	-	67
	Sub Total	164	-	164	173	-	173	182	-	182	191	-	191	200	-	200
IV.	Other Costs.															
	a) Depreciation Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Maintenance ,,	10	10	20	10	15	25	10	15	25	10	15	25	10	15	25
	c) Interests	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	d) Miscellaneous (LS) ,,	2	-	2	2	-	2	2	-	2	2	-	2	2	-	2
	e) Tax if any	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sub Total	12	10	22	12	15	27	12	15	27	12	15	27	12	15	27
	Total operating cost	5470 00	10	5480.00	5581.65	15	5596.65	5693 56	15	5708.56	5826.58	15	5841.58	8983 49	15	8998.49
	Net operating cost			5480 00			5596.65			5708.56			5841.58			8998 49

Table-6.6: Continued (Operating/ Recurring cost).

Sl. No.	Items of Work	Year-16			Year-17			Year-18			Year-19			Year-20		
		LC	FC	Tot.	LC	FC	Tot	LC	FC	Tot	LC	FC	Tot	LC	FC	Tot.
I.	Raw Materials & Supplies.															
	a) Imported Materials.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Locally P. Raw Materials.															
	i) Cost of Gas	1154.45	-	1154 45	1162.44	-	1162 44	1171 24	-	1171.24	1179.13	-	1179.13	1192 36	-	1192 36
	ii) Duties & Taxes	7720.54	-	7720.54	7815 21	-	7815.21	7920.14	-	7920.14	8013.70	-	8013.70	8173 84	-	8173.84
	Sub Total	8874 99	-	8874 99	8977 65	-	8977.65	9091 38	-	9091.38	9192 83	-	9192.83	9366.20	-	9366.20
II.	Fuel and Power															
	a) Electricity.															
	b) Oil.	10	-	10	10	-	10	10	-	10	10	-	10	10	-	10
	c) Others.															
	Sub Total	10	-	10	10	-	10	10	-	10	10	-	10	10	-	10
III.	Manpower.															
	a) Foreign Personnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Local Personnel.															
	i) Officers.	139	-	139	145	-	145	151	-	151	157	-	157	163	-	163
	ii) Staffs	70	-	70	73	-	73	76	-	76	79	-	79	82	-	82
	Sub Total	209	-	209	218	-	218	227	-	227	236	-	236	245	-	245
IV.	Other Costs.															
	a) Depreciation Costs.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Maintenance „	10	15	25	10	15	25	10	15	25	10	15	25	10	15	25
	c) Interests	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	d) Miscellaneous (LS) „	2	-	2	2	-	2	2	-	2	2	-	2	2	-	2
	e) Tax if any	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sub Total	12	15	27	12	15	27	12	15	27	12	15	27	12	15	27
	Total operating cost	91 5.99	15	9120 99	9217 65	15	9232 65	9340 38	15	9355 38	9450 83	15	9465.83	9633 20	15	9648.20
	Net operating cost			9120 99			9232.65			9355 38			9465.83			9648.20

Table-6.7: Annual Value Output (Financial).

Year.	No. of Customer.					Consumption (MMCM).					Annual Value (Taka in lac).			
	Power	Ind.	Comm.	Dom.	Total.	Pow.	Ind.	Com.	Dom.	Total.	Well head	Excise	BAPEX	End User.
1.	0	15	29	3200	3244	0	5.37	0.34	2.74	8.41	18.50	222.56	6.39	407.87
2.	0	25	51	5760	5836	0	8.95	0.54	4.92	14.41	31.70	380.38	10.95	692.70
3.	0	34	71	8640	8745	0	12.17	0.75	7.39	20.31	44.68	533.42	15.44	972.81
4.	0	43	93	11660	11796	0	15.39	0.98	9.97	26.34	57.95	689.69	20.02	1259.14
5.	1	49	114	14400	14564	250	17.54	1.20	12.31	281.05	618.31	4012.90	213.60	7656.66
6	1	56	136	16450	16643	250	20.05	1.43	14.06	285.54	628.19	4130.94	217.01	7872.73
7.	1	62	156	18350	18569	250	22.20	1.64	15.69	289.53	636.97	4235.47	220.04	8064.36
8.	1	68	178	20250	20497	250	24.34	1.87	17.31	293.52	645.74	4340.30	223.08	8256.64
9.	1	74	198	22150	22423	250	26.49	2.08	18.94	297.51	654.52	4444.84	226.11	8448.28
10.	1	78	220	24050	24349	250	27.92	2.31	20.56	300.79	661.74	4529.88	228.60	8605.48
11.	1	82	241	25950	26274	250	29.36	2.53	22.19	304.08	668.98	4615.02	231.10	8762.82
12.	1	87	262	27850	28200	250	31.15	2.75	23.81	307.71	676.96	4709.69	233.86	8937.03
13.	1	92	283	29750	30126	250	32.94	2.97	25.44	311.35	684.97	4804.59	236.63	9111.66
14.	1	99	304	31650	32054	250	35.44	3.19	27.06	315.69	694.52	4919.06	239.92	9320.94
15.	2	108	325	33550	33985	450	38.66	3.41	28.69	520.76	1145.67	7615.82	395.78	14506.22
16	2	114	346	35450	35912	450	40.81	3.63	30.31	524.75	1154.45	7720.54	398.81	14698.21
17.	2	119	367	37350	37838	450	42.60	3.85	31.93	528.38	1162.44	7815.21	401.57	14872.42
18.	2	125	388	39250	39765	450	44.75	4.07	33.56	532.38	1171.24	7920.14	404.61	15064.83
19.	2	130	409	41150	41691	450	46.50	4.29	35.18	535.97	1179.13	8013.70	407.34	15237.07
20.	2	141	430	43250	43823	450	50.48	4.52	36.98	541.98	1192.36	8173.84	411.90	15527.87

GOB & PB's Gas Price Distribution (Effect from 01-09-2002)

Tk./ cum.

Sl.	Customer type	Well head	Excise	BAPEX	End Users Price.
1.	Power	0.22	1.281	0.076	2.47
2.	Industry	0.22	2.788	0.076	4.94
3.	Commercial	0.22	3.988	0.076	7.77
4.	Domestic	0.22	2.222	0.076	4.24

6.2 Project Analysis (Evaluation)

After calculation of investment costs, operating recurring costs and annual value output, computing desired NPV, BCR and IRR completes evaluation.

Net present value (NPV): is the difference between the present value of the cash inflows and the present value of the cash outflows generated by the investment and discounted at the assumed hurdle rate (minimum acceptable rate of return).

Benefit cost ratio (BCR): is the ratio of total benefit to total cost, at a particular discount rate.

Internal rate of return (IRR): of a cash flow is the discount rate, at which the present value of the cash flow is zero. The concept IRR determines a discount factor, which becomes the 'yardstick'. IRR measures the effective rate of return earned by an investment as though the money had been loaned at that rate.

6.2.1 Project analysis (financial)

Required inputs for calculation of BCR (F) and NPV (F) are tabulated in Table-6.8. As per standard of business, discount factor has been calculated at an allowable discount rate of 15%. From Table-6.8, discounted total cost = Tk. 30801.63 lac and discounted total benefit = Tk. 29592.29 lac.

$$\therefore Benefit\ Cost\ Ratio(BCR) = \frac{Total\ Benefit}{Total\ Cost} = \frac{29592.29}{30801.63} = 0.9607$$

$$And\ Net\ Present\ Value(NPV) = Total\ Benefit - Total\ Cost = 29592.29 - 30801.63 = -1209.34$$

Internal Rate of Return (IRR), has been calculated from Table-6.9, as shown below

$$\text{IRR (F)} = LDF + \frac{[NPVatLDF][HDF - LDF]}{[NPVatLDF] - [NPVatHDF]}$$

$$= 13 + \frac{1039.97 \times [14 - 13]}{1039.97 - [-161.44]} = 13.87\ \%$$

Where, LDF = Lower discount factor and HDF = Higher discount factor.

By plotting net benefit with designed life (Table-6.9) of the project, net cash position curve-showing payout has been obtained, as shown in Figure-6.1

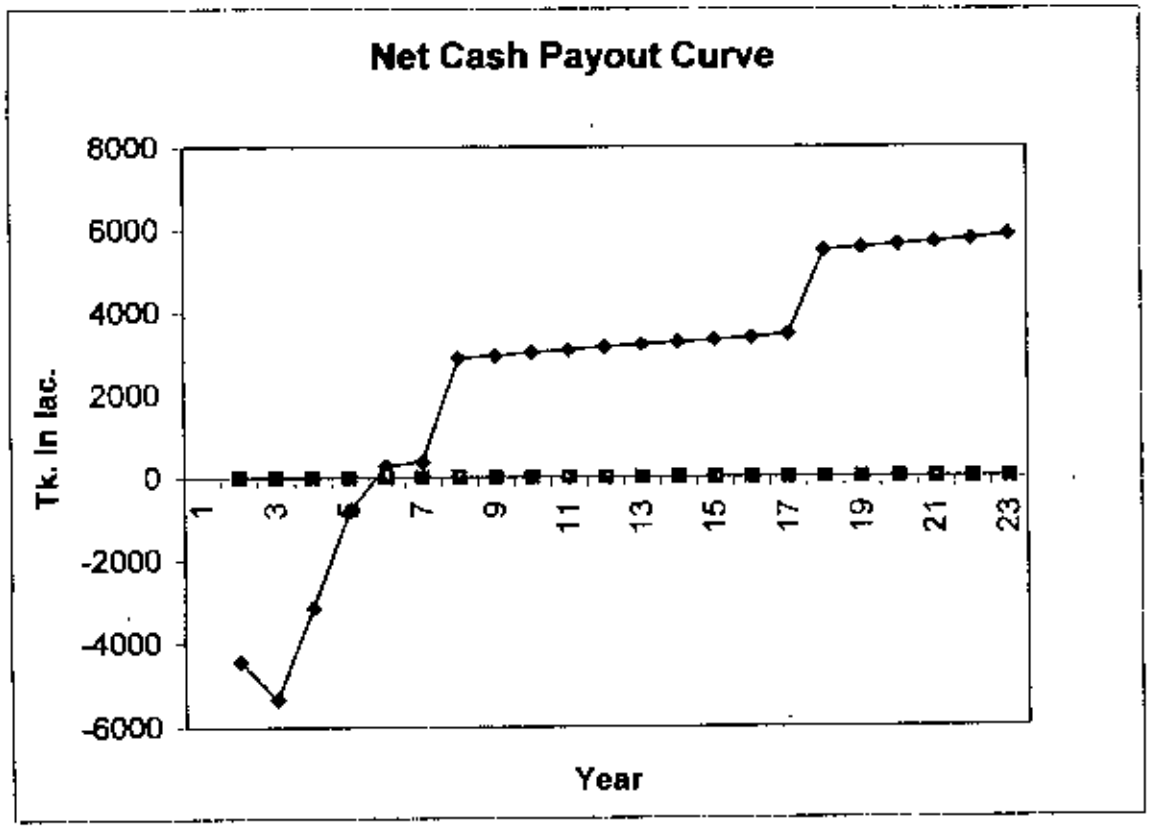


Figure-6.1: Net cash position curve-showing payout.

6.2.2 Project analysis (economical)

Due availability or scarceness of different goods/ services/ facilities of different countries are different. Hence economic values of costs or earnings are also different. In Bangladesh, standard cost factors (SCF) for different costs and values are given in next page.

Item wise standard cost factor for investment costs are:

Item of cost	Standard cost factor (SCF)
Pre-construction expenditure	0.82
Construction works	0.82
Foreign materials	1.20
Local materials	0.82
Transport vehicles	0.82
Managerial manpower	1.00
Skilled manpower	0.82
Unskilled manpower	0.72
Others	0.82

Item wise standard cost factor for operating/ recurring costs are:

Item of cost	Standard cost factor (SCF)
Cost of gas	0.82
Maintenance cost (local)	0.82
Maintenance (foreign)	1.20
Fuel and power	0.82
Managerial manpower	1.00
Skilled manpower	0.82
Unskilled manpower	0.72
Others	0.82

Standard cost factor annual value outputs are:

Value output items	Standard cost factor (SCF)
Domestic	1.15
Commercial	0.62
Industrial	1.26
Power	1.00

Applying the cost factors described above, economic value of investment cost, operating/ recurring cost and annual value outputs are calculated in Table-6.10, Table-6.11 and Table-6.12 respectively.

Finally the BCR (E), NPV (E) and IRR (E) as calculated from Table-6.13 are shown below.

$$\therefore Benefit\ Cost\ Ratio(BCR) = \frac{Total\ Benefit}{Total\ Cost} = \frac{15018.11}{12830.38} = 1.1705$$

$$Net\ Present\ Value(NPV) = Total\ Benefit - Total\ Cost = 15018.11 - 12830.38 = 2187.73$$

$$\text{And, IRR (E)} = LDF + \frac{[NPV at LDF][HDF - LDF]}{[NPV at LDF] - [NPV at HDF]}$$

$$= 17 + \frac{202.79 \times [18 - 17]}{202.79 - [-614.34]}$$

Finally, IRR (E) = 17.25 %

Table-6.8: Financial Analysis (NPV, BCR)

Tk. In Lac.

Year	Investment cost (PV)	Operating cost (PV)	Total cost (PV)	Total benefit (PV)	Discount factor @ 15%	Discounted (@ 15%) value of	
						Total cost	Total benefit
1	4442	0	4442.00	0	1.0000	4442.00	0
2	5326	0	5326.00	0	0.8696	4631.49	0
3	3295	253.06	3548.06	407.87	0.7561	2682.69	308.39
4	1065	424.08	1489.08	692.70	0.6575	979.07	455.45
5	0	692.10	692.10	972.81	0.5718	395.74	556.25
6	0	870.64	870.64	1259.14	0.4972	432.88	626.04
7	0	4763.21	4763.21	7656.66	0.4323	2059.14	3309.97
8	0	4910.13	4910.13	7872.73	0.3759	1845.72	2959.36
9	0	5032.44	5032.44	8064.36	0.3269	1645.10	2636.24
10	0	5155.04	5155.04	8256.64	0.2843	1465.58	2347.36
11	0	5277.36	5277.36	8448.28	0.2472	1304.56	2088.41
12	0	5378.62	5378.62	8605.48	0.2149	1155.87	1849.32
13	0	5480.00	5480.00	8762.82	0.1869	1024.21	1637.77
14	0	5596.65	5596.65	8937.03	0.1625	909.39	1452.27
15	0	5708.56	5708.56	9111.66	0.1413	806.62	1287.48
16	0	5841.58	5841.58	9320.94	0.1229	717.93	1145.54
17	0	8998.49	8998.49	14506.22	0.1069	961.94	1550.72
18	0	9120.99	9120.99	14698.21	0.0929	847.34	1365.46
19	0	9232.65	9232.65	14872.42	0.0808	746.00	1201.69
20	0	9355.38	9355.38	15064.83	0.0703	657.68	1059.06
21	0	9465.83	9465.83	15237.07	0.0611	578.36	930.98
22	0	9648.20	9648.20	15527.87	0.0531	512.32	824.53
						30801.63	29592.29

BCR (F) = 29592.29 ÷ 30801.63 = 0.9607

NPV (F) = 29592.29 - 30801.63 = (1209.34), in Lac Taka.

BCR = Benefit Cost Ratio

NPV = Net Present Value

Table-6.9: Financial Analysis (IRR)

Year	Total cost	Total benefit	Net benefit	NPV at higher discount rate of 14%		NPV at lower discount rate of 13%	
				Discount factor	NPV	Discount factor	NPV
1	4442.00	0	-4442.00	1.0000	-4442.00	1.0000	-4442.00
2	5326.00	0	-5326.00	0.8772	-4671.97	0.8850	-4713.51
3	3548.06	407.87	-3140.19	0.7695	-2416.38	0.7831	-2459.08
4	1489.08	692.70	-796.38	0.6750	-537.56	0.6931	-551.97
5	692.10	972.81	280.71	0.5921	166.21	0.6133	172.16
6	870.64	1259.14	388.50	0.5194	201.79	0.5428	210.88
7	4763.21	7656.66	2893.45	0.4556	1318.26	0.4803	1389.72
8	4910.13	7872.73	2962.60	0.3996	1183.85	0.4251	1259.40
9	5032.44	8064.36	3031.92	0.3506	1062.99	0.3762	1140.61
10	5155.04	8256.64	3101.60	0.3075	953.74	0.3329	1032.52
11	5277.36	8448.28	3170.92	0.2697	855.20	0.2946	934.15
12	5378.62	8605.48	3226.86	0.2366	763.48	0.2607	841.24
13	5480.00	8762.82	3282.82	0.2076	681.51	0.2307	757.35
14	5596.65	8937.03	3340.38	0.1821	608.28	0.2042	682.11
15	5708.56	9111.66	3403.10	0.1597	543.48	0.1807	614.94
16	5841.58	9320.94	3479.36	0.1401	487.46	0.1599	556.35
17	8998.49	14506.22	5507.73	0.1229	676.90	0.1415	779.34
18	9120.99	14698.21	5577.22	0.1078	601.22	0.1252	698.27
19	9232.65	14872.42	5639.77	0 0946	533.52	0.1108	624.89
20	9355.38	15064.83	5709.45	0.0829	473.31	0.0981	560.10
21	9465.83	15237.07	5771.24	0.0728	420.15	0.0868	500.94
22	9648.20	15527.87	5879.67	0.0638	375.12	0.0768	451.56
					-161.44		1039.97

$$\therefore \text{ IRR (F)} = LDF + \frac{[NPVatLDF][HDF - LDF]}{[NPVatLDF] - [NPVatHDF]} = 13 + \frac{1039.97 \times [14 - 13]}{1039.97 - [-161.44]}$$

Thus, IRR (F) = 13.87 %

Table-6.10: Economic Value of Investment Cost.

(Taka in lac.)

Item No.	Item of cost	Year-1			Year-2			Year-3			Year-4		
		PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV
1.	Preconstruction expenditure	489	0.82	400.98	395	0.82	323.90	295	0.82	241.90	35	0.82	28.70
2.	Construction works	865	0.82	709.30	1775	0.82	1455.50	1250	0.82	1025.00	408	0.82	334.56
3.	Foreign materials	918	1.20	1101.60	918	1.20	1101.60	261	1.20	313.20	-	1.20	-
4.	Local materials	1390	0.82	1139.80	1390	0.82	1139.80	1052	0.82	862.64	417	0.82	341.94
5	Transport vehicles	50	0.82	41.00	50	0.82	41.00	50	0.82	41.00	50	0.82	41.00
6.	Managerial manpower	25	1.00	25	35	1.00	35	45	1.00	45	55	1.00	55
7.	Skilled „	7	0.82	5.74	10	0.82	8.20	13	0.82	10.66	16	0.82	13.12
8.	Unskilled „	5	0.72	3.60	8	0.72	5.76	9	0.72	6.48	12	0.72	8.64
9.	Others	245	0.82	200.90	465	0.82	381.30	325	0.82	266.50	97	0.82	79.54
				3627.92			4492.06			2812.38			902.50

AV = Annual Value
PV = Present Value
SCF = Standard Cost Factor

Table-6.11: Economic Value of Operating/ Recurring Cost.

Item of cost	Year-1			Year-2			Year-3			Year-4			Year-5		
	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV
Cost of gas(w.h)	18.50	0.82	15.17	31.70	0.82	25.99	44.68	0.82	36.64	57.95	0.82	47.52	618.31	0.82	507.01
Maint. (local)	-	0.82	-	-	0.82	-	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20
„ (foreign)	-	1.20	-	-	1.20	-	-	1.20	-	-	1.20	-	-	1.20	-
Fuel & Power	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20
Managerial(m.p)	45	1.00	45	55	1.00	55	61	1.00	61	67	1.00	67	73	1.00	73
Skilled „	13	0.82	10.66	17	0.82	13.94	19	0.82	15.58	20	0.82	16.40	22	0.82	18.04
Unskilled „	9	0.72	6.48	11	0.72	7.92	12	0.72	8.64	14	0.72	10.08	15	0.72	10.80
Other cost	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64
Total			87.15			112.69			139.90			159.04			626.89

Table-6.11 Continued (Economic Value of Operating/ Recurring Cost).

Item of cost	Year-6			Year-7			Year-8			Year-9			Year-10		
	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV
Cost of gas(w.h)	628.19	0.82	515.12	636.79	0.82	522.17	645.74	0.82	529.51	654.52	0.82	536.71	661.74	0.82	542.63
Maint. (local)	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20
„ (foreign)	10	1.20	12	10	1.20	12	10	1.20	12	10	1.20	12	10	1.20	12
Fuel & Power	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20
Managerial(m.p)	79	1.00	79	85	1.00	85	91	1.00	91	97	1.00	97	103	1.00	103
Skilled „	24	0.82	19.68	26	0.82	21.32	28	0.82	22.96	29	0.82	23.78	31	0.82	25.42
Unskilled „	16	0.72	11.52	17	0.72	12.24	18	0.72	12.96	20	0.72	14.40	21	0.72	15.12
Other cost	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64
Total			655.36			670.77			686.47			701.93			716.21

Table-6.11 Continued (Economic Value of Operating/ Recurring Cost).

Item of cost	Year-11			Year-12			Year-13			Year-14			Year-15		
	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV
Cost of gas(w.h)	668.98	0.82	548.56	676.96	0.82	555.11	684.97	0.82	561.68	694.92	0.82	569.83	1145.67	0.82	939.45
Maint. (local)	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20
,, (foreign)	10	1.20	12	15	1.20	18	15	1.20	18	15	1.20	18	15	1.20	18
Fuel & Power	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20
Managerial(m.p)	109	1.00	109	115	1.00	115	121	1.00	121	127	1.00	127	133	1.00	133
Skilled ,,	33	0.82	27.06	35	0.82	28.70	37	0.82	30.34	38	0.82	31.16	40	0.82	32.80
Unskilled ,,	22	0.72	15.84	23	0.72	16.56	24	0.72	17.28	26	0.72	18.72	27	0.72	19.44
Other cost	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64
Total			730.50			751.41			766.34			782.75			1160.73

Table-6.11 Continued (Economic Value of Operating/ Recurring Cost).

Item of cost	Year-16			Year-17			Year-18			Year-19			Year-20		
	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV
Cost of gas(w.h)	1154.45	0.82	946.65	1162.44	0.82	953.20	1171.24	0.82	960.42	1179.13	0.82	966 89	1192.36	0.82	977.74
Maint. (local)	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20
,, (foreign)	15	1.20	18	15	1.20	18	15	1.20	18	15	1.20	18	15	1.20	18
Fuel & Power	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20	10	0.82	8.20
Managerial(m p)	139	1.00	139	145	1.00	145	151	1.00	151	157	1.00	157	163	1.00	163
Skilled ,,	42	0.82	34.44	44	0.82	36.08	46	0 82	37.72	47	0.82	38.54	49	0.82	40.18
Unskilled ,,	28	0.72	20.16	29	0.72	20.88	30	0.72	21.60	32	0.72	23 04	33	0.72	23.76
Other cost	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64	2	0.82	1.64
Total			1176.29			1191.20			1206 78			1221.51			1240.72

Table-6.12: Annual Value of Output (Economical).

Taka in lac.

Yr.	Power			Industrial			Commercial			Domestic			Total AV	Fact. Excise AV.	Total Economic AV
	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV	PV	SCF	AV			
1.	0	1.00	0	265.28	1.26	334.25	23.31	0.62	14.45	116.18	1.15	133.61	482.31	249.27	233.04
2.	0	1.00	0	442.13	1.26	557.08	41.96	0.62	26.02	208.61	1.15	239.90	823.00	426.03	396.97
3.	0	1.00	0	601.20	1.26	757.51	58.28	0.62	36.13	313.34	1.15	360.34	1153.98	597.43	556.55
4.	0	1.00	0	760.27	1.26	957.94	76.15	0.62	47.21	422.73	1.15	486.14	1491.29	772.45	718.84
5.	6175	1.00	6175	866.48	1.26	1091.76	93.24	0.62	57.81	521.94	1.15	600.23	7924.80	4133.28	3791.52
6.	6175	1.00	6175	990.47	1.26	1247.99	111.11	0.62	68.89	596.14	1.15	685.56	8177.44	4254.87	3922.57
7.	6175	1.00	6175	1096.68	1.26	1381.82	127.43	0.62	79.01	665.26	1.15	765.05	8400.88	4363.53	4037.35
8.	6175	1.00	6175	1202.40	1.26	1515.02	145.30	0.62	90.09	733.94	1.15	844.03	8624.14	4470.51	4153.63
9.	6175	1.00	6175	1308.61	1.26	1648.85	161.62	0.62	100.20	803.06	1.15	923.52	8847.57	4578.19	4269.38
10.	6175	1.00	6175	1379.25	1.26	1737.86	179.49	0.62	111.28	871.74	1.15	1002.50	9026.64	4665.78	4360.86
11.	6175	1.00	6175	1450.38	1.26	1827.48	196.58	0.62	121.88	940.86	1.15	1081.99	9206.35	4753.51	4452.84
12.	6175	1.00	6175	1538.81	1.26	1938.90	213.68	0.62	132.48	1009.54	1.15	1160.97	9407.35	4850.98	4556.37
13.	6175	1.00	6175	1627.24	1.26	2050.32	230.77	0.62	143.08	1078.66	1.15	1240.46	9608.86	4948.73	4660.13
14.	6175	1.00	6175	1750.74	1.26	2205.93	247.86	0.62	153.67	1147.34	1.15	1319.44	9854.04	5066.63	4787.41
15.	11115	1.00	11115	1909.80	1.26	2406.35	264.96	0.62	164.28	1216.46	1.15	1398.93	15084.49	7844.29	7240.20
16.	11115	1.00	11115	2016.01	1.26	2540.17	282.05	0.62	174.87	1285.14	1.15	1477.91	15307.95	7952.16	7355.79
17.	11115	1.00	11115	2104.44	1.26	2651.59	299.15	0.62	185.47	1353.83	1.15	1556.90	15508.96	8049.67	7459.29
18.	11115	1.00	11115	2210.65	1.26	2785.42	316.24	0.62	196.07	1422.94	1.15	1636.38	15732.87	8157.74	7575.13
19.	11115	1.00	11115	2297.10	1.26	2894.35	333.33	0.62	206.66	1491.63	1.15	1715.37	15921.38	8254.11	7677.27
20.	11115	1.00	11115	2493.71	1.26	3142.07	351.20	0.62	217.74	1567.95	1.15	1803.14	16277.95	8419.06	7858.89

Table-6.13: Economic Analysis (NPV, BCR and IRR)

Year	Investment Cost (AV)	Operating Cost(AV)	Total Cost(AV)	Total Benefit (AV).	Net Benefit (AV).	Discounted Value @ 15%			NPV at HDF		NPV at LDF	
						Discount Factor	Total Cost	Total Benefit	D. Factor @ 18 %	NPV	D. Factor @ 17 %	NPV
1.	3627.92	0	3627.92	0	-3627.92	1.0000	3627.92	0	1.0000	-3627.92	1.0000	-3627.92
2.	4492.06	0	4492.06	0	-4492.06	0.8696	3906.30	0	0.8475	-3807.02	0.8547	-3839.36
3.	2812.38	87.15	2899.53	233.04	-2666.49	0.7561	2192.33	176.20	0.7182	-1915.07	0.7305	-1947.87
4.	902.50	112.69	1015.19	396.97	-618.22	0.6575	667.49	261.01	0.6086	-376.25	0.6244	-386.02
5.	0	139.90	139.90	556.55	416.65	0.5718	79.99	318.24	0.5158	214.91	0.5337	222.37
6.	0	159.04	159.04	718.84	559.80	0.4972	79.07	357.41	0.4371	244.69	0.4561	255.32
7.	0	626.89	626.89	3791.52	3164.63	0.4323	271.00	1639.07	0.3704	1172.18	0.3898	1233.57
8.	0	655.36	655.36	3922.57	3267.21	0.3759	246.35	1474.49	0.3139	1025.58	0.3332	1088.63
9.	0	670.77	670.77	4037.35	3366.58	0.3269	219.27	1319.81	0.2660	895.51	0.2848	958.80
10.	0	686.47	686.47	4153.63	3467.16	0.2843	195.16	1180.88	0.2255	781.84	0.2434	843.91
11.	0	701.93	701.93	4269.38	3567.45	0.2472	173.52	1055.39	0.1911	681.74	0.2080	742.03
12.	0	716.21	716.21	4360.86	3644.65	0.2149	153.91	937.15	0.1619	590.07	0.1778	648.02
13.	0	730.50	730.50	4452.84	3722.34	0.1869	136.53	832.24	0.1372	510.71	0.1520	565.80
14.	0	751.41	751.41	4556.37	3804.96	0.1625	122.10	740.41	0.1163	442.52	0.1299	494.26
15.	0	766.34	766.34	4660.13	3893.79	0.1413	108.28	658.48	0.0985	383.54	0.1110	432.21
16.	0	782.75	782.75	4787.41	4004.66	0.1229	96.20	588.37	0.0835	334.39	0.0949	380.04
17.	0	1160.73	1160.73	7240.20	6079.47	0.1069	124.08	773.98	0.0708	430.43	0.0811	493.05
18.	0	1176.29	1176.29	7355.79	6179.50	0.0929	109.28	683.35	0.0600	370.77	0.0693	428.24
19.	0	1191.20	1191.20	7459.29	6268.09	0.0808	96.25	602.71	0.0508	318.42	0.0592	371.07
20.	0	1206.78	1206.78	7575.13	6368.35	0.0703	84.84	532.53	0.0431	274.48	0.0506	322.24
21.	0	1221.51	1221.51	7677.27	6455.76	0.0611	74.63	469.08	0.0365	235.64	0.0433	279.53
22.	0	1240.72	1240.72	7858.89	6618.17	0.0531	65.88	417.31	0.0309	204.50	0.0370	244.87
							12830.38	15018.11		-614.34		202.79

BCR (E) = 15018.11 ÷ 12830.38 = 1.1705

NPV (E) = 15018.11 - 12830.38 = 2187.73, in Lac Taka.

$$\text{IRR (E)} = LDF + \frac{[NPVatLDF][HDF - LDF]}{[NPVatLDF] - [NPVatHDF]} = 17.25\ \%$$

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Apathy toward technological progress, combined with inefficient and corrupt management has inflicted severe damage to all state-run organizations. The gas sector is no exception. In order to establish an ideal gas distribution system, it is therefore a prerequisite to first conduct a thorough investigation of an existing system. Such investigation should reveal both technical and as well as management or administration related problem areas. Also a careful study of the customer base, the geography and environment of the proposed project region must be undertaken before any design work is attempted.

Adoption of modern technology to design and control of a gas network ensure the appropriate flow and pressure of natural gas at the customer inlets. Reform activities to minimized administrative weaknesses and competitive increment of users facility play active rolls in idealization of gas distribution networks. Provision of calculated remuneration structure based on basic need, for the employees of the proposed system, is an effective measure of human resource. To break the present unprogressive inertia, some modernized and effective tools like 'Monitoring and Evaluation' and 'Strategic Business Unit (SBU)' are very helpful.

For this project, calculated IRR (financial) = 13.87 and IRR (economic) = 17.25, indicates meaningful results on evaluation, which confirms the facts describe above. The evaluated result will impress and attract private entrepreneurs, to invest in the gas sectors, from both country and abroad.

Recommendations for idealization of a gas distribution networks are:

1. Proper survey and elaborate study on existing systems and on proposed region should be conducted before design any distribution network

2. Technological aspects should be considered on priority basis, during planning of a distribution network

3. Before designing a network, it should be analyzed by recognized and sophisticated software

4. Provisions should be there for internationally recognized and economically viable gas controlling equipments (Meter, Regulator, Valve, Strainer etc.), for the network

5. Modernized communications and controlling system should be deployed

6. Skilful and effective maintenance system should be implemented

7. Administrative formations in consideration of modernized human resources management need to be adapted

8. Easy and harmonized gas sales system should be promoted

9. Introduction and implementation of short-cut methods for better service to the users should be introduced

10. Application of the latest administrative tools like 'Monitoring and evaluation', 'Strategic Business Unit (SBU)' etc. should be adapted

11. Proper evaluations (both financial and economical) of the project must be conducted before implementation of the project.

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Appendix-A

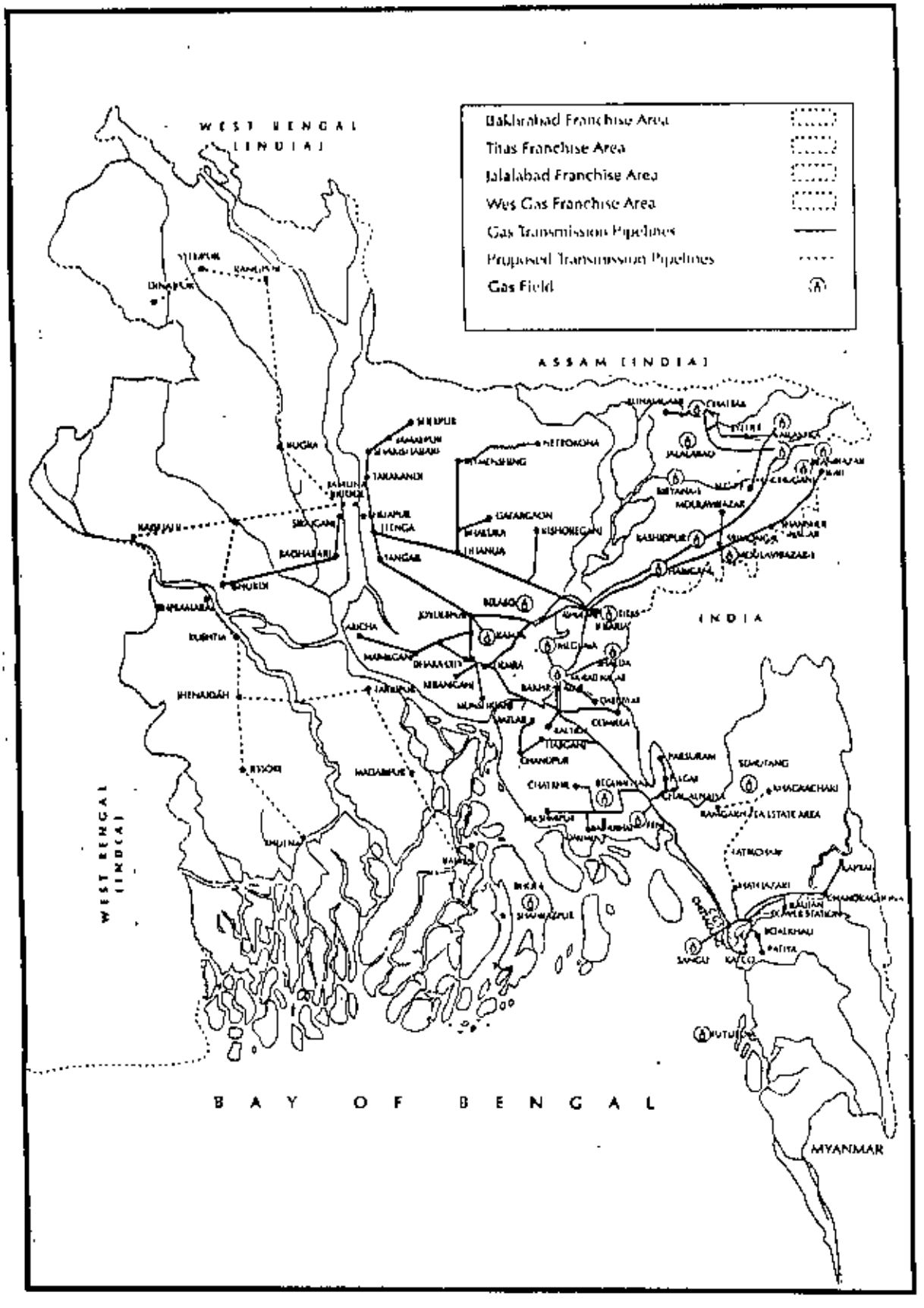

Figure-A1: Franchise areas with transmission lines of the four distribution companies.

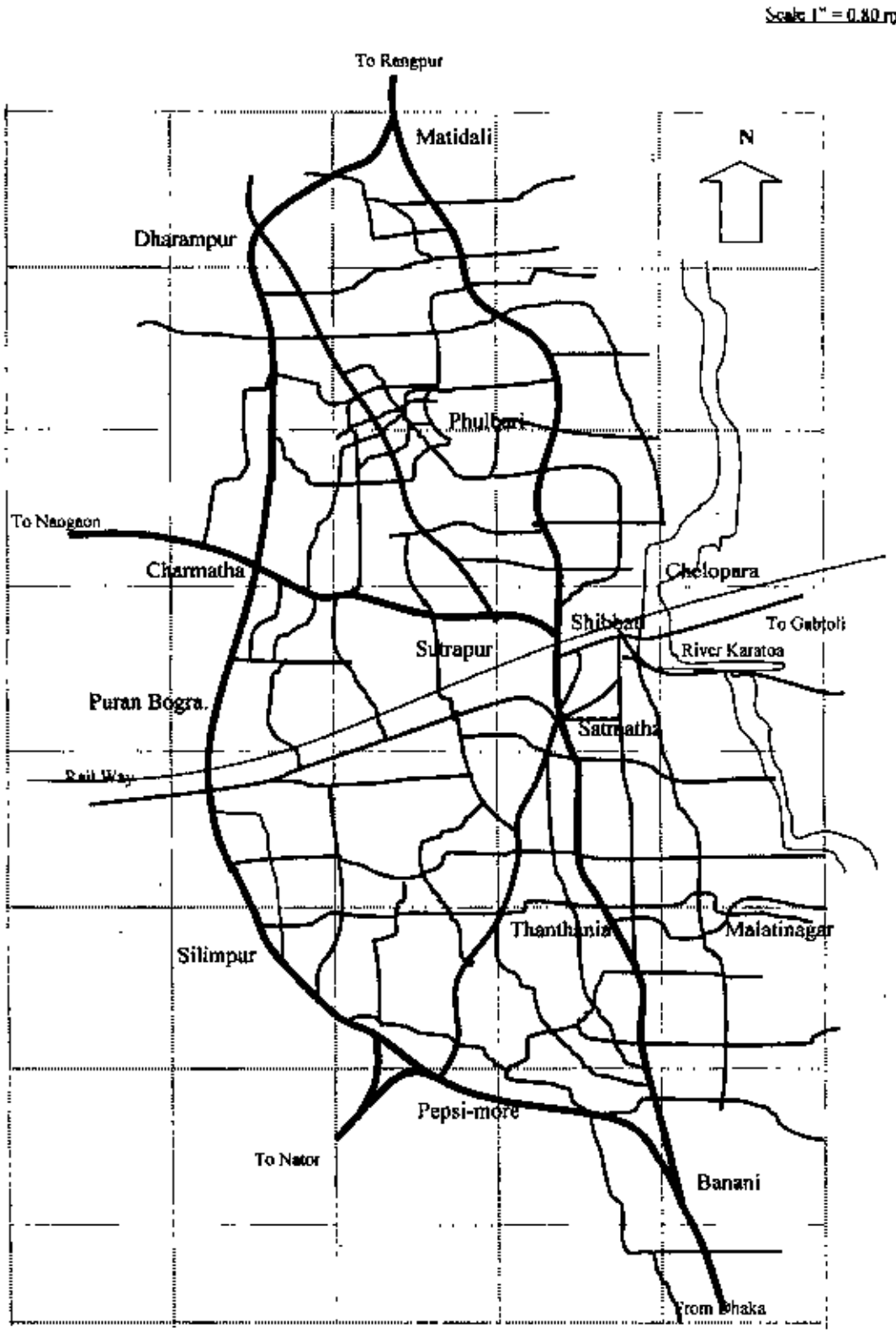

Figure-A2: Bogra Municipality.

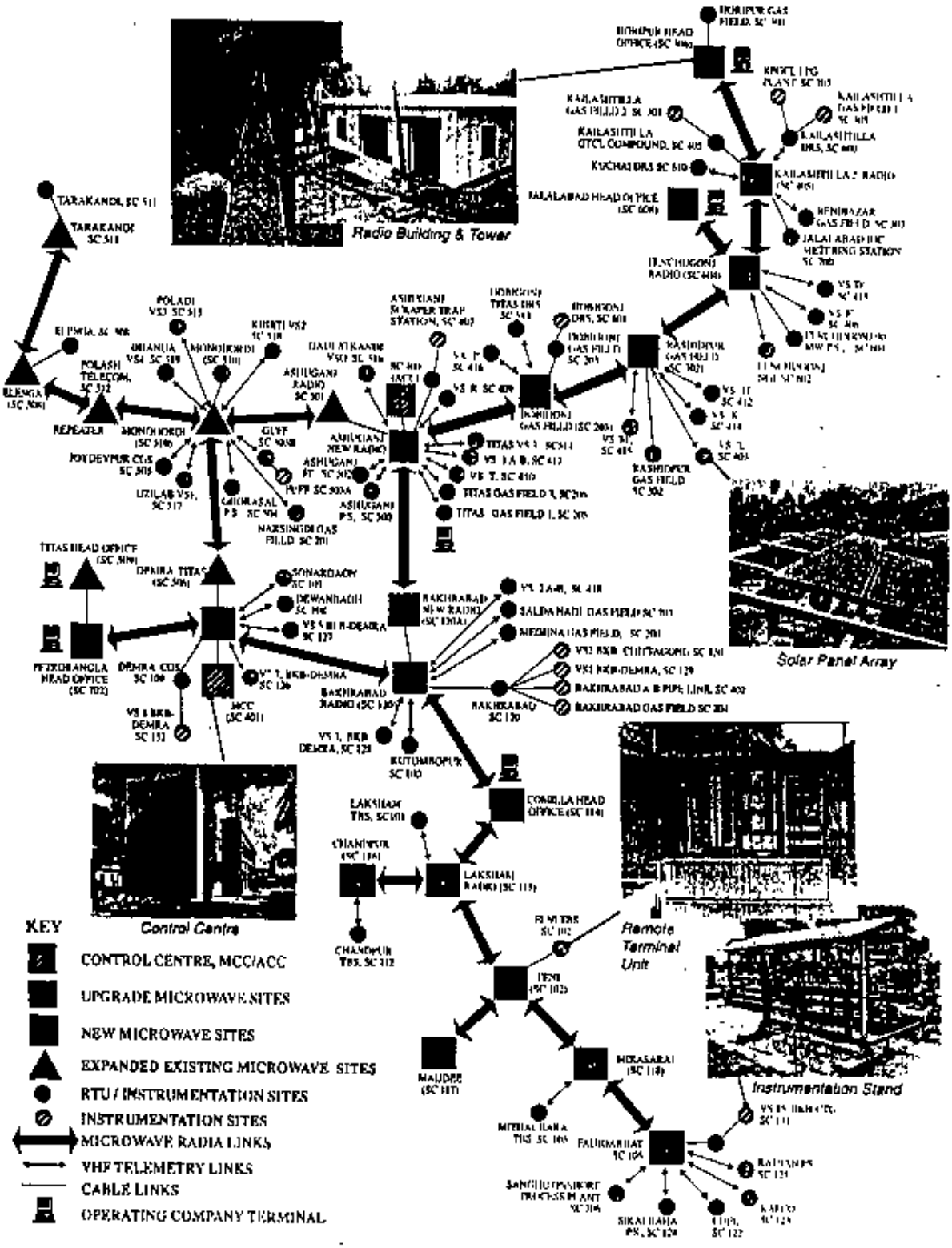

Figure-A3: SCADA system for transmission network.

Appendix-B

SBU Report Format

From: Team Leader
SBU core monitoring team
WGCL, Bogra.

Address: L House
Phone:

Memo No:

To: CE/ SE/ XEN.

Sub:

Please furnish the following information which will be required for the SBU program.

Sl. No.	Description of work with address	Remarks.
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		

Signature:

Copy to: 1)
2)

SBU CORE TEAM

MONITORING FORMAT

Memo: Date:

Sl. No.	Work Description	Work Schedule	Achieved
1.	For survey work, team to be formed comprising 1 officer, 1 technician and 1 helper. Each team will survey 25 consumers daily and fill up the format.	No of team to be formed: Work start on: Daily to be surveyed:	Team Formed: Survey done: Date of inspection:
2.	Local team leader will make a daily summary sheet on the work and give it to SBU core team.	As per prescribed summery sheet.	Followed:
3.	Local team leader will procure stopwatch for meter testing.	From team leaders contingency.	No of set procured:
4.	After receiving the summery sheet 1, SBU core team will send sheet to contractor to do the required works.	No of contractors engaged: Daily work to be done:	Meter replaced: Service replaced
5.	No. of total RMS: a) Customer name Loss % b) " " " " c) " " " "	Loss reduction scheme work start: Existing loss Target loss Date a) b)	RMS wise loss reduction target: RMS name Loss Date a) b)
6.	CI ratio (present month): Name of month: CI ratio (June to July):	Target: Date:	CI ratio (present) Month :
7.	Collection: m Tk. Name of month:	Target: Date:	Present month = m Tk.
8.	MOD to be done	Target: Date:	
9.	Local team leader will procure material.	Present stck:	Procured:
10.	Spot connection to be given by Xen of SBU team.	Preference given by local team leader.	Connection given:
11.	Gardening and beautification of office premises.	Name of incharge:	
12.	Remarks:		Signature: Name: Designation: Date:

Number of Consumers in Each Tariff Category

Name of Division:
Name of the Unit:

Month	Number of consumers in each tariff category								
	A	B	C	D	E	F	G	H	Total

Note: The information will cover last one year.

A = Domestic customer,
B = Commercial customer,
C = Industrial customer,
D = Seasonal Customer,
E = Power,
F = Fertilizer,
G = Captive power,
H = Others.

Staff Strength, their Salary and Wages

Name of Division:
Name of the Unit:

Name of post	No. of staff	Basic salary per month (Tk)	Other allowance per month (Tk)	Total/ month/ person (Tk.)	Total/ month (Tk.)	Total/ Year (Tk.)	Remarks
1	2	3	4	5 = 3+4	6 = 5×2	7 = 6×2	8

Name of month	Incentive and wages				Other expences		
	Bonus (Tk)	Overtime (Tk)	Others (Tk)	Total (Tk)	O&M (Tk)	Administrative (Tk)	Total (Tk)

Note: Q & M expenses shall be given for last one year.

Store Inventory

Name of Division:
Name of the Unit:

Sl. No.	Item Description	Code	Unit	Unit Price		Total Volume		Source of Fund	Remarks
				Price during procurement in Tk.	Present Market price in Tk.	During Procurement in Tk.	At Present Price in Tk.		

Note: Procurement year to be mentioned.

Appendix-C

Name of the company
Address of the head office

Application form for domestic connection

Photo

Application No ... ... Date ... ...

1. Name of the applicant :

2. Occupation :

3. Name of Father/Mother/Husband :

4. Age/Date of birth :

5. Communication Address :

Phone No:

6. Premise Address :

7. Information's of gas equipments :

Sl.	Description of Equipments		Number	Kitchen nos.	Comments
1.	Double Burner	Single Burner			
2.					
3.					

I certify that all the documents enclosed here with the application are absolutely true, also commit that I shall be bound to help in each aspects related to gas connections. I am fully informed about gas connection rules and appointed the contractor/ fitter for gas pipeline construction.

Signature of the applicant

Enclosures:

i. Two attested copies of pp size photo.
ii. Attested copies of land ownership docs.
iii. Signed stipulation between the contractor and the applicant.
iv. Four copies of drawing of internal wiring.

Name of the company
Address of the head office

Application form for commercial connection

Photo

Application No ... ... Date ... ...

1. Name of the organization :

2. Address of the premise :

3. Address for communication :

4. Type of ownership : Single ☐ Combined ☐ Limited Co ☐ Others ☐

5. Particulars of the proprietor:
   5.1 Name :
   5.2 Fathers/ Husbands name :
   5.3 Permanent Address :

6. Ownership of the land of the premise: Owner Hired Alotted

7. Name and Address of owner (in case of hiring)/ allotter:

8. Description of existing other gas connections (if necessary):

Sl.	Customer no,	Name and address of the organization.	Present condition.
1.			
2.			

9. Description of other gas connections in the same premise (if necessary):

Sl.	Customer no,	Name and address of the organization.	Present condition.
1.			
2.			

10. Trade license no: ... ... Date of expiry: ... ... Allotment authority: ... ...

11. TIN no : … … … Circle: … … …

12. Production System: Continuous ☐ Batch ☐ if batch, time period: … … …

13. Type of business: Hotel ☐ Restaurant ☐ Bakery ☐ Sweetmeat ☐

Others ☐

14. Information on gas equipments and burners:

Sl.	Description of Burner.	Burner range.	Number of burner	Total load.	Name of gas equipments	Size of equipments	Remark

15. Working periods: … … … … to … … … … (Total hour).

16. Authorized signatory persons (in special circumstances):

Sl.	Name	Designation/relation	Specimen signature

17. Declarations:

17.1 Information given above and all the enclosures are accurate and undoubted.
17.2 Bound to establish a specified shade on the RMS to ensure proper security.
17.3 Committed to facilitate required helps during connection and other official activities including inspection, after completion of gas connection.
17.4 I would have no right to make any change of the RMS shade or any obstacle to the way of the RMS.
17.5 Conditional ties of the signed stipulation will be the only directives.

_____
Signature of the applicant

Enclosures:

1) Two attested copies of pp size photo.
2) Trade license.
3) Attested copies of land ownership docs.
4) Signed stipulation between the landowner and the applicant in case of hiring.
5) Four copies of drawing of internal wiring.
6) Technical catalogues gas equipments.

Name of the company
Address of the head office

Application form for Industrial connection

Photo

Application No ... ... Date ... ...

1. Name of the Industry :

2. Address for communication :

2.1 Factory address : Phone:

2.2 Head office : Phone:

3. Ownership :

3.1 Government ☐ Semi-Government ☐ Autonomous ☐

Private Co. ☐ Partnership ☐ Limited Co. ☐ Others ☐

3.2 Type of Industry:

3.3 Trade license no: Tenure:

4. Short description of the proprietor/ directors:

Sl.	Name with father/ husband	Designation	Relation to other org.	Present address
1.				
2.				
3.				
4.				
5.				

5. Information on lands:

5.1 Position of factories:

Sl.	Mousa name	Daag no	Khatian no	Quantity of land
1.				
2.				
3.				
4.				
5.				

5.2 Total quantity of land … … … … … acre.

5.3 Ownership of land: Owne☐ Single ☐ Combined☐ Hired☐ Allotted ☐

5.4 Size of land (length and breath):

5.5 Name and address of the proprietor (if hired):

5.6 Name and address of the allotment authority (if allotted):

5.7 Any existing/ past gas connection: Yes ☐ No ☐

5.8 Description of existing/ past gas connection:

a) Customer no: … … … …
b) Owner name: … … … …
c) Connection condition: Running/ Temp. Disconnected/ Permanent/ disconnect.
d) Billing condition:

5.9 Description (including customer no) of any gas consuming organization in the name of present owner/ director:

6. Information on production of the organization:

6.1 Used raw materials (Yearly):

Sl.	Name of the products	Yearly production	Market place	
			Local	International
1.				
2.				
3.				

6.2 Production system: Continuous ☐ Periodic ☐

6.3 Running period (daily): From … … … to … … …

7. Information on financial conditions:

7.1 TIN no : … … … … … … …
7.2 VAT registration no : … … … … … … …
7.3 Name of Bank and its branch : … … … … … … …

8. Information relating loads:

8.1 Gas equipments and burners:

Sl.	Equipment					Burner				
	Name	Product of		Size	Prodtn. Capacity	Type	Nos	Orifice	Load	Total Load
		Co.	country							
1.										
2.										
3.										
4.										
5.										

8.2 Hourly gas consumption: … … … … Cubic meter.

8.3 Allowable pressure range: … … … … … to … … … … … psig/ bar.

8.4 Description of load extension:

… … … … Year … … … … Demand … … … … Cubic meter.

… … … … Year … … … … Demand … … … … Cubic meter.

… … … … Year … … … … Demand … … … … Cubic meter.

… … … … Year … … … … Demand … … … … Cubic meter.

9. Authorized signatory persons communication in favor of the organization:

Sl.	Name	Designation	Signature
1.			
2.			
3.			
4.			
5.			

10. I/We here by declared that, all the informations and documents enclosed with this application are true. We will be bound to obey all the pledges as committed above. The RMS will be build as per company design and no modification of the RMS will be allowed without company's concern.

Signature of the applicant : ... ...

Name of the applicant : ... ...

Designation of the applicant : ... ...

Enclosures:

1) Two attested copies of pp size photo.
2) Trade license.
3) TIN number.
4) In case of registered company, memorandum of articles of association and the certificate of incorporation.
5) Attested copies of land ownership docs.
6) Signed stipulation between the landowner and the applicant in case of hiring.
7) Layout plan of the factory.
8) Four copies of drawing of the proposed pipeline.
9) Technical catalogues of required gas equipments.

Name of the company
Address of the head office

Commissioning card for commercial customers

1. Customer No : … … … …

2. Name of the customer : … … … …

3. Customer address : … … … …
… … … …

4. Billing address : … … … …
… … … …

5. Short description of RMS:

Sl.	Item	Capacity	Number	Detail description	Manufacturer	Remark
1.						
2.						
3.						

6. Description of installed gas equipments:

Sl.	Type of burner	Orifice size	Capacity	Number of burner	Load (Cum)	Remark
1.						
2.						
3.						
Total						

7. Date of installation of meter : … … … …

8. Date of gas commissioning : … … … …

9. Outlet pressure : … … … …

10. Size of inlet/ outlet of the RMS : … … … …

11. Monthly approved load : … … … …

12. Meter reading during commissioning: … … … …

13.Gross flow at during full operation: … … … …

Customer representative

Company representative

Name of the company
Address of the head office

Commissioning card for Industrial customers

1. Customer No : ... ...

2. Name and address of the customer : ... ...
... ...

3. Date of gas commissioning : ... ...

4. RMS outlet pressure : ... ...

5. RMS inlet pressure : ... ...

6. Short description of RMS :

Sl.	Assembles	Capacity	Number	Manufacturer	Remarks
1.	Meter				
2.	Regulator				
3.	Relief valve				

7. Information on gas equipments :

Sl.	Gas equipments			Description of burner				
	Name	Size	Capacity	Type	Orifice Size	Capacity	Nos.	Load cum/hour
1.								
2.								
3.								
4.								
5.								

8. Monthly gas consumption : Not over ... ... cubic meter.

9. Meter reading during commissioning: ... ... cubic meter.

10. Meter reading during installation of RMS: ... ... cubic meter.

11. Remarks: ... ...

Signature of the company representative.

12. Signed after obtaining the meter card ... ...

Signature of the customer representative.