CHAPTER I
GAS SUPPLY

SUPPORTING REPORT I: GAS SUPPLY

Contents

I.1 General

As part of the Master Plan of Astana City, the study on the introduction of natural gas plays an important role in both environmental and economic aspects.

When natural gas becomes available to Astana City, it will be utilized for 1) city gas, 2) source of electric power and heat generation in TETs and, 3) source of heat generation in heat centers.

For the utilization of natural gas for the purposes of city gas and as a source for electric power and heat generation, economic and environmental evaluation must be conducted in order to assess whether the introduction of natural gas is feasible or not. This Section focuses mainly on the use of natural gas for city gas, while the utilization for electric power and heat generation is discussed in CHAPTER H. Power and Heat Supply.

I.2 Present Condition of Gas Supply

In the general energy conditions in Kazakhstan, oil and coal have been subject to export, while natural gas has been imported. Production rate was about 8 billion m^3/y in 1998.

For better understanding the present condition,
"I.2.1 Natural Gas Availability",
"I.2.2 Natural Gas Provided Area and Situation in Kazakhstan",
"I.2.3 Present Condition of Used Fuel",
"I.2.4 Potential Demand of Natural Gas" and
"I.2.5 Effect of Using Natural Gas"
are introduced.

I.2.1 Natural Gas Availability

To consider the future introduction of natural gas in Astana City, analysis of the availability of natural gas is essential.

The present energy status in Kazakhstan needs to be reviewed.

Source of Power Generation

Coal is the most inexpensive fossil fuel and this leads the electric companies to be mainly dependent on coal as the primary energy source. The share of coal as the energy source for overall power generation is almost 80%, as shown in the following table.

Source for Power Generation in Kazakhstan (in 1997)

	Ratio (%)
Coal Thermal Power	80
Hydroelectric Power	16
Gas & Oil Thermal Power	3
Nuclear Power	1

Investment on Energy Industry

In forecasting the future energy situation in Kazakhstan, a document compiled by the Statistical Agency of the Republic of Kazakhstan, entitled "Investment in fixed capital by branches of industry" was analyzed.

Investment in fixed capital by branches of industry (in 1998)

	Investment (Million kzt)	Ratio (%)
All Industry	**134,528**	**100**
Electric Power	11,834	8.8
Coal industry	2,031	1.5
Oil and gas industry	**84,278**	**62.6**
Ferrous metallurgy	11,189	8.3
Non-ferrous metallurgy	7,547	5.6
Chemical and petrochemical industry	821	0.6
Machinery and metalworking	849	0.6
Logging, woodworking, pulp and paper industry	108	0.1
Building material industry	917	0.7
Light industry	296	0.2
Food industry	11,014	8.2
Other branches of industry	3,644	2.7

Source: Statistical Yearbook by the Statistical Agency of the Republic of Kazakhstan.

Yearly trend of ratio by branches of industry (from 1995 to 1998)

	1995	1996	1997	1998
All Industry (Million kzt)	84,487	65,782	84,976	134,528
Electric Power	14.4%	18.9%	6.6%	8.8%
Coal industry	7.8%	6.2%	6.2%	1.5%
Oil and gas industry	**42.9%**	**45.4%**	**59.2%**	**62.6%**
Ferrous metallurgy	9.9%	5.1%	5.1%	8.3%
Non-ferrous metallurgy	16.8%	14.2%	11.0%	5.6%
Chemical and petrochemical industry	1.3%	2.1%	0.7%	0.6%
Machinery and metalworking	1.1%	0.9%	0.5%	0.6%
Logging, woodworking, pulp and paper industry	0.2%	0.1%	0.0%	0.1%
Building material industry	0.6%	1.9%	2.5%	0.7%
Light industry	0.1%	0.2%	0.1%	0.2%
Food industry	**2.8%**	**3.3%**	**6.2%**	**8.2%**
Other branches of industry	2.1%	1.8%	2.1%	2.7%

Investment in the category "Oil and gas industry" was very high and only this branch and "Food industry" were increasing. This situation gives rise to many possibilities for increasing the production rate of natural gas.

Production of Fossil Energy

The production rate of natural gas was declining until 1994, negatively affected by the declining economic condition of the nation, but started increasing rapidly thereafter.

Production of Fossil Energy

	1990	1993	1994	1995	1996	1997
Oil (including condensate) Unit: 1000t (100% in 1990)	25820 (100%)	22975 (89%)	20279 (79%)	20450 (79%)	22960 (89%)	25776 (100%)
Natural gas Unit: Million m^3 (100% in 1990)	7114 (100%)	6685 (94%)	4488 (63%)	5916 (83%)	6524 (92%)	8115 (114%)
Coal Unit: Million t (100% in 1990)	131 (100%)	112 (85%)	105 (80%)	83 (63%)	77 (59%)	72.6 (55%)
(For reference)						
Electric Power Gen. Unit: Million kWh (100% in 1990)	87839 (100%)	77444 (88%)	66397 (76%)	66659 (76%)	58657 (67%)	51984 (59%)

Source: Statistical Yearbook of Kazakhstan & Situation on Kazakhstan social & economic – by Agency for Strategic and Reform

Import & Export Balance of Fossil Fuel

In the overall balance of import and export, oil and coal have always been exported in net, while natural gas has always been imported in net up to 1998.

Import & Export Balance of Fossil Fuel

	1990	1993	1994	1995	1996	1997	1998
Oil (Million t)							
Import							
Crude Oil (incl. Condensate)	12.80	8.50	4.70	0.68	0.34	1.73	-
Refined Oil	1.95	0.85	0.33	0.14	0.17	0.16	-
Gasoline for Auto	3.60	1.30	0.70	1.11	0.18	0.07	-
Diesel Oil	1.34	0.70	0.34	0.15	0.10	0.18	-
Export							
Crude Oil (incl. Condensate)		11.70	5.70	11.25	14.50	14.89	22.59
Refined Oil	-	0.27	0.14	0.02	0.25	0.13	-
Gasoline for Auto	-	0.32	0.06	0.47	1.31	0.72	0.03
Diesel Oil	-	0.05	0.02	0.32	0.66	0.59	0.20
Fuel Oil	-	-	-	-	-	-	0.80
Natural Gas (Billion m^3)							
Import	11.9	11.2	9.6	7.4	5.5	3.0	3.1
Export	5.6	3.0	2.0	-	2.4	2.4	2.3
Coal (Million t)							
Import				1.2	1.1	1.0	1.2
Export				21.0	21.0	25.1	23.7

Source: CIS Statistics Committee

Natural Gas Pipeline

There was a feasibility study on the construction of a pipeline for supplying natural gas to Astana City completed by the American Corporation BSI Industries in compliance with a grant allocated by the Agency on Trade and Development of the USA and a contract concluded with "KazTransOil" national company on the 8th February 2000.

The following information presents a brief of this study.

Brief Introduction of Pipeline Study

Natural gas supply route was studied on the following three cases, i.e.

Case-A: Ishim – Petropavlovsk – Astana

Case-B: Travniki – Petropavlovsk – Astana

Case-C: Omsk – Petropavlovsk – Astana

A comparative study in the report conduced that Case-C is the most feasible because of ample possibilities of using existing petroleum pipelines.

The utilization plan of the existing petroleum pipeline is:

- The existing non-operating petroleum pipeline with the diameter of 500 mm that connects Petropavlovsk City and Omsk City.
- The existing no-operating petroleum pipeline with the diameter of 300 mm that connects Astana City and Petropavlovsk City.

However there were some problems for utilizing the existing petroleum pipeline. The main problem was the distance that is required to be maintained between the pipeline and the railway. According to SNiP, the distance required is 120m for the gas pipeline and 50m for the petroleum pipeline. About 300km of this pipeline is already installed by the railway, designed as a petroleum pipeline, so this part needs to be reinstalled for maintaining the distance of 120m if used as a gas pipeline. This reinstallation made utilizing the existing petroleum pipeline infeasible.

Natural Gas Pipeline Plan

After the above-mentioned feasibility study, KazTransGas conducted a pipeline plan based on Case A above. The following presents an introduction of this plan.

For the natural gas pipeline plan, the natural gas supply of Astana City and accompanying consumers was confirmed between the Government of Kazakhstan and the Government of the Russian Federation by Item 8 of the

Minutes of Meeting about the collaboration in gas systems of the Russian Federation and the Government of Kazakhstan, dated 16 July 1999.

The project realization regarding the natural gas supply to Astana City and accompanying consumers has been started according to a Memorandum between the Government of Kazakhstan and the Government of the Russian Federation regarding collaboration in the sphere of energy systems of the two countries, dated 8 October 2000.

The followings were decided in this meeting.

1. Confirm the Astana City natural gas project
2. Approve the project implementation schedule set forward jointly by CSC Kaztransgas, OSC Gaspromrazvitie and OSC Stroytransgas.
3. To Akims (Provincial Governors) of the cities of Astana, Petropavlovs, Kokshetau, Karaganda and Akims of the oblasts (regions) of North-Kazakhstan, Akmola, Karaganda:
   - Recommend creating each a structure in the Akimat for the development of gas projects in their cities and oblasts.
   - Recommend the allocation of city and oblast budgets for 2001 as a special article of expenditure for receiving gas, designing of gas supply network for towns, cities, and oblasts.
   - Identify the consumer group of long-term vast consumption.
   - Recommend utilizing the experience of OSC Stroytransgas for the consideration of regional gasification.
4. To resolve the problems regarding gas supply of Astana City, the Government of Kazakhstan shall cooperate in the following issues.
   - Contract conclusion between the Government of Kazakhstan and OSC Gasprom of Russia on gas supply.
   - Agree to a conclusion between the Ministry of Energy, Industry and Trade of Kazakhstan and the Ministry of Fuel and Energy of Russia regarding gas supply on the grounds of mutual exchange.
   - Entrust the Ministry of Energy, Industry and Trade of Kazakhstan to design a program utilizing gas by regions and cities located along the gas transmission line.
   - Allocate the national budget in 2001 for the gas project together with the local self-governing body.

The implementation schedule of this project is as shown in the figure on the following page.

Schedule of Gas Pipeline

No.	Item	Responsibility	2000					2001												2002			
			8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	Declaration of intentions	GPR																					
2	Cartographic material preparation base of aerospace photography and computer imitation "Route Flyby"	STG																					
3	Coordination of agreement for implementation terms and cost of feasibility study	GPR, STG, KTG																					
4	Coordination of the sub-contracting organizations and funding sources of the FS	GPR, STG, KTG																					
5	Adoption of the declaration of intentions	KTG																					
6	Choosing the basic variant of the gas pipeline and its coordination with the interested authorities	KTG																					
7	Recommendations of the choice of the general direction of the gas pipeline, survey initial data collection	GPR, STG																					
8	Coordination of the general direction of the main route of the gas-pipeline, getting technical specifications, initial data implementation of the engineering survey of the soils	KTG, GPR, STG, KDO																					
9	The feasibility study of the project	KTG, GPR																					
10	Carrying out the FS expertise and getting its approval from the interested authorities	KTG, GPR, STG																					
11	Taking decision of the construction of the trunk gas pipeline	KTG																					
12	Choosing the contractor for implementation of building and assembly jobs on the construction of the trunk gas pipeline, including development of the project documentation	KTG																					
13	Construction of the trunk gas-pipeline	Contractor																					

<Legend> GPR: Open Public Organization "Gaspromrazvitiye"
KDO: Kazakhstan Design Organizations
KTG: Closed JSC "KazTransGas"
STG: Open JSC "Stroytransgas"

Since this plan is based on a newly installed pipeline, much of the total volume of the natural gas transferring will be required for feasibility of this pipeline.

From the above analysis, the following can be deduced:

- Coal has been the primary choice for power generation because of the low price.
- Natural gas has been imported in net balance, but a relatively high share of investment is going to the oil and gas industry, and this may be a cause for the recent increase in the production rate of natural gas.
- There is actually no pipeline between the natural gas production area and Astana City, but there is a high possibility that natural gas can be made available in Astana City.

I.2.2 Natural Gas Provided Area and Situation in Kazakhstan

Out of the 14 oblasts in Kazakhstan, natural gas is supplied in 8 oblasts as well as in Almaty City. The three southern oblasts receive natural gas from Uzbekistan via an international gas pipeline "Gazli-Shimkent-Zhambyl (Taraz)-Almaty". Since other forms of energy such as coal, heavy oil and electricity are not common in these areas, natural gas has become widely utilized. For example, in 1991, natural gas consumption in these areas was 6.0 million m^3, which accounts for nearly half of the total consumption of the whole of Kazakhstan.

The remaining regions (Manghystau, Atyrau, Western-Kazakhstan, Aktobe, and Kostanai) consume natural gas supplied by the Manghystau pipelines.

Natural gas consumption in Kazakhstan decreased in recent years from 13 billion m3/year in 1990 and 1991 to 4.5 billion m^3/year in 1999. The main reason behind this sharp fall is the unstable gas tariff policy. For example, the tariff in Almaty fluctuated between US$ 25 and US$ 100 per 1000m^3 over several years causing difficulty on the consumers' side to pay the tariff. Also, after Traktebel C.A. acquired concession on the transport of gas from Russia, the price of gas settled at US$ 42-45 per 1000m^3, which was 1.5 times as much as it was when Kazakhgas had ownership.

In the past few years, the price for gas showed a gradual tendency toward stability. Namely, in the southern regions, the price decreased from US$ 50 to US$ 35, and in the western regions from US$ 42 to US$ 32 per 1000m^3, respectively. With these price levels, natural gas is preferable compared to other types of fuels.

Case in point is that natural gas for cooking purposes in Almaty costs Tenge 95 per person per month, while in Astana the LPG utilized costs Tenge 180.

Although it is necessary to make a feasibility study of wide natural gas utilization in comparison with other fuels, natural gas utilization is more preferable for residential and public buildings, which presently use LPG and petroleum oil.

I.2.3 Present Conditions of Used Fuel

The followings are the main consumers of fuels in Astana City (not including fuel for transportation).

- For electric power
- For heat supply
- For housing (domestic use)
- For public use such as laundries, public baths, catering enterprise, public health institute, and bread baking plants, other trade & consumer services.

(1) Electric and Heat Supply

A large portion of fuel is used for generating the electric power and heat supply. Coal is mainly used for this fuel in Astana City, which is a common practice in Kazakhstan as shown in I.2.1. Heavy oil is also used for some substantial portions, but heavy oil is much more expensive than coal and power & heat suppliers intend to use more coal instead of heavy oil.

More detail is as descried in "Chapter H Power and Heat Supply".

(2) Domestic Consumption

The bulk of energy for domestic use is supplied as the electric power and heat supply produced at TETs-1 and TETs-2.
According to SNiP 2.02.08-87, the required heat duty of gas for domestic living can be calculated from the housing area, population, and the house type.

Categorized required heat duty will be as follows:

A) Apartment equipped with gas cooker and district hot water supply - 2,800 MJ/year

B) Apartment equipped with gas cooker and gas hot water heater (without district hot water supply) – 8,000 MJ/year

C) Apartment equipped with gas cooker, and without district hot water supply neither gas hot water heater – 4,600 MJ/year

Based on the data in "3 Urban and Architectural Planning", heat duty and consumption of natural gas is as shown in the below table, following the ASTANA-2's estimation methodology.

	Unit	Multi-stored House	Individual House		Total
			(New)	(Old)	
Population	Person Percent	284,443 86.0 %	24,806 7.5%	21,499 6.5 %	330,748 100.0 %
Heat Duty per Person	MJ/ Person y	2,800	8,000	4,600	-
Heat Duty	TJ/y	796	198	99	1094
Natural Gas Consumption	Million Nm^3/y	25.1	6.2	3.1	34.4

Note: Natural Gas LHV = 31.8 MJ/Nm^3

(3) LPG

LPG is widely used in Astana City as a convenient source of gas energy.

1) LPG Consumer

Consumption of LPG is estimated based on Alautransgas's information, following the categories of LPG consumers, as summarized below.

	Present Condition of LPG		Pipeline FS Report (by BSI)	
User	Consumption k-t/y [Note 2]	Equiv. NG Million Nm^3/y	Consumption k-t/y	Equiv. NG Million Nm^3/y
Residential use (U/G [Note 1] tank)	10.8	12.7	-	-
(Container)	5.4	6.4	-	-
Public Use	2.7	3.2	-	-
Total	18.9	22.3	27.6	32.6

Note 1. U/G: Under Ground
2. Consumption values are estimated by interview value. (7.2, 3.6, 1.8 respectively and share of 2/3)

2) LPG Facility

Existing facilities for LPG are as follows:

Transportation from "LPG producer" to "LPG supplier" in Astana.

Receiving LPG by rail lorry to suppliers' storage facility.

The form of this supplier is private company while the form of producers is depended on characteristics of refinery.

Example routes from producers to suppliers are as follows:

Aktay Petroleum Refinery (4,300km)

Atyray city, Kulsary settlement, Gas Refinery (3,400km)

Shimkent Petroleum Refinery (700km)

Pavlodar Petroleum Refinery (436 km)

Gas pipeline or railway LPG transportation from Russia (Omsk City Russian producers of LPG)

Since the LPG has odor added as a protective measure in refineries, LPG supplier does not have any facility to further add odor.

Transportation from Supplier to Users

There are two LPG supplying methods; collective supply at apartments and individual supplies by containers.

a) Collective Supply at Apartments

In collective supply, the gas supplier first installs the required equipment such as underground LPG storage and feed line to users etc.
The supplier regularly refills this underground tank, by tank trucks.

LPG storage

The number of underground gas storage tanks per one underground tank unit is decided according to required capacity normally 2, 4, 6, 8, 10. All of the tanks are connected.

Capacity of underground storage tank

2.5m^3 or 5m^3

Number of storage tanks in Astana City of Major Supplier

2.5m^3 tank	380
5m^3 tank	962
Total	1,342

Number of storage units in Astana City

Total number is 320 units, of which those in operation are 286 units. (Non-operation is mostly due to user's payment problems. In most cases the facilities themselves are in a good state for operation)

Feed Line from underground storage tank to users

The feed line to user apartments is installed under ground and buried directly (depth is 1.1-1.2m). An example of the diameter of the feed line is 50 mm in the mainline and 25-40 mm in sub-lines.

At a point near the supply target, the line goes aboveground without insulation.

For removing condensing gas in the feed line due to low temperature, a trapping device is installed below the ground level. A special hand pump can recover trapped condensing gas.

There are two main types of connection for this feed line to each home.
One is inside the apartment and the other is outside on the wall of apartment.

Timing of LPG unload to LPG underground storage

The gas supplier has some statistical data and there is a simple measuring unit installed in the underground storage tank.

The measurement unit utilizes three dipper indicator pipes in the tank, at depths of 15%, 45% and 85% of the full depth. By these dipper indicator pipes, the liquid level of the underground storage tank can be gauged from the above three liquid levels (i.e., 15%, 45% and 85% of the full depth).

b) Individual Supply by Container

Transferable containers for individual consumers are delivered to users by truck.
Size of transferable containers
- For residential consumers: 27 liter or 10 kg
- For industrial consumers: 50 liter or 20 kg

Handling Required for LPG

As indicated in above, LPG is supplied to users in many steps as follows;
- LPG producer in various refineries
- Long distance transportation to LPG supplier in Astana City
- Adjustment to required specifications including calorie control
- Supply to underground tank by Lorry or to each users by container

However, these handling steps have the possibility of disruption and can result in unexpected incidents.

(4) Regulation and Norm for Gas Supply

Some regulations and norms specify and restrict the gas supply. These will be barriers to the introduction of natural gas in Astana City, and may decrease the estimate of natural gas consumption.

Restrictions of Utilizing Gas

According to SNiP 2.08.01-89 No. 3.10, 3.13 and SNiP 2.08.02-89 No. 3.55, gas utilization is restricted as follows:

1) Water Heater Fuel for Individual Apartments

Individual apartment water heaters (including small volume heating boilers) operated by gas are permitted to be placed in dwellings with up to two stories excluding ground floors.

Heating boilers operating with solid based fuel are to be installed in the kitchen or isolated area. Areas with access to the heating boiler may be permitted through an auxiliary box room.

2) Cookers in Kitchen

In kitchen in dwellings with 11 stories or higher, hostels, retirement houses, and households of the physically handicapped, electric cookers should be provided. For dwellings comprised of a variable number of floors with one part of the dwelling consisting of 11 floors and more shall be equipped with electric cookers in all parts of the house. Installation of gas equipment is prohibited for catering facilities, shops, and service enterprises that are built in the dwellings.
Electric cooker installation is permitted in houses with floors of any number, which are equipped with central heating systems and hot water supply, in accordance with the power Supply Company.

3) Gas Equipment in Public Buildings and Other Buildings

Installation of gas equipment in the kitchens of kindergartens, buffet halls and cafes of theatres and cinemas is prohibited. Hospitals and ambulance clinics are permitted to provide a central gas supply system only for premises used for cooking food, laboratories, and dentistry as long as they are located in separate buildings.

4) Pressure of Gas Supply System

According to SNiP 2.04.08-87 "Gas supply system and norms of gas pressure", gas pipelines are categorized dependent on pressure and type of gas.

1st Category High Pressure Gas Pipelines;

- Working pressure: 0.6 M Pa (6 Kg/cm^2)- 1.2 M Pa (12 Kg/cm^2), for natural gas and gas-air mix

- Working pressure: 0.6 M Pa (6 Kg/cm^2)- 1.6 M Pa (16 Kg/cm^2) for liquid petroleum gases (LPG).

2nd Category High Pressure Gas Pipelines;

Working pressure: 0.3 M Pa (3 Kg/cm^2)- 0.6 M Pa (6 Kg/cm^2)

Medium Pressure Gas Pipelines

Working pressure 500 da Pa (0.05 Kg/cm^2)- 0.3 M Pa (3 Kg/cm^2)

Low Pressure Gas Pipelines

Working pressure up to 500 da Pa (0.05 Kg/cm^2)

	Gas Consumers	Gas Pressure
1	Production buildings of industrial and agricultural enterprises, and independent boiler houses and consumer services enterprises of industrial character (baths, laundries, dry cleaning factory, enterprises of bread and confectionery production industry)	0.6 M Pa (6 Kg/cm^2)
2	Consumer services enterprises of industrial character, stated in the pos. 1, additional in the outhouses of the buildings of other industrial purpose, or built-in into these buildings;	0.3 M Pa (3 Kg/cm^2)
3	Consumer services enterprises of non-industrial character, and public buildings	500 da Pa (500 mm H_2O)
4	Apartment, houses	300 da Pa (300 mm H_2O)

The gas pressure in the gas pipelines laid inside buildings must not be more than as shown in the above Table.

For heat facilities of industrial enterprises and independent boiler-houses, a gas pressure of 1.2 M Pa (12 Kg/cm^2) is allowed for use, if such pressure is required according to the conditions of the manufacturing technology.

In boiler-houses placed outside of the production buildings, a gas pressure up to 0.6 M Pa (6 Kg/cm^2) is allowed.

The gas pressure before domestic gas appliances is to be accepted in accordance with the design data of the appliances, but no more than that indicated in the above table, position 4 (Apartment, houses: 300 da Pa= 300 mm H_2O).

I.2.4 Potential Demand of Natural Gas

Natural Gas can be used as a safe and clean fuel for many energy sources. In this sub-section, the possibilities of natural gas as city gas are investigated.

(1) Gas Demands in Astana

Natural gas will be used as a replacement of existing fuel, and in addition to this, there will be another usage.

For power and heat supply, proper fuel is discussed in "Chapter H Power and Heat Supply". The major areas except for power and heat supply are:

Domestic use

Public use

Mini boilers, etc..

(2) Gas Consumption Estimate

Regarding gas demand in Astana, ASTANA-2's the methodology according to SNiP etc., is presented:

1) Domestic Use

As indicated in "I.2.3 (2)", SNiP specifies categorized required heat duty. Based on apartment type and, number of inhabitants the required natural gas consumption can be calculated.

2) Public Use

Based on population (N) and estimation of natural gas supply (Y = 0.5), natural gas consumption of various public usages can be calculated. Q_N^R is LHV of natural gas.

Laundries

$V_{laund} = 100 \times Z_{laund} \times N \times Y \times q_{laund} / 1{,}000 \times Q_N^R$, [$Nm^3$]. Where

Z_{laund} –population ratio using laundry services- 0.1

q_{laund} – norm (1 ton of dry laundry) MJ;

q_{laund} = (8,800+12,600 +18,800)/3 = 13,400 MJ/tons of laundry

Baths

$V_{bath} = Y \times Z_{bath} \times N \times 52 \times q_{bath} / Q_N^R$, [$Nm^3$]. Where

Z_{bath} – the population quantity attending baths- 0.165

52 – washing numbers per year;

q_n =(40+50)/2 = 45 MJ/washing – norm (per 1 washing)

Catering enterprises

$V_{cater} = Y \times 360\, Z_{cater} \times N \times q_{cater} / Q_N^R$, [$Nm^3$]. Where

Z_{cater} – population ratio covered by catering services- 0.2

q_{cater} = 6.3 MJ: 4.2(lunch)+ 2.1(supper) – norms

Healthcare establishments

$V_{h.c.} = Y \times 12 \times N \times q_{h.c.} / 1{,}000\ Q_N^R$, [$Nm^3$]. Where

12 – number of beds per 1,000 people

$q_{h.c.}$ – norm-3,200 MJ/1 bed per year;

Bakery and confectionery producing enterprises

$V_{bake.} = Y \times 0.7 \times 365 \times N \times q_{bake.} / Q_N^R$, [$Nm^3$]. Where

0.7 – norm daily bakery production in tons per 1,000 people;

q_{bake}= (2,500+5,450+7,750)/3=5,233 MJ/ton of baked production

Trade domestic service enterprises (ateliers, workshops, hairdressers', shops)

$V_t = 0.05 \times V_{h.f.}$, [$Nm^3$], Where

$V_{h.f.}$– annual gas consumption for domestic use of the city, [Nm^3]

See " 1) Domestic Use ".

3) Mini Boilers etc.

This required heat duty is estimated based on heat requirement forecasted in "4.5 Planning of Power and Heat Supply System".

The number of mini boilers will not increase so much because new heat centers can cover the required heat. New heat centers are planned to cover 90% of the required heat supply. Natural gas and other fuels will be used for the rest 10%. Accordingly, 5% of heat centers are assumed for estimating heat duty for mini boilers using natural gas.

I.2.5 Effect of Using Natural Gas

In this sub-section, the important aspects of using natural gas, that relate to the economical, operational, and environmental aspects, will be studied.

(1) Economic Aspect

1) Domestic Use

Rivals of natural gas are LPG and Electric Power.

Heat Value of Natural Gas: 31.8 MJ/Nm^3, and Exchange Rate is 144.5 kzt/ US$ are applied.

LPG

Heat value is 45.7 MJ/kg and unit cost is 0.22 USD/kg (32.22 kzt/kg) as underground tank base.

Electric Power:

Conversion Ratio of 3.6MJ is 1kWh, and unit cost is 0.027 USD/ kWh (3.84 kzt/kWh).

Accordingly, the cost corresponding to a heat value of 1,000Nm^3 NG is as follows:

LPG: USD 153 = (31,800MJ/1,000Nm^3)(0.22USD/kg)/(45.7MJ/kg)

E. Power: USD 239 = (31,800MJ/1,000Nm^3)(0.027USD/kWh)/ (3.6MJ/kWh)

According to SNiP, the required categorized heat duty is specified as per "I.2.4 (2)", and the table below presents the effect of natural gas only for domestic use.

Effect of Economical

(Per person)

Gas Consumption, MJ/year	**A) 2,800**	**B) 8,000**	**C) 4,600**	**Total**
Equal to NG, m^3/year	**88.05**	**251.57**	**144.65**	
Equal to LPG, kg/year	61.27	175.05	100.65	
Equal to power, kWh/year	778.4	2,224	1,278.8	
Cost of NG,* USD/year	**3.52**	**10.06**	**5.79**	**4.16**
Cost of LPG, USD/year	13.48	38.51	22.14	15.92
Cost of power, USD/year	21.02	60.05	34.53	24.84
Ratio of Each Population**	86%	7.5%	6.5%	100%

* Based on 40 USD/1,000Nm^3-NG

** Assumed based on forecasted population

The table below shows the result based on "Estimation of ratio of Each Population".

Year		**2010**	**2020**	**2030**
Population		490,000	690,000	800,000
Yearly Cost Difference NG vs. LPG	Million USD	5.763	8.116	9.410
Yearly Cost Difference NG vs. Power	Million USD	10.127	14.260	16.534

Year Period			**2010 - 2020**	**2010 - 2030**
Total Cost Difference NG vs. LPG	Million USD	-	75.160	162.787
Total Cost Difference NG vs. Power	Million USD	-	132.064	286.036

2) Public Use

Comparison of fuel cost is almost the same as 1). This chapter focuses mainly on the use of natural gas for city gas. Accordingly, there will

not be big industrial factories using coal in the center of the city. However, a comparison including coal and diesel oil is shown as below.

Coal

Heat Value is14,047 MJ/t, and unit cost is 7.71 USD/t (1,114 kzt/t*).

* Note: In case a lot of coal is procured as TETs etc., this cost will decrease. However, the object of this comparison is with a facility installed in the city center area. Accordingly coal cost applied in TEI's etc., is excluded from this comparison.

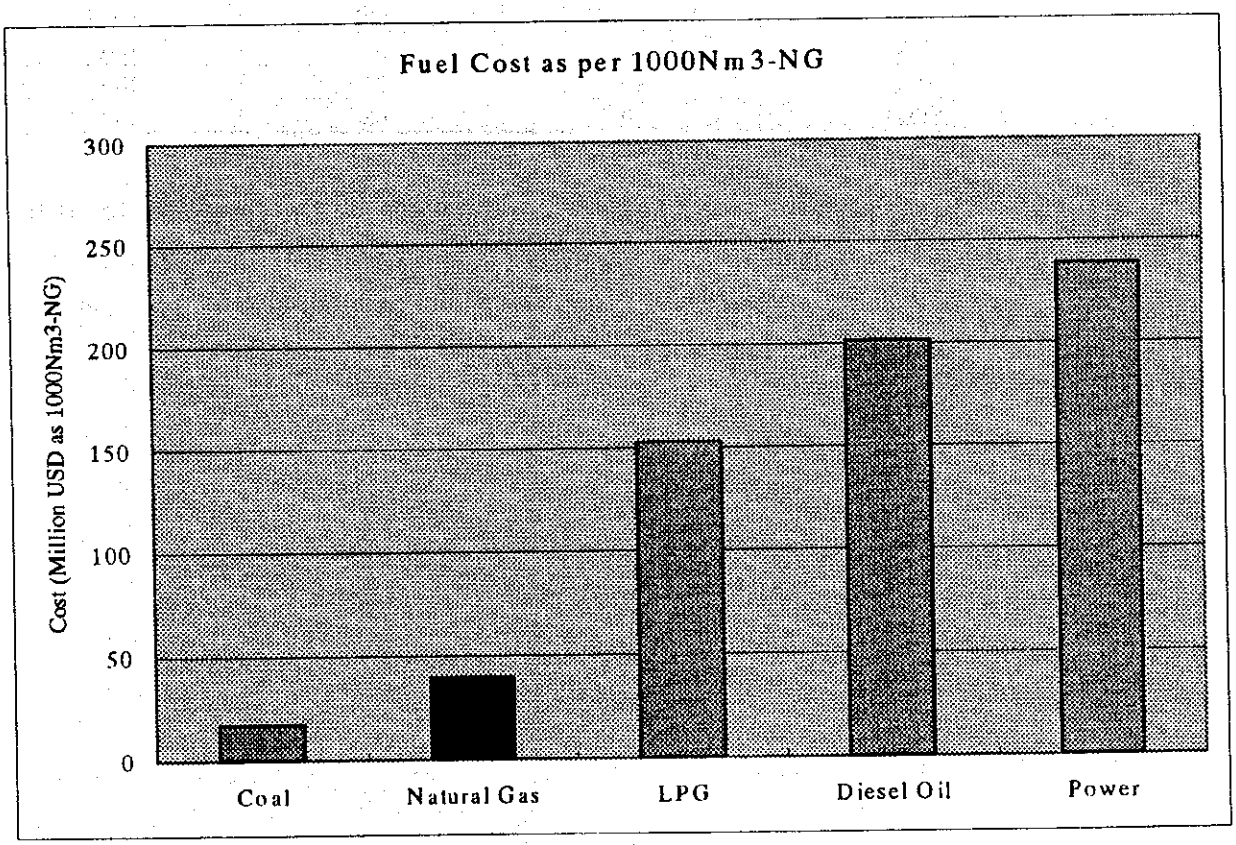
Coal: USD17.5 = (31,800MJ/1,000Nm^3)(7.71USD/t)/(14,047MJ/t)

Diesel Oil

Heat Value is 42.6 MJ/kg, and unit cost is 0.27 USD/kg

Diesel Oil: USD 201.5 = (31,800MJ/1,000Nm3)(0.27USD/kg)/ (42.6MJ/kg)

Natural gas is superior to other fuels with the exception of coal, as shown in the graph below.



3) Mini boilers for heat energy generation

Combustion efficiency is not the same as that for public usage discussed above, but these differences can be neglected in this rough comparison.

(2) Operability and Maintainability

LPG needs a number of steps for reaching consumers, and heavy oil requires some additional steps to reach consumers, and makes more emissions than natural gas.

Coal is the cheapest but handling as fuel is troublesome due to the volume of solid materials, heavy emissions, and after treatment of the burning ash, makes it's handling much more difficult than the handling of natural gas.

(3) Environmental Aspect

Natural gas conformity to environmental regulations is superior to other fossil fuels.

The following superiority will be expected.

	Natural Gas	Oil	Coal
CO_2	57	83	100
NO_X	29	71	100
SO_X	0	68	100

Source: Natural Gas Prospect to 2010: IEA

Content of sulfur and nitrogen in natural gas are less than other fossil fuels. Combustion control for natural gas is also easier. Using natural gas would reduce the emissions of not only NO_X and SO_X but also CO_2 compared with other types of fuel.

I.3 Basic Concept for Gas Supply Development Plan

Natural gas is a clean source of energy and discharges less CO_2 than other fossil fuels when burnt. As an alternative source of energy for the national capital, natural gas has ample possibilities to improve the quality of life of the residents of Astana. In this Sub-section, the natural gas development plan is proposed.

I.3.1 Base of Planning

The following population data is used as the basis of this study.

The population projection and spatial distribution mentioned in Sub-section 3.2 and 3.7 are utilized and are summarized below.

Year / Area	2000	2010	2020	2030
1. Central Planning Region	175,500	190,800	212,400	218,400
2. Northern Planning Region	16,310	9,034	9,034	9,034
3. Southeastern Planning Region	92,236	217,753	282,403	282,403
4. Southern Planning Region	16,012	41,759	97,396	186,788
5. Northwestern Planning Region	30,690	30,690	86,199	99,399
Total	330,748	490,036	687,432	796,024

I.3.2 Natural Gas Demand Forecast

As for demand for city gas as natural gas, the following are expected as promising demands in consideration of both economical and environmental standpoints.

Users of natural gas can be categorized "Domestic use", "Public use" and "Boiler in City Area". Refer to "I.2.4 (2)" for calculation of natural gas demand.

Domestic Use

At present, LPG is widely used in residential areas in Astana, due to its favorable energy cost compared to electric power. The cost of natural gas is lower than LPG even if there will be cost fluctuation of LPG as shown in "I.2.5 Effect of Using Natural Gas". Making the introduction of natural gas is economically viable.

There are reportedly more than 300 units of underground LPG tanks (solely the possession of Alautransgas) in the existing city on the right bank, most of which are obsolete and potentially hazardous. The replacement of LPG to natural gas is therefore advantageous in the safety point of view as well Public Use.

As fuel to be used in urban areas, natural gas is the most suitable. Although coal is superior in the pure comparison of costs, environmental protection measures are

required for the use within urbanized areas of the city. Considering the required measures for coal, natural gas could be economically for small facilities.

The brick industry, for example, may become one of the most promising consumers of natural gas, because locally available materials in Astana could be used as raw materials, and quality bricks are imported at present. Natural gas will make this industry more feasible.

Mini Boilers

There are several existing mini boilers in the city, which burn heavy oil or diesel oil for fuel. Replacing the heavy oil and diesel oil to natural gas is economically viable and environmentally preferable.

Forecasted Demand

Demand is forecasted based on ASTANA 2 calculation methods according to SNiP.

The population and residential areas etc., as specified in "3.7 District Planning for New City Area" are used as the basic information for this calculation.

Unit: Million Nm^3/y

Item \ Year	2000	2010	2020	2030
Population (x 1000)	330	490	690	800
Natural Gas Consumption				
< Domestic Use >	**34.4**	**51.0**	**71.5**	**82.8**
< Public Use >	**13.9**	**20.2**	**29.0**	**33.5**
Laundries	0.7	1.0	1.5	1.7
Bath-house	2.0	3.0	4.2	4.8
Catering Enterprise	2.4	3.5	4.9	5.7
Public Health Institute	0.2	0.3	0.4	0.5
Bread-Baking plants	7.0	10.3	14.5	16.7
Services Enterprises (dressmaking, workshops, hairdressers', shops etc.)	1.7	2.1	3.6	4.1
<Independent Mini-boiler>	**-**	**5.0**	**10.3**	**16.7**
Subtotal Consumption	**48.3**	**76.2**	**110.8**	**133.0**

In addition to the above, there is a plan to introduce new individual heat centers using natural gas for fuel, as described in "Section 4.5 Planning of Power and Heat Supply System". The forecast demand is as follows.

Item \ Year	2000	2010	2020	2030
New HC (Nm^3/h)	-	27,300	56,100	90,500
New HC (Million Nm^3/y)	-	100.7	206.8	333.7
Total Consumption (Million Nm^3/y)	**48.3**	**176.9**	**317.6**	**466.7**

I.3.3 Source of Natural Gas

In Kazakhstan, the volume of imported natural gas is 3,100 million Nm^3/y while the exported volume is 2,300 Million Nm^3/y, showing an overall balance of 800 million Nm^3/y import in 1998.

Natural gas can be produced in the western part of Kazakhstan, but there is no gas pipeline between the western part and Astana City.

Availability of natural gas in Astana City depends on the following factors:

- Pipeline plan
- Production capacity development plan in Kazakhstan
- Supply availability from Russia

There is a relatively high investment on the gas industry in Kazakhstan. This could increase the production rate of natural gas as discussed in Sub-section "I.2.1 Natural Gas Availability", which could make natural gas available for Astana City.

I.3.4 Proposed Natural Gas System for Astana City

Regarding the decennial development plan, the city gas network will be expanded according to the growth of the city as indicated above.

The basic concept of the planned network is as follows:

(Refer to attached "FIGURE. 4.6.1 Plan for City Gas Network")

- The network will be connected with the planned Trans National Gas Pipeline.
- The pressure of the natural gas supplied from the Trans National Gas Pipeline will properly be adjusted for high-pressure distribution (1.2 MPa). High-pressure networks (hereinafter called HP-network) are aligned along the main road.
- The HP-network will cover the areas of each development district of the city.
- The HP-network shall be installed underground, including the crossing of the Ishim River. To reduce construction cost, lines crossing the Ishim River and railways shall be minimized.
- Since the required quantity for Heat Centers is enormous, HP-network is planned close to the Heat Centers.

- For the Heat Centers and some industries, the high pressure (1.2MPa) will be utilized without pressure reduction.
- For other consumers such as domestic and general industry etc., pressure will be adjusted in the Gas Distribution Station (GDS), according to SNiP.
- City gas adjusted to low pressure (below 0.6MPa) will be supplied to each general consumer by low-pressure network (hereinafter called LP-network).
- Loop-type network is considered for stabilizing pressure at each point, but this policy should be further studied at the design stage in consideration of cost reduction.
- The network system will be connected to storage tanks installed in the existing LPG area. This LPG area is close to the railway network and already has the required facilities for supplying LPG. In case of delay of natural gas development, LPG could be supplied by using this new network. Considering that LPG is presently supplied using underground tank or LPG container, the new network is also superior in the sense of safety.

I.4 Gas Supply Development Plan

I.4.1 Rules and Procedures of Gas Supply to Astana City

The City Gas Operating (Distribution) Company will conclude the contract with major consumers for gas purchase, and then will contract with Gas Transportation Company, as present practice. The Gas Transportation Company will be CJSC "KazTransGas" or some joint enterprise with Russia, because 30% of the proposed pipeline from Ishim City will be in the Russian territory (150-160 km).

There is a Law of the Russian Federation about "Gas and Rules on gas supply" approved by the Russian Government, No.162, dated 5 February 1998.

Without intergovernmental agreements for gas supply between Russia and Kazakhstan, this Law will be referred to as the contract of commercial base for gas supply.

The quality of natural gas is specified by Russian standard (OST 51.40-93 Natural fuel gases supplied and transported by major pipeline), which is designed by VNIIGAS institute (Moscow). The technical terms can be also applied in accordance with this standard - OST 51.40-93.

In the event that the contract will be on a commercial base (i.e., not intergovernmental agreement), terms and conditions should be approved by the Local Government for the efficient and stable supply of natural gas.

I.4.2 Short Term Development Needs

For the introduction of city gas, a HP-network of natural gas shall be established in the planned development area. Since a considerable number of new buildings will be erected before the completion of the international main gas pipeline, the design of new buildings shall comply with the possibility of the future introduction of natural gas. The key factor herein is to realize city gas being readily available for the buildings, and for this purpose, the timely installation of HP- network is crucial.

Close monitoring of the progress of the international gas pipeline, therefore, is important for this development.

In order to accelerate the establishment of the gas network, utilizing the existing LPG gas supplier facilities is relevant. These facilities will be useful not only for support of the natural gas network by LPG, but also for peak saving of demand and storage.

Furthermore, a large quantity of natural gas is planned to be used for the generation of electric power and heat as described in "Section 4.5 Power and Heat

Supply". Natural gas supply at high pressure is preferable for these consumers (TETs-1 and 2), and to save procurement cost, natural gas should be directly connected from a natural gas transporter, and not via the city gas network. Accordingly, the boundary of this pipeline between transporter and consumer should be adjusted close to the international gas pipeline.

This pipeline route shall be as short as possible, positioned along main streets, and connecting between the transporter and consumers.

I.4.3 Long Term Development Needs

After the completion of short-term development, introduced natural gas will become a popular source of energy, and will probably be accepted as useful energy in Astana, as is the case in Almaty. The gas network will be expanded according to the subsequent urban development.

The development plan itself shall be adjusted according to the economic availability of natural gas.

I.5 Pre-Design Proposal for New City Center

For the New City Center, the infrastructure planned for 2010 is proposed as follows.

(Refer to attached "FIGURE. 4.6.2 New City Center Gas Supply")

(1) Domestic use

The HP-network for this area will be installed as per "FIGURE. 4.6.1 Plan for City Gas Network". From the HP-network in this area, pressure is adjusted to 300da Pa in the Gas Distribution Station for domestic use. The LP-network does not cross the Ishim River.

(2) Industrial use

Since there will be no special industries in this area, accordingly such consumer usage is not considered.

(3) Mini boiler

Since the required heat for this area can be covered by Heat Center–1 (HC-1), the introduction of mini boilers is not considered.

CHAPTER J
TELECOMMUNICATION

SUPPORTING REPORT J: TELECOMMUNICATION

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J.1 Present Conditions of Telecommunication

J.1.1 Introduction

In this section an analysis of potential problems will be made by the study of present conditions of telecommunications in Astana and the telecommunication requirements will be picked out on the basis of Master Plan perspective.

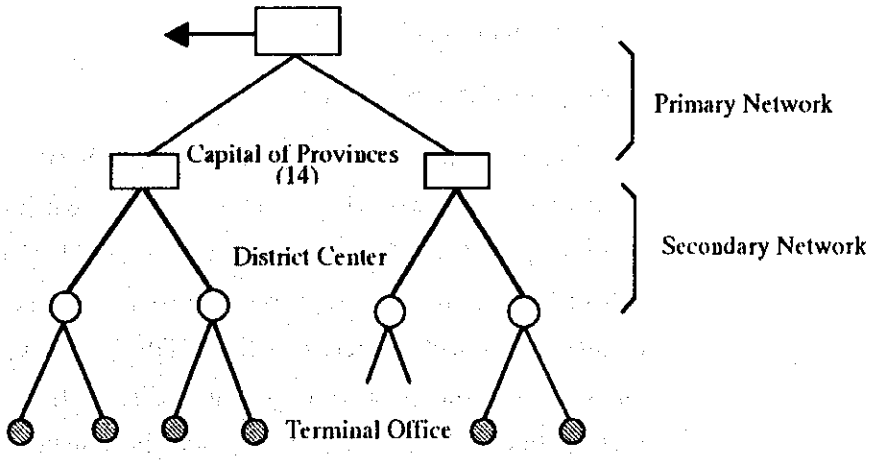
J.1.2 Analysis of Present Conditions of Telecommunications Services

In Astana the telecommunications services are offered by Astanatelecom, a regional affiliate of the Open Stock Company Kazakhtelecom (hereinafter referred to as Kazakhtelecom). Under the supervision of the Ministry of Transportation and Communications, Kazakhtelecom provides the following kinds of services by expanding and reinforcing the telecommunications network:

- Local telephone communication
- Inter-city telephone communication
- International telephone communication
- Telegraph and telex communication
- Data transmission
- Satellite communication

(1) Network Configuration

Kazakhstan is divided into fourteen (14) Provinces (Oblasts), and each province is farther divided into multiple districts. The national telephone network in Kazakhstan is composed of the inter-regional network (primary network) and the intra-regional network (secondary network), having a hierarchical structure.



Current Network Configuration in the Republic of Kazakhstan

(2) Telephone Services and Facilities

1) Telephone Services

In Kazakhstan there are approximately 1,820,000 telephone lines. Average telephone density as of October 1998 was 11.5 lines per 100 inhabitants (comparing with 17.7 in Russia; 16.9 in Ukraine; 6.9 in Uzbekistan). In Astana there are 64,544 telephone lines and average telephone density as of March 2000 was 20.1 lines per 100 inhabitants. Fig.J.1.1 shows the location of present telephone exchanges in Astana.

2) Switching Facilities

Digitalization of the switching system in Astana has been strongly promoted in the last few years. The old analogue type switches remain 37% of the total capacity of the existing switches as of March 2000. Table J.1.1 indicates the state of the existing switching facilities in Astana.

3) Transmission Facilities

The digitalization of transmission lines is in progress to cope with that of telephone exchanges in the existing city area. In the urban area of Astana, the main part of local junction network is SDH optical cable transmission ring with STM-4 Add-drop multiplexes, and STM-1 level SDH optical transmission lines are also employed as the branch lines. Additionally, 140Mb/s and 34Mb/s radio transmission systems are also adopted. The structure of optical fiber cable transmission network in Astana is illustrated in Figure J.1.2 and the radio links in Astana are shown in Figure J.1.3.

4) Outside Plant Facilities

Subscriber Cable Network

The type of the subscriber cable distribution method adopted in Kazakhstan is two kinds, which are a cabinet method (Flexible Network) and a direct distribution method (Rigid Network). The subscriber cable is categorized into a primary cable (main cable) connecting a section between the MDF (main distribution frame) and the cabinet, and a secondary cable(distribution cable) connecting a section between the cabinet and distribution box at a subscriber end. Primary and secondary cables used are air-core type (pressurized with dry air) installed in a duct system. The existing cables in Astana are

conduit cables and aerial cables. Most of these underground cables are paper insulated, lead sheathed cables installed more than 20 to 25 years ago, and mainly these aged cables cause communication failures. Self-support type aerial cable is also used based on the geographical feature. The diameter of the conductor of subscriber cable used is 0.4mm and 0.5mm. For the number of pairs, a cable of 100 to 600 pairs is used for the duct section, cable of 10 to 100 pairs is used for aerial section. For the cabinet, three types are used. Their capacity is 300 pairs, 600 pairs and 1,200 pairs, respectively.

Civil Work

Manholes are generally made of reinforced concrete. The manholes that were made in recent years have been fitted with hardware and the space is sufficient. Manholes are built at a typical interval of 150m maximum. Duct is basically used in the primary cable and secondary cable section. The inside diameter of duct is classified into two types. They are 100mm and 50mm. The asbestos cement is used for the material of the duct.

(3) Numbering Plan

Presently, Kazakhstan has two kinds of own numbering system, which are national numbering system and inter-zones numbering system. Kazakhtelecom will change it to the ITU standard, including special service numbers in the near future.

(4) Signaling System

The signaling system currently used here is a unique system compatible with the ITU-T standardized signaling systems of R1, R2 and No.5 method.

(5) Tariff System

The tariff system of main telecommunication service is applied with three user categories; individuals, government office and enterprises. Table J.1.2 shows Tariff System of Main Telecommunication Services.

(6) Present Service Quality

Generally, telephone service quality is measured by the following indicators; telephone call completion rate, telephone line fault rate, and fault clearance rate. In the telephone network in Astana, the old type exchanges still remain in operation, and most of underground cables are obsolete paper insulated

and lead sheathed cables as mentioned above. In such situation the service quality of Astanatelecom in 1999 is explained in the following table.

Telephone Service quality of Astanatelecom in 1999

Indicators	Results of Astanatelecom	Reference
Call Completion Rate	45 % at inter-city & international call connection	The percentage of call attempts which receive answer. A rate above 60% can be achieved in a good network.
Line Fault Rate	5	The rate indicates as the number of faults a month per 100 main lines. Users will not always satisfy with a rate near 8 that occurs nearly one fault a year.
Fault Clearance Rate	96%	The percentage of cleared faults within next one day. Astanatelecom has regulated an original rule by the kind of faults.
Waiting Applicants (Telephone Density)	About 14,600 (20.1%)	It is expected that the figure of waiting applicants will be nearly zero as a service in the capital.

(7) Present Demand

Present demand in Astana is about 83,500 as indicated in the following table.

(As of January 1st, 2000)

Name	DEL's	Waiting Applicants	Suppressed Demand (30%)	Demand Total
Astana	64,544	14,564	4370	83,478

DEL: Direct Exchange Line

J.1.3 Planned Improvements of the Telecommunication Network by Kazakhtelecom

The telecommunications development plan for the year 2000 of Astanatelecom are shown bellow:

- Network development plan based on a perspective construction plan in Astana.
- Transfer to No.7 common signaling system between digital exchanges.

(1) Committed Projects

According to the Kazakhtelecom, the telecommunication network modernization and development plan for the year 2000~2002 in Astana is approved with the necessary finance sources.

- Introduction of new technology to subscriber line
- Arrangement of digital path for subscribers and provision of ISDN
- Usage of optical fiber cable communication system which is compatible with FTT

- Further development of WLL system
- Usage of TV coaxial cable system for the compatibility of digital communication system
- Further development of SDH transmission network
- Introduction of ATM network
- Development of IP and FR protocols for data transmission system
- Usage of ADSL technology
- Creation of voice transmission in data transmission system, creation of internet networks.

The investment plan includes the construction of digital telephone stations, the construction of remote unit stations in some zones of the right bank of Ishim river and Chubary settlement, construction of new ITS and the replacement of out of date analogue ATCs to the latest digital ATCs. The total capacity of new modernized switching facilities will be 52,572 switch terminals, and their inaugurations were scheduled from 2000 to 2002. Five thousand telephone terminals of them are assembled and supplied by cables for the installation of telephone lines in Abilai-han street and micro districts of N1, 2, 2a, 3, 4, 5. The further development of the telecommunication network will be made by a new capacity accessing on the existing ATC-21 and ATC-36. The following table shows the items of committed projects by Kazakhtelecom.

Updating and Expansion Plan of Telecommunication Network in Astana for 2000~2002

Year	Project	Capacity	Notes
2000	ATC-75	12,000	HOST station
2000	ATC-77	8,000	HOST station
2000	ATC-337/338	2,500	Expansion of RSU (S-12)
2000	ATC-32	3,000	Expansion (S-12)
2000	ATC-34	6,000	Construction of HOST station
2000	ATC, Agrogorodok	1,000	RSU
2000	ATC, Lesozavod	1,700	RSU
2000	ATC, Base of Logistics	1,300	RSU
2000	ATC, Chubary	4,000	HOST station of RSU
2000	Construction of ITS	6,572	New construction
2000	Supplement of SDH ring		
2001	ATC, Agrogorodok		Expansion
2001	ATC-75, ATC-77		Installation and assembling access network cable
2001	ATC-28	6,000	Closing down of ATC-28, and expansion of ATC-21(HOST) for 6,000T (4,000+1,000+1,000)
2001	Project, Okraina		Installation and assembling access network cable in Karaotkel, Energetika villages, micro-districts 15,16 and Tekstilshiky(numbering capacity from ATC-36)
2001	ATC, Promyshlenney	500	Installation of access network and RSU
2001	Junction Circuit		Installation of optical fiber cable network in SDH ring from ATC-335 to ATC-34
2002	New ATC on the left bank of Ishym river		Capacity will be determined according to the development plan of the left bank.
2002	ATC, Kirovo village		Replacement of ATC expanding tel. lines behind the village

J.1.4 Demand Analysis

Astana is the new capital of Kazakhstan, having already more than 20% DEL density. Therefore, the demand forecast of Astana will be estimated by a special method.

(1) Telephone Demand Forecast

According to the capital development plan by JICA Master Plan Team, the zones to be newly developed until 2030 are known as the map of Phase-1 (up to the year 2010), Phase-2 (up to 2020) and Phase-3 (up to 2030). See Figure J.1.4 Planned Districts and Sub-Zoning in Astana. Table J.1.3 Population Framework of the Planned Districts in Astana and Table J.1.4 Working Population Framework of the Planned Districts in Astana. The new telephone office areas will be established, prospecting coming 30 years and according to the population framework of the new area development plan of Astana. See Figure J.1.5 Location Plan of Telecommunication Center and

Telecommunication Center Service Area. Astana has already more than 20% DEL density, therefore the demand forecast of it will be estimated by a special method, in stead of commonly used macroscopic demand forecast (ITU regression model, using statistical data of GDP per capita). Considering that Astana is the new capital and a rapidly developing city, the penetration of DEL is assumed to be:

- 30DELs per 100 inhabitants for Phase-1 (2001~2010)
- 35DELs per 100 inhabitants for Phase-2 (2011~2020)
- 40DELs per 100 inhabitants for Phase-3 (2021~2030)

The telephone density of busy area like New City Center will be estimated not only by the volume of inhabitants but also by the number of working population/floor space and the kind of activities there in the daytime; activities of commercial, presidential, governmental, diplomatic, etc.. The number of DELs for working population of the present Master Plan, however, has been calculated by the following method.

- 30DELs per 100 working population for the new development area
- 25DELs per 100 working population for the existing area

Table J.1.5 shows DEL Forecast of New Development Area in Astana up to 2030, Table J.1.6 shows DEL Forecast of the Existing Town Area in Astana up to 2030 and the following table shows the DEL forecast of the whole city of Astana.

DEL Forecast of the Whole City of ASTANA (up to 2030)

Area	Population	Phase-1(2001-2010)		Phase-2(2011-2020)		Phase-3(2021-2030)	
		Pop.	DEL	Pop.	DEL	Pop.	DEL
NDA	Residents	127,386	38,216	278,642	97,525	368,034	147,215
	Working Pop.	107,548	32,264	168,600	50,582	208,201	62,461
	Sub-total	–	70,480	–	148,107	–	209,675
ETA	Residents	362,650	108,795	408,790	143,077	427,990	171,196
	Working Pop.	146,558	36,640	205,142	51,287	228,015	57,004
	Sub-total	–	145,435	–	194,364	–	228,200
Astana Total		490,036	215,915	687,432	342,471	796,024	437,875
Telephone Density(%)		44.1		49.8		55.0	

NDA: New Development Area, DEL: Direct Exchange Line
ETA: Existing Town Area, Pop: Population

J.1.5 Analysis of Issues in Present Conditions

(1) World Trend on Telecommunications Needs

Recent technological development in the fields of telecommunications, data processing, transportation and various production processes allows us the

worldwide social and economic activities. Consequently the international economic relationship has been getting more complex and tighter day by day. Under such circumstances, the volume of information transactions has much increased, not only in the industrial and service sectors but also by individuals. Furthermore, as a new trend of the world, Information Technology (IT) is being introduced to the whole fields of the society. The new attempt to build a digital government (including local governments) is one of them, which aims the realization of more efficiency of government performance itself, to open governmental information to the public, better access services to the inhabitants/enterprises and a kind of digital democracy. In order to support such information transaction needs, the increase of conventional telephony type service and the introduction of new type telecommunications services such as data communication service (including Internet service) and data/information-processing services are indispensable. Accordingly the new type telecommunication network is an essential infrastructure for the recent social and economical activities and for the efficiency and welfare of individual life.

(2) Telecommunication Needs in the Capital "Astana"

According to the document of "Program on Modernization and Development of Kazakhtelecom from 1999 to 2003", issued by Kazakhtelecom in 1999, the total amount of the project cost for 1999 to 2003 is estimated as about 300 million US$. The financing of the project will mainly depend on the supplier's credit by almost 80% of the project cost, comparing with 20% by own assets. The selection of suppliers will be made by tendering. This supplier's credit might oppress the account balance of the company as a relatively heavy burden in future. The Table J.1.7 shows Major Projects of Modernization and Development Program of Kazakhtelecom from 1999 to 2003, and the Table J.1.8 shows a Prospect on Main Activities of Kazakhtelecom from 1998 to 2003. Another issue concerning company management is how to introduce the time duration charging system to the local call service. Kazakhtelecom says that the time duration charging system is now under an experiment at two places including Karaganda City. It is expected to be introduced to Astana City as early as possible.

The government of Kazakhstan has been emphasizing the needs of adequate, efficient and reliable infrastructures in the national development policy, to realize a higher economic growth of the country and an improvement of the people's standard of living. The telecommunication development is placed on the highest priority, for the efficiency of the whole society, for the

industrial development, for the efficiency and welfare of individual life with educational and clinic support by new telecommunication means, and also for a solution to cope effectively with the severe nature during relatively long winter season in Astana. In this context, the telecommunication system is vital and indispensable to perform the functions as the new capital of Astana, which represents Kazakhstan internationally and domestically. Until 2030 there will appear not only a new city center but also several new residential areas on the both sides of Ishim river. For the daily activities in newly designed commercial, presidential, governmental and diplomatic buildings, the telecommunication system will be essentials and one of the basic social infrastructures. The introduction of a new telecommunication system to Astana new capital is especially important.

J.2 Basic Concepts for Telecommunication Development Plan

J.2.1 Telecommunication Policy for Astana

The basic plan for the development of the telecommunications network in Astana aims to fulfill the telephone demand in the new development area of Astana as soon as possible, in accordance with the present Master Plan. The new telecommunication network will be constructed to upgrade the network structure to more reliable and efficient one and also preparing for the introduction of new type of telecommunication means, considering the increasing roll of the capital and its status. For the realization of it, the latest digital technologies such as optical fiber access network, digital switching systems, optical fiber transmission systems, SDH, IP network and so on, will be used.

J.2.2 Telecommunication Network Plan

(1) Basic Concept of Network Plan

The basic concept of network plan will be framed in line with the following telecommunications policy.

1) The Telecommunications Policy

- Telecommunications facilities should be provided to all the applicants, at cost-based tariffs.
- Universal service should cover the whole country's territory. This implies easy access to basic telecommunications services to all users at affordable and reasonable prices.

- Acceptable quality of service should be attained for basic/ supplementary services for national and international communications.
- Waiting lists for telecommunication services should be eliminated.
- Prompt and effective attention should be focused on both customer complaints and improvement of public relations.

2) Basic Concept of Network Plan

The Basic Concept of Network Plan will be framed in line with the above telecommunications policy and designed in consideration of:

- The basic telephone service is provided by the network, which is economical not only in the installation but also in the operation;
- The network will be made up applying the latest technologies. Targets of the telecommunications quality will be established;
- The network is capable to fulfill every new application of basic telephone service within one year after its registration;
- Satisfaction of customers is responded by an effective operation and maintenance.
- Adoption of the timed local charge system will be assumed;

3) Telecommunication Policy for the Existing Town Area of Astana

Various improvement measures are progressing in the existing town area of Astana under the control of Kazakhtelecom. On the long-term development plan for the existing town area, the following policies will be recommended to Kazakhtelecom, in harmony with the telecommunication development of the new development area of Astana.

- A systematical local network expansion plan is necessary in order to satisfy all the new telephone demands occurring in the area.
- A planned replacement from the old analogue type facilities to the latest digital type facilities is necessary to be promoted with optical fiber access network, digital switching systems, etc.
- To promote a perspective arrangement of telephone office area.
- The key stations like ITC and AMTC should be dispersed by unit/location in order to upgrade the reliability of the capital telecommunication network.

- Preparation for the diversification of telecommunication measures; IP network for data communication and telephone service, cellular telephone service, etc.

(2) Fundamental Technical Plan

1) Numbering Plan

The numbering plan should be studied carefully, considering the following items.

- Numbering structure: country code, trunk code and local number
- Exchange code numbering plan in Astana
- Special service numbers
- Escape code
- Numbering capacity

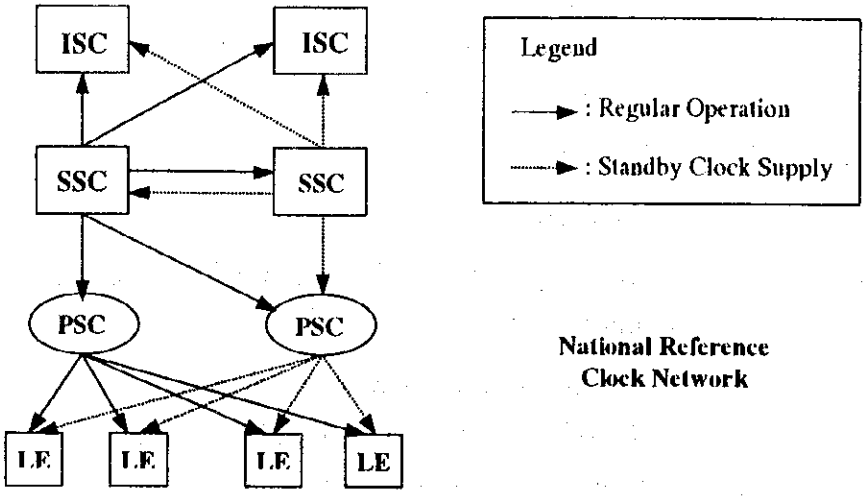
2) Signaling Plan

ITU-T Recommendations indicate the No.7 Signaling System protocols which provide the signaling functions required to support services in a telephone network, data communication network, as well as basic bearer services and supplementary services for voice and non-voice applications in an compliance with the specifications defined by such Recommendations.

ITU-T No.7 Signaling System is essential to introduce ISDN and other new services.

3) Synchronization Plan

The synchronization plan is progressing in Kazakhtelecom. The master clock should have the accuracy of 10^{-11} to satisfy the requirements on slip rate recommended by ITU-T for international digital links. It is recommended that the high accuracy master clock should be introduced to the digital international switch and all digital switches in Kazakhstan should be synchronized to the master. The following figure shows the national reference clock network.



4) Inter-Network Connection

In Astana there are several telecommunication networks besides Kazakhtelecom network, i.e. cellular telephone network, data communication network, etc. A new network will be inter-connected with the existing network through a gate switch. A number of gate switches or the connection points shall be necessary to increase in proportion to the growth of inter-network traffic. The signaling system between the gate switches should be ITU-T No.7 signaling system.

5) Charging System Plan

The charging of calls in new network shall depend on: duration, time of day and distance. The local exchange shall be capable of charging calls. The new switch equipment will comprise IDD facilities, and charging at the booking offices/manual switchboards will be also possible. Charging information will have to be stored on data processing media and the specification for the new switching technology has to be compatible with the existing data format.

(3) Traffic Forecast

Inter-office telephone traffic in Astana is calculated according to the following conditions.

1) Calling Rate(erlang per subscriber)

On the basis of current data in Kazakhtelecom, 0.06 erlang as originating call CR is applied. Moreover, the CR for calls originating and terminating are to be equal to each other.

2) Traffic Distribution

The traffic will be distributed according to the following values on the basis of current data in Kazakhtelecom.

- Intra-office call: 20%
- Local call: 65%
- Toll call: 10%
- International call: 5%

3) Method of Traffic Forecast

Mutual traffic between local switching offices in Astana will be forecast with

Gravity Model Method. Table J.2.1, J.2.2, J.2.3 indicates the traffic matrix in Astana in 2010, 2020, 2030 respectively, calculated from the above mentioned conditions.

4) Sign of Extreme Traffic Growth

Inter-office telecommunication traffic in Astana will be expected to grow rapidly by the following factors.

- Explosive traffic growth of Internet multi media services; data flow by file transfer, down load of movie pictures, e-mail, retrieved information etc. in the near future.
- Traffic growth by the increase of cellular telephone subscribers.
- Traffic growth by the increase of the number of leased circuits.

etc.

(4) Calculation of the Number of Circuits

1) Loss Probability

According to the engineering standard, the loss probability of 0.005 is assigned per link.

2) Circuit Diagram

Figure J.2.1 illustrates the circuit diagram plan of Astana local network.

All circuits are set up with direct final route.

Table J.2.4, J.2.5, J.2.6 indicates the circuit matrix in 2010, 2020, 2030 respectively, calculated under the above mentioned conditions.

J.3 Telecommunication Development Plan

J.3.1 Telecommunication Development Plan

The telecommunication development plan for Astana aims to fulfill the telephone demand in the new development area of Astana as soon as possible, in accordance with the present Master Plan. The new telecommunication network will be constructed to upgrade the network structure to more reliable and efficient one and also preparing for the introduction of new type of telecommunication means, considering the increasing roll of the capital and its status. For the realization of it, the latest digital technologies such as optical fiber access network, digital switching systems, optical fiber transmission systems, SDH, IP network and so on, will be used. The facility plan to construct a telecommunication network in prospective areas of Astana will be made with the latest equipment, where the new population is expected to reach 150,000 by 2010, 310,000 by 2020, 400,000 by 2030, respectively. Issues as to how the proposed facility to be connected with the existing network will also be considered.

(1) Switching Facilities

- The facilities to be introduced shall satisfy the demand planned for 2010, 2020 and 2030, respectively in the prospective areas of Astana.
- Digital switching systems shall exclusively be adopted for new installation.

The following table shows the work quantity of switching facilities.

Work Quantity of Switching Facilities

ATS	Switching Facilities (2010)			Switching Facilities (2020)		
	Type	Capacity	Contents	Type	Capacity	Contents
ATC-A	Digital	29,400	New	Digital	53,800	Expansion
ATC-B	Digital	22,100	New	Digital	29,400	Expansion
ATC-C	Digital	12,300	New	Digital	14,100	Expansion
ATC-D	–	–	–	Digital	15,200	New
ATC-E	–	–	–	Digital	17,600	New
ATC-F	–	–	–	Digital	18,200	New
Total		63,800	-	-	148,300	-

ATS	Switching Facilities (2030)			Remarks
	Type	Capacity	Contents	
ATC-A	Digital	72,800	Expansion	
ATC-B	Digital	33,200	Expansion	
ATC-C	Digital	15,900	Expansion	RSU(HOST: ATC-B)
ATC-D	Digital	26,500	Expansion	
ATC-E	Digital	19,800	Expansion	RSU(HOST: ATC-B)
ATC-F	Digital	41,700	Expansion	
Total		209,900	-	

(2) Transmission Facilities

Considering the network reliability, the ring configuration as the SDH transmission network topology will be adopted at Phase-1 (~2010), connecting three (3) new switching offices; ATS-A, ATS-B and ATS-C. Other three new switching offices; ATC-D, ATC-E and ATC-F will be added to the ring configuration at Phase-2 (~2020).

- The new ring will have the independent structure with the existing ring network. The connection points of these two ring networks shall be at ATC-21 and ATC-36 offices.
- To be economical, some joint facilities will be installed between new ring and the existing ring as long as no infliction to the network independence will occur. Main facilities of these rings are cable ducts between telephone offices and DF (Distribution Frame) in the offices.

Figure.J.3.1 shows Future Configuration of Astana Local SDH Ring Transmission System (Phase-1), Figure.J.3.2 shows that of Phase-2 and Figure.J.3.3 shows the Route Plan of Astana Local Junction Cable Ring.

Work Quantity of Local Junction Network Facilities

Items	Year	Quantity	Notes
STM-16 ADM	Phase-1	1	Ring configuration by SDH (ATC-A－ATC-B－ATC-C－ATC-36－ATC-21－ATC-A)
STM-16 ADM	Phase-2	Expansion	Ring configuration by SDH (ATC-A－ATC-D－ATC-E－ATC-B－ATC-C－ATC-36－ATC-21－ATC-F－ATC-A)

(3) DLC(Digital Loop Carrier) Facilities

Considering the possibility of introducing various new services, optical cable transmission systems would be introduced in subscriber lines to nearby subscribers as close as possible. Specifically, the introduction of FTTC (Fiber to the Curb) system will be planned in the residential district. Introduction of FTTB (Fiber to the Building) system will be planned mainly in the New City Center, Business Area, Governmental Area and Presidential Area, which will be in ATC-A office area. The following table shows the work quantity of DLC Facilities.

Work Quantity of DLC Facilities

Telephone Office	2010		2020		2030		Notes
	Cap.	Quant.	Cap.	Quant.	Cap.	Quant.	
ATC-A:							
DLC Controller		4		6		8	
Indoor DLC	720	44	720	80	720	108	
Outdoor DLC	480	2		4		5	
ATC-B:							
DLC Controller		6		7		8	
Outdoor DLC	480	51	480	68	480	77	
ATC-C:							
DLC Controller		3		4		4	
Outdoor DLC	480	29	480	33	480	37	
ATC-D							
DLC Controller		-		4		7	
Outdoor DLC	-	-	480	35	480	61	
ATC-E							
DLC Controller		-		5		5	
Outdoor DLC	-	-	480	41	480	46	
ATC-F							
DLC Controller		-		5		10	
Outdoor DLC	-	-	480	42	480	96	

(4) Outside Plant Facilities

Telecommunication outside plant consists of cable facilities and civil facilities. Figure.J.3.4 shows the outside plant facilities to be considered in the present Master Plan. The design criteria for them are as described below.

Subscriber Cable Network:

■ Efficient construction of reliable subscriber cable network will be realized with DLC (Digital Loop Carrier). In this system, the cable from the telephone exchange to DLC (Outdoor or Indoor Type) is called optic feeder cable, while the metallic cable from the DLC to DP (Distribution Point) is called the secondary cable. The application of DLC (Outdoor Type/Indoor Type) in the new development area is as follows.

Application of DLC

DLC	Area to be applied
Indoor Type (Capacity:720 lines)	Business area, Governmental area and Presidential area of the New City Center
Outdoor Type (capacity:480 lines)	All the residential district, Diplomatic area of the New City Center

■ Distribution of Optic Feeder Cable

In consideration of the security of the facilities, the duct system will be used for optic feeder cable, which has to accommodate a large number of subscribers. This system facilitates easy cable expansion to meet increased demand and easy replacement of fault cables. This system can also protect cables from damages due to construction work for other underground facilities. Cable connection will be done in manholes.

■ Distribution of Secondary Cable

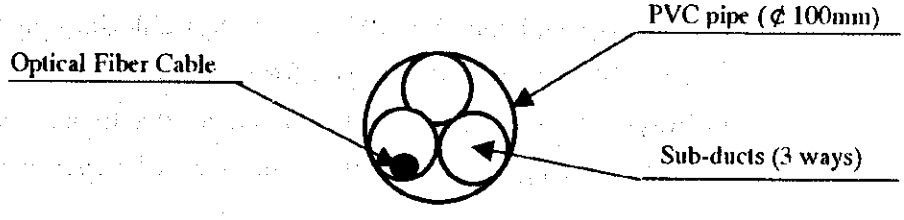
For secondary cables, the direct buried cable method (steel tape armored cables) in which cables are directly buried under the ground will be used in principle.

■ Catchment Area

A distribution area is an area used to achieve effective management of outside plant facilities which permit efficient utilization and proper expansion of facilities and once established, the area boundary may not be changed easily. The area size will be so designed that approximate 500 subscribers will be accommodated in each area. The area is usually bounded by highways, rivers, railways, etc.

■ Primary Cable and Secondary Cables Installation

For primary cable to be installed into sub-duct, Optical Fiber Cable (OFC) will be used. For secondary cable to be installed buried directly under the ground, jelly-filled, polyethylene insulated and polyethylene sheathed cable will be used, so that cable can be protected from faults due to water penetration. By this method, the cable maintenance level can be raised



■ Calculation of number of DLCs at the present Master Plan

Following calculation formula shall be applied for this project.

P = (Switching capacity x 1.1)/ Digital loop carrier (DLC) capacity

■ Calculation of number of pairs of secondary cable

Following calculation formula shall be applied for this project

S = (Switching capacity x 1.1) x 1.3

■ Type of Cables

Optical fiber cable (primary cable) core number, jelly-filled cable (secondary cable) pair number and conductor diameter to be used are listed in the following table.

Type of Cables

Cables	Contents		Usage
Optical Fiber Cable	12 cores, 24 cores		Primary cable
Armored Jelly-Filled Cable	Conductor Diameter	Cable Pairs	Secondary cable
	0.4mm	200, 100, 50, 30, 20, 10	
	0.5mm	200, 100, 50, 30, 20, 10	

Junction Cable Network:

■ Optical fiber cable is established by utilizing existing duct of Kazakhtelecom, where available.

■ Composition of Optical Fiber Junction Cable System

The optical fiber cable system to be applied for this project shall consist of some sub-systems and items such as:

- Sub-duct system
- Conduit optical fiber cable system
- Optical fiber cable jointing and terminating

Civil Work :

■ Types of Conduit

For underground conduits, PVC (polyvinyl-chloride) pipes will be used in general. Steel pipes will be used for cables installed along a bridge and a railway, or for the section liable to damages due to other construction work, or at the crossing of heavy traffic roads, etc., wherever necessary.

■ Sub-duct

Sub-duct pipes shall be pulled into already installed 100 mm PVC pipes or 100 mm galvanized steel pipes for the accommodation of optical fiber cables.

■ Type of Manholes

Manholes will be installed at cable connection points or branching points, or any other points necessary for ensuring proper cable installation and maintenance. Sizes of manholes will be determined in view of the following.

- Necessary number of conduits
- Required working space
- Existence/non-existence of cable joints
- Size to meet requirement of radius of curvature

■ Manhole Section

Manhole section should be determined in consideration of locations of cable branching and DLC, road configuration, etc. In any case, it should not exceed 250m in consideration of workability in cable installation.

■ Protection of Direct Buried Cables

To protect direct buried cables from damages due to construction work for underground structures of other authorities; a warning tape should be buried between the direct buried cables and the ground surface.

(5) Power Supply Facilities

■ Receiving the general power supply at each office, the power supply system shall allow automatic changeover to a generator at the time of service interruption.

■ The power supply capacity shall be planned in consideration of the future facilities expansion in addition to the exchange and transmission facilities planned to be constructed in the project.

■ The battery discharge time shall be about 2 hours in an office with a generator.

Work Quantity of Power Supply Facilities

Telephone Office	Power Receive	Rectifier	Battery	Generator	Air Conditioner
ATC-A	New	New	New	New	New
ATC-B	New	New	New	New	New
ATC-C	New	New	New	New	New
ATC-D	New	New	New	New	New
ATC-E	New	New	New	New	New
ATC-F	New	New	New	New	New

(6) Buildings

As for the new telephone office, the buildings that comply with the standard of Kazakhtelecom will be built.

Work Quantity of Buildings

Telephone Office	State	Notes
ATC-A	New	Standard type for 73,000 lines station
ATC-B	New	Standard type for 34,000 lines station
ATC-C	New	Standard RSU type for 16,000 lines station
ATC-D	New	Standard type for 27,000 lines station
ATC-E	New	Standard RSU type for 20,000 lines station
ATC-F	New	Standard type for 42,000 lines station

(7) Administration Data Communication Network

It will be urgently necessary to install an Administration Data Communication Network which connects all categories of state and government communications among Government, Ministries, General Administration Offices and Astana local government, in order to realize more efficiency of government performance, improving the information exchange speed and reliability greatly. The new network will be consisted of Internet Protocol (IP) network. See Figure J.3.5 Administration Data Communication System by IP Network in Astana.

J.3.2 Project Implementation Plan

(1) Preliminary Cost Estimation

The project investment amount shall be calculated according to the basic policy below.

- This project shall be implemented by the turn key basis.
- A consultant shall be hired for smooth project implementation.
- The investment amount shall be calculated for the foreign and local currencies.

1) Project investment amount by the facilities of Astana new local telecommunication network.

The following table shows the project investment amount by the facilities of Astana new local telecommunication network.

Project Investment Amount of Facilities-1

(Unit : thousand US$)

Facilities	Phase-1		Phase-2		Phase-3	
	Foreign Portion	Local Portion	Foreign Portion	Local Portion	Foreign Portion	Local Portion
Switching System	6,700	429	8,900	570	6,444	413
Transmission System (STM-16 ADM)	559	76	743	101	538	73
Digital Loop Carrier Equipment	13,776	1,572	18,300	2,088	13,250	1,512
Outside Plant	10,230	4,651	13,590	6,179	9,839	4,473
Power Supply System	857	62	1,139	82	824	60
Buildings	0	460	0	611	0	442
Training	225	0	225	0	225	0
Sub-total	32,347	7,250	42,897	9,631	31,120	6,973
Consultant Fee(7%)	2,264	507	3,002	674	2,178	488
Sub-total 2	34,611	7,757	45,899	10,305	33,298	7,461
Grand Total	42,367		56,204		40,759	

2) Project Investment Amount of Administration Data Communication Network (IP Network)

The following table shows the project investment amount by the facilities of Administration Data Communication Network (IP Network)

This project has been planed for phase-1 period.

Project Investment Amount of Facilities-2

(Unit : thousand US$)

Facilities	Foreign Portion	Local Portion
Capital Sub-Center System	7,526	489
IT Center System	795	52
Sub-total	8,321	541
Consultant Fee(7%)	583	38
Sub-total 2	8,904	579
Grand Total	9,483	

(2) Project Implementation Plan

1) Basic Policy

The following matters shall be taken into consideration in formulating the implementation plan.

■ The turn-key method shall be adopted for implementation of the project.
A consultant shall be hired for smooth project implementation.

The jobs to be performed by the consultant are as follows:

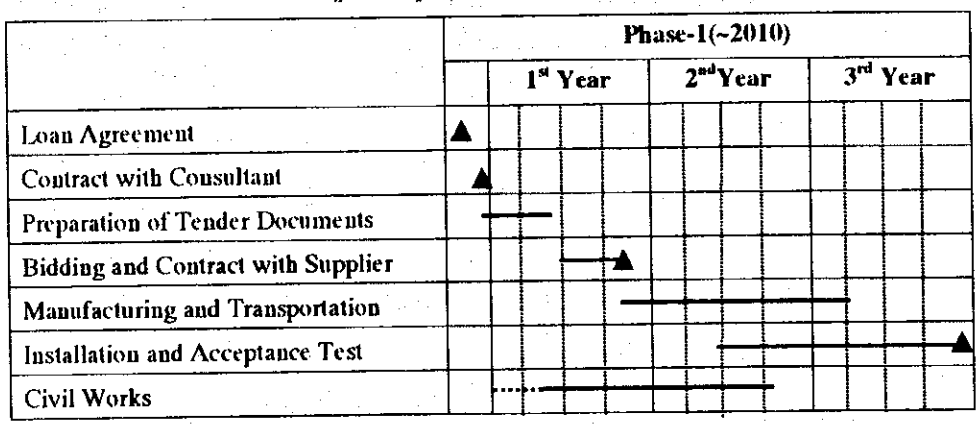
- Preparing the detailed design, specification and tender documents
- Examining bid documents and supporting negotiation for contract
- Witnessing factory inspection of products
- Supervising the construction work and witnessing the acceptance test

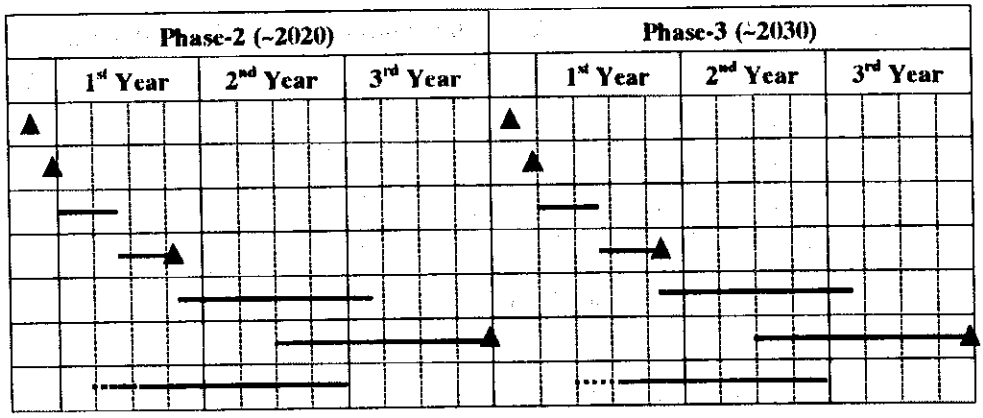
The construction work shall be completed within three (3) years after the contract of loan agreement.

2) Implementation Schedule

The following table shows the implementation schedule of the project.

Project Implementation Schedule





J.4 Pre-Design Proposals for New City Center Area

Considering the character of the area as the core district of the new capital, the telecommunication network will be constructed to make the network structure more reliable and efficient and also preparing for the introduction of new type of telecommunication means. For this purpose, the latest digital technologies such as optical fiber access network, digital switching system, optical fiber transmission system, SDH, IP network, and so on, will be adopted.

The plans ordered and the construction works in progress in the existing villages like old Prigorodonoye in the New City Area will be given careful considerations. The following table shows the telecommunication facility plan for the New City Center in 2010, and Figure. J.4.1 shows Telecommunication Facility Plan for New City Center in 2010.

Telecommunication Facility Plan for New City Center(2010)

Facilities	Capacity, Type, etc.	Contents	Remarks
Switching Facilities	Total 26,500 lines, Digital	New	ATC-A, ATC-B, ATC-C
Transmission System	STM-16, Digital	New	ATC-2－ATC-A－ ATC-B－ATC-C－ ATC-36
DLC Equipment	Indoor Type, Outdoor Type	New	ATC-A, ATC-B, ATC-C
Outside Plant	Optical Fiber Access Network	New	ATC-A, ATC-B, ATC-C
Power Supply System	Power Receive, Rectifier, Battery, Generator, Air Conditioner	New	ATC-A, ATC-B, ATC-C
Buildings	Standard type for 68,000 L. Standard type for 33,000 L. Standard type for 16,000 L.	New	ATC-A, ATC-B, ATC-C

Note. L.: Lines

TABLE

Table J.1.1 Existing Switching Facilities in Astana (as of March, 2000)

Exchange	Type	Style	Capacity	No. of Lines	Notes
ITC	S-12	Digital	1,500		International Switch
AMTC/ATC-33	S-12	Digital	5,940		Inter-city Switch, in 1994
ATC-32	S-12	Digital	8,192	7,495	Local Switch In 1994
ATC-33/ATTE	S-12	Digital	2,000	1,862	In 1994
ATC-370	DTS-1100A	Digital	500	326	In 1998
ATC-390	DTS-3100	Digital	512	386	In 1997
ATC-391	ALCATEL, 4300L	Digital	2,500	944	In 1998
ATC-26	ATS-54A	Decade-Step	7,000	6,321	In 1978
ATC-28	ATSKU	Coordinate	4,000	3,634	In 1995
ATC-36	S-12	Digital	17,000	9,743	In 1999
335/6	S-12 RSU	Digital	1,952	1,883	In 1995
345/6	S-12 RSU	Digital	1,976	942	In 1995
ATC-34	S-12	Digital	3,840	3,478	In 1995
331/2	S-12 SSA	Digital	1,960	900	In 1994
355/6	S-12 RSU	Digital	1,952	1,708	In 1995
337/8	S-12 RSU	Digital	1,464	1,387	In 1994
ATC-24	ATS-54/54A	Decade-Step	10,000	1,057	In 1972
ATC-77	ATSKU	Coordinate	6,000	5,781	In 1989
ATC-75	ATS-54/54A	Decade-Step	10,000	9,297	In 1975
ATC-21	5ESS(HOST)	Digital	4,000	128	In 1999
224/5 228/9	5ESS RAIU-1	Digital	4,000	1,625	In 2000
226/7	5ESS RAIU-2	Digital	2,000	1,074	In 2000
221-3	5ESS RAIU-3	Digital	3,000	1,568	In 1999
230 237-9	5ESS RAIU-4	Digital	4,000	382	In 1999
231-3	5ESS RAIU-5	Digital	3,000	1,560	In 1999
286	PSK-1000	Coordinate	1,000	951	In 1987
ATC-58	DEFINITY	Digital	120	51	In 1999
Total			109,408	64,544	

Table J.1.2 Tariff System of Main Telecommunication Services (with VAT)

Type of Service	Individuals	Government Office	Enterprises
1.Telegraph service			
1) Telegrams within Kazakhstan			
- Normal(tenge/word)	3.4	6.0	7.2
- Urgent(tenge/word)	8.5	10.2	12.24
2) International telegrams for CIS countries			
- Normal($/word)	0.38	0.38	0.38
- Urgent($/word)	0.77	0.77	0.77
3) International telegrams for other countries			
- Europe($/word)	1.1	1.1	1.1
- Asia, Africa, America, Australia($/word)	1.23	1.23	1.23
2. Telephone service			
1) Inter-city call(tenge/minute)			
- up to 100 km (1 zone)	5.8	8.88	19.44
- 101－300 (2 zone)	7.3	9.96	21.72
- 301－600 (3 zone)	8.7	10.92	24.24
- 601－1,000 (4 zone)	10.3	12.96	29.04
- 1,001－3,000 (5 zone)	10.5	14.16	30
2) International call($/minute)			
- 1 zone(CIS)			
Caucasian countries(except Azerbaijan)			
Central Asia(except Turkmenistan)	0.36	0.76	0.76
- 2 zone(CIS)			
Russia, Ukraine, Moldova,			
Turkmenistan, Azerbaijan,	0.50	1.0	1.0
Belorussia, Baltic countries			
-3 zone			
Europe-1, America-1			
-4 zone	1.50	1.50	1.50
Asia-1, Europe-2, America-2			
-5 zone	2.09	2.09	2.09
Europe-3, Australia, Asia-2			
America-3	2.50	2.50	2.50
-6 free zone			
America-4, Asia-3, Africa			
Australia-2(Outside territories)	3.22	3.22	3.22
Europe-4			
-7 Free zone			
Asia-4, America-5, Oceanian countries			
-8 zone	4.13	4.13	4.13
INMARSAT A			
INMARSAT B	7.40	7.40	7.40
INMARSAT M,	6.80	6.80	6.80
INMARSAT AIRCOM	6.80	6.80	6.80
3) Local call	7.40	7.40	7.40
-Installation Charge(tenge)			
To digital station	12,000	51,600	51,600
To analogue station	8,000	38,400	38,400
-Call Charge			
Time charge(tenge/minute)	0.5	0.7	0.7
Flat charge(tenge/month)			

Single telephone line	370	703.2	1,140
Coupled telephone line	290	558	912
-Connection to governmental line of ATS in Astana(tenge/month)	-	7,118.4	7,118.4
3. Radio Service			
- For major radio connections(tenge/month)	25.2	30.96	42.84
4. Dial-up Internet($/hour)			
working time: hours and minutes			
-Monday—Friday			
8:00-18:00	1.4	1.4	1.4
18:00-23:00	2.28	2.28	2.28
23:00- 8:00	1.08	1.08	1.08
-Saturday—Sunday			
8:00-23:00	1.08	1.08	1.08
23:00- 8:00	0.72	0.72	0.72

VAT: Value Added Tax

Table J.1.3 Population Framework of the Planned Districts in Astana

Planning Region	Sub-Zoning	Population			Notes
		2010	2020	2030	
1. Central Planning Region	Residential District 3	46,300	52,300	58,300	
	Residential District 4A	63,200	69,600	69,600	
	Residential District 5	39,000	43,900	43,900	
	Residential District 6	42,300	46,600	46,600	
2. Northern Planning Region	Northern Industrial District	5,624	5,624	5,624	
	Central Industrial District	3,410	3,410	3,410	
	Planning District I	0	0	0	
	Planning District II	0	0	0	
	Planning District III	0	0	0	
	Planning District IV	0	0	0	
3. South-Eastern Planning Region	Residential District 7	78,891	81,891	81,891	
	Residential District 8	30,800	30,800	30,800	
	Residential District 9	29,174	29,174	29,174	
	Residential District 10	5,800	11,000	11,000	
	Industrial District-Station 40	10,062	10,062	10,062	
	Residential District 17	59,131	69,272	69,272	
	Residential District 18	0	28,391	28,391	
	Residential District 19	0	17,918	17,918	
	Planning District V	3,895	3,895	3,895	
4. Southern Planning Region	Residential District 11	3,940	7,080	54,156	
	Residential District 12	16,315	16,315	16,315	
	Residential District 13	8,825	8,825	8,826	
	Residential District 14	9,753	26,758	45,821	
	Residential District 15	0	15,470	18,006	
	Residential District 16	426	20,448	41,165	
	Planning District VI (New Airport Planning Unit)	0	0	0	
	Planning District VII	2,500	2,500	2,500	
	Planning District VIII	0	0	0	
5. Northwest Planning Region	Residential District 1	4,500	9,000	13,500	
	Residential District 2	22,500	31,200	39,900	
	West Industrial District	70	70	70	
	Residential District 4B	3,620	45,929	45,929	
	Planning District IX	0	0	0	
Grand Total		490,036	687,432	796,024	

Table J.1.4 Working Population Framework of the Planned Districts in Astana

Planning Region	Sub-Zoning	Population			Notes
		2010	2020	2030	
1. Central Planning Region	Residential District 3	23,971	36,523	42,185	
	Residential District 4A	33,390	47,410	53,471	
	Residential District 5	5,338	6,478	6,841	
	Residential District 6	5,144	6,121	6,494	
2. Northern Planning Region	Northern Industrial District	21,220	31,231	33,706	
	Central Industrial Zone	31,923	45,133	48,455	
	Planning District I (High Tech Industrial Park)	0	0	0	
	Planning District II (High Tech Industrial Park)	0	0	0	
	Planning District III (High Tech Industrial Park)	0	0	0	
	Planning District IV (Military Academy)	0	0	0	
	Planning District IV (Cargo Center+Services)	600	1,200	1,800	
3. South-Eastern Planning Region	Residential District 7	9,595	10,757	11,412	
	Residential District 8	4,289	4,624	4,880	
	Residential District 9	4,063	4,380	4,623	
	Residential District 10	808	1,651	1,743	
	Industrial Zone Station 40	3,624	4,402	4,496	
	Residential District 17	8,235	10,399	10,976	
	Residential District 18	0	4,262	4,498	
	Residential District 19	0	2,690	2,839	
	Planning District V	471	500	510	
4. Southern Planning Region	Residential District 11	549	1,063	8,581	
	Residential District 12	2,272	2,449	2,585	
	Residential District 13	54,286	69,351	76,741	
	Residential District 14	33,324	55,612	72,957	
	Residential District 15	0	2,322	2,853	
	Residential District 16	59	3,070	6,522	
	Planning District VI (Airport- Airport City)	2,500	2,500	2,500	
	Planning District VII (Sports City)	0	389	224	
	Planning District VII (University)	0	1,650	2,800	
	Planning District VII (International Exhibition)	483	180	867	
	Planning District VIII	0	0	0	
6. North-Western Planning Region	Residential District 1	627	1,351	2,139	
	Residential District 2	3,134	4,684	6,322	
	Western Industrial Zone	3,699	4,467	4,919	
	Residential District 4B	504	6,895	7,277	
	Planning District IX	0	0	0	
Grand Total		254,106	373,742	436,216	

Table J.1.5 Direct Exchange Lines Forecast of New Development Area in ASTANA (up to 2030)

ATC	Population	Phase-1(2001-2010)		Phase-2 (2011-2020)		Phase-3 (2021-2030)		Remarks (District No.)
		Population	DEL	Population	DEL	Population	DEL	
A	Residents	12,802	3,841	45,277	15,847	66,876	26,751	New City Center
	Working Population	85,075	25,522	126,487	37,946	153,425	46,028	
	Sub-total		29,363		53,793		72,779	(13*1, 14, 15, VI, VII)
B	Residents	62,772	18,832	72,913	25,520	72,913	29,165	
	Working Population	10,662	3,198	12,825	3,848	13,403	4,021	
	Sub-total		22,030		29,368		33,186	(13*2,17)
C	Residents	33,809	10,143	33,809	11,833	33,809	13,524	
	Working Population	7,153	2,146	7,469	2,241	7,713	2,314	
	Sub-total		12,289		14,074		15,838	(9, 13*3)
D	Residents	426	128	38,366	13,429	59,083	23,634	
	Working Population	59	18	5,760	1,728	9,361	2,809	
	Sub-total		146		15,157		26,443	(16, 19)
E	Residents	13,957	4,187	42,348	14,822	42,348	16,940	
	Working Population	4,095	1,229	9,164	2,750	9,504	2,851	
	Sub-total		5,416		17,572		19,791	(18, Station40, V)
F	Residents	3,620	1,086	45,929	16,076	93,005	37,202	
	Working Population	504	151	6,895	2,069	14,795	4,438	
	Sub-total		1,237		18,145		41,640	(4B, 11, IX)
NDA Total	Residents	127,386	38,216	278,642	97,525	368,034	147,214	
	Working Population	107,548	32,264	168,602	50,582	208,201	62,461	
	Total		70,480		148,107		209,675	
Telephone Density (%)		55.3		53.2		57.0		

ATC: Automatic Telecommunication Center,
DEL: Direct Exchange Line
NDA: New Developing Area
*1: Left bank of Ishim River, *2: Northern part of the right bank of Ishim River,
*3: Eastern & Southern part of the right bank of Ishim River

Table J.1.6 Direct Exchange Lines Forecast of Existing Town Area in ASTANA (up to 2030)

ATC / Phase		Phase-1(2001-2010)		Phase-2 (2011-2020)		Phase-3 (2021-2030)		Remarks (District No.)
		Population	DEL	Population	DEL	Population	DEL	
ATC-36	Residents	118,901	35,670	127,101	44,486	127,101	50,840	(7,8,10, Central Ind.) (Ⅲ, Ⅳ)
	Working Population	47,214	11,803	63,365	15,842	68,290	17,072	
ATC-21	Residents	81,300	24,390	90,500	31,675	90,500	36,200	(5, 6)
	Working Population	10,482	2,621	12,599	3,150	13,335	3,334	
ATC-32	Residents	83,455	25,037	92,995	32,549	92,995	37,198	(4A, 11, 12)
	Working Population	36,211	9,053	50,922	12,731	57,119	14,280	
ATC-27	Residents	78,994	23,698	98,194	34,368	117,394	46,958	(1, 2, 3, North Ind.) (West Ind. Ⅰ, Ⅱ)
	Working Population	52,651	13,163	78,256	19,564	89,271	22,318	
ETA Total	Residents	362,650	108,795	408,790	143,077	427,990	171,196	
	Working Population	146,558	36,640	205,142	51,287	228,015	57,004	
	Sub-Total		145,435		194,364		228,200	
Telephone Density (%)		40.1		47.5		53.3		

ATC: Automatic Telecommunication Center
DEL: Direct Exchange Line
ETA: Existing Town Area

Table J.1.7 Major Projects of Modernization and Development Program from 1999 to 2003

(mil. US$)

No	Name of Project	Capacity	Cost (mil US$)	Imple. Term	Financial Condition		Volume of Investment					Total
					Own Funds	Credit	1999	2000	2001	2002	2003	
1	Installation of Super Main Transmission Route											
	Shymkent-Aktyubinsk-Atyrau-Russia	2,500 km	43.70	1999-2000	5.7	38	17.53	26.17				43.70
	Akmola-Pavlodar-Ust Kamenogorsk-Taldykorgan	2,100 km	36.80	2000-2002	4.8	32		12.27	12.27	12.26		36.80
	Almaty-Petropavlovsk	1,400 km	24.73	2000-2002	3.23	21.5		8.24	8.24	8.25		24.73
	Atyrau-Aktau	500 km	8.63	2001-2003	1.13	7.5			2.88	2.88	2.87	5.76
	Atyrau-Uralsk	500 km	8.63	2001-2003	1.13	7.5			2.88	2.88	2.87	5.76
	Aktyubinsk-Kostanai-Akmola	1,300 km	23.00	2001-2003	3	20			7.67	7.67	7.66	15.34
	Aktyubinsk-Uralsk-Russia	500 km	8.63	2001-2003	1.13	7.5			2.88	2.88	2.87	5.76
	Central RR Line, Zharkent-Almaty-Bishkek-Abai		0.20	1999	0.2	0	0.20					0.20
	Central RR Line, Karaganda-Balkhash-Kapchagai		4.25	1999	0.28	3.97	4.25					
2	Introduction of Digital ATC	600,000 lines	99.80	1998-2001	33.27	66.53	32.70	32.70	32.70			98.10
3	Installation of Equipment, Replacement of AMTS	16,890 lines	6.60	1998-1999	1.6	5	6.60					6.60
4	DAMA		8.00	1998-2000	2	5.997	2.40	5.60				8.00
5	National Data Transmission Network		10,00	1999-2001	0	10	3.33	3.33	3.34			10.00
6	Public telephones	10,000 lines	4.32	1998-1999	0.2	4.12	4.32					4.32
7	Multiplexing Equipment for Subscriber's Lines: PCM		1.13	1999	0	1.13	1.13					1.13
8	Others		10.40	1999	5.4	5	10.40	10.00	10.00	10.00	10.00	10.00
	TOTAL		298.82		63.07	235.75	82.86	98.31	82.86	46.82	26.27	276.20

Table J.1.8 Prospect on Main Activities of Kazakhtelecom from 1998 to 2003

Activities	Unit	1998	1999	2000	2001	2002	2003
1. The number of main telephone lines	thousand	1,785	1,813	1,881	1,959	1,964	1,969
Total resident lines	thousand	1,430	1,430	1,477	1,540	1,544	1,548
Residents lines in urban	thousand	1,240	1,240	1,287	1,345	1,349	1,353
Resident lines in rural	thousand	190	190	190	195	195	195
Total organization lines	thousand	355	383	404	419	420	421
Organization lines in urban	thousand	315	343	364	379	380	381
Organization lines in rural	thousand	40	40	40	40	40	40
Growth rate in comparison with the previous year	percent	99	102	104	104	100	100
Telephone density	percent	11.3	11.5	11.9	12.4	12.4	12.5
2. Revenues due to main activity total	mln.tenge (mln$)	23,500(294)	24,965(312)	27,924(350)	29,506(369)	33,544(419)	34,161(427)
Growth rate in comparison with the previous year	percent		106	112	105	114	102
3. Profit due to main activity	mln.tenge (mln$)	5,547(69)	6128(77)	11,533(144)	13,342(167)	16,870(211)	17,358(217)
Growth rate in comparison with the previous year	percent			188	116	126	103
4. Incomes per worker	thous.tenge (thous.$)	618(7.7)	832(10.4)	1,119(14.0)	1,475(18.4)	1,677(21.0)	1,708(21.4)
Growth rate in comparison with the previous year	percent		135	134	132	114	102
5. Profitability of Business	percent	12	12	23	26	30	31

Table J.2.1 Traffic Matrix in Astana(2010)

	ATC36	ATC21	ATC32	ATC27	A	B	C	D	E	F	ATTE	ITS	Total
ATC36	542.34	285.56	307.59	330.14	330.75	245.54	190.07	1.08	52.51	19.36	271.17	135.59	2,711.70
ATC21	285.34	320.64	317.21	219.91	104.07	60.35	30.05	0.32	14.28	10.56	160.32	80.16	1,603.20
ATC32	307.13	316.99	397.02	353.67	157.34	79.32	36.48	0.43	18.50	20.45	198.51	99.25	1,985.10
ATC27	330.18	220.11	354.24	407.24	198.37	110.19	45.58	0.65	27.88	36.33	203.62	101.81	2,036.22
A	330.45	104.07	157.44	198.17	335.57	186.99	60.75	1.12	35.35	16.27	167.78	83.89	1,677.84
B	245.39	60.36	79.39	110.10	187.04	255.31	71.83	1.40	67.06	7.20	127.66	63.83	1,276.56
C	189.90	30.05	36.50	45.54	60.75	71.81	138.66	0.24	13.05	2.81	69.33	34.67	693.30
D	1.08	0.32	0.43	0.65	1.12	1.40	0.24	1.73	0.33	0.04	0.86	0.43	8.64
E	52.49	14.28	18.52	27.87	35.37	67.08	13.06	0.33	70.99	1.72	35.50	17.75	354.96
F	19.34	10.55	20.46	36.28	16.26	7.19	2.81	0.04	1.72	35.28	17.64	8.82	176.40
ATTE	271.17	160.32	198.51	203.62	167.78	127.66	69.33	0.86	35.50	17.64	-	-	1,252.39
ITS	135.59	80.16	99.25	101.81	83.89	63.83	34.67	0.43	17.75	8.82	-	-	626.20
Total	2,710.38	1,603.41	1,986.57	2,035.01	1,678.32	1,276.67	693.54	8.64	354.91	176.48	1,252.39	626.20	14,402.51

Table J.2.2 Traffic Matrix in Astana(2020)

	ATC36	ATC21	ATC32	ATC27	A	B	C	D	E	F	ATTE	ITS	Total
ATC36	678.00	309.59	327.98	364.06	472.78	227.94	182.07	90.88	128.91	99.30	339.00	169.50	3,390.00
ATC21	309.48	412.52	374.98	268.85	164.93	62.10	31.91	29.55	38.86	60.04	206.26	103.13	2,062.62
ATC32	327.68	374.78	521.62	425.32	245.28	80.30	38.11	39.88	49.52	114.39	260.81	130.40	2,608.08
ATC27	364.20	269.05	425.87	582.25	319.71	115.33	49.23	61.64	77.18	210.11	291.13	145.56	2,911.26
A	472.83	165.01	245.53	319.62	593.68	253.88	85.11	138.51	126.93	122.02	296.84	148.42	2,968.38
B	227.98	62.14	80.39	115.31	253.90	341.12	65.34	112.18	156.36	35.06	170.56	85.28	1,705.62
C	182.09	31.93	38.15	49.22	85.11	65.34	159.25	20.20	31.41	14.12	79.63	39.81	796.26
D	90.92	29.58	39.93	61.65	138.56	112.21	20.21	178.93	68.96	19.52	89.47	44.73	894.66
E	128.98	38.89	49.60	77.19	126.99	156.41	31.43	68.97	215.59	22.21	107.80	53.90	1,077.96
F	99.21	60.00	114.39	209.84	121.90	35.02	14.10	19.49	22.18	214.20	107.10	53.55	1,071.00
ATTE	339.00	206.26	260.81	291.13	296.84	170.56	79.63	89.47	107.80	107.10	-	-	1,948.58
ITS	169.50	103.13	130.40	145.56	148.42	85.28	39.81	44.73	53.90	53.55	-	-	974.29
Total	3,389.88	2,062.89	2,609.64	2,910.01	2,968.09	1,705.49	796.19	894.43	1,077.60	1,071.62	1,948.58	974.29	22,408.71

Table J.2.3 Traffic Matrix in Astana(2030)

	ATC36	ATC21	ATC32	ATC27	A	B	C	D	E	F	ATTE	ITS	Total
ATC36	755.16	308.99	325.64	386.42	542.55	218.86	184.45	141.83	124.62	220.91	377.58	188.79	3,775.80
ATC21	308.91	468.08	390.41	299.23	198.47	62.53	33.90	48.37	39.39	140.06	234.04	117.02	2,340.42
ATC32	325.43	390.26	609.70	471.01	293.68	80.44	40.28	64.93	49.95	265.52	304.85	152.42	3,048.48
ATC27	386.60	299.45	471.53	756.18	409.14	123.49	55.62	107.28	83.20	521.27	378.09	189.04	3,780.90
A	542.75	198.59	293.97	409.10	793.33	293.95	103.97	260.67	147.97	327.36	396.67	198.33	3,966.66
B	218.94	62.57	80.52	123.47	293.95	385.86	66.78	176.62	152.49	78.69	192.93	96.46	1,929.30
C	184.51	33.92	40.32	55.61	103.97	66.78	179.82	33.56	32.32	33.43	89.91	44.96	899.10
D	141.89	48.40	65.00	107.28	260.69	176.64	33.56	311.99	109.29	71.20	155.99	78.00	1,559.94
E	124.70	39.43	50.01	83.21	148.01	152.54	32.34	109.32	243.00	50.20	121.50	60.75	1,215.00
F	220.72	139.97	265.46	520.58	326.96	78.60	33.39	71.11	50.12	525.20	262.60	131.30	2,626.02
ATTE	377.58	234.04	304.85	378.09	396.67	192.93	89.91	155.99	121.50	262.60	-	-	2,514.16
ITS	188.79	117.02	152.42	189.04	198.33	96.46	44.96	78.00	60.75	131.30	-	-	1,257.08
Total	3,775.98	2,340.73	3,049.85	3,779.23	3,965.77	1,929.08	898.98	1,559.65	1,214.60	2,627.74	2,514.16	1,257.08	28,912.86

Table J.2.4 Circuit Matrix in Astana(2010)

SWName	Total	ATC36	ATC21	ATC32	ATC27	A	B	C	D	E	F	ATC3201	ATTE	ITS
Total	21810	2355	1425	4995	1800	1500	2625	585	105	315	255	3900	1290	660
ATC36	2355	0	315	750	360	360	525	0	15	0	30	0	0	0
ATC21	1425	315	0	585	240	120	120	0	15	0	30	0	0	0
ATC3201	4995	750	585	0	690	435	510	0	15	0	60	1950	0	0
ATC27	1800	360	240	690	0	225	210	0	15	0	60	0	0	0
A	1500	360	120	435	225	0	315	0	15	0	30	0	0	0
B	2625	525	120	510	210	315	0	585	15	315	30	0	0	0
C	585	0	0	0	0	0	585	0	0	0	0	0	0	0
D	105	15	15	15	15	15	15	0	0	0	15	0	0	0
E	315	0	0	0	0	0	315	0	0	0	0	0	0	0
F	255	30	30	60	60	30	30	0	15	0	0	0	0	0
ATC3201	3900	0	0	1950	0	0	0	0	0	0	0	0	1290	660
ATTE	1290	0	0	0	0	0	0	0	0	0	0	1290	0	0
ITS	660	0	0	0	0	0	0	0	0	0	0	660	0	0

Table J.2.5 Circuit Matrix in Astana(2020)

SWName	Total	ATC36	ATC21	ATC32	ATC27	A	B	C	D	E	F	ATC3201	ATTE	ITS
Total	33630	2880	1815	7425	2520	2565	4080	660	840	885	1005	5970	1980	1005
ATC36	2880	0	330	870	390	495	570	0	105	0	120	0	0	0
ATC21	1815	330	0	720	300	195	150	0	45	0	75	0	0	0
ATC3201	7425	870	720	0	900	720	735	0	195	0	300	2985	0	0
ATC27	2520	390	300	900	0	345	270	0	75	0	240	0	0	0
A	2565	495	195	720	345	0	495	0	165	0	150	0	0	0
B	4080	570	150	735	270	495	0	660	225	885	90	0	0	0
C	660	0	0	0	0	0	660	0	0	0	0	0	0	0
D	840	105	45	195	75	165	225	0	0	0	30	0	0	0
E	885	0	0	0	0	0	885	0	0	0	0	0	0	0
F	1005	120	75	300	240	150	90	0	30	0	0	0	0	0
ATC3201	5970	0	0	2985	0	0	0	0	0	0	0	0	1980	1005
ATTE	1980	0	0	0	0	0	0	0	0	0	0	1980	0	0
ITS	1005	0	0	0	0	0	0	0	0	0	0	1005	0	0

Table J.2.6 Circuit Matrix in Astana(2030)

SWName	Total	ATC36	ATC21	ATC32	ATC27	A	B	C	D	E	F	ATC3201	ATTE	ITS
Total	42780	3210	2055	9360	3225	3360	4635	735	1410	990	2280	7680	2550	1290
ATC36	3210	0	330	930	420	570	555	0	165	0	240	0	0	0
ATC21	2055	330	0	780	330	225	165	0	60	0	165	0	0	0
ATC3201	9360	930	780	0	1065	915	810	0	330	0	690	3840	0	0
ATC27	3225	420	330	1065	0	435	285	0	135	0	555	0	0	0
A	3360	570	225	915	435	0	570	0	285	0	360	0	0	0
B	4635	555	165	810	285	570	0	735	345	990	180	0	0	0
C	735	0	0	0	0	0	735	0	0	0	0	0	0	0
D	1410	165	60	330	135	285	345	0	0	0	90	0	0	0
E	990	0	0	0	0	0	990	0	0	0	0	0	0	0
F	2280	240	165	690	555	360	180	0	90	0	0	0	0	0
ATC3201	7860	0	0	3840	0	0	0	0	0	0	0	0	2550	1290
ATTE	2550	0	0	0	0	0	0	0	0	0	0	2550	0	0
ITS	1290	0	0	0	0	0	0	0	0	0	0	1290	0	0