Appendix-6

Result of Pipeline Network Analysis

Gas Pipeline Network Analysis

Gas pipeline network analysis has been carried out to evaluate the transport capacity of the pipeline network in Bangladesh in fiscal year 2015, 2020, 2025, and 2030. This is to report the results.

1. Methods and Preconditions

(1) Numerical Calculations

VB linked Excel program is used. It is the same program used for "The Study for Master Plan on Coal Power Development in the Peoples Republic of Bangladesh, June 2010、JICA/TEPCO"

(a) Equation

The equation to express the relation between flow and pressures, Panhandle (A) with upper-limit, is widely used in pipeline analysis. It is expressed as follows,

$$Q = K \left(\left(P_1^2 - P_2^2 \right) \times D^5 / s L \right)^{1/2} \quad (1)$$

Where $K = 3.83 \left(T_0 / ZT \right)^{1/2} \times \left(1 / f \right)^{1/2}$ (2)

$$\left(1 / f \right)^{1/2} = \mathrm{Min} \left[6.872 E \cdot Re^{0.07305} , 4 E \log_{10} \left(3.7 D / \varepsilon \right) \right] \quad (3)$$

Q: flow rate [Nm^3/h]

K: flow coefficient

P_1, P_2 : pressure at each end of a pipeline [$kg / cm^2 abs$]

D: inner diameter of a pipeline

s : specific gravity [air = 1.0]

L: length of a pipeline

Z: compression factor

T: temperature [K]

T_0 : 273.5 [K]

f: friction factor

ε: roughness of a pipe wall [μm]

Re: Reynolds number $Re = \left(4.662 \times 10^{-5} \right) \times \left(sQ / \mu D \right)$ (4)

μ: Viscosity [kg・sec / m^2]

E: efficiency factor

Equation (3) gives a friction factor. It is a selection of smaller value between 6.872E×Re^0.07305 (valid for medium range turbulent flow) and $4E\log_{10}(3.7D/\varepsilon)$ (valid for fully developed turbulent flow).

It is well known that, in a fully developed turbulent flow, the friction factor converges with a constant value, which is a function of the roughness of the wall. It is also known that many pipeline flows are in the range of medium turbulence.

E is a factor to correct the deviations resulting from curved pipes, fittings like valves, diameter changes, inaccurate data of sizes, and scaffolds etc. 0.93 or so is widely used for E in Japan. This factor is used usually for a medium range turbulent flow in order to conform to the calculated results to measured data. Instead, in case of a fully developed turbulent flow, ε is used for this purpose. In the calculation here, however, we applied E to both the turbulent regions for convenience and used standard value for ε .

The compression factor Z is defined as PV = ZRT. It is a factor utilized to count the deviation from an ideal state of a gas. It is calculated in accordance with the AGA manual (AGA Report No.8, Compressibility Factor of Natural Gas and Related Hydrocarbon Gases 1994). The gas composition data in Table 1, which is considered to be a typical representation of the gas composition in Bangladesh, is used for the calculation.

Table 1 Typical gas composition data

CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	other
96.76	1.80	0.39	0.17	0.06	0.82

Source: Annual Report 2008, Petrobangla

(b) Procedures

Basically, the solution means to solve the relations satisfying Kirchhoff's law (i.e. Sum of inflows into a node equals zero. Summation of pressure drops around a loop is zero.). The Hardy-Cross method is used here. One can avoid large scale matrix calculations by using the method.

First, we did a calibration of the program in preparation by adjusting the aforementioned efficiency factors of each pipeline in the network. Then, we set the predicted loads at respective nodes and calculated the pressure losses throughout the network. If necessary pressures are secured at the respective load nodes, it means that there is no trouble in the supply. Necessary pressure would be, for example, 250 psi (1.7MPa) in order to drive a gas turbine of large capacity yet low pressure ratio without any gas compressor. The pressure can be much lower in other cases.

(2) Network

Fig. 1 is a schematic drawing of the current network. Figures with prefix 'N' are tag numbers of the nodes. Networks under plan are shown in Fig.2 to Fig.5. Blue rectangles in Figs mean gas fields. Other rectangles mean gas consuming points. Pipe sizes are shown by colors in Figs. They are also shown in Table 2 and Table 3. Data were given by concerned agents in Bangladesh.

(3) Input Data

Data necessary to run the program were presented by JICA study team.

They are as follows

(a) Actual Measurement Value

The same data of actual measurement value which were used in "The Study for Master Plan on

Coal Power Development in the Peoples Republic of Bangladesh, June 2010, JICA/TEPCO" were used for the calibration.

Table 4 and Table 5show the measured data of gas consumption, supply (gas field), and pressure at respective nodes at 8:00,24th Oct., 2009.

(4)Gas Consumptions

Assumed average and peak (average×1.1) gas consumptions at respective nodes in each fiscal year are shown in Table 6 and Table 7. The sign 'OUT' in the tables means places where gas is consumed. Peak gas consumptions are assigned to respective nodes to evaluate the transport capacity.

(5) Gas Fields

Locations of the gas fields are shown in above mentioned pipeline network diagrams. The total production is assumed sufficient to feed the demands. Matching analysis between supply and consumption is not done here. In principle, gas fields are dealt as pressure designated nodes. The outlet pressures of gas fields are shown in Table 8. In following cases, gas supply rates are assigned instead of pressure.

(a) Nodes where outlet pressure is unknown

As to many newly born gas fields under plan, due to the lack of pressure information, supply rate is assigned at each node to be connected.

(b) Nodes where both gas field and gas consuming area overlap, with gas demand exceeding gas supply

As the gas fields can no more supply gas to other nodes, those are dealt as gas consuming nodes. Subtraction of the latter from the former is assigned.

(c) Nodes of which outlet pressure is too low

Although it is a particular case, if the pressure at a certain gas field is smaller than the network pressure, the field can not supply gas to the network; reverse flow occurs in the calculation.

In such a case, gas compressors are needed to elevate the pressure level. Gas supply rate should be assigned in the calculation instead of gas pressure.

Gas supply rates from gas fields are shown in Table 6 and Table 7, where the sign 'IN' means gas supply. 1.1 times of average supply rates are used in the analysis.

In case of a network with one inlet and one outlet, the inlet node is usually set as a pressure-designated node. In this case, it is obvious from the law of conservation of mass that setting a flow rate at the outlet automatically gives the same flow rate at the inlet. In case of a network with a multi-inlet and multi-outlet, some inlets can be dealt as flow designated nodes. In this case, other inlet nodes work as pressure designated nodes, at which flows are adjusted in the calculation process so that the total outflow matches the total inflow. Looking from another point, a pressure designated node (gas field) keeps the constant pressure despite demand fluctuations and can

supply endlessly as much natural gas as the demand requires; the supply is controlled only by a pressure gradient of the network. Contrarily, a flow designated node can not supply a larger flow than the set flow, resulting in a situation where other gas fields must cover the discrepancy between demand and supply. In this analysis, gas fields are dealt as pressure-designated nodes in principle.

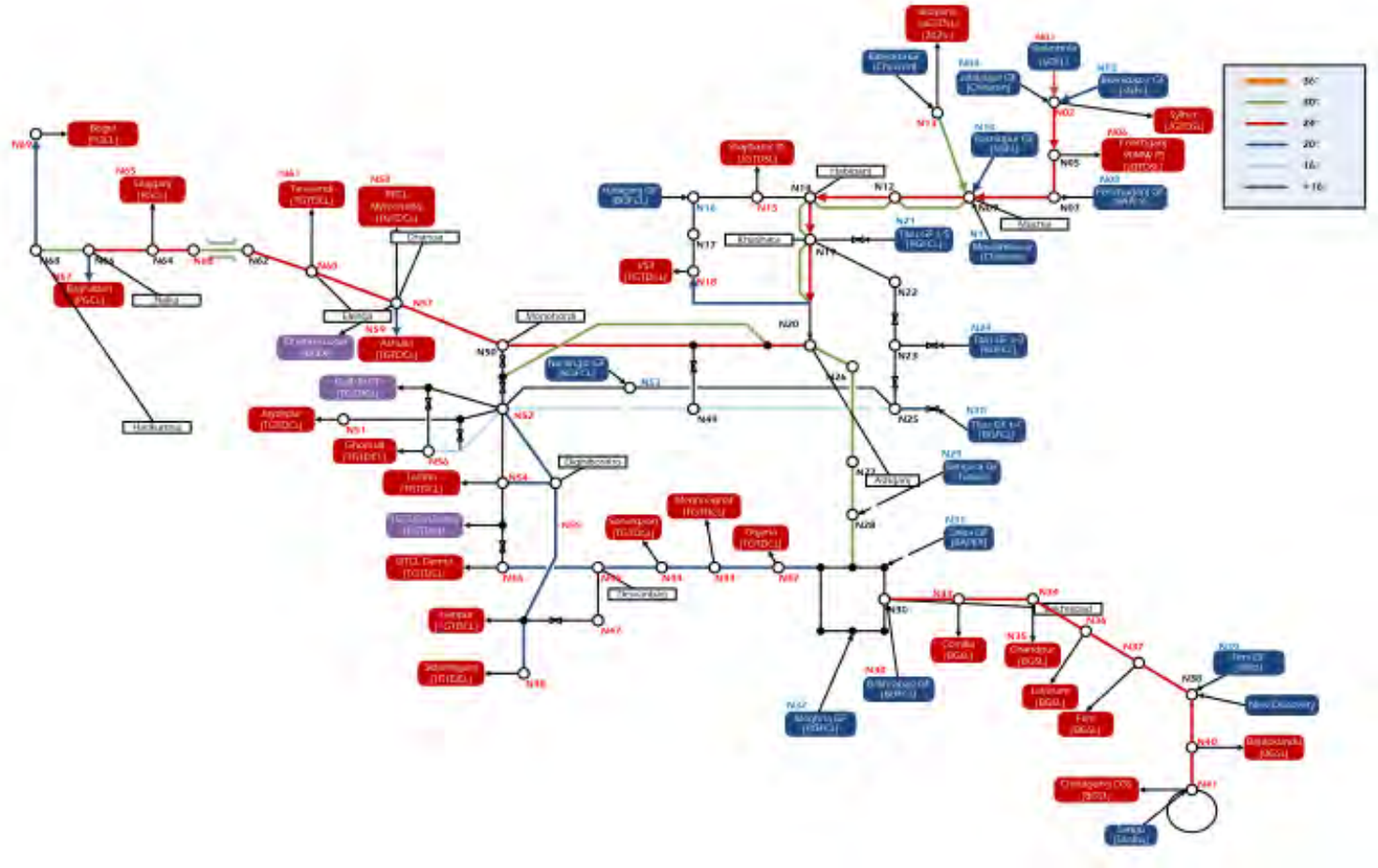

Fig.1 Schematic Flow Diagram of Network (FY 2011)

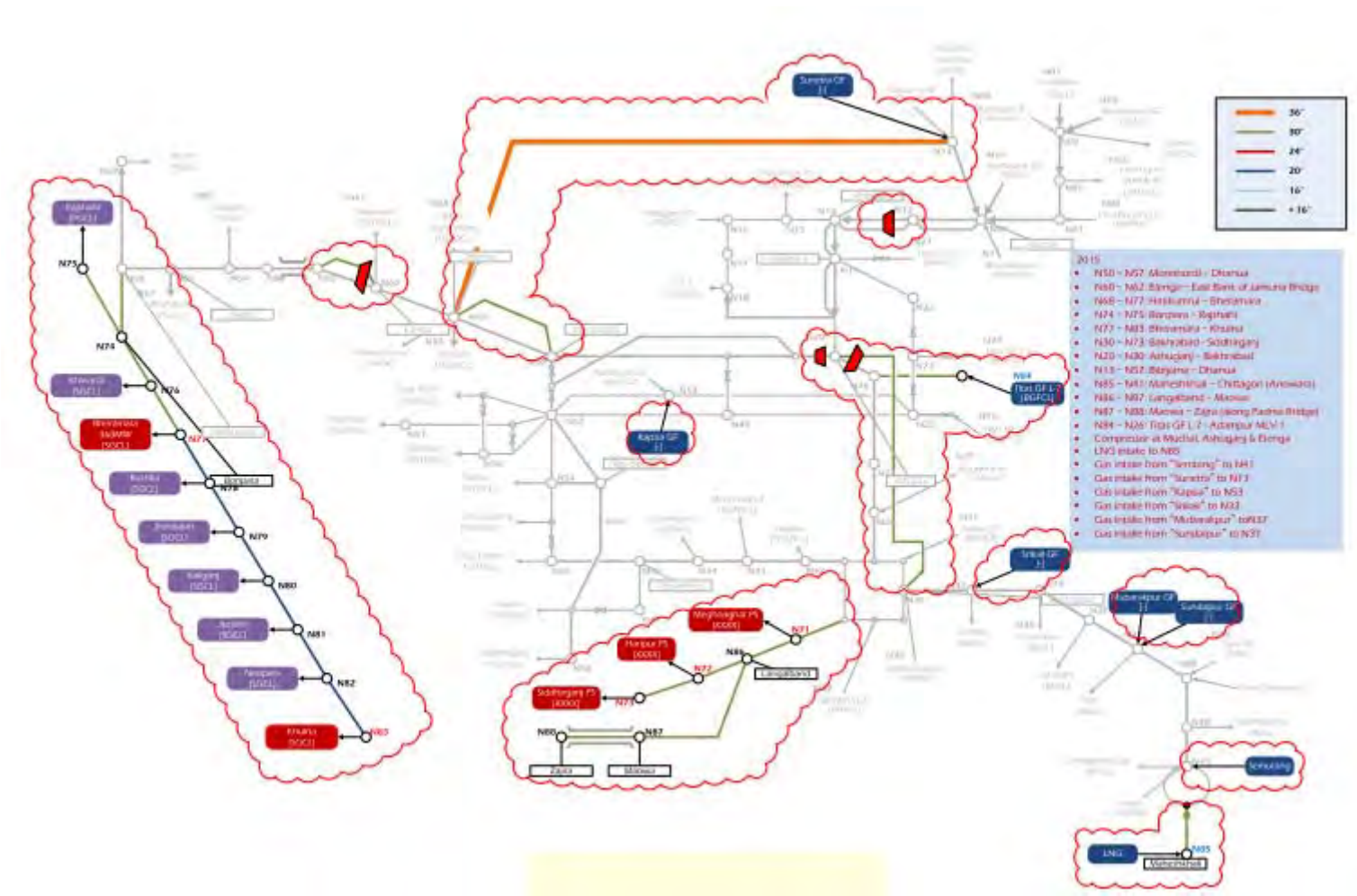

Fig.2 Schematic Flow Diagram of Network (FY 2015)

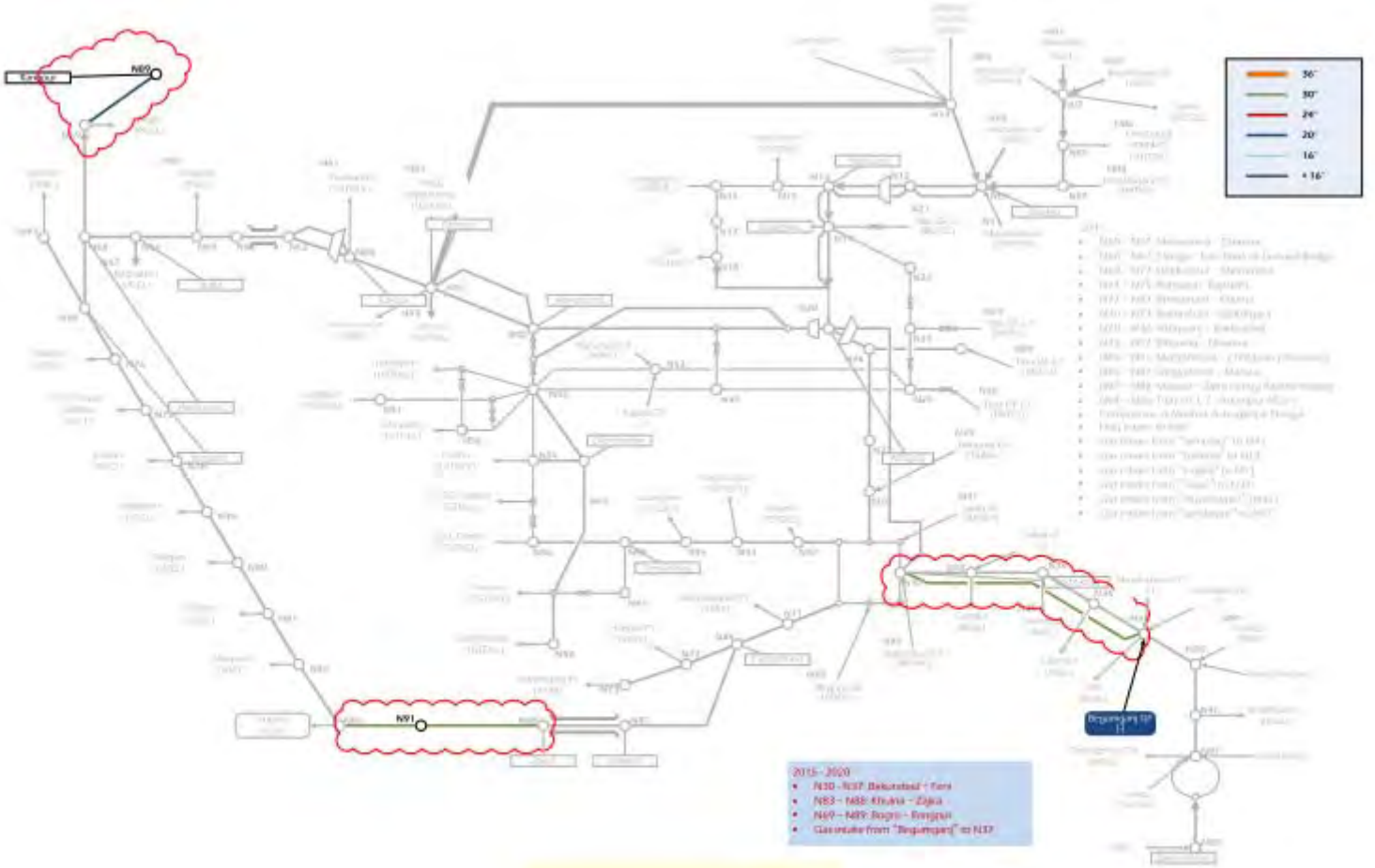

Fig.3 Schematic Flow Diagram of Network (FY 2020)

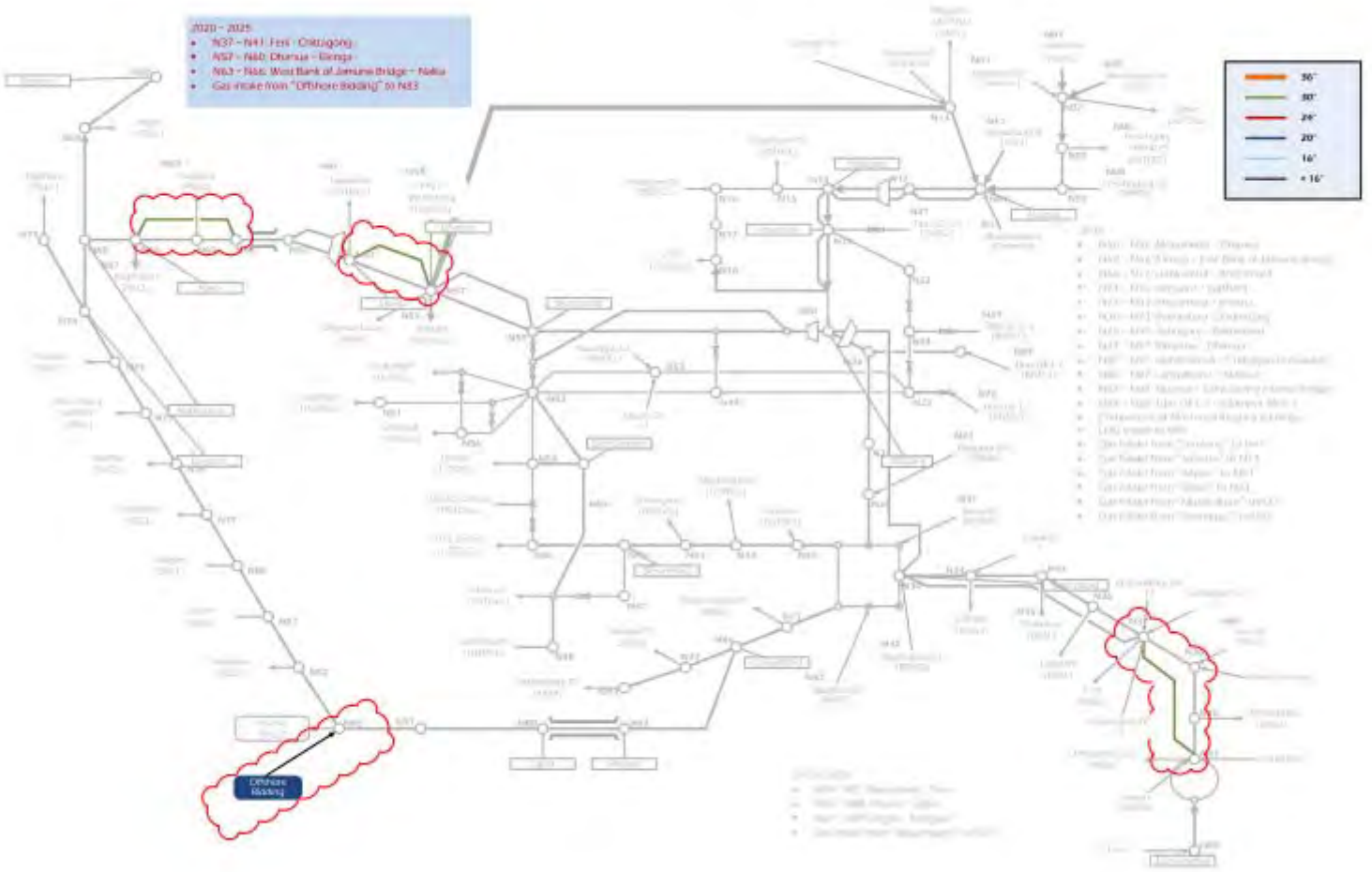

Fig.4 Schematic Flow Diagram of Network (FY 2025)

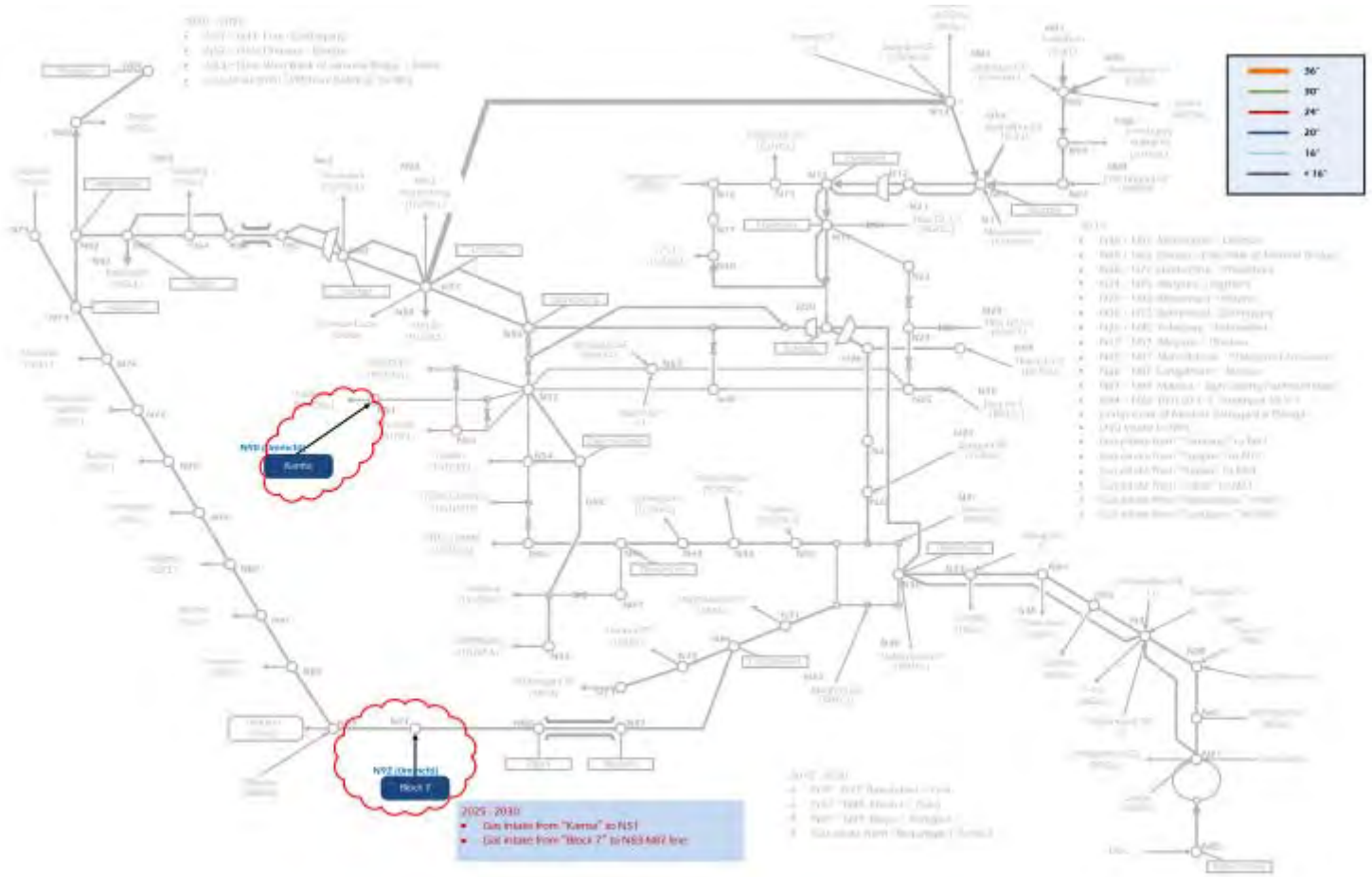

Fig.5 Schematic Flow Diagram of Network (FY 2030)

Table 2 Length and Pipe Diameter btwn. Nodes

No.	Node end	Node end	Dia (mm)	Length (m)	exist at yeat	P/L Name
1	1	2	600	500	2011	
2	2	3	500	1,800	2011	
3	2	4	350	1,500	2011	
4	2	5	600	1,500	2011	
5	5	6	300	1,500	2011	
6	5	7	600	5,000	2011	
7	7	8	300	7,500	2011	
8	7	9	600	73,000	2011	
9	9	10	500	1,700	2011	
10	9	11	350	2,200	2011	
11	9	12	600	2,800	2011	
12	9	12	750	2,800	2011	
13	9	13	750	42,000	2011	
14	12	14	600	41,000	2011	
15	12	14	750	41,000	2011	
16	14	15	300	500	2011	
17	14	19	600	3,000	2011	
18	14	19	750	3,000	2011	
19	15	16	300	500	2011	
20	16	17	300	40,000	2011	
21	17	18	300	13,500	2011	
22	18	20	500	2,000	2011	
23	19	20	600	10,000	2011	
24	19	20	750	10,000	2011	
25	19	21	300	540	2011	
26	19	22	300	500	2011	
27	20	26	750	40,000	2011	
28	20	49	600	4,000	2011	
29	22	23	300	5,000	2011	
30	23	24	300	500	2011	
31	23	25	300	3,000	2011	
32	25	70	500	1,000	2011	
33	25	49	400	13,920	2011	
34	25	53	350	43,770	2011	
35	26	27	750	1,500	2011	
36	27	28	750	600	2011	
37	28	29	250	1,000	2011	
38	28	30	750	17,900	2011	
39	30	31	250	35,000	2011	
40	30	32	200	28,000	2011	
41	30	33	600	16,000	2011	
42	30	42	500	49,000	2011	
43	33	34	600	28,000	2011	
44	34	35	200	46,000	2011	
45	34	36	600	22,000	2011	
46	36	37	600	24,000	2011	
47	37	38	600	7,000	2011	
48	38	39	200	7,100	2011	
49	38	40	600	54,000	2011	
50	40	41	600	26,000	2011	
51	42	43	500	4,000	2011	
52	43	44	500	4,000	2011	
53	44	45	500	4,000	2011	
54	45	46	500	3,000	2011	
55	45	47	350	1,580	2011	
56	46	54	350	1,000	2011	
57	47	48	500	4,000	2011	
58	47	55	500	5,000	2011	
59	49	50	600	3,300	2011	
60	49	52	400	32,390	2011	
61	20	50	750	37,000	2011	

Table 3 Length and Pipe Diameter btwn. Nodes Cont.

No.	Node end	Node end	Dia (mm)	Length (m)	exist at yeat	P/L Name
62	50	57	600	37,000	2011	
63	50	52	500	25,000	2011	
64	52	53	350	5,620	2011	
65	52	54	350	31,410	2011	
66	52	55	500	32,000	2011	
67	52	56	350	12,000	2011	
68	52	56	350	12,000	2011	
69	52	56	400	12,000	2011	
70	54	55	500	3,000	2011	
71	56	51	350	24,000	2011	
72	57	58	300	40,000	2011	
73	57	59	500	47,000	2011	
74	57	60	600	52,000	2011	
75	60	61	300	43,000	2011	
76	60	62	600	14,000	2011	
77	62	63	750	9,000	2011	
78	63	64	600	10,000	2011	
79	64	65	200	500	2011	
80	64	66	600	5,000	2011	
81	66	67	500	35,000	2011	
82	66	68	750	6,000	2011	
83	68	69	500	54,000	2011	
84	30	71	750	47,000	2015	Bakhrabad - Siddhriganj
85	71	86	750	5,800	2015	Bakhrabad - Siddhriganj
86	86	72	750	5,200	2015	Bakhrabad - Siddhriganj
87	72	73	750	2,000	2015	Bakhrabad - Siddhriganj
88	68	74	750	36,000	2015	Hatikumrul - Bheramara
89	74	76	750	36,000	2015	Hatikumrul - Bheramara
90	76	77	750	15,000	2015	Hatikumrul - Bheramara
91	74	75	400	53,000	2015	Bonpara - Rajshahi
92	77	78	750	22,000	2015	Bheramara - Khulna
93	78	79	750	43,000	2015	Bheramara - Khulna
94	79	80	750	15,000	2015	Bheramara - Khulna
95	80	81	750	30,000	2015	Bheramara - Khulna
96	81	82	750	28,000	2015	Bheramara - Khulna
97	82	83	750	2,700	2015	Bheramara - Khulna
98	50	57	750	37,000	2015	Monohordi - Dhanua
99	60	62	750	14,000	2015	Elenga - East of Jamuna Bridge
100	20	26	750	40,000	2015	Ashuganj - Bakhrabad
101	26	27	750	1,500	2015	Ashuganj - Bakhrabad
102	27	28	750	600	2015	Ashuganj - Bakhrabad
103	28	30	750	17,900	2015	Ashuganj - Bakhrabad
104	13	57	900	135,000	2015	Bibiyana - Dhanua
105	84	26	300	8,000	2015	Titas G.F. Loc7 - A-B Pipeline
106	86	87	750	40,000	2015	Langalband - Maowa
107	87	88	750	20,000	2015	Along Padma Bridge (Maowa - Zajira)
108	85	41	750	91,000	2015	Maheshkhali - Anowara (Chittagong)
109	30	33	750	16,000	2020	Bakhrabad - Feni
110	33	34	750	28,000	2020	Bakhrabad - Feni
111	34	36	750	22,000	2020	Bakhrabad - Feni
112	36	37	750	24,000	2020	Bakhrabad - Feni
113	69	89	500	100,000	2020	Bogra - Rangpur
114	88	91	750	55,000	2020	Zajira - Khulna
115	91	83	750	55,000	2020	Zajira - Khulna
116	37	38	750	7,000	2025	Feni - Chittagong
117	38	40	750	54,000	2025	Feni - Chittagong
118	40	41	750	26,000	2025	Feni - Chittagong
119	57	60	750	52,000	2025	Dhanua - Elenga
120	63	66	750	15,000	2025	West of Jamuna Bridge - Nalka
121	51	90	300	19,000	2030	Kamta - Joydepur
122	91	92	750	60,000	2030	Block 7

Table 4 Gas Consumption, Supply, and Pressure at Respective Nodes (8:00 A.M. 24th Oct. 2009)

Area	node	Gas demand mmcf/h	Gas supply mmcf/h	Pressure psig
TGTDCL	18	1.5230		846
	19			
	20			846
	21		2.9960	920
	22			
	23			
	24		4.2940	900
	25			
	26			
	27			
	28			
	29		5.0180	984
	42	0.6250		
	43	2.8148		446
	44	0.1670		
	45	0.0000		
	46	5.6540		460
	47	3.4603		440
	48	6.2790		430
	49			
	50			800
	51	4.2910		430
	52	0.5420		
	53		1.4140	
	54	2.6338		
	55	0.5525		
	56	5.8780		588
	57	3.3250		620
	58	2.6460		490
	59	4.6750		568
	60	1.7460		600
	70		8.0440	900
BGSL	30		1.5000	688
	31		8.1160	780
	32			
	33	1.2500		
	34			
	35	0.1440		
	36	0.0640		
	37	0.4640		
	38			
	39		0.0920	
	40	0.7900		
	41	6.3600		435
	71			
	72			
	73			

Table 5 Gas Consumption, Supply, and Pressure at Respective Nodes Cont.

Area	node	Gas demand mmcf/h	Gas supply mmcf/h	Pressure psig
JGTDSL	1		1.9860	1,130
	2	1.1350		
	3			
	4		7.1010	1,127
	5			
	6	1.0350		1,066
	7			
	8		1.0050	1,086
	9			
	10		1.9840	1,063
	11		2.1780	1,072
	12			
	13		23.0800	1,143
	14			
	15	1.7983		
	16		9.4580	990
	17			
PGCL	61	1.7380		490
	62			
	63			
	64			
	65	0.1250		
	66			
	67	1.3740		560
	68			
	69	0.3330		558
SGCL	74			
	75			
	76			
	77			
	78			
	79			
	80			
	81			
	82			
	83			
	1(*2)			
Total		63.4227	78.2660	

Table 6　Assumed Average and Peak Gas Yields/Consumption at Respective Nodes

IN:Gas field,OUT:Consuming node

No		Name of place	2015 mmcfd	2020 mmcfd	2025 mmcfd	2030 mmcfd	2015 mmcfd	2020 mmcfd	2025 mmcfd	2030 mmcfd
1	IN	Kailashtila Gas Field	39.22	239.78	154.74	34.06	43.137	263.75	170.21	37.471
2	OUT	Sylhet	50.80	72.80	71.20	71.20	55.88	80.08	78.32	78.32
3	IN	Beanibazar Gas Field	16.00	16.00	0.00	0.00	17.6	17.6	0	0
4	IN	Jalalabad Gas Field	280.00	155.65	51.00	0.00	308	171.21	56.103	0
5	-	VS-E Fenchuganj					0	0	0	0
6	OUT	Fenchganj PS	86.48	88.52	91.20	99.60	95.126	97.367	100.31	109.56
7	OUT	Uttarbag	5.32	8.56	10.33	11.83	5.8537	9.4113	11.36	13.018
8	IN	Fenchganj Gas Field	85.00	30.00	0.00	0.00	93.5	33	0	0
9	-	-					0	0	0	0
10	IN	Rashidpur Gas Field	46.29	483.26	463.67	101.77	50.915	531.58	510.04	111.95
11	IN	Moulabibazar Gas Field	360.00	207.46	0.00	0.00	396	228.2	0	0
12	-	Muchai					0	0	0	0
13	IN	Bibiyana Gas Field	1,124.07	931.30	456.86	289.93	1236.5	1024.4	502.55	318.93
13	OUT	Bibiyana	160.80	160.80	225.40	211.80	176.88	176.88	247.94	232.98
14	-	Hobiganj					0	0	0	0
15	OUT	Shahjibazar PS	116.80	135.77	105.35	114.19	128.48	149.34	115.89	125.61
16	IN	Hobiganj Gas Field	83.57	206.73	72.70	15.00	91.931	227.4	79.975	16.498
17	-	-					0	0	0	0
18	OUT	VS3	351.16	468.19	349.65	509.74	386.27	515	384.61	560.71
19	-	Khatihata					0	0	0	0
20	-	Ashuganj					0	0	0	0
21	IN	Titas Gas Field Location 5	185.79	552.65	350.24	83.94	204.37	607.91	385.27	92.336
22	-	-					0	0	0	0
23	-	-					0	0	0	0
24	IN	Titas Gas Field Location 3	0.00	0.00	0.00	0.00	0	0	0	0
25	-	Ghatura					0	0	0	0
26	-	Adampur MLV-1					0	0	0	0
27	-	-					0	0	0	0
28	-	-					0	0	0	0
29	IN	Bangora Gas Field	120.00	64.00	20.97	6.87	132	70.4	23.069	7.5591
30	IN	Bakhrabad Gas Gield	56.00	100.00	100.00	0.00	61.6	110	110	0
31	IN	Salda Gas Field	53.00	30.00	5.00	0.00	58.3	33	5.5	0
32	IN	Meghna Gas Field	10.00	10.00	3.28	0.00	11	11	3.6045	0
33	IN	Srikail	15.00	15.00	4.92	1.61	16.5	16.5	5.4067	1.7717
33	OUT	Comilla	19.20	19.20	0.00	0.00	21.12	21.12	0	0
34	OUT	Bijra	18.40	18.40	18.40	18.40	20.24	20.24	20.24	20.24
35	OUT	Chandpur	0.00	0.00	0.00	0.00	0	0	0	0
36	OUT	Laksham	0.00	0.00	0.00	0.00	0	0	0	0
37	IN	Feni	30.00	40.00	19.83	13.22	33	44	21.813	14.543
37	OUT	Feni	20.81	29.83	27.14	30.05	22.889	32.813	29.853	33.056
38	-	-					0	0	0	0
39	IN	Feni Gas Field	2.00	2.00	0.00	0.00	2.2	2.2	0	0
40	OUT	Barabkundu	208.36	336.32	384.93	426.23	229.19	369.95	423.42	468.85
41	IN	Chittagon City Gate Station	185.00	185.00	158.62	108.95	203.5	203.5	174.48	119.84
41	OUT	Chittagon City Gate Station	239.80	239.80	229.40	143.00	263.78	263.78	252.34	157.3
42	OUT	Gojaria	0.00	0.00	0.00	0.00	0	0	0	0
43	OUT	Meghnaghat	147.49	199.20	259.02	248.90	162.24	219.12	284.93	273.79
44	OUT	Sonargaon	0.00	0.00	0.00	0.00	0	0	0	0
45	OUT	Dewanbag	50.40	50.40	50.40	0.00	55.44	55.44	55.44	0
46	OUT	GTCL Demra	171.98	283.87	305.13	317.84	189.18	312.26	335.64	349.62

Table 7 Assumed Average and Peak Gas Yields/Consumption at Respective Nodes Cont.

	IN:Gas field,OUT:Consuming node									
			2015	2020	2025	2030	2015	2020	2025	2030
No		Name of place	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd
47	OUT	Haripur	298.50	492.69	529.58	551.64	328.34	541.96	582.54	606.81
48	OUT	Siddhiriganj	31.20	31.20	31.20	35.00	34.32	34.32	34.32	38.5
49	-	Doulatkandi					0	0	0	0
50	OUT	Monohordi	4.80	4.80	0.00	0.00	5.28	5.28	0	0
51	OUT	Joydepur	0.00	0.00	0.00	0.00	0	0	0	0
52	OUT	-	15.02	24.80	26.65	27.76	16.525	27.276	29.318	30.539
53	IN	Narsingdi Gas Field	48.00	41.73	20.70	10.93	52.8	45.903	22.769	12.024
54	OUT	Tarabo	8.29	9.52	3.36	3.50	9.1216	10.476	3.6932	3.8471
55	OUT	Dighiborabo	0.00	0.00	0.00	0.00	0	0	0	0
56	OUT	Ghorasal	356.64	405.78	417.77	252.94	392.31	446.35	459.55	278.24
57	OUT	Dhanua	51.40	6.40	0.00	0.00	56.54	7.04	0	0
58	OUT	RPCL Mymensing	26.40	26.40	26.40	0.00	29.04	29.04	29.04	0
59	OUT	Ashulia	486.37	773.13	827.61	860.18	535.01	850.45	910.37	946.2
60	OUT	Elenga	4.00	4.00	0.00	0.00	4.4	4.4	0	0
61	OUT	Tarakandi	45.00	45.00	45.00	45.00	49.5	49.5	49.5	49.5
62	-	East Bank of Jamuna Bridge					0	0	0	0
63	OUT	West Bank of Jamuna Bridge	36.43	83.55	85.34	137.87	40.072	91.91	93.873	151.66
64	-	Kodda					0	0	0	0
65	OUT	Sirajganj	5.23	8.35	55.14	56.67	5.7519	9.1902	60.653	62.342
66	-	Nalka					0	0	0	0
67	OUT	Baghabari	66.83	35.55	10.14	11.67	73.512	39.11	11.153	12.842
68	-	Hatikumrul					0	0	0	0
69	OUT	Bogra	10.03	13.15	10.14	11.67	11.032	14.47	11.153	12.842
70	IN	Titas Gas Field Location 1	0.00	0.00	0.00	0.00	0	0	0	0
71	OUT	Meghnaghat (future)	45.60	45.60	45.60	45.60	50.16	50.16	50.16	50.16
72	OUT	Haripur (future)	54.40	54.40	54.40	54.40	59.84	59.84	59.84	59.84
73	OUT	Siddhiriganj (future)	125.60	125.60	125.60	125.60	138.16	138.16	138.16	138.16
74	-	Bonpara					0	0	0	0
75	OUT	Rajshahi					0	0	0	0
76	OUT	Ishwardi					0	0	0	0
77	OUT	Bheramara	61.90	65.40	66.46	66.05	68.09	71.94	73.111	72.653
78	OUT	Kushtia					0	0	0	0
79	OUT	Jhinaidah					0	0	0	0
80	OUT	Kaliganj					0	0	0	0
81	OUT	Jessore					0	0	0	0
82	OUT	Noapara					0	0	0	0
83	OUT	Khulna	7.50	11.00	12.06	11.65	8.25	12.1	13.271	12.813
83	IN	Khulna	0.00	0.00	0.00	0.00	0	0	0	0
84	IN	Titas Gas Field Location 7	150.00	117.45	69.35	40.95	165	129.2	76.288	45.048
85	IN	Maheshkhali	500.00	500.00	500.00	500.00	550	550	550	550
86	-	Langalband					0	0	0	0
87	-	Maowa					0	0	0	0
88	-	Zajira					0	0	0	0
89	-	Rangpur					0	0	0	0
90	IN	Kamta	0.00	0.00	0.00	0.00	0	0	0	0
91	-						0	0	0	0
92	IN	Block 7	0.00	0.00	0.00	0.00	0	0	0	0
		Total IN	**3,389**	**3,978**	**2,452**	**1,207**				
		OUT	**3,389**	**4,378**	**4,500**	**4,500**				

Table 8 Outlet pressures of Gas Fields

NO		Name	Company	psig	Remarks
1	IN	Kailashtila Gas Field	SGFL	1,125	
3	IN	Beanibazar Gas Field	SGFL		
4	IN	Jalalabad Gas Field	-	1,123	
8	IN	Fenchganj Gas Field	BAPEX	1,094	
10	IN	Rashidpur Gas Field	SGFL	1,077	
11	IN	Moulabibazar Gas Field	Chevron	1,082	
13	IN	Bibiyana Gas Field	-	1,223	
16	IN	Hobiganj Gas Field	BGFCL	990	
21	IN	Titas Gas Field Location 5	BGFCL	950	
24	IN	Titas Gas Field Location 3	BGFCL	950	
29	IN	Bangora Gas Field	Tullow	904	
30	IN	Bakhrabad Gas Gield	BGFCL	678	
31	IN	Salda Gas Field	BAPEX	732	
32	IN	Meghna Gas Field	BGFCL		
39	IN	Feni Gas Field	Niko		
41	IN	Chittagon City Gate Station Semtang	-		
53	IN	Narsingdi Gas Field	BGFCL		
70	IN	Titas Gas Field Location 1	BGFCL		
83	IN	Khulna	-		
84	IN	Titas Gas Field Location 7	BGFCL	950	
85	IN	Maheshkhali	BGFCL		
90	IN	Kamta	BGFCL		
91	IN	Block 7	-		

2. Calculation Results and Considerations

Transportation capacity of a network can be judged by checking if required pressure is secured at each gas consumption node. In case gas is supplied to a gas turbine without fuel gas compressor, the supply pressure should be higher than 1.7MPa (250psi) or so. In conventional cases, say 0.5 MPa (about 70psi) would be enough.

(1) Calibration

As mentioned previously, the efficiency factor of each pipeline was adjusted so as to match the actually measured flow and pressure distribution to the calculated results. The actually measured data are shown in Table 4 and Table 5. It should be noted that the total supply to the network is not consistent with the total consumption from the network. It is perhaps due to errors in measurement, leakage, and/or the unsteady local behavior. Whatever the reason is, it contradicts the law of conservation of mass. Therefore, complete conformance between the measured and the calculated is impossible.

In this report, some nodes of gas supply from gas fields were identified as pressure designated nodes, at which the calculated gas supplies may differ from the measured data. Fig.6 shows measured /calculated gas pressures at major nodes and measured /calculated gas supplies at supply nodes.

Generally speaking, the efficiency factor of a pipeline in Japan is about 0.93. However, many factors are below 0.8 in the study. There is a possibility that the pipelines are acting up. Sediment deposits may have accumulated inside.

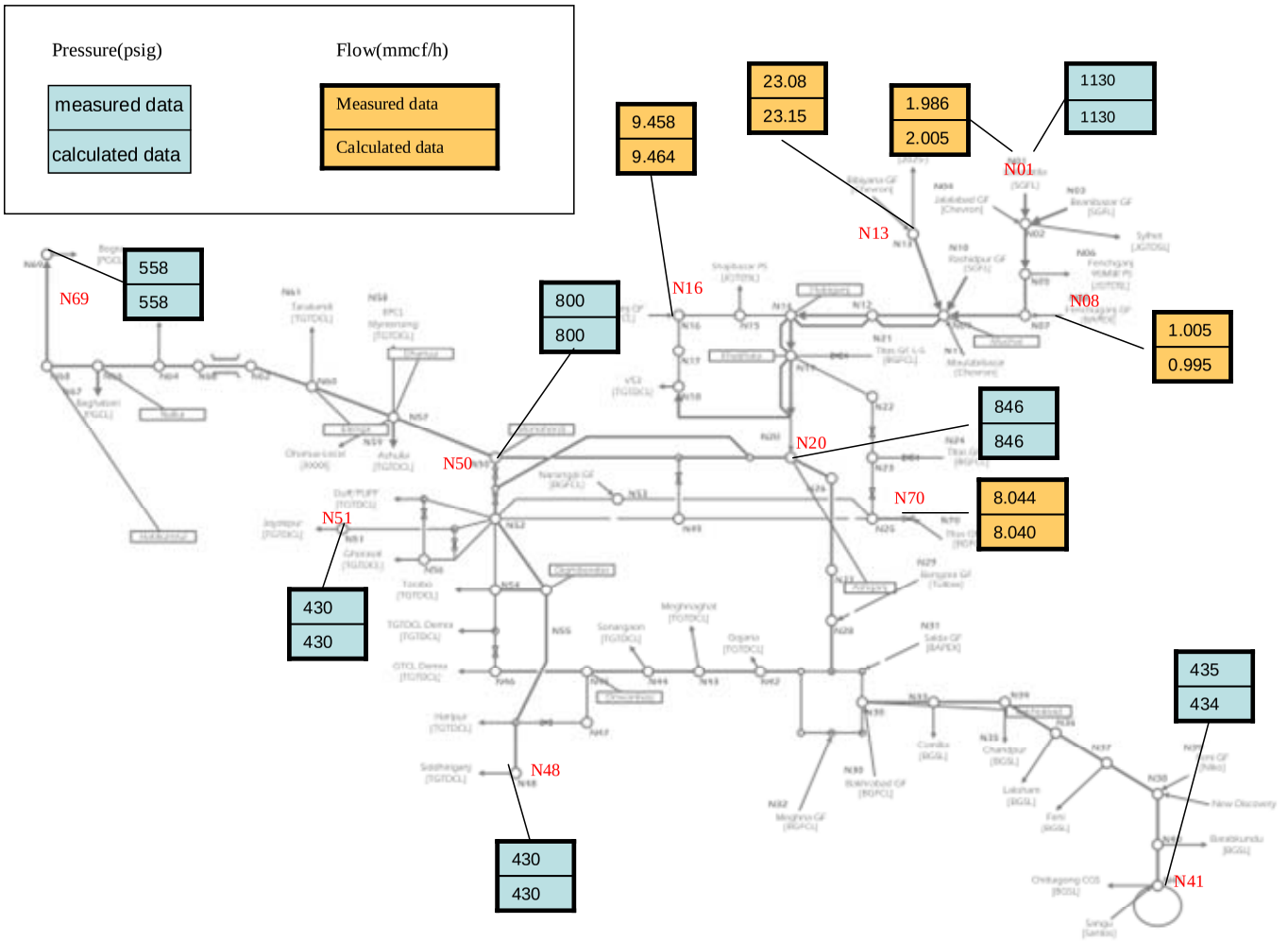

Fig.6 Gas Pressure at Measure Nodes and Supply from Gas Fields (Calibration)

(2) The study results on FY 2015

As there are compressors installed in the network and discontinuous pressure boosts occur at those points, the network was divided into 4 regions, which are Region1(down stream of N60), Region2 (between N20 and N60), Region3(between N12 and N20), and Region4(upstream of N12). The calculation was performed step by step from downstream region to upstream region. Calculation on Region3 and Region4 can not avoid some inaccuracy, because due to inability of supply occurred at one node in Region2 (will explain later), the flow rate through N20 can not be confirmed.

The results of numerical calculation, i.e. flow rates, gas demands, supplies, and pressure distribution in each region are shown in Tables 9 to 14. Some pressures in Table 9, 11 and 14 are also shown in Fig.7. Each pipeline can be identified by the node number of both edges. A positive figure in the column of the gas flow rate means that the gas flows from the node of left number to the node of the right number and a negative number means “in reverse”. In the above mentioned Tables or Figs, ‘Unable’ means being unable to supply gas, and red figure means insufficient pressure (<250psi).

Situations in each region are as follows.

・ Region 1(Table9)

This is the downstream region from the compressor at N60

Discharging pressure of 1000 psi at N60 decreases gradually toward the end of Bheramara-Khulna line, but all pressures exceed 780 psi. The transportation ability is sufficient.

・ Region 2(Table 10 and Table 11)

This is the region between two compressors, N20 and N60.

Table 10 is the result of the first calculation and Table 11 is that of second calculation.

A valve on the pipeline between N22 and N23 is assumed to be closed, as it is necessary to avoid the return flow through the pipelines from the outlet to the inlet of the compressor at N20.

The reason why we calculated twice is that, in the first run, a reverse flow appears at Bakhrabad GF (N30. See the right column of Table 10.). It is because we dealt gas fields near Bakhrabad (N29, N30, and N31) as pressure designated nodes. If the pressure in the network is larger than the pressure at a gas field, a reverse flow occurs. It may be a phenomenon in the virtual world of calculation; the reverse flow will not occur if the hypogeal pressure of a gas field should be higher enough than the outlet pressure. Several ‘Unable’ appears between N41 and N48 in the first run. These are also due to the low pressures assigned at N29 to 31. As nodes between N41 and N48 are situated downstream from N30, pressures are calculated by subtracting the pressure losses from the fixed pressure at N30, of which procedure results in the quite low pressures in the downstream area; N29 or N31 undertakes the same role if N30 is assigned supply rate.

So, whatever the actual phenomena will be, it is necessary to assign flow rate (supply rate) to those

nodes to circumvent this problem.

The second run was performed by setting the flow rates to those gas fields. As already mentioned, the flow rates are 1.1 times of gas yields. In Table 11, calculated pressures at N29, N30, and N31 mean the necessary pressure to deliver assumed amount of gas to the network.. They must be secured by introducing compressors.

'Unable' appears only at N59, which is connected to N57 by a 2-inch pipeline. A parallel pipeline would be necessary.

- Region 3(Table 12)

This is the region between the compressor at N12 and the compressor at N20.

Pressure of 1000 psi at N12 gradually decreases toward 579psi at the inlet of N20.

- Region 4(Table 13)

This is the upstream region from N12.

All pressures are above 1000psi except N06. The compressor inlet pressure at N12 is 1012psi, which is higher than the outlet pressure at N12 (1000 psi. See Table 12.). The result means we do not need a compressor at N12 if other kind of problems, such as pressure drops at some gas fields, do not occur.

- Region 3&4(Table 14)

We did a calculation for two regions combined. It is assumed we have no compressor at N12.

The result shows that pressures are secured without any compressor.

Table 9　Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2015, Region1)

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
60	62	23.74
62	63	206.71
63	64	166.63
64	65	5.75
64	66	160.88
66	67	73.51
66	68	87.37
68	69	11.03
68	74	76.34
74	76	76.34
76	77	76.34
74	75	0.00
77	78	8.25
78	79	8.25
79	80	8.25
80	81	8.25
81	82	8.25
82	83	8.25
60	62	182.97

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcf	Pressure psi
60		CO	206.71	1000.02
62	0.00			996.58
63	40.07			954.31
64	0.00			854.20
65	5.75			852.07
66	0.00			803.18
67	73.51			787.27
68	0.00			796.87
69	11.03			788.04
74	0.00			794.70
75	0.00			794.70
76	0.00			792.54
77	68.09			791.64
78	0.00			791.62
79	0.00			791.58
80	0.00			791.57
81	0.00			791.54
82	0.00			791.51
83	8.25			791.51

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

Table 10 Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2015, Region2,first)

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
20	26	484.91
20	49	327.09
23	24	0.00
23	25	0.00
25	70	0.00
25	49	-130.55
25	53	130.55
26	27	540.09
27	28	586.17
28	29	-49.50
28	30	558.09
30	31	-24.53
30	32	-11.00
30	33	-247.98
30	42	405.54
33	34	-252.60
34	35	0.00
34	36	-272.84
36	37	-272.84
37	38	-262.73
38	39	-2.20
38	40	-260.53
40	41	-489.72
42	43	405.54
43	44	243.30
44	45	243.30
45	46	48.76
45	47	139.11
46	54	-140.42
47	48	34.32
47	55	-223.56
49	50	-125.07
49	52	321.61
20	50	345.41
50	57	-19.59
50	52	276.98
52	53	-183.35
52	54	106.10
52	55	267.00
52	56	114.76
52	56	114.76
52	56	162.78
54	55	-43.44
56	51	0.00
57	58	29.04
57	59	535.01
57	60	260.61
60	61	49.50
30	71	248.16
71	86	198.00
86	72	198.00
72	73	138.16
50	57	-42.33
20	26	839.62
26	27	934.82
27	28	888.74
28	30	966.32
13	57	943.12
84	26	150.38
86	87	0.00
87	88	0.00
85	41	550.00

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
13		P	943.12	1223.04
20		CO	1997.03	1000.02
23	0.00			908.23
24	0.00			908.23
25	0.00			908.23
26	0.00			818.54
27	0.00			809.32
28	0.00			805.95
29		P	49.50	904.02
30	1154.22	P		678.01
31		P	24.53	731.92
32		S	11.00	710.53
33	4.62			716.56
34	20.24			780.97
35	0.00			780.97
36	0.00			834.97
37		S	10.11	890.08
38	0.00			904.46
39		S	2.20	904.88
40	229.19			1006.93
41	60.28			1147.83
42	0.00			UNABLE
43	162.24			UNABLE
44	0.00			UNABLE
45	55.44			UNABLE
46	189.18			UNABLE
47	328.34			UNABLE
48	34.32			UNABLE
49	0.00			953.86
50	5.28			960.39
51	0.00			348.17
52	16.52			489.61
53		S	52.80	563.40
54	9.12			UNABLE
55	0.00			UNABLE
56	392.31			348.17
57	56.54			961.01
58	29.04			940.66
59	535.01			UNABLE
60	211.11	CI		906.58
61	49.50			802.73
70	0.00			908.23
71	50.16			647.86
72	59.84			643.33
73	138.16			642.91
84		P	150.38	949.96
85		S	550.00	1284.83
86	0.00			645.44
87	0.00			645.44
88	0.00			645.44

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

Table 11 Flow Rates, Gas Demands, Supplies, and Pressure Distribution

(FY 2015, Region2,second)

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
20	26	109.74
20	49	295.70
23	24	0.00
23	25	0.00
25	70	0.00
25	49	-116.86
25	53	116.86
26	27	79.51
27	28	79.51
28	29	-132.00
28	30	127.84
30	31	-58.30
30	32	-11.00
30	33	-247.98
30	42	479.91
33	34	-252.60
34	35	0.00
34	36	-272.84
36	37	-272.84
37	38	-262.73
38	39	-2.20
38	40	-260.53
40	41	-489.72
42	43	479.91
43	44	317.68
44	45	317.68
45	46	108.25
45	47	153.98
46	54	-80.93
47	48	34.32
47	55	-208.68
49	50	-110.21
49	52	289.05
20	50	313.51
50	57	-16.09
50	52	248.85
52	53	-169.66
52	54	84.90
52	55	213.83
52	56	114.76
52	56	114.76
52	56	162.78
54	55	-5.15
56	51	0.00
57	58	29.04
57	59	535.01
57	60	260.61
60	61	49.50
30	71	248.16
71	86	198.00
86	72	198.00
72	73	138.16
50	57	-34.73
20	26	190.02
26	27	137.68
27	28	137.68
28	30	221.36
13	57	932.02
84	26	-82.56
86	87	0.00
87	88	0.00
85	41	550.00

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
13		P	932.61	1223.04
20		CO	1068.49	1000.02
23	0.00			925.21
24	0.00			925.21
25	0.00			925.21
26	0.00			989.45
27	0.00			989.23
28	0.00			989.15
29		S	132.00	1418.34
30		S	61.60	982.88
31		S	58.30	1158.26
32		S	11.00	1005.58
33	4.62			1009.85
34	20.24			1056.77
35	0.00			1056.77
36	0.00			1097.46
37		S	10.11	1140.11
38	0.00			1151.41
39		S	2.20	1151.74
40	229.19			1233.77
41	60.28			1351.48
42	0.00			487.04
43	162.24			423.19
44	0.00			390.53
45	55.44			355.07
46	189.18			351.29
47	328.34			281.70
48	34.32			280.62
49	0.00			961.89
50	5.28			967.01
51	0.00			504.97
52	16.52			611.97
53		S	52.80	664.93
54	9.12			360.98
55	0.00			361.03
56	392.31			504.97
57	56.54			967.44
58	29.04			947.23
59	535.01			UNABLE
60	211.11	CI		913.39
61	49.50			810.39
70	0.00			925.21
71	50.16			962.32
72	59.84			959.25
73	138.16			958.97
84	82.56	P		949.96
85		S	550.00	1469.80
86	0.00			960.68
87	0.00			960.68
88	0.00			960.68

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

Table 12 Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2015, Region3.)

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
12	14	312.63
12	14	560.76
14	15	-146.99
14	19	365.54
14	19	654.84
15	16	-275.47
16	17	103.46
17	18	103.46
18	20	-282.82
19	20	426.61
19	20	765.18
19	21	-171.41
19	22	0.00

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
12		CO	873.39	1000.02
14	0.00			655.29
15	128.48			748.72
16		P	378.93	989.92
17	0.00			697.36
18	386.27			566.86
19	0.00			641.85
20	908.97	CI		578.83
21		P	171.41	949.96
22	0.00			641.85

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

Table 13　Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2015, Region4)

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
1	2	59.65
2	3	-17.60
2	4	-11.86
2	5	33.23
5	6	95.13
5	7	-61.90
7	8	-60.05
7	9	-7.70
9	10	-71.38
9	11	-63.47
9	12	315.06
9	12	565.11
9	13	-753.02

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
1		P	59.65	1125.04
2	55.88			1024.80
3		S	17.60	1024.88
4		P	11.86	1122.91
5	0.00			1023.55
6	95.13			843.76
7	5.85			1032.17
8		P	60.05	1094.04
9	0.00			1030.40
10		P	71.38	1076.97
11		P	63.47	1081.95
12	880.17	CI		1011.78
13		P	1861.92	1223.04

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

Table 14　Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2015, Region3&4)

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
1	2	60.20
2	3	-17.60
2	4	-11.97
2	5	33.89
5	6	95.13
5	7	-61.23
7	8	-61.22
7	9	-5.87
9	10	-75.03
9	11	-66.24
9	12	320.14
9	12	574.21
9	13	-758.96
12	14	320.15
12	14	574.21
14	15	-137.71
14	19	369.75
14	19	662.32
15	16	-266.20
16	17	99.97
17	18	99.97
18	20	-286.30
19	20	427.85
19	20	767.42
19	21	-163.20
19	22	0.00

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
1		P	60.20	1125.04
2	55.88			1035.76
3		S	17.60	1035.84
4		P	11.97	1122.91
5	0.00			1034.78
6	95.13			857.31
7	5.85			1044.61
8		P	61.22	1094.04
9	0.00			1046.15
10		P	75.03	1076.97
11		P	66.24	1081.95
12	0.00			1030.44
13		P	1867.86	1223.04
14	0.00			690.09
15	128.48			768.20
16		P	366.17	989.92
17	0.00			721.86
18	386.27			607.55
19	0.00			677.36
20	908.97	CI		618.77
21		P	163.20	949.96
22	0.00			677.36

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

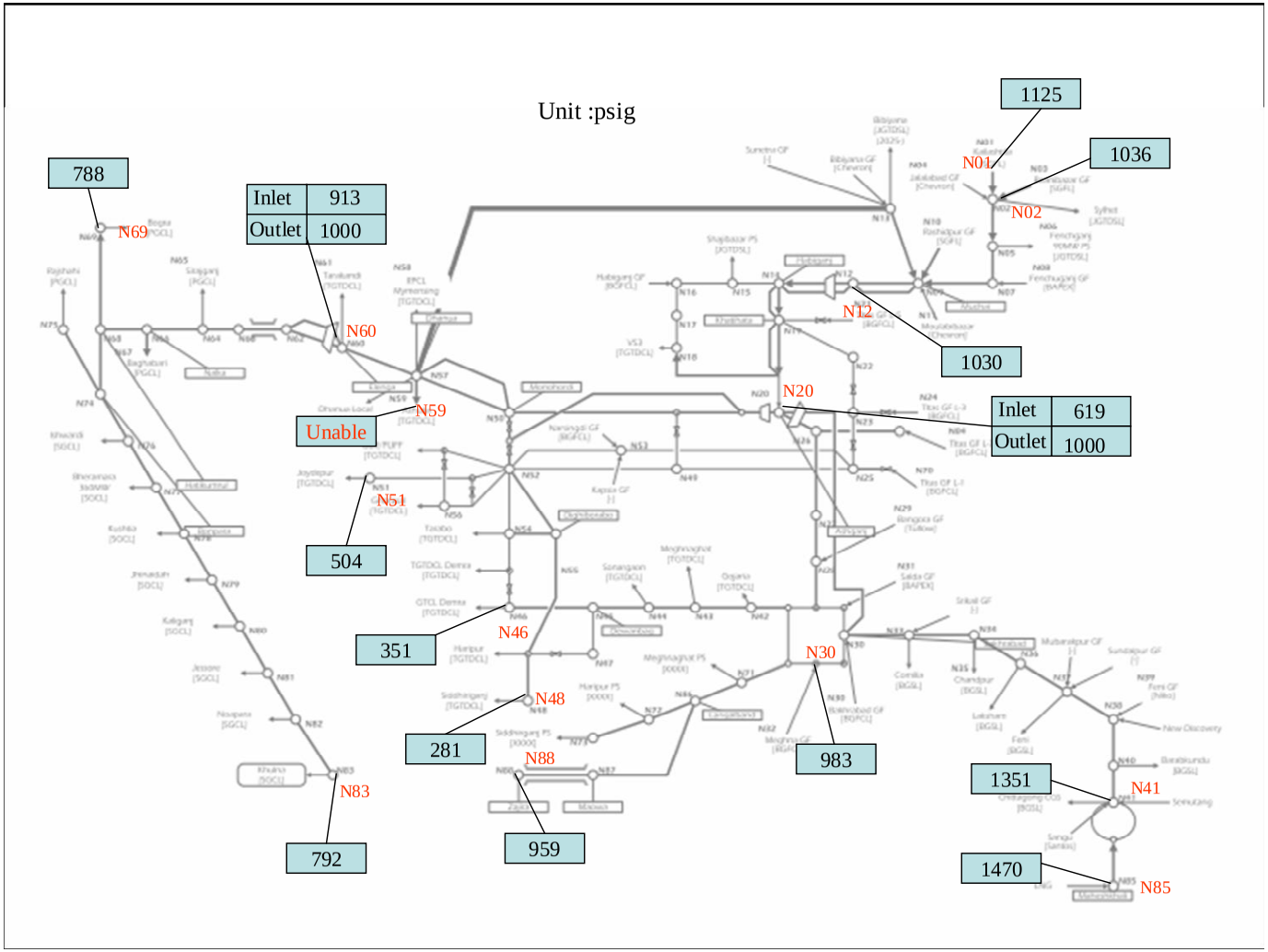

Fig.7 Pressure Distribution in Pipeline Network(FY 2015)

(3) The study results on FY 2020

・ Region 1 and Region 2

It is assumed that Zajira (N88) and Khulna(Node83) have been connected by then. As loop lines from the outlet of the compressor at N60 to the inlet of the same compressor are formed, Region 1 and Region 2 must be calculated simultaneously. The results are shown in Table 15 and 16. The pressure distribution is also shown in Fig.8. In Table 15, new 'Unable' appears along the lines from Bakhrabad through Dewanbag to Monohordi (See N42 to N48, N51 to N56 in Table 15).They are the circular lines around Dhaka. The transportation trouble is partly due to the assumption of supply and consumption. In FY 2020, 2025, and 2030, Total gas consumption exceeds the total gas supply from gas fields, and the discrepancy is very large (See the bottom of Table 7). As many newly developed gas fields are dealt as supply designated nodes and hence pressure designated gas fields are concentrated in Region3 and Region 4, most part of gas supply including the above mentioned discrepancy comes from north east. This phenomenon inevitably brings down large pressure loss between north east area and areas around the west part of the circular lines. Those pipelines must be reinforced. Direct introduction of LNG into those lines would be helpful.

Pressures in south-west area (N64 to N83) are high enough. Gas transport to the area will be secured as long as the pipelines are well maintained. The pressure difference between N83 and N88 is very small. It is almost balanced. This connection line does not contribute to the supply so much at this time stage. The pressure level can be secured without it (It has been checked by other simulation). Gas can flow to any direction on situations.

Pressures around Chittagong(N41,N85) are quite high. The concerned staff should deliberately check the design pressure of the pipelines if the plans are to be realized as it is.

As to the compressor at N60, the pressure ratio is 1.14(1015/894=1.14). It is relatively low, which means no problem in installing the compressor.

・ Region 3 and Region4

Calculation can not be performed because failure of transport takes place in the downstream region and the flow through the compressor at N20 can not be confirmed. However, as there are lots of gas fields in these areas and their pressures are high, the possibility of transport failure will be small.

Table 15 Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2020, Region1&2)

Flow rate in each pipeline			Demand/supply and pressure distribution				
Left number	Right number	Flow rate mmcfd	Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
20	26	238.72	13		P	990.82	1223.04
20	49	386.52	20		CO	1485.08	1000.02
23	24	0.00	23	0.00			947.31
23	25	0.00	24	0.00			947.31
25	70	-240.85	25	0.00			947.31
25	49	60.80	26	0.00			954.59
25	53	180.05	27	0.00			952.97
26	27	229.31	28	0.00			952.33
27	28	229.31	29		S	70.40	1108.36
28	29	-70.40	30		S	110.00	928.71
28	30	255.08	31		S	33.00	996.52
30	31	-33.00	32		S	11.00	952.68
30	32	-11.00	33	4.62			929.47
30	33	-34.96	34	20.24			930.91
30	42	682.30	35	0.00			930.91
33	34	-36.45	36	0.00			932.43
34	35	0.00	37		S	11.19	934.09
34	36	-42.98	38	0.00			937.42
36	37	-42.98	39		S	2.20	937.83
37	38	-121.97	40	369.95			961.83
38	39	-2.20	41	60.28			1108.41
38	40	-119.77	42	0.00			UNABLE
40	41	-489.72	43	219.12			UNABLE
42	43	682.30	44	0.00			UNABLE
43	44	463.18	45	55.44			UNABLE
44	45	463.18	46	312.26			UNABLE
45	46	166.21	47	541.96			UNABLE
45	47	241.53	48	34.32			UNABLE
46	54	-146.05	49	0.00			936.56
47	48	34.32	50	5.28			935.42
47	55	-334.75	51	0.00			UNABLE
49	50	48.26	52	27.28			UNABLE
49	52	399.06	53		S	45.90	34.59
20	50	446.50	54	10.48			UNABLE
50	57	47.23	55	0.00			UNABLE
50	52	339.90	56	446.35			UNABLE
52	53	-225.95	57	7.04			932.12
52	54	139.63	58	29.04			911.13
52	55	351.65	59	850.45			UNABLE
52	56	130.57	60in	204.38	CI		878.66
52	56	130.57	60out		CO	199.97607	1000.0232
52	56	185.21	61	49.50			771.13
54	55	-16.90	62	0.00			996.97
56	51	0.00	63	91.91			960.88

60in=Inlet Side of Comp. 60out=Outlet Side of Comp.
P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

Table 16 Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2020, Region1&2)

Cont.

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
57	58	29.04
57	59	850.45
57	60	253.87522
60	61	49.499647
93	62	22.962179
62	63	199.97607
63	64	108.06571
64	65	9.1900189
64	66	98.875695
66	67	39.11034
66	68	59.765354
68	69	4.3040374
30	71	276.73799
71	86	226.5781
86	72	197.99944
72	73	138.15964
68	74	55.461317
74	76	55.461317
76	77	55.461317
74	75	0
77	78	-16.47899
78	79	-16.47899
79	80	-16.47899
80	81	-16.47899
81	82	-16.47899
82	83	-16.47899
50	57	102.35248
93	62	177.01389
20	26	413.33944
26	27	397.03686
27	28	397.03686
28	30	441.66336
13	57	990.82075
84	26	-25.71805
86	87	28.578664
87	88	28.578664
85	41	550.00013
30	33	-73.33727
33	34	-76.466
34	36	-90.17308
36	37	-90.17308
69	89	-10.16624
88	91	28.578664
83	91	-28.57866

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
64	0.00			920.54
65	9.19			916.11
66	0.00			902.99
67	39.11			898.92
68	0.00			900.41
69	14.47			899.17
70		P	240.85	999.88
71	50.16			901.99
72	59.84			898.27
73	138.16			897.98
74	0.00			899.42
75	0.00			899.42
76	0.00			898.44
77	71.94			898.03
78	0.00			898.09
79	0.00			898.22
80	0.00			898.26
81	0.00			898.34
82	0.00			898.42
83	12.10			898.43
84	25.72	P		949.96
85		S	550.00	1249.68
86	0.00			899.76
87	0.00			899.44
88	0.00			899.29
89		P	10.17	900.04
91	0.00			898.86

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

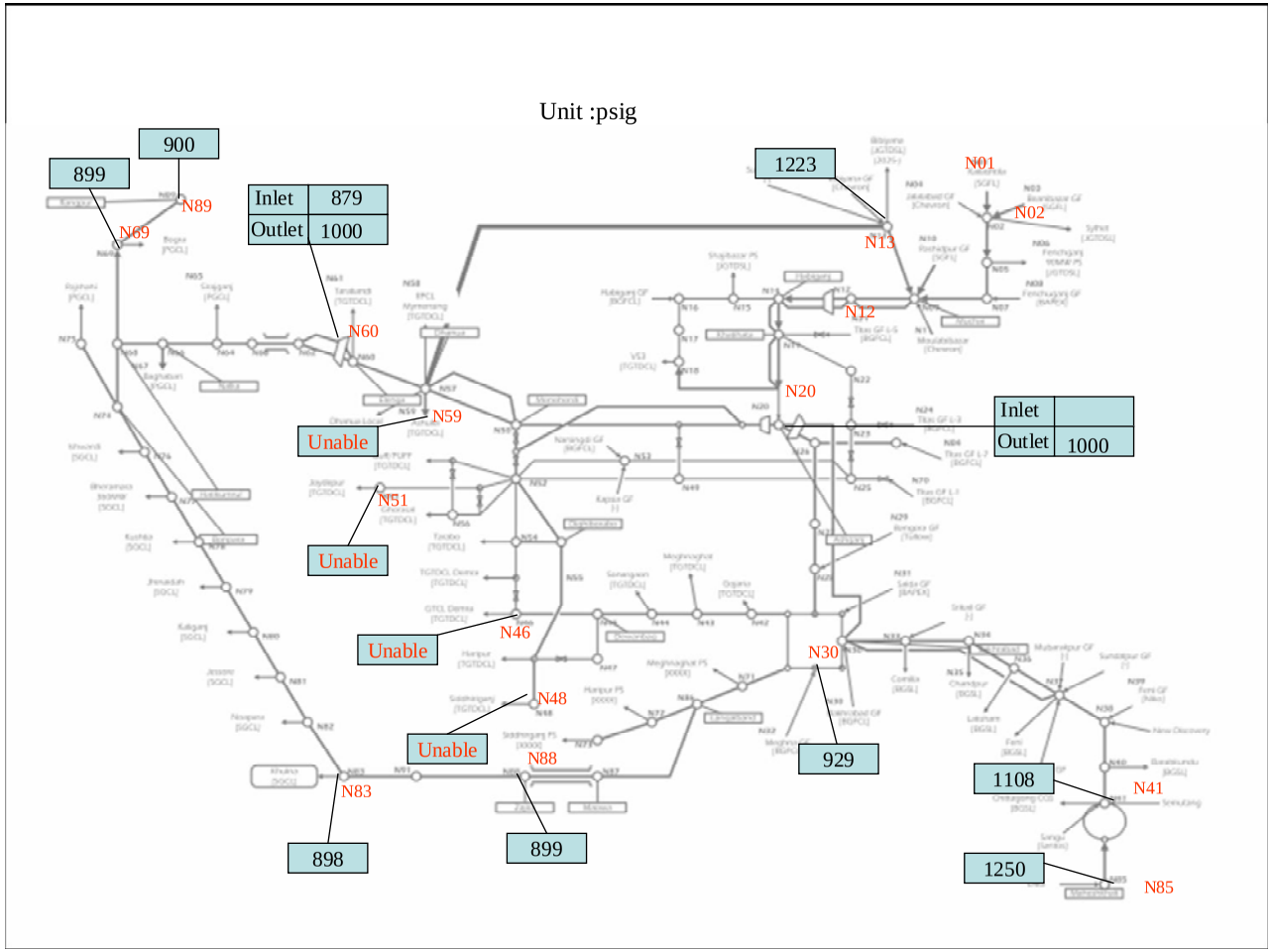

Fig.8 Pressure Distribution in Pipeline Network(FY 2020)

(4) The study results on FY 2025

・ Region 1 & Region 2

The calculation results are shown in Table 17 and Table 18. The pressure distribution is also shown in Fig.9.

The situation does not change from FY 2020. ‘Unable’ appears along the circular lines from Bakhrabad to Monohordi. About 40 mmcfd of gas is supplied from Khulna toward Zajira through the connection line (N83-N91).

Table 17 Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2025, Region1&2)

Flow rate in each pipeline			Demand/supply and pressure distribution				
Left number	Right number	Flow rate mmcfd	Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
20	26	279.63	13		P	1088.91	1223.04
20	49	559.50	20		CO	1058.77	1000.02
23	24	0.00	23	0.00			773.80
23	25	0.00	24	0.00			773.80
25	70	0.00	25	0.00			773.80
25	49	-182.28	26	0.00			938.61
25	53	182.28	27	0.00			936.00
26	27	294.83	28	0.00			934.95
27	28	294.83	29		S	23.07	956.41
28	29	-23.07	30		S	110.00	901.62
28	30	303.28	31		S	5.50	904.22
30	31	-5.50	32		S	3.60	904.77
30	32	-3.60	33		S	5.41	901.67
30	33	-8.34	34	20.24			901.73
30	42	765.69	35	0.00			901.73
33	34	-6.60	36	0.00			901.91
34	35	0.00	37	8.04			902.10
34	36	-13.13	38	0.00			902.18
36	37	-13.13	39	0.00			902.18
37	38	-15.73	40	423.42			902.77
38	39	0.00	41	77.86			921.83
38	40	-15.73	42	0.00			UNABLE
40	41	-152.39	43	284.93			UNABLE
42	43	765.69	44	0.00			UNABLE
43	44	480.76	45	55.44			UNABLE
44	45	480.76	46	335.64			UNABLE
45	46	169.01	47	582.54			UNABLE
45	47	256.32	48	34.32			UNABLE
46	54	-166.63	49	0.00			869.59
47	48	34.32	50	0.00			871.56
47	55	-360.55	51	0.00			UNABLE
49	50	-62.19	52	29.32			UNABLE
49	52	439.41	53		S	22.77	UNABLE
20	50	635.48	54	3.69			UNABLE
50	57	62.50	55	0.00			UNABLE
50	52	375.28	56	459.55			UNABLE
52	53	-205.04	57	0.00			865.59
52	54	150.88	58	29.04			842.98
52	55	379.99	59	910.37			UNABLE
52	56	134.43	60in	298.01	CI		847.18
52	56	134.43	60out		CO	298.01	1000.02
52	56	190.68	61	49.50			735.14
54	55	-19.45	62	0.00			993.62
56	51	0.00	63	93.87			916.13

60in=Inlet Side of Comp. 60out=Outlet Side of Comp.
P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

Table 18　Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2025, Region1&2)

Cont.

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
57	58	29.04
57	59	910.37
57	60	138.71906
60	61	49.499647
93	62	34.216204
62	63	298.01232
63	64	33.865483
64	65	60.652599
64	66	-26.78712
66	67	11.152952
66	68	132.33347
68	69	5.4551062
30	71	207.66358
71	86	157.50369
86	72	197.99944
72	73	138.15964
68	74	126.87837
74	76	126.87837
76	77	126.87837
74	75	0
77	78	53.766738
78	79	53.766738
79	80	53.766738
80	81	53.766738
81	82	53.766738
82	83	53.766738
50	57	135.51484
93	62	263.79611
20	26	484.16481
26	27	510.5032
27	28	510.5032
28	30	525.12637
13	57	1088.9091
84	26	41.544884
86	87	-40.49575
87	88	-40.49575
85	41	550.00013
30	33	-17.5022
33	34	-13.83721
34	36	-27.5479
36	37	-27.5479
69	89	-5.697846
88	91	-40.49575
83	91	40.49575
37	38	-32.99262
38	40	-32.99262
40	41	-319.7465
57	60	208.79299
63	66	170.27354

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
64	0.00			911.30
65	60.65			749.85
66	0.00			912.86
67	11.15			912.47
68	0.00			901.67
69	11.15			899.74
70	0.00			773.80
71	50.16			885.55
72	59.84			882.88
73	138.16			882.58
74	0.00			897.08
75	0.00			897.08
76	0.00			892.49
77	73.11			890.59
78	0.00			890.02
79	0.00			888.91
80	0.00			888.52
81	0.00			887.75
82	0.00			887.03
83	13.27			886.96
84		P	41.54	949.96
85		S	550.00	1087.29
86	0.00			884.39
87	0.00			885.01
88	0.00			885.31
89		P	5.70	900.04
91	0.00			886.14

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

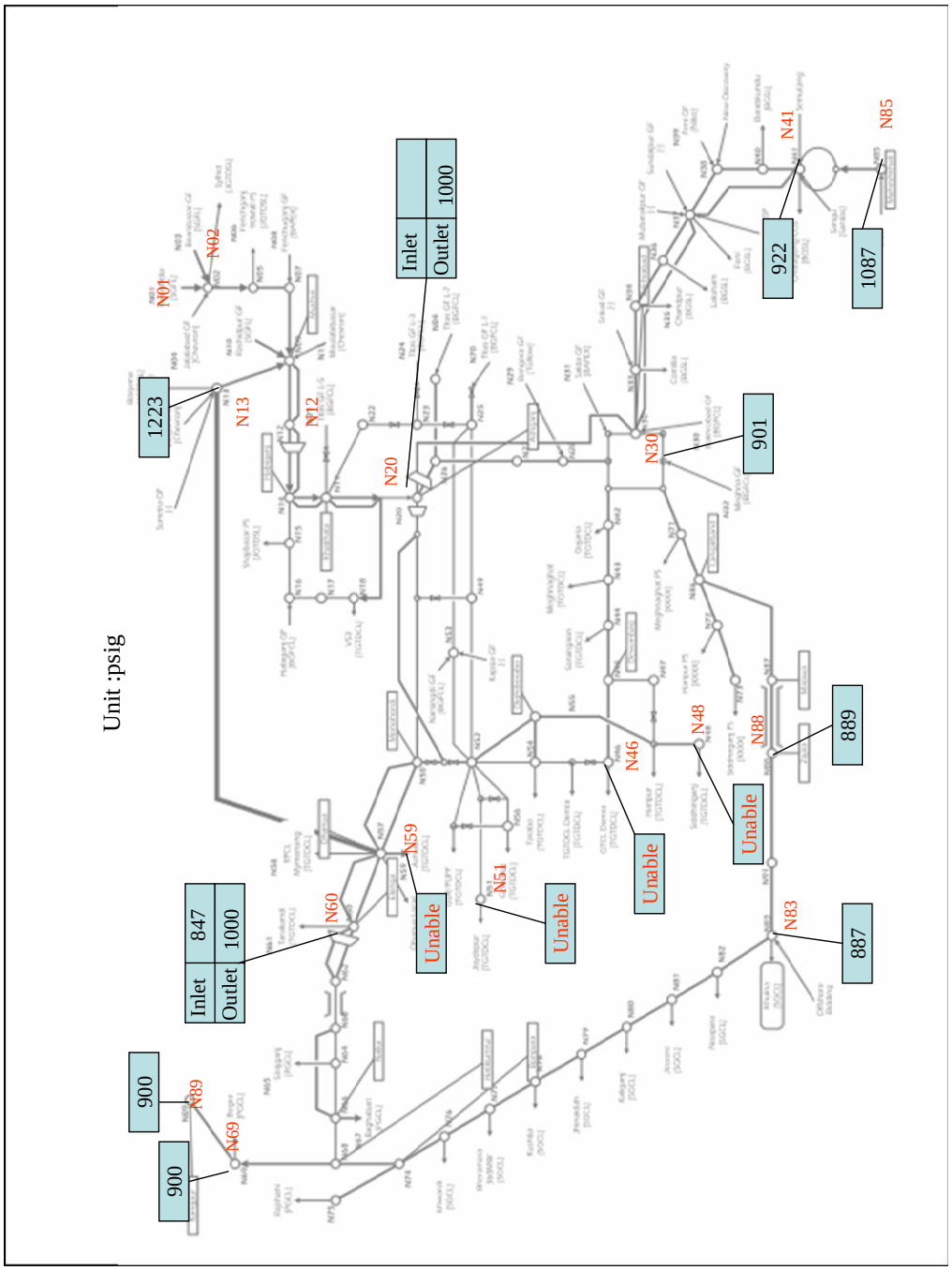

Fig.9 Pressure Distribution in Pipeline Network(FY 2025)

(5) The study results on FY 2030

・ Region 1 & Region 2

The calculation results are shown in Table 19 and Table 20. The pressure distribution is also shown in Fig.10.

The situation does not change from FY 2020. ‘Unable’ appears along the circular lines from Bakhrabad to Monohordi.

Table 19 Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2030, Region1&2)

Flow rate in each pipeline			Demand/supply and pressure distribution				
Left number	Right number	Flow rate mmcfd	Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
20	26	305.45	13		P	1072.83	1223.04
20	49	521.25	20		CO	1951.76	1000.02
23	24	0.00	23	0.00			815.95
23	25	0.00	24	0.00			815.95
25	70	0.00	25	0.00			815.95
25	49	-157.67	26	0.00			927.26
25	53	157.67	27	0.00			924.05
26	27	327.48	28	0.00			922.77
27	28	327.48	29		S	7.56	925.54
28	29	-7.56	30	0.00			883.07
28	30	330.25	31	0.00			883.07
30	31	0.00	32	0.00			883.07
30	32	0.00	33		S	1.77	883.07
30	33	-2.17	34	20.24			883.08
30	42	709.83	35	0.00			883.08
33	34	-1.60	36	0.00			883.15
34	35	0.00	37	18.51			883.23
34	36	-8.13	38	0.00			883.30
36	37	-8.13	39	0.00			883.30
37	38	-14.10	40	468.85			883.79
38	39	0.00	41	37.46			906.41
38	40	-14.10	42	0.00			UNABLE
40	41	-165.44	43			273.79	UNABLE
42	43	709.83	44	0.00			UNABLE
43	44	436.04	45	0.00			UNABLE
44	45	436.04	46			349.62	UNABLE
45	46	169.35	47			606.81	UNABLE
45	47	266.69	48			38.50	UNABLE
46	54	-180.27	49	0.00			886.66
47	48	38.50	50	0.00			886.80
47	55	-378.62	51	0.00			UNABLE
49	50	-15.20	52			30.54	UNABLE
49	52	378.78	53		S	12.02	UNABLE
20	50	596.19	54			3.85	UNABLE
50	57	81.42	55			0.00	UNABLE
50	52	323.04	56			278.24	UNABLE
52	53	-169.69	57	0.00			877.21
52	54	159.94	58	0.00			877.21
52	55	402.80	59			946.20	UNABLE
52	56	81.39	60in	335.08	CI		855.24
52	56	81.40	60out		CO	335.08	1000.02
52	56	115.45	61	49.50			744.40
54	55	-24.18	62	0.00			992.07
56	51	0.00	63	151.66			894.79

60in=Inlet Side of Comp. 60out=Outlet Side of Comp.
P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

Table 20 Flow Rates, Gas Demands, Supplies, and Pressure Distribution (FY 2030, Region1&2)

Cont

Flow rate in each pipeline		
Left number	Right number	Flow rate mmcfd
57	58	0.00
57	59	946.20
57	60	153.51399
60	61	49.499647
93	62	38.480079
62	63	335.07614
63	64	32.624381
64	65	62.341772
64	66	-29.71739
66	67	12.841278
66	68	108.23108
68	69	-13.63095
30	71	198.9504
71	86	148.79051
86	72	197.99944
72	73	138.15964
68	74	121.86203
74	76	121.86203
76	77	121.86203
74	75	0
77	78	49.208929
78	79	49.208929
79	80	49.208929
80	81	49.208929
81	82	49.208929
82	83	49.208929
50	57	176.53061
93	62	296.59607
20	26	528.87626
26	27	567.03069
27	28	567.03069
28	30	571.82252
13	57	1072.8328
84	26	60.185072
86	87	-49.20893
87	88	-49.20893
85	41	550.00013
30	33	-4.544119
33	34	-3.344825
34	36	-17.05278
36	37	-17.05278
69	89	-26.47223
88	91	-49.20893
83	91	49.208929
37	38	-29.58952
38	40	-29.58952
40	41	-347.1067
57	60	231.06156
63	66	150.78975
51	90	0
91	92	0

Demand/supply and pressure distribution				
Node	Demand mmcfd	P/S	Supply mmcfd	Pressure psig
64	0.00			890.17
65	62.34			714.41
66	0.00			892.11
67	12.84			891.59
68	0.00			884.24
69	12.84			894.91
70	0.00			815.95
71	50.16			867.93
72	59.84			865.33
73	138.16			865.02
74	0.00			879.90
75	0.00			879.90
76	0.00			875.56
77	72.65			873.76
78	0.00			873.27
79	0.00			872.31
80	0.00			871.97
81	0.00			871.30
82	0.00			870.68
83	0.00			870.62
84		P	60.19	949.96
85		S	550.00	1074.21
86	0.00			866.87
87	0.00			867.77
88	0.00			868.21
89		P	26.47	900.04
90	0.00			UNABLE
91	0.00			869.42
92	0.00			869.42

P/S:P=Pressure set point S=Supply rate set point
CO=Compressor outlet CI=Compressor inlet

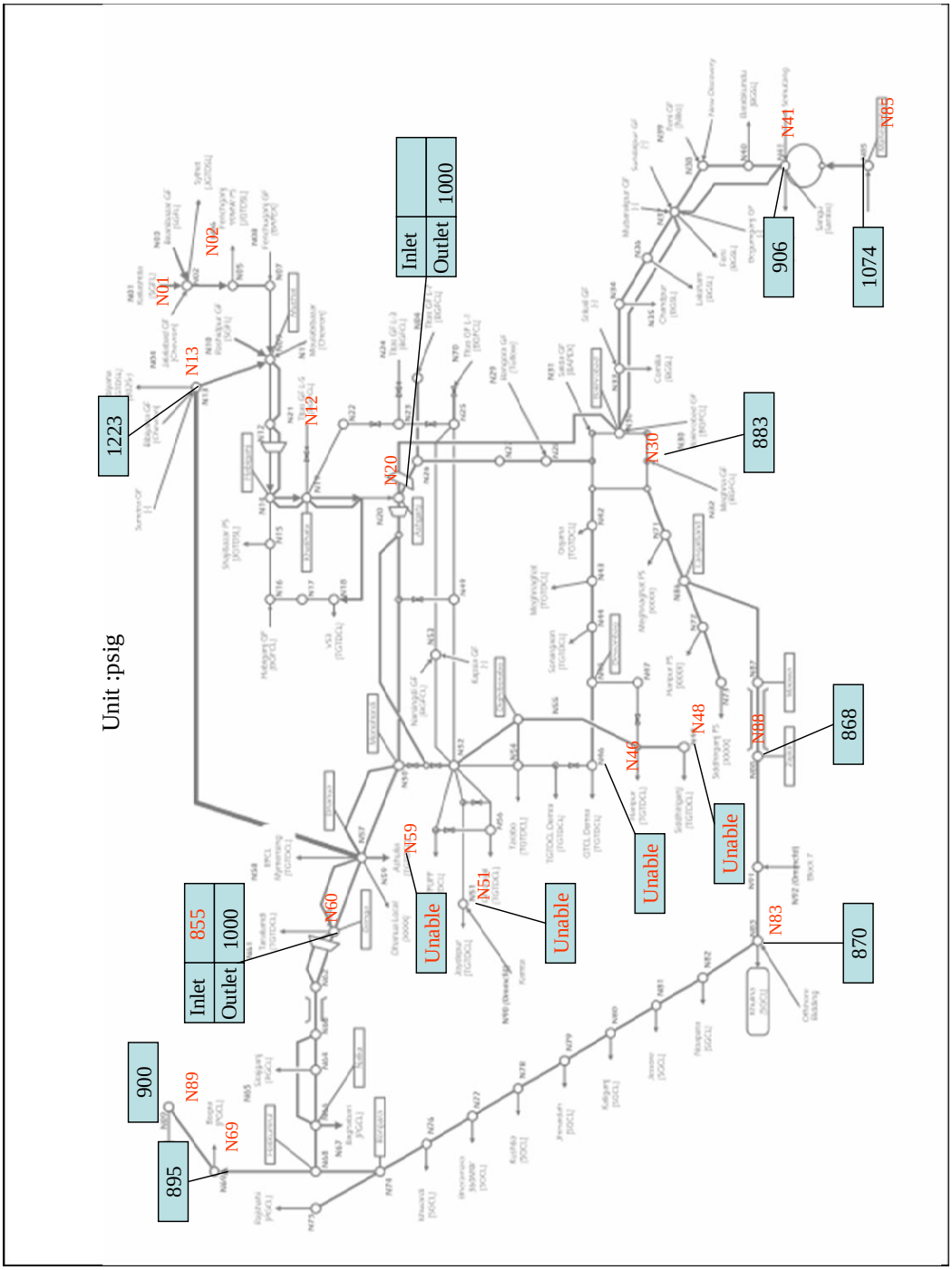

Fig.10 Pressure Distribution in Pipeline Network(FY 2030)

3. Conclusions

Numerical Simulations were carried out to evaluate the capacity of the pipeline network in Bangladesh.

The results show,

(1) In FY 2015, almost all areas except Ashulia(N59) can secure gas supply, on condition that compressors are installed at the outlets of Bangora GF(N29), Salda GF(N31), and Bakhrabat GF(N30). The discharging pressures should be higher than 1,000 psi.
(2) In FY 2020 and onward, supply trouble appears along the lines from Bakhrabad through Dewanbag to Monohordi.
(3) To ensure the supply to the area around Chittagong,the pipeline pressure in the area must be very high. Design pressure should be checked.
(4) South west lines from Hatikumrul(N69) to Khurna can maintain necessary pressure.

Appendix-7

Basis of the Projection of Subsidy in Gas Sector

Production

Volume

	2009-2010 Actual (BCF)	2015 Supply (BCF)	2015 Demand (BCF)	2020 Supply (BCF)	2009-2010 Actual (MMCFD)	2015 Supply (MMCFD)	2015 Demand (MMCFD)	2020 Supply (MMCFD)
SGC	330	589	589	672	903	1615	1,615	1841
IOC	373	821	707	528	1,023	2248	1,936	1446
LNG	0	183	0	183	0	500	0	500
Total	703	1,592	1,296	1,382	1,926	4363	3,551	3787

Cost (LTk)

	2009-2010		2015(Adj)	2020
SGC	139,900		250,200	285,200
IOC	908,400		1,719,400	1,284,400
LNG	0		0	2,328,400
Total	**1,048,300**		**1,969,600**	**3,898,000**

Production Unit Cost (US$/MCF)

0.59 Sales Price (1.31US$/MCF) x 45%

3.38 IOCs Gas Price(2.66US$/MCF) + Delivery Cost (0.72US$/MCF

17.72 LNG Spot Price (17US$/MCF) + Delivery Cost (0.72US$/MCF)

Sales

Sales Volume (BCF)

Year		Power	Captive P.	Fertilizer	Industrial	Comm.	Domestic	CNG,Tea	Total
2009	(Actual)	393		65	119	8	80	39	703
2015	(Demand)	572	194	111	197	13	150	61	1,296
2020	(Supply)	459	262	96	266	16	208	74	1,382

Sales Prices (based on the present unit prices) (LTk)

Year		Power	Captive P.	Fertilizer	Industrial	Comm.	Domestic	CNG,Tea	Total
2009	(Actual)	313,600	0	47,300	197,100	21,700	117,200	253,400	**950,300**
2015	(Demand)	456,800	229,600	80,800	326,300	33,600	218,900	394,400	**1,740,400**
2020	(Supply)	366,700	310,400	70,200	441,200	43,600	303,900	484,100	**2,020,100**
Unit Price (Tk/mcf)		79.85	118.36	73.06	165.94	268.16	146.11	651.29	

Assumption:

1) Exchange Rate: 1.0US$ = 72.0Tk
2) The production unit cost (constant) is assumed with using the following Petrobangla Data.
   - Gas sales price: 1.31US$/MCF, - IOCs gas price: 2.66US$/MCF
   - LNG spot price: 17US$/MCF
3) The gas delivery cost of 0.72US$/MCF as calculated in the next page is added to the IOC gas and LNG.
4) The present gas unit price is used for calculating the sales prices in 2009, 2015 and 2020.

Calculation of Gas Delivery Cost excluding Bapex, DWMB & Wellhead Margin

Year		Power	Captive P.	Fertilizer	Industrial	Comm.	Domestic	CNG,Tea	Total	US$/MCF
2009	(Actual)	106,300	0	16,400	78,200	9,100	45,600	107,300	362,900	0.72
2015	(Demand)	154,900	86,100	28,100	129,400	14,000	85,200	167,000	664,700	0.71
2020	(Supply)	124,300	116,400	24,400	175,000	18,200	118,300	205,000	781,600	0.79

Delivery Cost

Tk/CM

	Power	Captive P.	Fertilizer	Industrial	Comm.	Domestic	CNG,Tea
PDF Margin	0.317	0.456	0.268	0.766	1.3355	0.709	6.1
Bapex Margin	0.048	0.048		0.048	0.048	0.048	0.11
DWMB	0.04	0.04	0.04	0.04	0.04	0.04	0.2
Wellhead Margin	0.225	0.225	0.225	0.225	0.225	0.225	0.3
Trans Margin	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Distr Margin	0.225	0.591	0.155	0.955	1.735	0.725	0.156
GDF	0.094	0.201	0.153	0.283	0.558	0.255	3.164
Total	1.269	1.881	1.161	2.637	4.2615	2.322	10.35
Total exc. Bapex, DWMB & Wellhead Margin	0.956	1.568	0.896	2.324	3.9485	2.009	9.74

1CM=35.3CF
35.3146667
1MCF=28.32CM
28.3168466

Tk/mcf

Current Unit Price	79.85	118.36	73.06	165.94	268.16	146.11	651.29
Current Unit Priceexc. Bapex, DWMB &	60.16	98.67	56.38	146.24	248.46	126.42	612.90

Appendix-8

Financial Statements of Petrobangla's Affiliated Companies

1. Exploration & Production Companies

1) BAPEX: Bangladesh Petroleum Exploration and Production Company

BAPEX Financial Outlook

(Unit: Taka million)

No.	Items	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
1	Gas Production (mmcm)			322.00	391.00	412.00	
2	Gas Sales (mmcm)						
3	Revenues from Gas & Condensate	169.54	155.85	104.39	455.42	483.90	
4	Gas Exploration Surcharge	361.08	384.99	371.68	375.88	400.43	
5	Other Income	146.33	241.75	181.18	59.16	533.04	
6	Total	676.95	782.59	657.25	890.46	1,417.37	
7	% of exploration surcharge	53.34	49.19	56.55	42.21	28.25	
8	Total Capital & Reserves	6,594.99	6,813.64	7,040.29	7,510.14	11,217.50	
9	Total Long Term Borrowings	750.64	712.37	1,139.80	1,261.62	1,290.46	
10	Total Other Long Term Liabilities	134.05	134.05	134.05	134.05	134.05	
11	Total Capital Employed	7,479.68	7,660.06	8,314.14	8,905.81	12,642.01	
12	Total Fixed Assets	3,697.35	3,639.38	3,620.33	3,875.98	4,198.36	
13	Return on Net Fixed Assets (%)	18.31	21.50	18.15	22.97	33.76	
14	Debt Service Ratio (times)	0.77	0.92	0.52	0.64	0.99	
15	Self Financing Ratio (%)	974.22	870.65	1,071.17	843.40	791.43	
16	Debt Financing (%)	23.93	23.26	35.19	36.01	33.93	

Note: Mmcm means million cubic meter.

Source: Petrobangla & its affiliated companies Annual Report

2) BGFCL: Bangladesh Gas Field Company Limited

BGFCL Financial Outlook

(Unit: Taka million)

No.	Items	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
1	Gas Production (mmcf)					258,314.99	
2	Gas Sales (mmcf)					257,881.64	
3	Gas Sales - Inter Group				16,139.57	17,872.08	
4	Sales Oil & Other Products				1,510.14	1,404.52	
5	Payment to GOB - SD & VAT				-14,538.70	-16,320.12	
6	Other Income				0.00	0.00	
7	Total				3,111.01	2,956.48	
8	Per Cent of Revenue				567.33	652.01	
9	Total Capital & Reserves				13,098.46	14,062.26	
10	Total Long Term Borrowings				2,314.75	2,206.91	
11	Total Other Long Term Liabilities				8,858.07	9,540.99	
12	Total Capital Employed				24,271.28	25,810.16	
13	Total Fixed Assets				13,993.22	15,180.29	
14	Return on Net Fixed Assets (%)				22.23	19.48	
15	Debt Service Ratio (times)				0.28	0.25	
16	Self Financing Ratio (%)				421.04	475.64	
17	Debt Financing (%)				79.84	77.39	

Note: Mmcm means million cubic meter.

Source: Petrobangla & BGFCL Annual Reports

3) SGFL: Sylhet Gas Field Limited

SGFL Financial Outlook

(Unit: Taka million)

No.	Items	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
1	Gas Production (mmcm)	1,717.39	1,848.57	1,741.36	1,627.52	1,621.60	
2	Gas Sales (mmcm)	1,678.04	1,809.82	1,825.36	1,624.90	1,619.12	
3	Gas Sales - Inter Group	3,345.33	3,660.44	3,837.56	3,872.75	4,227.30	
4	Sales Oil & Other Products	1,317.99	2,228.94	2,981.36	4,102.91	6,437.49	
5	Payment to GOB - SD & VAT	-3,049.90	-3,488.01	-3,770.09	-3,994.12	-4,672.11	
6	Other Income	0.00	0.00	0.00	0.00	0.00	
7	Total	3,291.46	4,211.19	4,874.19	5,606.44	5,992.68	
8	Per Cent of Revenue	141.68	139.85	139.90	142.26	177.96	
9	Total Capital & Reserves	7,971.57	8,905.14	10,526.58	12,915.23	15,373.99	
10	Total Long Term Borrowings	1,414.55	1,130.61	1,006.14	901.49	821.57	
11	Total Other Long Term Liabilities	35.93	27.13	56.53	34.29	11.09	
12	Total Capital Employed	9,422.05	10,062.88	11,589.25	13,851.01	16,206.65	
13	Total Fixed Assets	4,489.15	4,825.36	5,053.63	5,190.88	5,666.75	
14	Return on Net Fixed Assets (%)	73.32	87.27	96.45	108.01	105.75	
15	Debt Service Ratio (times)	2.27	3.64	4.59	5.99	7.20	
16	Self Financing Ratio (%)	242.19	211.46	215.97	230.36	256.55	
17	Debt Financing (%)	32.31	23.99	21.03	18.03	14.69	

Note: Mmcm means million cubic meter.

Source: Petrobangla & SGFL Annual Reports

2. Transmission Company

1) GTCL: Gas Transmission Company Limited

GTCL Financial Outlook

(Unit: Taka million)

No.	Items	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
1	Gas Transmission (mmcm)						
2	Transmission Charges including Line Rent	2,948.07	3,533.04	4,178.08	4,186.09	4,525.67	
3	Other Income	0.00	0.00	0.00	0.00	0.00	
4	Total	2,948.07	3,533.04	4,178.08	4,186.09	4,525.67	
5	% of transmission charge	100.00	100.00	100.00	100.00	100.00	
6	Total Capital & Reserves	12,638.52	14,545.92	17,509.90	19,969.36	24,932.69	
7	Total Long Term Borrowings	9,605.68	8,666.60	8,268.74	8,232.21	13,347.86	
8	Total Other Long Term Liabilities	0.00	0.00	0.00	0.00	0.00	
9	Total Capital Employed	22,244.20	23,212.52	25,778.64	28,201.57	38,280.55	
10	Total Fixed Assets	20,300.88	20,014.44	20,065.32	19,154.73	29,111.74	
11	Return on Net Fixed Assets (%)	14.52	17.65	20.82	21.85	15.55	
12	Debt Service Ratio (times)	0.31	0.41	0.51	0.51	0.34	
13	Self Financing Ratio (%)	428.70	411.71	419.09	477.04	550.92	
14	Debt Financing (%)	47.32	43.30	41.21	42.98	45.85	

Note: Mmcm means million cubic meter.

Source: Petrobangla & GTCL Annual Reports

3. Distribution Companies

1) TGTDCL: Titas Gas Transmission and Distribution Company Limited

TGTDCL Financial Outlook

(Unit: Taka million)

No.	Items	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
1	Gas Sales (mmcm)	10,165.00	11,205.00	12,244.00	13,446.00	14,963.00	
2	Gas Sales - End Customers				52,305.98	63,794.89	67,813.68
3	Other Income				597.15	762.19	737.55
4	Total				52,903.13	64,557.08	68,551.23
5	% of exploration surcharge				98.87	98.82	98.92
6	Total Capital & Reserves				16,638.64	20,997.82	28,246.37
7	Total Long Term Borrowings				2,548.50	2,148.72	2,088.80
8	Total Other Long Term Liabilities				7,463.81	7,965.09	8,095.81
9	Total Capital Employed				26,650.95	31,111.63	38,430.98
10	Total Fixed Assets				11,744.62	11,407.87	11,588.96
11	Return on Net Fixed Assets (%)				450.45	565.90	591.52
12	Debt Service Ratio (times)				5.28	6.38	6.73
13	Self Financing Ratio (%)				31.45	32.53	41.20
14	Debt Financing (%)				85.25	88.66	87.88

Note: Mmcm means million cubic meter.

Source: Petrobangla & TITAS Annual Reports

2) BGSL: Bakhrabad Gas System Limted

BGSL Financial Outlook

(Unit: Taka million)

No.	Items	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
1	Gas Sales (mmcm)	2,664.00	2,798.00	2,827.00	2,881.00	3,009.00	
2	Gas Sales - End Customers		11,921.82	14,600.25	17,925.15	16,000.66	
3	Other Income		160.25	163.14	169.39	197.07	
4	Total		12,082.07	14,763.39	18,094.54	16,197.73	
5	% of exploration surcharge		98.67	98.89	99.06	98.78	
6	Total Capital & Reserves		7,459.55	8,256.82	9,210.55	10,069.07	
7	Total Long Term Borrowings		290.76	258.11	189.21	120.84	
8	Total Other Long Term Liabilities		1,939.74	2,541.21	3,030.39	3,810.37	
9	Total Capital Employed		9,690.05	11,056.14	12,430.15	14,000.28	
10	Total Fixed Assets		2,883.30	2,841.06	2,817.76	2,784.14	
11	Return on Net Fixed Assets (%)		419.04	519.64	642.16	581.79	
12	Debt Service Ratio (times)		5.42	5.27	5.62	4.12	
13	Self Financing Ratio (%)		61.74	55.93	50.90	62.16	
14	Debt Financing (%)		77.36	98.53	114.26	141.20	

Note: Mmcm means million cubic meter.

Source: Petrobangla & BGSL Annual Reports

3) JGTDSL: Jalalabad Gas Transmission and Distribution System Limited

JGTDSL Financial Outlook

(Unit: Taka million)

No.	Items	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
1	Gas Sales (mmcm)	719.00	727.00	907.00	1,254.00	1,445.00	
2	Gas Sales - End Customers	2,205.60	2,357.12	2,945.34	4,431.23	5,470.63	
3	Other Income	35.48	116.25	39.47	85.32	136.51	
4	Total	2,241.08	2,473.37	2,984.81	4,516.55	5,607.14	
5	% of exploration surcharge	98.42	95.30	98.68	98.11	97.57	
6	Total Capital & Reserves	2,250.77	2,429.12	2,625.66	3,039.84	3,328.39	
7	Total Long Term Borrowings	473.39	395.70	326.19	386.91	324.18	
8	Total Other Long Term Liabilities	286.78	300.84	552.55	596.47	721.37	
9	Total Capital Employed	3,010.94	3,125.66	3,504.40	4,023.22	4,373.94	
10	Total Fixed Assets	1,533.20	1,530.54	1,509.49	1,659.47	1,618.65	
11	Return on Net Fixed Assets (%)	146.17	161.60	197.74	272.17	346.41	
12	Debt Service Ratio (times)	2.95	3.55	3.40	4.59	5.36	
13	Self Financing Ratio (%)	100.43	98.21	87.97	67.30	59.36	
14	Debt Financing (%)	49.58	45.51	58.21	59.26	64.59	

Note: Mmcm means million cubic meter.

Source: Petrobangla & JGTDSL Annual Reports

4. CNG Company

1) RPGCL: Rupantarita Prakritik Company Limited)

RPGCL Financial Outlook

(Unit: Taka million)

No.	Items	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
1	Gas Sales (mmcm)						
2	Gas Sales - End Customers				357.29	206.75	
3	Sales Oil & Other Products				2,909.51	2,344.64	
4	Payment to GOB - SD & VAT				-360.97	-295.75	
5	Other Income				46.74	31.68	
6	Total				3,266.80	2,287.32	
7	Per Cent of Revenue				100.00	111.54	
8	Total Capital & Reserves				1,841.31	2,184.22	
9	Total Long Term Borrowings				1,687.77	1,847.54	
10	Total Other Long Term Liabilities				700.98	817.03	
11	Total Capital Employed				4,230.06	4,848.79	
12	Total Fixed Assets				1,886.25	2,610.55	
13	Return on Net Fixed Assets (%)				173.19	87.62	
14	Debt Service Ratio (times)				1.37	0.86	
15	Self Financing Ratio (%)				56.36	95.49	
16	Debt Financing (%)				126.64	102.07	

Note: Mmcm means million cubic meter.

Source: Petrobangla & RPGCL Annual Reports

Appendix-9

Outline of Requested Projects

Requested by BAPEX

Requirement of Hardware & Software to Develop 2nd 3D Crew of BAPEX:

Sl No.	Hardware and Software	Description(Brief)	Procurement Type	Cost in BDT (Lac)	Cost in USD (million)
1	Topo Survey	RTK GPS (20 Set), Hand GPS (50 Nos), Total Station (10), TGO (2 Nos), TBC (2 Nos), GP Seismic (2 Nos), ArcGis (2 Nos), Graphnet(2 Nos),.	Foreign	1500	2
2	Design and QC	Geoland , SPSNET, Easy QC ArcGis, etc. (01 Set)	Foreign	750	1
3	Recording	Recording Instrument(01 Set), Cables and Geophone, FDU (6000 Nos), walky-talky(200 N0s) etc.	Foreign	4500	6
4	Seismic Drilling	Seismic Drilling Machine(80 Nos), Hose pipe(5 km), Electric Generator (20 Nos) etc.	Foreign	750	1
5	Processing	Geocluster processing system(01 Set)	Foreign	1500	2
6	Interpretation	Geoframe , Tigress , Opend Tect interpretation system etc (01 Set).	Foreign	1500	2
			Total	**10500**	**14**

* 1 Dollar = 75 BDT

30/11/11

Mortuza Ahmad Faruque
Managing Director
Bangladesh Petroleum Exploration & Production Co. Ltd.
Dhaka

Date : 30.11.2011

Proposed Training Program By BAPEX Under JICA Project

Sl No.	Training Course	Duration (Week)	Number of Participant
1	Reservoir Engineering and Simulation	2	4
2	Well Logging Techniques and Basic Operation	2	4
3	Reservoir Characterization	1	2
4	Petroleum Exploration and Development	2	2
5	Production Logging Techniques and Interpretation	1	4
6	Geological & Geophysical Modeling	2	4
7	IT Management (2D & 3D Processing and Interpretation System)	2	2
8	IT Management (2D & 3D Acquisition Equipment and System administration)	2	2
9	Design and QC 2D & 3D	4	4
10	Advance processing (2D Seismic Data)	4	2
11	Advance processing (3D Seismic Data)	4	2
12	Advance Interpretation (2D Seismic Data)	4	2
13	Advance Interpretation (3D Seismic Data)	4	2
14	2D Acquisition equipment operation and maintenance	4	2
15	3D Acquisition equipment operation and maintenance	4	3
16	Remote Sensing & Geoinformatics, Basic Geodesy, Geodesy equipment operation	4	4
17	2D & 3D Seismic Project Management	2	4
18	Advance Course on Drilling Technology	2	6
19	Cementing Technology	1	4
20	Advance Drilling and Completion Fluid Technology	2	3
21	Well Design and Engineering	2	4
22	Drilling Fluid Technology	2	4
23	Gas Process Plant Design	1	4
24	VFD and PLC Programming	2	4
	Total	**60**	**78**

30.11.2011

Md. Abdus Sabur
Company Secretary
BAPEX, Dhaka.

30.11.2011

Mortuza Ahmad Faruque
Managing Director
Bangladesh Petroleum Exploration & Production Co. Ltd.
Dhaka

Requested by GTCL

ANNEXURE-III

1. 3.4.2 Proposal for the ODA Loans of Chapter 3 Results of the Survey, page-86:

The following two projects may also be considered as the prospective project for Japanese ODA loan:

(3) Gas transmission pipeline, (a) Langalband-Mawa, 30″dia. x 40 km
(b) Mawa-Janjira including Padma Bridge Portion, 30″dia. x 20 km

Executing Agency: GTCL

National gas grid is planned to the expanded upto South/South-Western region of the country by constructing (a) a 30″dia. x 40 km gas transmission pipeline from Langalband (Narayenganj) to Mawa and (b) a 30″dia. x 20 km gas transmission pipeline from Mawa to Janjira along the Padma Bridge. Extension of gas network in that region will contribute significantly in establishment of gas based power plants, industrial and commercial units thus improving the overall socio-economic condition of the region.

(4) Gas transmission pipeline, Sunetra Gas Field-Kishorganj, 20 inch, 80 km

Executing Agency: GTCL

The proposed Sunetra Gas Field-Kishoreganj 20″dia x 80 km gas transmission pipeline will ensure evacuation of gas produced from Sunetra gas field and transmit the same to the national gas grid. Nearly 100 mmcfd gas will thus be added at Kishoreganj point of national gas grid by the end of 2014 which will support meeting additional gas demand in West and South-West region of the country.

Requested by TGTDCL

তিতাস গ্যাস ট্রান্সমিসন এণ্ড ডিষ্ট্রিবিউশন কোং লিঃ

(পেট্রোবাংলার একটি কোম্পানী)

সূত্র নংঃ এসইআইপি/১৪.২/৯৫১১/২ তারিখঃ ০৩-০১-২০১২ খ্রি.

পরিচালক (পরিকল্পনা)
পেট্রোবাংলা
৩, কাওরান বাজার বা/এ
ঢাকা-১২১৫।

বিষয়ঃ MAIN POINTS OF DRAFT FINAL REPORT এর উপর মতামত প্রেরণ প্রসংগে।

মহোদয়,

উপর্যুক্ত বিষয়ে পেট্রোবাংলা হতে প্রাপ্ত পত্র, সূত্র নংঃ ৩২.০৩.১৯/৫৩৫ তারিখঃ ২৬-১২-২০১১ খ্রি. এবং বর্ণিত পত্রের সঙ্গে সংযুক্ত ও জাইকা হতে প্রাপ্ত "MAIN POINTS OF DRAFT FINAL REPORT" শীর্ষক প্রতিবেদনের উপর কোম্পানীর মতামত পরবর্তী কার্যার্থে এত্দসঙ্গে সংযুক্ত করা হল।

ধন্যবাদান্তে,
আপনার বিশ্বস্ত

(মো. আব্দুল আজিজ খান)
ব্যবস্থাপনা পরিচালক

বিতরনঃ
১। ব্যবস্থাপক (সমন্বয়), চেয়ারম্যান শাখা , পেট্রোবাংলা, ঢাকা।
২। Mr. Kazutora KONO, Consulting Engineers, Oriental Consultants Co. Ltd.

প্রধান কার্যালয় ঃ "তিতাস গ্যাস ভবন" ১০৫, কাজী নজরুল ইসলাম এভিনিউ, কাওরান বাজার বাণিজ্যিক এলাকা, ঢাকা-১২১৫, বাংলাদেশ।
ফ্যাক্সঃ- ৮৮০-২-৮১১৩০৩১ টেলিফোন ঃ পিএবিএক্স- ৮১১২১৩৫-৪২
ই-মেইল ঃ titasgas@bdonline.com, mdtgas@dbn-bd.net, ওয়েব সাইট ঃ www.titasgas.org.bd

Ref.: 3.4.2 Proposals for the Japanese ODA Loans

Titas Gas Transmission and Distribution Co. Ltd (TGTDCL) is requesting the following proposals to be considered for the assistance of Japanese ODA.

Proposal	Entry	Justification
1: Operational Strengthening and Measurement Efficiency Improvement • Development of Remote Gas Metering System for 1000 load intensive customers and distribution input metering and counter metering station, comprising design, procurement and installation of required meters and ancilliary facilities. • Design, Procurement, Installation and Commissioning of 300,000 nos. of Pre-paid Gas Meters for the Domestic/ Commercial customers. • Extensive CP and leakage survey of gas distribution network and domestic customers house lines, including procurement and installation of materials/equipment as necessary. • Strengthening emergency response preparedness including development of elaborate emergency response plan, procurement of modern, effective tools, equipment and vehicles.	TGTDCL	Advanced and hi-tech metering system like smart gas metering system for load intensive customers within TFA can be a solution to the problem of system loss by inaccurate metering. For improvement of customer end measurement it is envisaged to build up a remote metering network involving 1000 load intensive industrial consumers, input metering and counter metering. Under this program digital meters with EVCs and modems will be installed at the premises of these customers and their gas consumption will be monitored and recorded round the clock by means of the server of a central control centre(s) via existing GSM network or thru fibre optic cable network or thru wireless network. Unmetered domestic customers resort to phenomenal wastage and misuse of gas. They pay gas bill amounting to 450 taka per month for a double burner for whatever quantity of gas they can use. If prepaid meters are installed the customers will have to pay for the volume of gas they consume. This will make them sincere and responsible about wastage and misuse of gas. This arrangement will help in eliminating system loss incurred due to use of unlimited gas in unauthorized gas appliances. And the company will be able to realize actual revenue in advance. This will reduce monitoring cost and manpower requirement. This will also help to improve customer service as well. On the other hand the TGTDCL Distribution network in the Dhaka Metropolitan City & adjoining areas is two-to-four decade old. These network was built during seventies with the existing available materials. This network provides extensive coverage with the help of pipe lines ranging from 6" DN to 16" DN X 150/350 PSIG Distribution mains to 6" DN to 12" DN X 50 PSIG Feeder mains and ¾" DN to 4" DN Distribution & Service Lines to domestic, commercial & Industrial Customers in different areas. The area of Dhaka city has been extended tremendously and will take the shape and status of a mega city within a decade. Many of the areas

		are densely populated. Urban areas are rapidly shifting to the outskirts of the City. Many of the roads & by-roads are narrow (1 to 2 meters). Drainage and sewerage pipe lines of DWASA, underground cables of BTTB, DESA and DESCO has been laid along and across the gas pipelines. The construction process of pipelines and underground cables by the aforementioned utility organizations causes significant damage to the CP system of this company. Although the gas pipelines are laid as per applicable technical standards and there is an arrangement of protective Wrapping & Coating under Cathodic Protection System, external impact or normal Wear and Tear of the system poses a threat to the integrity & safe operation of the extremely intricate gas distribution network. Leakages in the distribution mains are not wide spread, but not uncommon either. Domestic customers of this company use unmetered gas. In their house lines after the riser of gas connection unto the domestic burners leakages of gas is quite common. The survey for the detection of these domestic house line leakages is yet to be made with a view to arrest wastage of gas vis-à-vis revenue loss. So it is necessary to conduct an extensive survey within the Distribution Network and house lines of the domestic customers with the help of modern equipment. It is also necessary to take appropriate steps to analyze, balance and strengthen the existing CP System. The job consists of a study part which is followed by procurement and installation of necessary materials and equipment.
2: Rehabilitation of the existing critical pipeline sections • Construction of 4"~16" DN × 50-150 psig× 150 km pipelines for rehabilitation of Distribution Main Lines/ Distribution Network and installation of Metering and Regulating facilities in prospective load growth centers in and around greater Dhaka. • Rehabilitation of existing pipeline River crossing section by Horizontal Directional Drilling Method (HDD) as necessary.	TGTDCL	Greater Dhaka is expanding rapidly. Newly developed areas are of great prospect for consuming natural gas. Rajuk and private large housing projects, large industrial parks are rapidly developing giving new dimension to the greater Dhaka area which may double or even triple the present demand in near future. To ensure safe and reliable supply to the Mega city, a new layer of backbone network needs to be established. Most of the river crossing sections of the existing Transmission and Distribution Pipelines has been constructed by Open Cut Method during Late Seventies and Nineties. Some of them are presently at very vulnerable conditions, which are urgently required to be replaced for safety reasons. Hence, a Component for rehabilitation of the existing pipeline river crossing section by HDD method is proposed.

3: Study of existing Distribution network system of TGTDCL and its components. • To assess the condition of the existing Gas Distribution Pipeline Network system using latest network analysis software. • Procurement and supply of latest Design/ Software Analysis Software and Hardware. • On-job Training of the TGTDCL Engineers.	TGTDCL	TGTDCL distribution network consists of more than 12,000 Km of pipelines of different sizes ranging from 1" to 16" in dia, which were built during the late seventies. The network is a result of bits and pieces planning as different pipelines are added on from time to time to meet some imminent requirements. As a result the network is unwieldy and imbalanced in places resulting in pockets and areas with low gas pressure problem. An extensive network analysis is required to identify the weaknesses of the system and to plan extensions to cater for mid and long term gas requirements. The study will carry out a detailed network analysis of TGTDCL distribution system employing latest network analysis software. TGDTDCL engineers will be trained on-the-job. Also the design / Network Analysis Software and Hardware to be procured under the project will be handed over the Company for future analysis purpose.
4: Intelligent Pigging for safe & efficient operation of TGTDCL owned major transmission Pipelines. • To assess the condition of the following existing transmission network: A.1 Titas M & R Station (Ghatura)~Narsingdi VS 12 - 14"x1000 Psig x 49.39 Km A.2 Narsingdi VS 12~Demra CGS - 14"x1000 Psig x 32.41 Km A.3 Ashuganj VS 3- ZFCL Complex - 10"x1000 Psig x 3.43 Km A.4 Titas M & R Station (Ghatura)~Narsingdi VS 12 Parallel Pipeline - 16"x1000 Psig x 46.31 Km A.5 Narsingdi VS 12~Ghorashal 2x14"x1000 Psig x 12.00 Km A.6 Narsingdi VS 12~Ghorashal Third Parallel Pipeline16"x1000 Psig x 12.00 Km A.7 Ghorashal to Joydevpur CGS-14"x1000 Psig x 24.50 Km A.8 Elenga to Tarakandi - 12"x1000 Psig x 43.00 A.9 Monohardi to Narsingdi – 20"x1000 Psig x 25.00 Km	TGTDCL	TGTDCL has a transmission system of 613 km comprising 12" DN, 14"DN, 16" DN, & 20" DN Pipe lines. These pipelines have major river & railway track crossings. One major transmission pipeline (14' x 1000 Psig) also crosses the mighty Meghna River along the Railway Bridge. The pipe lines were laid at different times between 1968 and 1999, which are currently under full capacity utilization, supplying gas to a number of Power & Fertilizer Plants as well as major load centers including Metropolitan City. These transmission pipelines are required to undergo Intelligent Pigging in order to assess their operational integrity & safety and to take steps for replacement of pipeline sections as necessary.

A.10 Narsingdi Valve Station-12 ~ Siddirganj P.S RMS- 20"x1000 Psig x 41.00 Km A.11 Dhanua ~ Mymensingh 12"x1000 Psig x 56.00 Km • To ascertain whether the existing transmission pipeline will be replaced by higher-diameter pipelines keeping in view the safety factors and growing gas demand.		
5: Capacity Building and Human Resource Development • Development of operation and maintenance manuals for supervisory and operator level manpower. • Providing foreign training of Company's technical manpower in the fields of Pipeline transmission and distribution design, design/ operation/ maintenance of metering and regulating system, cathodic protection, and telemetry and remote metering and management level training/seminar/ symposium for the senior officials. • Providing on-the-job Training for Company's manpower in the fields of design, development, operation, maintenance, environmental safety, hazard and risk management, corrosion control, project finance and management by expatriate specialists.	TGTDCL	Efficient and skilled human resource is an inevitable part for the smooth and reliable operation of gas transmission and distribution system and the efficient performance of the Company as well. And thus it necessitates extensive training to inculcate skills and expertise in the personnel employed in different sectors of the Company. Once a good number of skilled and efficient human resources are attained it is certain that the operational performance of the Company will be promoted to a desired level. So it is imperative that a comprehensive training be incorporated under the project.

06-03-22

তিতাস গ্যাস ট্রান্সমিসন এণ্ড ডিষ্ট্রিবিউশন কোং লিঃ

(পেট্রোবাংলার একটি কোম্পানী)

সূত্র নংঃ এসইআইপি/১৪.২ /১৫৬৬/২

তারিখঃ ১৮-০১-২০১২ খ্রি.

পরিচালক (পরিকল্পনা)
পেট্রোবাংলা
৩, কাওরান বাজার বা/এ
ঢাকা-১২১৫।

বিষয়ঃ MAIN POINTS OF DRAFT FINAL REPORT এর উপর মতামত প্রেরণ প্রসংগে।

মহোদয়,

উপর্যুক্ত বিষয়ে পেট্রোবাংলা হতে প্রাপ্ত পত্র, সূত্র নংঃ ৩২.০৩.১৯/৫৩৫ তারিখঃ ২৬-১২-২০১১ খ্রি. এর সঙ্গে সংযুক্ত ও জাইকা হতে প্রাপ্ত "MAIN POINTS OF DRAFT FINAL REPORT" শীর্ষক প্রতিবেদনের উপর অত্র কোম্পানীর মতামত ইতঃপূর্বে পত্র, সূত্র নংঃ এসইআইপি/১৪.২/১৫১১/১ তারিখঃ ০৩-০১-২০১২ খ্রি. এর মাধ্যমে পেট্রোবাংলায় প্রেরণ করা হয়, যা ই-মেইলের মাধ্যমে জাইকা কর্তৃপক্ষের নিকট প্রেরিত হয়। তৎপ্রেক্ষিতে জাইকার সংশ্লিষ্ট প্রতিনিধির নিকট হতে প্রাপ্ত ইলেকট্রনিক মেইলের চাহিদা অনুযায়ী অন্যান্য তথ্যাদি অর্ন্তভুক্ত করতঃ সম্মিলিত প্রতিবেদন প্রস্তুত করা হয়েছে। বর্ণিত প্রতিবেদনের একটি কপি পরবর্তী কার্যার্থে এতদ্সঙ্গে সংযুক্ত করা হল।

ধন্যবাদান্তে,

আপনার বিশ্বস্ত,

(মো. আব্দুল আজিজ খান)
ব্যবস্থাপনা পরিচালক

বিতরনঃ
১। ব্যবস্থাপক (সমন্বয়), চেয়ারম্যান শাখা , পেট্রোবাংলা, ঢাকা।
২। Mr. Kazutora KONO, Consulting Engineers, Oriental Consultants Co. Ltd.

প্রধান কার্যালয় ঃ "তিতাস গ্যাস ভবন" ১০৫, কাজী নজরুল ইসলাম এভিনিউ, কাওরান বাজার বাণিজ্যিক এলাকা, ঢাকা-১২১৫, বাংলাদেশ।
ফ্যাক্সঃ- ৮৮০-২-৮১১৩০৩১ টেলিফোন ঃ পিএবিএক্স- ৮১১২১৩৫-৪২
ই-মেইল ঃ titasgas@bdonline.com, mdtgas@dbn-bd.net, ওয়েব সাইট ঃ www.titasgas.org.bd

TITAS GAS TRANSMISSION AND DISTRIBUTION CO. LTD

(A Company of Petrobangla)
105, Kazi Nazrul Islam Avenue
Kawran Bazar C/A, Dhaka-1215

Projects Proposal for Japanese Government ODA Loans

Sl No.	Name of the Component	Estimated Cost (In Lakh Taka)			Implementation Period	Remarks
		F/C	L/C	T/C		
I	**1: Operational Strengthening and Measurement Efficiency Improvement**					
	Sub-components: a) Development of Remote Gas Metering System for 1000 load intensive customers and distribution input metering and counter metering station, comprising design, procurement and installation of required meters and ancilliary facilities.	Tk. 685.00	Tk. 3385.00	Tk. 4070.00	4.0 years	Turn-key Contracts
	b) Design, Procurement, Installation and Commissioning of 300,000 nos. of Pre-paid Gas Meters for the Domestic/Commercial customers.	Tk. 23800.00	Tk. 9220.00	Tk. 33020.00		Turn-key Contracts
	c) Extensive CP and leakage survey of gas distribution network and domestic customers house lines, including procurement and installation of materials/equipment as necessary.	Tk. 1900.00	Tk. 3480.00	Tk. 5380.00		Survey, Engineering, Procurement & Installation
	Sub-Total (Component 1):	**Tk. 26385.00**	**Tk. 16085.00**	**Tk. 42470.00**		
	2: Rehabilitation of the existing critical pipeline sections					
	Sub-components: a) Construction of 4"~16" DN × (50-150) psig ×150 km pipelines for rehabilitation of Distribution Main Lines/ Distribution Network and installation of Metering and Regulating facilities in prospective load growth centers in and around greater Dhaka.	Tk. 13000.00	Tk. 17145.00	Tk. 30145.00	3.0 years	Survey, Engineering, Procurement & Construction
	b) Rehabilitation of existing pipeline River crossing section by Horizontal Directional Drilling Method (HDD) as necessary.	Tk. 3645.00	Tk. 1200.00	Tk. 4845.00		-do-
	Sub-Total (Component 2):	**Tk. 16645.00**	**Tk. 18345.00**	**Tk. 34990.00**		
	3: Study of existing Distribution network system of TGTDCL and its components.					
	Sub-components: a) To assess the condition of the existing Gas Distribution Pipeline Network system using latest network analysis software.	Tk. 1398.00	Tk. 475.00	Tk. 1873.00	2.5 years	Survey & Study
	b) Procurement and supply of latest Design/ Software Analysis Software and Hardware.					Procurement & Training
	c) On-job Training of the TGTDCL Engineers.					
	Sub-Total (Component 3):	**Tk. 1398.00**	**Tk. 475.00**	**Tk. 1873.00**		

Sl No.	Name of the Component	Estimated Cost (In Lakh Taka)			Implementation Period	Remarks
		F/C	L/C	T/C		
	4: Intelligent Pigging for safe & efficient operation of TGTDCL owned major transmission Pipelines.					
	Sub-components: a) To assess the condition of the following existing transmission network: A.1 Titas M & R Station (Ghatura)~Narsingdi VS 12 -14"x1000 Psig x 49.39 Km A.2 Narsingdi VS 12~Demra CGS -14"x1000 Psig x 32.41 Km A.3 Ashuganj VS 3- ZFCL Complex - 10"x1000 Psig x 3.43 Km A.4 Titas M & R Station (Ghatura)~Narsingdi VS 12 Parallel Pipeline - 16"x1000 Psig x 46.31 Km A.5 Narsingdi VS 12~Ghorashal 2x14"x1000 Psig x 12.00 Km A.6 Narsingdi VS 12~Ghorashal Third Parallel Pipeline16"x1000 Psig x 12.00 Km A.7 Ghorashal to Joydevpur CGS- 14"x1000 Psig x 24.50 Km A.8 Elenga to Tarakandi - 12"x1000 Psig x 43.00 Km A.9 Monohardi to Narsingdi – 20"x1000 Psig x 25.00 Km A.10 Narsingdi VS-12 ~ Siddirganj P.S RMS- 20"x1000 Psig x 41.00 Km A.11 Dhanua ~ Mymensingh 12"x1000 Psig x 56.00 Km	Tk. 2520.00	Tk. 220.00	Tk. 2740.00	2.5 years	Study & Operation
	b) To ascertain whether the existing transmission pipeline will be replaced by higher-diameter pipelines keeping in view the safety factors and growing gas demand.					
	Sub-Total (Component 4):	**Tk. 2520.00**	**Tk. 220.00**	**Tk. 2740.00**		
	5: Capacity Building and Human Resource Development					
	Sub-components: a) Development of operation and maintenance manuals for supervisory and operator level manpower.	Tk. 25.00	Tk. 5.00	Tk. 30.00	02 years	Study
	b) Providing foreign training of Company's technical manpower in the fields of Pipeline transmission and distribution design, design/ operation/ maintenance of metering and regulating system, cathodic protection, and telemetry and remote metering and management level training/seminar/ symposium for the senior officials.	Tk. 130.00	Tk. 90.00	Tk. 220.00		Foreign Training
	c) Providing on-the-job Training for Company's manpower in the fields of design, development, operation, maintenance, environmental safety, hazard and risk management, corrosion control, project finance and management by expatriate specialists.	Tk. 345.00	Tk. 10.00	Tk. 355.00		Local On-job Training
	Sub-Total (Component 5):	**Tk. 500.00**	**Tk. 105.00**	**Tk. 605.00**		
	Grand-Total (Component 1+2+3+4+5):	**Tk. 47448.00**	**Tk. 35230.00**	**Tk. 82678.00**		

Requested by BERC

Application Form for Technical Cooperation (Expert)

By the Government of Japan

1. Outline of the Assignment	
(1) Assignment Title	Preparation of Safety Code, Review and upgrading of Grid Code and Distribution Code for Electricity Transmission and Distribution Operation and Maintenance.
(2) Type of Assignment (New/ Extension/ Successor)	New - Consultancy
(3) Period of Assignment and Desirable Time of Dispatch	6 Months January 2011.
(4) Number of Expert(s) Required	03 (three)
(5) Category of Service	☑ Policy Consultation/ ☐ Administrative System Development/ ☐ Research and Study/ ☐ Appropriate Technology Development/ ☐ Technology Diffusion/ ☐ Seminar/ ☐ Others ( )
(6) Name of Related Project/ Scheme	Formulation of Regulatory Codes
(7) Name of Requesting Ministry/ Organization and Specific Department/ Division/ Unit of which the Expert is attached	Bangladesh Energy Regulatory Commission, Energy and Mineral Resources Division, Ministry of Power Energy and Mineral Resources.
(8) Location of Service and Distance from the Capital	Dhaka, Capital itself.
2. Counterpart Personnel	
(1) Number, Names and Posts of Counter-part Personnel	4 Nos. Mr. Mohammad Bazlur Rahman, Director; Mr. Md. Haronur Rashid, Deputy Director; Mr. Md. Morshed Iqbal, Deputy Director; Mr. Md. Asaduzzaman, Assistant Director
(2) Name and Post of Supervising Authority to which the Expert is answerable	Mr. Md. Emdadul Hoque Member
3. Background Information on Request of Expert(s)	BERC is an independent and impartial Commission for the energy sector created by an Act of Parliament titled *"Bangladesh Energy Regulatory Commission Act, 2003"*. It functions in an independent environment primarily to serve the public interest by ensuring that energy prices reflect true cost

	of production and service. BERC has to play vital role in regulating the energy sector to safeguard stakeholders' interests including investors and help ensure affordable energy supply for the economic development of Bangladesh. Vested functions are carried out in accordance with the provisions laid down in the Act. The objectives as stated in the preamble of the Act are: *"Whereas it is expedient to make provisions for the establishment of an independent and impartial regulatory commission to create an atmosphere conducive to private investment in the generation of electricity, and transmission, transportation and marketing of gas resources and petroleum products, to ensure transparency in the management, operation and tariff determination in these sectors; to protect consumers' interest and to promote the creation of a competitive market".* BERC aims at bringing transparency in the management, operation and tariff determination in this sector, to protect consumer's interest and to promote the creation of a competitive, level-playing field for the operators. To regulate the electricity transmission and distribution utilities and to achieve discipline in and among these entities, operational and safety codes are necessary. Grid Code and Distribution Code are being prepared which needs review by experts. Presently, there is no Safety Code for Operation and Maintenance electrical transmission and distribution system. This has to be prepared, approved and adopted by BERC.
4. Objective of the Assignment	The objectives the assignment are: o To adopt Safety Code for Operation and Maintenance of Transmission and Distribution Network

	o To adopt Grid Code and Distribution Code for regulation of electric utilities and establish uniformity in standard, O&M, planning, customers' service and relation, reporting and performance monitoring.
5. Expected Output of the Assignment	o Safety Code for Operation and Maintenance of electrical transmission and distribution system. o Grid Code reviewed and updated. o Distribution Code reviewed and updated.
6. Duties and Job Description of the Expert	The Experts will be responsible for: Expert - 1: o To examine the existing safety provisions in the Electricity Rules o To review the prevailing safety practices of the utilities o To finalize the aspects of the Transmission and Distribution operation and maintenance safety Code o Prepare a Safety Code accordingly and finalize the code by interactions with the stakeholders. Expert - 2/3: o To examine the existing operational and maintenance provisions in the Electricity Rules and Manuals of the utilities. o To review the Grid Codes and Distribution Codes of different countries and prepare a comparative statement including the codes being prepared by BERC and prepare review and recommendation matrix. o To examine and review the customers' relation practices of the utilities and prepare recommendations for inclusion in the Distribution Code. o To finalize the aspects of the Transmission and Distribution Codes. o Assist in preparing the final drafts of Grid Code and Distribution Code for adoption by BERC.

7. Inputs by the Recipient Side on the Assignment	
(1) Expenses for Activities of the Expert	BERC will support the following local expenses on reimbursement basis: House Rents and utility costs Stationeries
(2) Provision of the Office and Motor Vehicle for the Expert	BERC will provide office space for the Experts. Transportation will be arranged on rental basis out of the project or purchase of transport, whichever is economical.
8. Qualifications and Experience required	
(1) Age Limit	Minimum 45 years
(2) Educational Background (Doctor/ Master/ Bachelor)	2 - Post Graduate in Electrical Engineering 1 - Post Graduate in Mechanical/ Safety Engineering
(3) Practical Experience on Rental Field	At least 15 years
(4) Language (Name/ Level)	English
(5) Other Qualification and Experience	Experience on grid planning/ protection. Should have exposure to energy regulatory practices in home and abroad.
9. Correspondence Name and address of the official to whom correspondence regarding this application should be forwarded	Mr. Mohammad Bazlur Rahman Director (Power) and Project Director Bangladesh Energy Regulatory Commission TCB Building 3rd Floor 1 Karwan Bazar, Dhaka-1215.

Application Form for Technical Cooperation (Training)

By the Government of Japan

1.	Outline of the Assignment	
	(1) Assignment Title	Training on Safety Code, Grid Code and Distribution Code for Electricity Transmission and Distribution Operation and Maintenance.
	(2) Type of Assignment (New/ Extension/ Successor)	New - Training
	(3) Period of Assignment and Desirable Time of Dispatch	6 Months January 2011.
	(4) Number of Personnel to be trained	30 (Thirty) including personnel from utilities
	(5) Category of Service	☐ Policy Consultation/ ☐ Administrative System Development/ ☐ Research and Study/ ☐ Appropriate Technology Development/ ☐ Technology Diffusion/ ☐ Seminar/ ☑ Others (Training)
	(6) Name of Related Project/ Scheme	Formulation of Regulatory Codes
	(7) Name of Requesting Ministry/ Organization and Specific Department/ Division/ Unit of which the Expert is attached	Bangladesh Energy Regulatory Commission, Energy and Mineral Resources Division, Ministry of Power Energy and Mineral Resources.
	(8) Location of Training	Japan and Dhaka
2.	Counterpart Personnel	
	(1) Number, Names and Posts of Counter-part Personnel	4 Nos. Mr. Mohammad Bazlur Rahman, Director; Mr. Md. Haronur Rashid, Deputy Director; Mr. Md. Morshed Iqbal, Deputy Director; Mr. Md. Asaduzzaman, Assistant Director
	(2) Name and Post of Supervising Authority to which the Expert is answerable	Mr. Md. Emdadul Hoque Member
3.	Background Information on Request of Expert(s)	BERC is an independent and impartial Commission for the energy sector created by an Act of Parliament titled *"Bangladesh Energy Regulatory Commission Act, 2003"*. It functions in an independent environment primarily to serve the public interest by ensuring that

	energy prices reflect true cost of production and service. BERC has to play vital role in regulating the energy sector to safeguard stakeholders' interests including investors and help ensure affordable energy supply for the economic development of Bangladesh. Vested functions are carried out in accordance with the provisions laid down in the Act. The objectives as stated in the preamble of the Act are: *"Whereas it is expedient to make provisions for the establishment of an independent and impartial regulatory commission to create an atmosphere conducive to private investment in the generation of electricity, and transmission, transportation and marketing of gas resources and petroleum products, to ensure transparency in the management, operation and tariff determination in these sectors; to protect consumers' interest and to promote the creation of a competitive market".* BERC aims at bringing transparency in the management, operation and tariff determination in this sector, to protect consumer's interest and to promote the creation of a competitive, level-playing field for the operators. To regulate the electricity transmission and distribution utilities and to achieve discipline in and among these entities, operational and safety codes are necessary. Grid Code and Distribution Code are being prepared which needs review by experts. Presently, there is no Safety Code for Operation and Maintenance electrical transmission and distribution system. This has to be prepared, approved and adopted by BERC. Formulation of Codes and implementation needs personnel from BERC as well as from the regulated utilities be trained in relevant field.
4. Objective of the Assignment	The objectives the assignment are: o To acquaint personnel from Regulators and regulated Utilities with Safety Code for Operation and Maintenance of

	Transmission and Distribution Network prevailing in different countries. o To make familiar related personnel with Grid Code and Distribution Code for regulation of electric utilities which aims to establish uniformity in standard, O&M, planning, customers' service and relation, reporting and performance monitoring.
5. Expected Output of the Assignment	o Trained personnel on Safety Code, Grid Code and Distribution for Operation and Maintenance of electrical transmission and distribution system. o Transfer of Technology o Improved operation of Transmission and Distribution networks.
6. Duties of the Training Organization	The Organizer will be responsible for: o Setting training curriculum o Prepare Training Schedule in home and abroad Foreign Training - o Arrange venue, accommodation, trainers/ resource persons and conducting training. o Travelling arrangement, air tickets and facilitating visa for the participants. o Disburse per diem to the participants. Local Training - o Arrange accommodation of trainers/ resource persons and conducting training. o Travelling arrangement, air tickets and facilitating visa for the expatriate trainers. o Disburse per diem to the expatriate trainers.
7. Inputs by the Recipient Side on the Assignment	
(1) Expenses for Activities of the Trainer	BERC will support the following local expenses on reimbursement basis: Venue reservation and associated expenses Stationeries

	Per diem to participants for local trainings.
(2) Provision of the Office and Motor Vehicle for the Trainer	BERC will provide transportation of the expatriate trainers to and from the hotel.
8. Qualifications and Experience required	
(1) Age Limit	Minimum 45 years
(2) Educational Background (Doctor/ Master/ Bachelor)	2 - Post Graduate in Electrical Engineering 1 - Post Graduate in Mechanical/ Safety Engineering
(3) Practical Experience on Rental Field	At least 15 years
(4) Language (Name/ Level)	English
(5) Other Qualification and Experience	Experience on safety code, grid planning/ protection. Should have exposure to energy regulatory practices in home and abroad.
9. Correspondence Name and address of the official to whom correspondence regarding this application should be forwarded	Mr. Mohammad Bazlur Rahman Director (Power) and Project Director Bangladesh Energy Regulatory Commission TCB Building 3rd Floor 1 Karwan Bazar, Dhaka-1215.

PRELIMINARY DEVELOPMENT PROJECT PROFORMA/PROPOSAL (PDPP) FOR AIDED PROJECTS

TECHNICAL ASSISTANCE FOR STRENGTHENING BANGLADESH ENERGY REGULATORY COMMISSION AND OTHER AGENCIES FOR INSPECTION, TESTING & ENSURING COMPLIANCE OF THE QUALITY AS PER INTERNATIONAL STANDARD OF THE PETROLEUM OIL AND LUBRICATING PRODUCTS IN BANGLADESH.

Sponsoring Ministry/Division
Ministry of Power, Energy and Mineral Resources, EMR Division
Government of the People's Republic of Bangladesh
Bangladesh Secretariat, Dhaka 1000.

Executing Agency
Bangladesh Energy Regulatory Commission (BERC)
TCB Bhaban (3rd floor)
1 Karwan Bazar, Dhaka-1215.

PRELIMINARY DEVELOPMENT PROJECT PROFORMA/PROPOSAL (PDPP) AIDED PROJECTS.

1.	**Project Title**	:	Technical Assistance for Strengthening Bangladesh Energy Regulatory Commission and other agencies for inspection, testing & ensuring compliance of the quality as per international standard of the Petroleum Oil and Lubricating products in Bangladesh.
2.	i) **Sponsoring Ministry/Division**	:	Ministry of Power, Energy and Mineral Resources/Energy and Mineral Resources Division
	ii) **Executing Agency**	:	Bangladesh Energy Regulatory Commission (BERC)
3.	**Expected date of commencement and completion.**	:	01 January 2011 and 31 December 2011.
4.	**Relevance of Proposal with concerned sect oral allocation.**	:	The consumption of Petroleum and Lubricating Oil (POL) products has attained quite high level and it is increasing due to scarce availability of natural gas in Bangladesh. No substantial development has so far been undertaken to ascertain the quality of these products. Apart from Eastern Refinery Limited (ERL) there is no standard and satisfactory laboratory in country to test and ensure the product qualities commensuration to the present world standards. Even in Eastern Refinery there is no adequate facility for testing and certify the quality of the lubricating products. This state cannot be allowed to continue. It would pose serious threat in maintaining environmental and public safety & security of the ever-growing Petroleum sector. It would in turn throw the sector in dire straits.
5.	**Main objectives and brief description of the project with justification.**	:	Use of POL products is an ever-growing in the energy sector. It requires well-trained professionals, properly equipped laboratory and workshop with equipment and testing facilities to regulate and ensure the activities in petroleum sector most efficiently, safely & in technically sound manner. But till date no intergraded efforts have been undertaken to carry out such activities to apply highly professional test required to ensure the quality & standard of POL products in the country in truly regulatory perspective. As a result, improper and substandard qualities of products have become a growing concern in maintaining safety & quality. The main objective of this project is to bring the sector under close regulation

through rigorous testing & certification mechanism. Setting of well-equipped & technology-based modern laboratory and testing facilities with fully developed processing & data preservation is a must for putting the mechanism in place. To attain the aforesaid objectives, BERC must have well-trained professionals with sufficient laboratory and testing facilities capable of doing the entire test independently prior to issuance of Test Certificate.

In the absence of such facilities, BERC will not be able to perform one of the major functions of framing codes & standards and enforce those with a view to ensuring quality of service. In this order, the proposed workshop & infrastructural setup will play a pivotal role for public safety. To establish efficient POL products quality testing facilities capable of meeting the requirements of the quality of POL products in the sector, technical cooperation and financial assistance in the form of grant from suitable donor, country or institution will be necessary in the following areas/manner:

(A) **Human Resource Development (HRD):** Consultancy assistance is required for the preparation of comprehensive & need-based HRD programmed for POL products testing, certification and documentation of test data. This will cover hands-on training for technicians and engineers for testing and preservation of data, documentations for analysis and references. In achieving the said objective, a need-analysis would be required for which visit to all relevant organizations like BERC, Bangladesh Standard and Testing Institute (BSTI), ERL and petroleum oil marketing companies ensure to identify weakness so as to prepare a true professional-based training program. Based on findings the consultant(s) will prepare/design tailor-made training curriculum suitable for entry level, mid-level & higher-level personnel.

(B) **Capacity Development:** It is required to assess the existing testing facilities and capabilities of BSTI, ERL, LP Gas Limited the blending plants now operating in Bangladesh and the marketing companies namely Podma Oil Company, Jamuna Oil Company Limited, Meghna Petroleum Limited and private entrepreneurs engaged in petroleum operations. Based on the findings, list of equipments, materials etc. will be prepared for establishing well equipped and adequate laboratory & testing workshop for conducting

			necessary tests for ensuring product qualities and control mechanism. This will also cover preparation of specifications of equipments, preparation of bidding document for turnkey installation including supply of necessary software and hardware for monitoring and issuance of test certificates, bid evaluation, preparation of the training program to be provided by the vendors etc.
6.	**Relevance of the Project with short/medium/long term policies/plans/programs etc.**	:	The acceptability & importance of POL products as transport, agriculture and industry is well established. Requirement of POL in the power sector will increase in many folds due to scarce availability of natural gas. Besides, as the country will move forward and the consumption of fuels will increase; the consumption of proper lubricating oil will also increase and if the quality of the lubricating oil is not ensured, enormous amount of damage will done in machineries in the form of wears & tears. The consumption of unnecessary POL products will be high due to un burnt fuel, release of Particulate matters and friction loss; as a result, environment will be polluted. In this backdrop, the standard & quality of items related to these products should be brought under close monitoring without any delay. This will directly & significantly impact short, medium & long-term development program in the energy sector. If quality control & certification system is not established the whole country will run in risk. Life & property will be in danger. The institutional structure of the sector should be put on a strong foundation by ensuring successful implementation of the proposed project. This will guarantee accountability which is a dire need in the sector.
7.	**Relevance with other development programs of the concerned sector.**		The consumption and distribution system of POL products is entwined with multifarious development program including in electricity generation system, of the country. The horizons of the sector will widen if reliability of the system can be ensured through proper testing of quality. Any expansion will have a direct relevance with other development programs of the concerned sector and monitoring compliance of standard.
8.	**Expected socio economic benefits/outputs of the proposed project.**	:	Operational cost is reduced sharply with the use of proper quality of POL products. It helps control the expense in transport, agriculture and industrial sector in term of reduced quantity of fuel and enhancement the life of machineries. In order to sustain in the steep competition of world market without compromising the quality of products, cost of production & transport must be substantially low. Moreover, employment opportunity has also

been created in the sector. Both the investment and resultant employment in the sector will go up with the passage of time. This sector is contributing in making the transport sector economically vibrant & cost effective. In the social development sector it is creating substantial opportunity for employment generation and in environment sector reducing health of cost by ensuring pollution-free environment.

9.	**i) Estimated amount and cost of the proposed project.** **ii) Nature of foreign assistance (loan/grant/others)**	:	Total Cost USD 1,500,000/- equivalent to Taka 105,000,000/- Summary of the Cost Break down (Fig in lakh Taka) I(a). USD 200,000/- = Tk. 14,000,000/- (b). USD 5,000/- = Tk. 350,000/- II. USD 1,120,000/- = Tk. 78,400,000/- III. USD 175,000/- = Tk. 12,250,000/- Please see the Annexure-A.
10.	**Likely source of foreign assistance**	:	World Bank, Asian Development Bank, Islamic Development Bank or any other donor agency.
11.	**Is there any proposal to undertake feasibility study for the project? If yes, what could be the estimated cost, nature and likely institutional arrangements for such study?**	:	No.
12.	**Any other relevant information.**	:	Use of proper quality of fuel and lubricating oil will have a positive impact in consumption of fossil fuel and environment. For running the whole sector properly the most important now is quality control and assurance. Only a reliable & acceptable system can play a positive role in development of this sector.

Signature of Head of Executing Agency

Signature of Secretary of the Sponsoring Ministry

Annex-A

Bangladesh Energy Regulatory Commission (BERC).

1. Appointment of Consultant.

(a) Local Consults & Staff	USD 200,000 =	Tk.	14,000,000/-
(b) Miscellaneous.	USD 5,000 =	Tk.	350,000/-
	USD 205,000 =		**Tk. 14,350,000/-**

II. Procurement of Equipment, Accessories to set up a testing Laboratory/workshop for performing Testing of CNG Cylinders & Conversions component.

(a). Equipment & Accessories	USD 1,000,000/-	= Tk.	70,000,000/-
(b). Buildings	USD 50,000/-	= Tk.	3,500,000/-
(c). Vehicle (1 Pickup double deck)	USD 58,000/-	= Tk.	4,060,000/-
(d). Miscellaneous (Driver + Fuel)	USD 12,000/-	= Tk.	840,000/-
	USD 1,120,000/-	**= Tk.**	**78,400,000/-**

III. Procurement of Training.

(a). Training	USD 100,000/-	= Tk.	7,000,000/-
(b). Tour	USD 40,000/-	= Tk.	2,800,000/-
(c). Books, Journal	USD 20,000/-	= Tk.	1,400,000/-
(d) Miscellaneous (Training Aids)	USD 15,000/-	= Tk.	1,050,000/-
	USD 175,000/-	**= Tk.**	**12,250,000/-**

Grand Total USD 1,500,000/- equivalent to Taka 105,000,000/-

PRELIMINARY DEVELOPMENT PROJECT PROFORMA/ PROPOSAL (PDPP)

FOR AIDED PROJECTS

TECHNICAL ASSISTANCE FOR SETTING UP SYNCHRONIZED ENERGY FLOW CENTRAL COMMAND SYSTEM

Sponsoring Ministry/ Division

Ministry of Power, Energy and Mineral Resources, EMR Division
Government of the People's Republic of Bangladesh
Bangladesh Secretariat, Dhaka-1000

Executing Agency

Bangladesh Energy Regulatory Commission (BERC)
TCB Bhaban, 3rd Floor
1 Kawran Bazar, Dhaka-1215.

1.	Project Title	:	Setting up Synchronized Energy Flow Central Command System
2.	Sponsoring Authority	:	Energy and Mineral Resources (EMR) Division. Ministry of Power, Energy and Mineral Resources
	Executing Agency	:	Bangladesh Energy Regulatory Commission (BERC)
3.	Expected date of Commencement and Completion	:	Date of Commencement : July 01, 2011 Date of Completion : June 30, 2014
4.	Whether included in the Rolling Program	:	No
5.	Main Objectives and Brief Description of the Project	:	a) Background:

BERC is an independent and impartial Commission for the energy sector created by an Act of Parliament titled *"Bangladesh Energy Regulatory Commission Act, 2003"*. It functions in an independent environment primarily to serve the public interest by ensuring that energy prices reflect true cost of production and service. BERC has to play vital role in regulating the energy sector to safeguard stakeholders' interests including investors and help ensure affordable energy supply for the economic development of Bangladesh. Vested functions are carried out in accordance with the provisions laid down in the Act. The objectives as stated in the preamble of the Act are:

"Whereas it is expedient to make provisions for the establishment of an independent and impartial regulatory commission to create an atmosphere conducive to private investment in the generation of

electricity, and transmission, transportation and marketing of gas resources and petroleum products, to ensure transparency in the management, operation and tariff determination in these sectors; to protect consumers' interest and to promote the creation of a competitive market".

BERC aims at bringing transparency in the management, operation and tariff determination in this sector, to protect consumer's interest and to promote the creation of a competitive, level-playing field for the operators.

Energy Audit is a very important need to verify energy use efficiency as well as energy conservation at different installations. This is a tool for monitoring financial and economical activities of the utilities dealing with energy.

Apart from cost rationalization and tariff fixation BERC has mandate to look into sound management principles and best practices in the energy sector including transparency and accountability of the utility entities. BERC has the responsibility to look into reasonable interests of the utility entities and investors' concerns while addressing consumers' rights. For this purpose, a road map has been chalked out to reach and achieve the objectives through setting of standards and close monitoring.

b) Main Objectives:

The project has several objectives:

(i) to monitor the use of energy to attain best efficiency;

(ii) constant monitoring of energy flow, both gas and electricity;

(iii) synchronize energy flow and load dispatch to optimize production/ generation, transmission and distribution of energy;

(iv) situation analysis to arrive at best possible decision;

(v) establishment of a Mimic System and train personnel for operation of the unit;

(vi) all of these will provide a best tool for BERC for establishing regulatory control over the entities in terms of Technical-efficiency, Quality and customers' services.

c) Brief Description of the Project:

BERC regulates energy sector of the country and both Power sector and Gas sector are prominent and inter-related. Presently, lack of coordination and data manipulation prevail in both sector. The outcome is inefficient energy system, in turn, suffering of the end consumers.

In recent days, to mitigate the suffering of the people arising from load shedding, gas supply has been diverted to power generation by curtailing the quota for fertilizer rather keeping several fertilizer plants shut. Still the power generation has not increased proportionately. This is due to selection of running inappropriate generator, which indicates that the operation people do not bother about the pressure and quantum of gas flow and the ultimate result is inefficient energy usage. If the gas flow could be monitored, situation would have been reversed. Presently, Load Dispatch Centre (LDC) organizes power generation and wheeling which is partially automated. Most of the generators and power-grid sections are not visible to the operators. They still depend on typical telecommunication system for controlling the national power grid and mishaps are common. However, an NLDC is under commissioning but this doesn't include the most of the new rental generating plants under construction. So, real time data on energy injected to the grid, energy flow through the transmission network and energy utilized at distribution level are not available.

Similarly, there is no integrated system to monitor gas reservoir capacity, production at various wells, energy flow through the transmission system, pressure & quantum of energy flow at transmission and distribution level.

Although both power and gas has SCADA individually, presently, there is no arrangement of visualizing the combined happenings of gas and power sector. Due to this, synchronizing between gas and power production is missing. Therefore, a Synchronized Energy Flow Mimic Panel and Load Dispatch Central Command System is required to effectively regulate the energy sector of the country.

The system aims to acquire data constantly for every control points of gas and power. Whenever, there is any major variation, for example, shortage or increase of gas production, the situation will be analyzed with alternatives and power generation will be rescheduled accordingly following best possible alternative. To achieve this, the system will have a Mimic Panel which will display the energy flow data at every control point. It will also have simulating software to perform command analysis leading possible decision and/or such alternatives. This central system shall have event logs, too; which will provide profile and event data for scrutiny and preventive analysis.

As the project will contain State of Art technologies personnel earmarked for operation of the System will require adequate training home and abroad.

6. Relevance of Objectives of the Project with the National Development Perspectives, Goals and Objectives in Five Year Plan : It has been recognized in the National Energy Policy that energy sector agencies have not been operated and managed efficiently. Due to lack of energy auditing; age old, inefficient plants and systems are consuming huge amount of scarce energy resources to produce only a minimum output. It is causing immense economic and financial loss to the energy starved country like Bangladesh. The proposed project will help BERC to set up an effective control and monitoring tool for regulating the energy sector. Synchronization of gas production versus gas consumption by the generators will be possible in most efficient way. Errors and irrational decisions out of the partial automated cum manual operation of both gas and power system

			can be avoided. Moreover, blaming each other by the utilities to shift responsibilities and failures will be eliminated, thereby establishing accountability.
7.	Relevance with the other Development Programmee of the concerned Sector	:	Oil, Gas, Petroleum, Mineral and Electricity Sector is the life line for development of the country. It is the main ingredient to enhance the quality of life standard and lower the poverty level. The energy sector itself is very dynamic having multiplier effect. To attain energy efficiency and in turn energy security, BERC has to be proactive by establishing appropriate energy auditing tools. To save huge avoidable wastage of energy, energy auditing is a must and a demand of the era.
8.	Expected Socio-Economic Benefits of the Project	:	With a Synchronized Energy Flow Central Command System, both gas and electricity sector will have strong coordination, best utilization of available resources, increased power generation and a healthy and well-accepted regulatory regime. This will in turn provide reliable supply for a longer period. Reliability in energy supply will attract further investment in the country. Ultimate benefit will be propagated to the end-users i.e., general mass raising their satisfaction-level.
9.	Relevance with Concerned Sectoral Allocation	:	Allocation for Oil, Gas & Mineral Resources exploration and Power Sector in current Five-year plan may be considered adequate for implementation of the project.
10.	Likely Source of Foreign Assistance	:	Kuwait Arab Economic Development Fund (KAEDF), USAID, The World Bank.
11.	Estimated Amount and Nature of Foreign Assistance	:	Total Cost is 3.500 Million USD which is equivalent to Taka 245.000 Million.
12.	Is there any Proposal to Undertake Feasibility Study for the Project?	:	No.

	If yes, what could be the Estimated Cost, Nature and Likely Institutional Arrangements for such Study?		Not applicable
13.	Any other Relevant Information	:	Regulatory regime in the energy sector is new in the country and most of the general people are not familiar with this Commission. When BERC is effective and can act for betterment for the people, its existence will be sensed automatically. Development of the energy sector including attracting investment, will only be possible when an independent, transparent, rational Regulator of quasi-judicial nature establishes just and fair regulatory environment and level playing competitive market ensuring customers' interest. This can be achieved by establishing the proposed project, which is considered a best tool for monitoring and forming a coordinated energy sector.

Signature of Head of Executing Agency

Signature of Secretary of the Sponsoring Ministry

Application Form for Technical Cooperation (Equipment)

By the Government of Japan

1.	Subject of Technical Transfer (by the Expert/s) for which Equipment should be Provided	Setting up Synchronized Energy Flow Central Command System
2.	Outline of Activities by the Related Expert(s)	Technology Transfer in respect of Synchronized Energy Flow Mimic Panel and Load Dispatch Central Command System required to effectively regulate the energy sector of the country. The system aims to acquire data constantly for every control points of gas and power. Whenever, there is any major variation, for example, shortage or increase of gas production, the situation will be analyzed with alternatives and power generation will be rescheduled accordingly following best possible alternative. To achieve this, the system will have a Mimic Panel which will display the energy flow data at every control point. It will also have simulating software to perform command analysis leading possible decision and/or such alternatives. This central system shall have event logs, too; which will provide profile and event data for scrutiny and preventive analysis.
3.	Estimated Cost of Equipment	USD 3.5 Million
4.	Place of Procurement	☑ Recipient Country/ ☐ Japan/ ☐ Third Country
5.	Preferable Time of Delivery	By June 2012
6.	Necessity of Dispatch of Expert/s for Installation and Adjustment of the Equipment	Yes. The project shall be of turn-key nature and experts will be required to train operational and supervisory personnel.
7.	Name of Recipient Organization	Bangladesh Energy Regulatory Commission
8.	Place of Installation and the Distance from the Capital	Dhaka, Capital itself
9.	Background Information on the Request of the Equipment and its Role in Technical Transfer	a) Background: BERC is an independent and impartial Commission for the energy sector

	created by an Act of Parliament titled *"Bangladesh Energy Regulatory Commission Act, 2003"*. It functions in an independent environment primarily to serve the public interest by ensuring that energy prices reflect true cost of production and service. BERC has to play vital role in regulating the energy sector to safeguard stakeholders' interests including investors and help ensure affordable energy supply for the economic development of Bangladesh. Vested functions are carried out in accordance with the provisions laid down in the Act. The objectives as stated in the preamble of the Act are: *"Whereas it is expedient to make provisions for the establishment of an independent and impartial regulatory commission to create an atmosphere conducive to private investment in the generation of electricity, and transmission, transportation and marketing of gas resources and petroleum products, to ensure transparency in the management, operation and tariff determination in these sectors; to protect consumers' interest and to promote the creation of a competitive market".* BERC aims at bringing transparency in the management, operation and tariff determination in this sector, to protect consumer's interest and to promote the creation of a competitive, level-playing field for the operators. Energy Audit is a very important need to verify energy use efficiency as well as energy conservation at different installations. This is a tool for monitoring financial and economical activities of the utilities dealing with

	energy. Apart from cost rationalization and tariff fixation BERC has mandate to look into sound management principles and best practices in the energy sector including transparency and accountability of the utility entities. BERC has the responsibility to look into reasonable interests of the utility entities and investors' concerns while addressing consumers' rights. For this purpose, a road map has been chalked out to reach and achieve the objectives through setting of standards and close monitoring. b) Main Objectives: The project has several objectives: (i) to monitor the use of energy to attain best efficiency; (ii) constant monitoring of energy flow, both gas and electricity; (iii) synchronize energy flow and load dispatch to optimize production/ generation, transmission and distribution of energy; (iv) situation analysis to arrive at best possible decision; (v) establishment of a Mimic System and train personnel for operation of the unit; (vi) all of these will provide a best tool for BERC for establishing regulatory control over the entities in terms of Technical-efficiency, Quality and customers' services. c) Brief Description of the Project: BERC regulates energy sector of the country and both Power sector and Gas sector are prominent and inter-related. Presently, lack of coordination and data

	manipulation prevail in both sector. The outcome is inefficient energy system, in turn, suffering of the end consumers. In recent days, to mitigate the suffering of the people arising from load shedding, gas supply has been diverted to power generation by curtailing the quota for fertilizer rather keeping several fertilizer plants shut. Still the power generation has not increased proportionately. This is due to selection of running inappropriate generator, which indicates that the operation people do not bother about the pressure and quantum of gas flow and the ultimate result is inefficient energy usage. If the gas flow could be monitored, situation would have been reversed. Presently, Load Dispatch Centre (LDC) organizes power generation and wheeling which is partially automated. Most of the generators and power-grid sections are not visible to the operators. They still depend on typical telecommunication system for controlling the national power grid and mishaps are common. However, an NLDC is under commissioning but this doesn't include the most of the new rental generating plants under construction. So, real time data on energy injected to the grid, energy flow through the transmission network and energy utilized at distribution level are not available. Similarly, there is no integrated system to monitor gas reservoir capacity, production at various wells, energy flow through the transmission system, pressure & quantum of energy flow at transmission and distribution level. Although both power and gas has SCADA individually, presently, there is no arrangement of visualizing the combined happenings of gas and power sector. Due to this, synchronizing between gas and power production is

	missing. Therefore, a Synchronized Energy Flow Mimic Panel and Load Dispatch Central Command System is required to effectively regulate the energy sector of the country. The system aims to acquire data constantly for every control points of gas and power. Whenever, there is any major variation, for example, shortage or increase of gas production, the situation will be analyzed with alternatives and power generation will be rescheduled accordingly following best possible alternative. To achieve this, the system will have a Mimic Panel which will display the energy flow data at every control point. It will also have simulating software to perform command analysis leading possible decision and/or such alternatives. This central system shall have event logs, too; which will provide profile and event data for scrutiny and preventive analysis. As the project will contain State of Art technologies personnel earmarked for operation of the System will require adequate training home and abroad.
10. Main Users of the Equipment	Bangladesh Energy Regulatory Commission and apex organizations of power and gas sectors
11. Expected Benefit and Effect of the Equipment Provided	With a Synchronized Energy Flow Central Command System, both gas and electricity sector will have strong coordination, best utilization of available resources, increased power generation and a healthy and well-accepted regulatory regime. This will in turn provide reliable supply for a longer period. Reliability in energy supply will attract further investment in the country. Ultimate benefit will be propagated to the end-users i.e., general mass raising their satisfaction-level.

12. List of the Equipment Requested			
Name of Equipment	Specification	Quantity	Cost
(1) Command System	Synchronized Energy Flow Command System having facilities for data acquisition from all control points, data analysis, decision alternatives, feedback commands including: • Study of present SCADA system • Design, supply and installation of energy flow command center • Mimic Panel • Data Acquisition Linkage with Power NLDC • Data Acquisition Linkage with Gas SCADA • Installations of new transducers and data acquisition system at missing places. • Development, supply and commissioning of customized software for data acquisition, analysis, reporting, command transmission and remote operations. • Imparting on-job training on operation of the center	01	USD 3.5 Million
(Detailed list and specifications of equipment shall be attached hereafter, if necessary)			

13. Assignment of Staff, Budgetary Allocation and Necessary Arrangements for Maintenance of the Equipment by the Recipient Country	Separate set of personnel will be deployed for operation of the center. Initially there will be maintenance contract with the equipment provider and gradually taken over by local personnel.
5. Expected Output of the Assignment	
(1) Budgetary allocation for operation and maintenance of the equipment	Will be borne by Govt. of Bangladesh
(2) Condition of Space (Capacity, electricity, water supply, etc.) for Operation and Maintenance of the equipment	Space to be acquired. Utility connections will be arranged by BERC.

(3) Assignment of Staff for Maintenance of the equipment	Separate set-up for maintenance of the equipment. Personnel will be deployed and required positions will be filled up by recruitment from open market.
14. Correspondence: Name, Postal and telegraphic address of official to whom correspondence regarding this application should be forwarded.	Mr. Mohammad Bazlur Rahman Director (Power) and Project Director Bangladesh Energy Regulatory Commission TCB Building 3rd Floor 1 Karwan Bazar, Dhaka-1215.

Appendix-10

Outline of Proposed Project for Seismic Survey & Drilling

Proposed 2D/3D Seismic survey and exploratory drilling programme in the Madarganj area of Jamalpur district to confirm the presence of hydrocarbon

Hydrocarbon potential in Madarganj-Sariakandi area

The Bogra shelf area did not generate much interest in the past and as a result limited exploration activities failed to offer any commercial discovery (Figure 1). Now it is quite evident from recent studies that a broad, low relief anticlinal fold having a NW-SE trending axis stretching from Sariakandi (Bogra) to Bhuapur (Tangail) was recognized, and the wells drilled so far in the shelf area were located over the flanks or downdip of this structure. This structure probably forms the crestal part of the largest play of the Bengal basin. From analogy of lithological, depositional and tectonic history to the surrounding gas producing areas, it may be logical to assume that a play of such magnitude must have produced conductive environment for hydrocarbon accumulation. Therefore the possibility of hydrocarbon accumulation over the crestal area along with other types of potential traps like low relief folds, unconformities, updip pinchouts, and fault related traps still remains to be explored.

In the Madarganj-Sariakandi areas, potential source rocks include the shales and carbonaceous shales of from Miocene to Paleocene and coal of Permo-Carboniferous age. So it has three petroleum systems. They are the Oligocene-Miocene-Pliocene, Paleocene-Eocene and the Gondwana petroleum systems. Basin modeling reveals that thermal maturation is sufficient to generate both oil and natural gas and natural gas liquids throughout much of the area.

An interpretation of seismic data revealed fault controlled broad and low relief structures in the Madarganj and Sariakandi areas located over the crestal part of this structure (Figure 2, Figure 3). Presence of seismic amplitude anomalies (Figure 2: Bright Spot) in the Oligocene-Miocene level of the section having direct detection features like polarity reversal and minor diffractions at the edges are indicative of the presence of hydrocarbon in those structures. Presence of time-sag beneath these amplitude anomalies and flat spots further indicate considerable thickness of the feature (Figure 2: Flat Spot). The known Kamta gas field and the Hazipur-1 well having gas and oil shows being located downdip along the axis of this fold and that the Bogra-X1 and Kuchma-1 wells with gas and oil shows being located on the western flank of this structure provide strong evidences on the generation and accumulation of hydrocarbon along the crestal part of this broad anticlinal structure. Plunge of this broad anticlinal fold seems to favour a northwestward (updip) migration of hydrocarbon and their accumulation beyond Hazipur-1 well within this play. Therefore significant accumulation of hydrocarbon at the updip edge of this huge anticlinal structure is not unlikely.

Having Bangabandhu Bridge, power generation and fertilizer production facilities in close proximity, any hydrocarbon discovery in this area would certainly boost industrialization of Bogra, Sirajganj, Tangail and Jamalpur areas and in the northwestern part of Bangladesh at large. Few more seismic lines and a test drill hole at Madarganj are necessary and therefore recommended in the area to confirm the presence of hydrocarbon and their commercial viability.

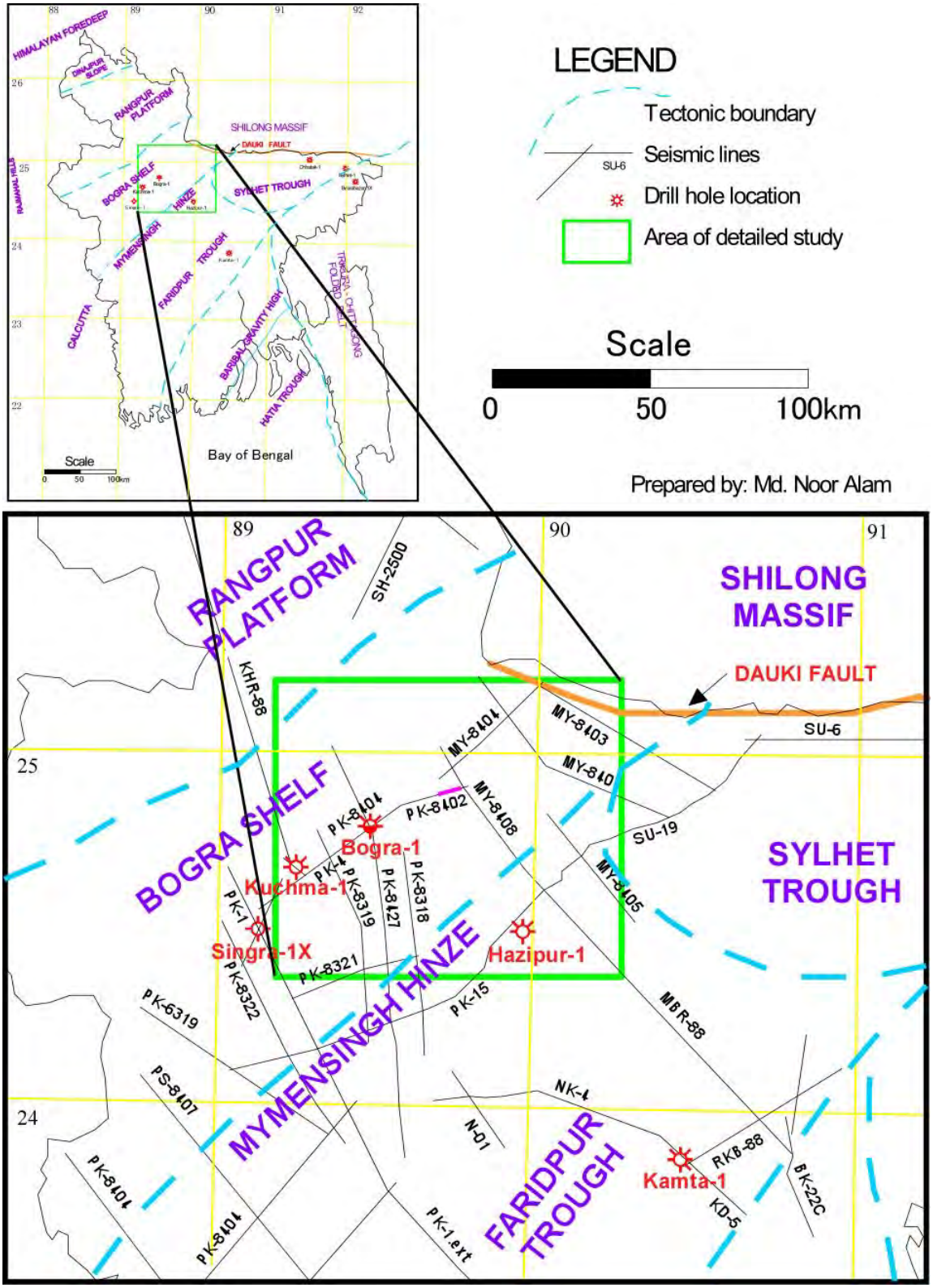

Figure 1: Map of Bangladesh showing tectonic divisions, location of seismic lines, drill holes and the area of detailed study

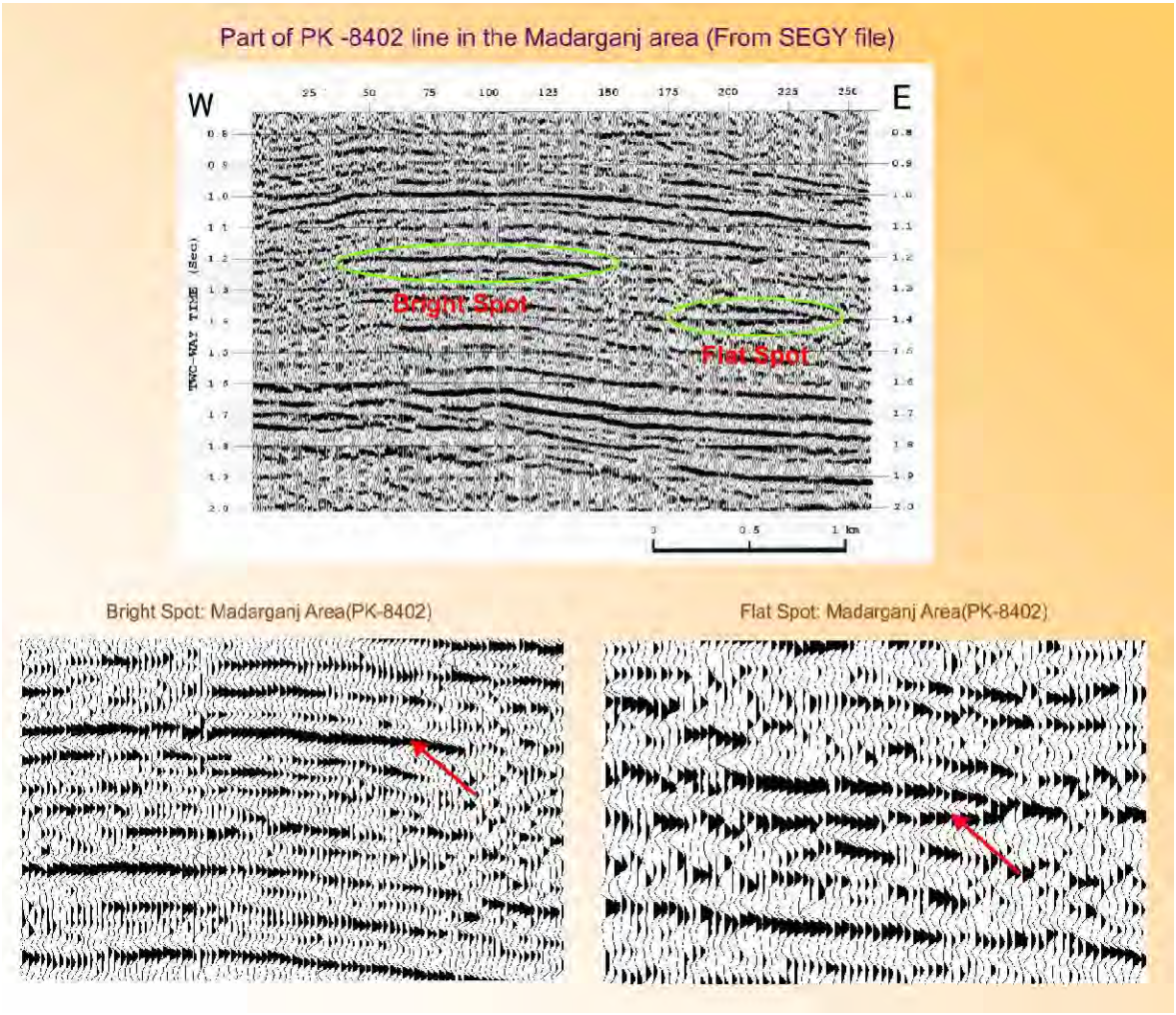

Figure 2: Seismic section (PK-8402) and direct hydrocarbon indication in the Madarganj area

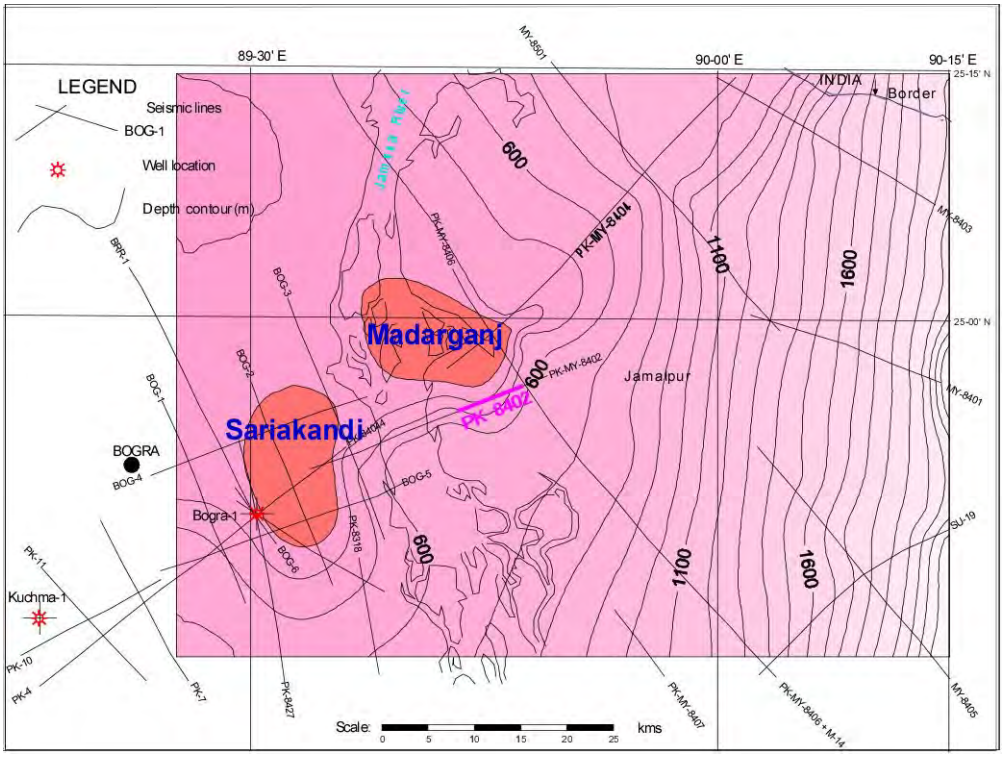

Figure 3: Depth Contour map of Miocene Surma Group in the Madarganj area

Conclusions:

- Broad and low relief structures in the Madarganj and Sariakandi areas located over the crestal part of this structure.
- Presence of seismic amplitude anomalies (Bright Spot) in the Oligocene-Miocene level of the section having direct detection features like Flat spot, polarity reversal and minor diffractions at the edges are indicative of the presence of hydrocarbon in those structures.
- The known Kamta gas field and the Hazipur-1 well is located downdip along the axis of this fold and that the Bogra-X1 and Kuchma-1 wells (With Gas shows in the Eocene Sylhet limestone and Oil shows in Tura Formation) is located on the western flank of this structure.
- The wells drilled so far in the Bogra Shelf area were located over the flanks or downdip of this structure and therefore they were dry.

Recommendations (Figure 4)

- Few more seismic lines over these two structures followed by two test drill holes, one at Madarganj and the other at Sariakandi are necessary to confirm the presence of hydrocarbon and to study their commercial viability.
- Bogra Shelf bears potential for hydrocarbon. It is therefore necessary to carry out high resolution seismic survey over the entire Bogra Shelf area to locate low relief structural and stratigraphic traps etc.

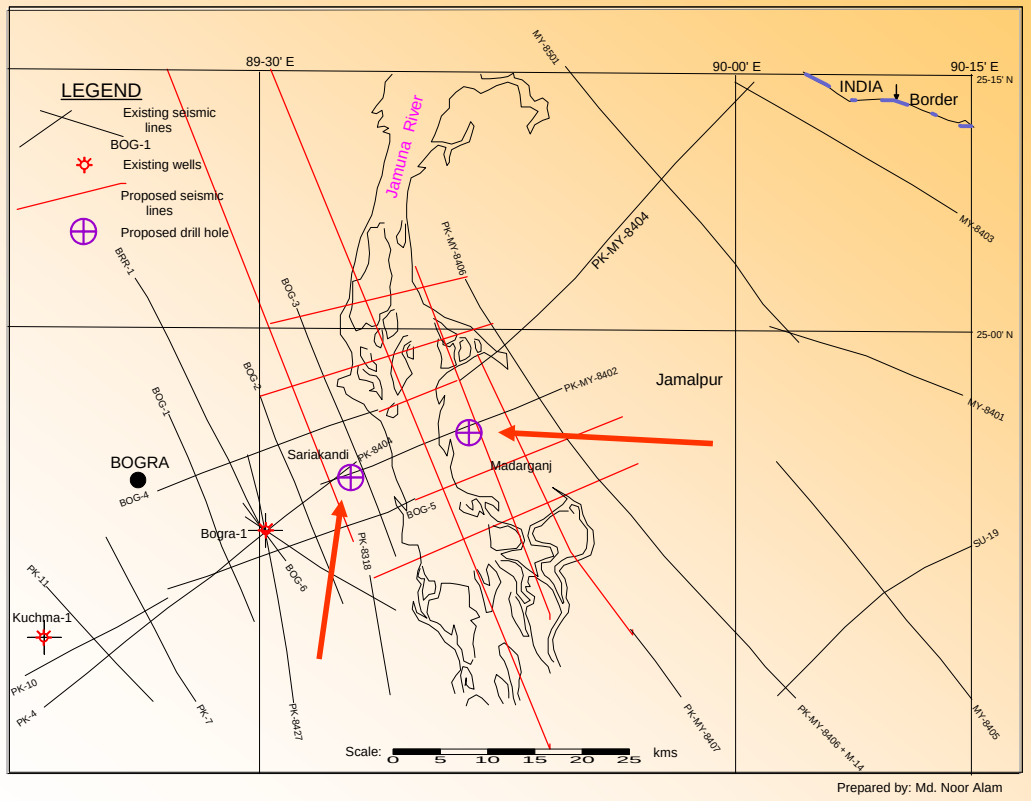

Figure 4: Proposed 2D seismic lines and drill hole locations for detailed study
(Note: Proposed lines are crossing the Jamuna River)

Volume of Survey and Budget (Approximate):

1. Seismic Survey

Seismic	Seismic line required	Unit cost	Approx. cost using Bapex's own crew
2D seismic survey	250 km	3,000 US$/km	0.75 million US$
3D seismic survey	300 sq.km	15,000 US$/sq.km	4.5 million US$

Time required for seismic survey: One season

2. Drill hole

Drilling	No.of wells	Unit cost/well	Approx. cost using Bapex's own Rig
drill hole (Approx.3200m)	2 well	650 million Taka 8 million US$	1,300 million Taka 16 million US$

References:

1. Alam, M. N., 2004: Seismic Evidences on the occurrence of hydrocarbon in the Madarganj and Sariakandi areas of Jamalpur and Bogra Districts Respectively. 5th Conference & Exposition on Petroleum geophysics, Hyderabad-2004, India, pp-380-387.

2. Alam, M.N., Nakayama, K., Matsuoka, T., Yohroh, T, 2006: Petroleum Systems of the bengal Basin in Bangladesh. 6th International Conference & Exposition on Petroleum Geophysics, " Kolkata-2006", pp-889-896.

3. Alam, M.N., 2007: Stratigraphic and Structural Features of the Surma Basin and the Upliftment of the Madhupur Tract of Northeastern Bengal Basin. Jounal Geological Society of India, Vol, 69, June 2007, pp-1319-1327.

Appendix-11

List of Collected Documents

List of Collected Documents

Received From	Document
ADB	Supplementary Appendixes of the report for "Natural Gas Access Improvement Project"
	Organization chart of executing agencies
	Past and projected financial performance
	Financial management review
	Economic analysis
	Summary initial environment examination
	Procurement capacity assessment
	Project readiness schedule
	Project implementation Arrangements
	Models for private sector participation in gas distribution
BAPEX	Annual Report 2006-07
	Annual Report 2007-08
	Annual Report 2008-09
	Annual Report 2009-10
	Proposed training program and requirement of hardware and software
BERC	Preliminary Development Project Proforma/Proposal (PDPP) for aided projects
	Answers to questionnaire
BGSL	Annual Report 2008
	Annual Report 2009
	Annual Report 2010
BOI	Brochure (Investing in Bangladesh)
BPC	Demand projection of petroleum products up to 2014
BPDB	Gas supply to the power sector (2004-2011)
	Projection of gas requirement for power plant up to 2018
	Power generation projects up to 2016
	Share of power generation energy 1990-2010
	Bulk tariff & retail tariff

List of Collected Documents

Received From	Document
EMRD	Extract from latest gas reserve report by Gustavson Associates
	Share of primary energy and commercial energy (2008-2009)
GTCL	Annual Report 2005-06
	Annual Report 2006-07
	Annual Report 2007-08
	Annual Report 2008-09
	Annual Report 2009-10
	Pipeline project list
	Development Project Proforma/Proposal (DPP) for gas pipeline (Monohordhi - Jamuna bridge) & compressor stations at Ashuganj and
	Development Project Proforma/Proposal (DPP) for gas pipeline (Jamuna bridge - Bheramara)
GTZ	Brochure of GTZ
HCU	About HCU
	Summary of gas reserve and production as of December 2011
JGTDSL	Annual Report 2005-06
	Annual Report 2006-07
	Annual Report 2007-08
	Annual Report 2008-09
	Annual Report 2009-10
KAFCO	Power and Energy Sector Road Map: An Update (MOF)
	Gas demand projection for fertilizer factories up to 2030
NWPGCL	Gas production projection up to 2020
	Yearly gas consumption 1990-2010
	Monthly gas consumption Jul/07~Dec/10
	Gas supply issue to Bheramara CCPP development project

List of Collected Documents

Received From	Document
Petrobangla	Annual Report 2009
	Annual Report 2010
	Gas Sector Reform Roadmap 2009-2012
	Gas Evacuation Plan 2010-2015
	Average purchase price from IOCs
	Answers to questionnaire
	Comments to the maint points of draft final report
PGCL	Annual Report 2007
	Annual Report 2008
	Annual Report 2009
	Annual Report 2010
Power Division	Implementation of 500MW solar power development program
	Roadmap for energy efficiency improvements & demand side management
RPGCL	Annual Report 2009-10
Santos	Annual Report 2010
SGFL	Annual Report 2005-06
	Annual Report 2006-07
	Annual Report 2007-08
	Annual Report 2008-09
	Annual Report 2009-10
TGTDCL	Annual Report 2009-10
	Annual Report 2010-11
	Proposals for the assistance of Japanese ODA
-	Energy & Power (Magazine for energy sector of Bangladesh) back numbers
Global Data	Gas Market Outlook in Bangladesh, 2010