No. 3

MASTER PLAN STUDY
ON
REHABILITATION AND RECONSTRUCTION
OF
ELECTRICITY SUPPLY IN BAKU
IN
AZERBAIJAN REPUBLIC

FINAL REPORT

SUMMARY

DECEMBER 2000

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
KRI INTERNATIONAL CORP.

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PREFACE

In response to a request from the Government of Azerbaijan Republic, the Government of Japan decided to conduct the master plan study on rehabilitation and reconstruction of electric supply in Baku and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent a study team headed by Mr. Yoshiaki Miyagawa of Nippon Koei Co., Ltd. organized by Nippon Koei Co., Ltd. and KRI International Corp. to Azerbaijan four times from August 1999 to October 2000.

The team held discussions with the officials concerned of the Government of Azerbaijan, and conducted related field surveys. After returning to Japan, the team conducted further studies and complied the final results in this report.

I hope this report will contribute to the improvement of the situation of electricity supply in Baku and the Azerbaijan's economic development, and to enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Azerbaijan Republic for their close cooperation throughout the study.

December 2000

Kunihiko SAITO
President
Japan International Cooperation Agency

December 2000

Mr. Kunihiko SAITO
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Saito,

Letter of Transmittal

We are pleased to submit you the final report on the Master Plan Study on Rehabilitation and Reconstruction of Electricity Supply in Baku in Azerbaijan Republic.

This study was conducted by the joint venture of Nippon Koei Co., Ltd. and KRI International Corp., under a contract to JICA, during the period from August 20, 1999 to January 30, 2001. In conducting the study, we have formulated the Master Plan for rehabilitation and reconstruction of the distribution network in Baku with due consideration to the present situation of Azerbaijan and examined the feasibility and rationale of the formulated rehabilitation project for the period from 2001 to 2010.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affair and the Ministry of International Trade and Industry. We would also like to express our gratitude to the officials concerned of the Baku City Executive Power, Baku Electric Network and Embassy of Japan in Azerbaijan for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Yoshiaki MIYAGAWA
Team Leader

Master Plan Study on Rehabilitation and
Reconstruction of Electricity Supply in Baku

Nippon Koei Co., Ltd.

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SUMMARY

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ABBREVIATIONS

ACSR	:	Aluminum Conductor Steel Reinforced
APHNE	:	Absheron Power and Heat Network Enterprise (Azerenerji)
AIOC	:	Azerbaijan International Operations Companies
ANB	:	Azerbaijan National Bank
Azenerji	:	AZERENERJI Joint-Stock Company
BCEP	:	Baku City Executive Power
BEN	:	Baku Electric Network
BICEX	:	Baku Interbank Currency Exchange
BKD	:	Book Keeping Department (BEN)
CB	:	Circuit Breaker
CPHNE	:	Central Power and Heat Network Enterprise (Azerenerji)
CHP	:	Combined Heat and Power (plant)
CIS	:	Commonwealth of Independent States
CLDC		Central Load Dispatching Center (Azerenerji)
CPI	:	Consumer Price Index
CT	:	Current Transformer
DAC	:	Development Assistance Committee
DEC	:	Department of Engineering Communication
DS	:	Disconnecting Switch
EBRD	:	European Bank for Reconstruction and Development
EIRR	:	Economic Internal Rate of Return
EML	:	Energy Meter Laboratory
ESE	:	Energy Sales Enterprise
EU	:	European Union
FDI	:	Foreign Direct Investment
FIRR	:	Financial Internal Rate of Return
FOB	:	Free on Board
FSU	:	Former Soviet Union
GDP	:	Gross Domestic Product
HDI	:	Human Development Index
IEC	:	International Electro-technical Committee
IDP	:	Internally Dispatched Person
IMF	:	International Monetary Fund
IRR	:	Internal Rate of Return
JBIC	:	Japan Bank for International Cooperation
JICA	:	Japan International Cooperation Agency

JSCBEN	:	Joint Stock Company Baku Electric Network
LDC	:	Load Dispatching Center
LF	:	Load Factor
LNO	:	Local Network Office
LRAIC	:	Long Run Average Incremental Cost
LRMC	:	Long Run Marginal Cost
LV	:	Low Voltage (400/220 V in Azerbaijan)
MV	:	Medium Voltage (35 kV, 20 kV, 10 kV and 6 kV in Azerbaijan)
NAO	:	Network Area Office (BEN)
NAP	:	New Azerbaijan Party
NPV	:	Net Present Value
NTL	:	Non-Technical Loss
O/H	:	Overhead (line)
O & M	:	Operation and Maintenance
PIP	:	Public Investment Program
PT	:	Potential Transformer
SCS	:	State Committee Statistics
SOCAR	:	State Oil Company of the Azerbaijan Republic
SLV	:	Special Laboratory Vehicle
SRIEED	:	Scientific Research Institute of Energetic and Energy Design
STF	:	Systematic Transformation Facility
TACIS	:	Technical Assistance for CIS
TFDD	:	Technical Forecast and Development Department
TL	:	Technical Loss
TRS	:	Transformer Repair Shop
TSD	:	Technical Supplement Department
U/G	:	Underground (line)
UNDP	:	United Nations Development Program
UNHCR	:	United Nations High Commissioner for Refugees
USSR	:	Union of Soviet Socialist Republics
WB	:	World Bank

UNITS

LENGTH

mm	:	Millimeters
cm	:	Centimeters (10.0 mm)
m	:	Meters (100.0 cm)
km	:	Kilometers (1,000.0 m)

EXTENT

cm^2	:	Square-centimeters (1.0 cm x 1.0 cm)
m^2	:	Square-meters (1.0 m x 1.0 m)
km^2	:	Square-kilometers (1.0 km x 1.0 km)
ha	:	Hectares (10,000 m^2)

VOLUME

cm^3	:	Cubic-centimeters (1.0 cm x 1.0 cm x 1.0 cm)
m^3	:	Cubic-meters (1.0 m x 1.0 m x 1.0 m)

WEIGHT

g	:	grams
kg	:	kilograms (1,000 g)
ton	:	Metric ton (1,000 kg)

TIME

sec.	:	Seconds
min.	:	Minutes (60 sec.)
hr.	:	Hours (60 min.)

CURRENCY

AZM	:	Azerbaijan Manat
RR	:	Russian Rouble
US$	:	United State Dollars
J¥	:	Japanese Yen
ECU	:	Euro Currency Unit

ELECTRIC

V	:	Volts (Joule/coulomb)
kV	:	Kilo volts (1,000 V)
A	:	Amperes (Coulomb/second)
kA	:	Kilo amperes (1,000 A)
W	:	Watts (active power) (J/s: Joule/second)
kW	:	Kilo watts (10^3 W)
MW	:	Mega watts (10^6 W)
GW	:	Giga watts (10^9 W)
Wh	:	Watt-hours (watt x hour)
kWh	:	Kilo watt-hours (10^3 Wh)
MWh	:	Mega watt-hours (10^6 Wh)
GWh	:	Giga watt-hours (10^9 Wh)

VA	:	Volt-amperes (apparent power)
kVA	:	Kilo volt-amperes (10^3 VA)
MVA	:	Mega volt-amperes (10^6 Wh)
var	:	Volt-ampere reactive (reactive power)
kvar	:	Kilo volt-ampere reactive (10^3 var)
Mvar	:	Mega volt-ampere reactive (10^6 var)

I. PRESENT SITUATION AND ISSUES

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1.1 Introduction

(1) Background of the Study

Azerbaijan is in the process of economic reform towards a stabilization of macro-economy and market-oriented economy, while overcoming an unstable economic situation since its independence in 1991 and conflict against Armenia. In almost all sectors, however, the infrastructure and production activity base has not been properly maintained with preventing their efficient operation. Azerbaijan is currently promoting national development, placing the rehabilitation and improvement of its infrastructure and production activity basis.

In Azerbaijan, Azerenerji Joint Stock Company (Azenerji) is a monopolistic electric power company, including generating, transmitting and distributing operation of electric power, except distributing operation in Baku, Sumgait and Ganja City.

Energy distribution in Baku City, which is the largest consumer of energy in Azerbaijan, has been undertaken by BEN (Baku Electric Network in Baku City Executive Power). The distribution facilities installed at the beginning of 1900's are still served, and extensively obsolete and overage mainly since only poor O&M has been provided due to a lack of fund resulted from its poor financial performance. Though energy losses against wholesale energy in the distribution system of Baku have been improved from 22.5% in 1997 to 16.8% in 1998, however are still at high level. Energy consumption of BEN's customer, which residential demand accounts for 80% of the total (in 1998), has been on the rise (except for 1995) and the annual average rate of increase is high at 11.4%. To properly correspond to an increasing energy demand in the near future, Baku City has noticed the importance of urgent rehabilitation and reconstruction of distribution facilities.

With the background mentioned above, the Azerbaijan Government prioritized the reconstruction and rehabilitation of distribution network system in Baku, and requested the Japanese Government to provide a technical cooperation for the Master Plan Study on rehabilitation and reconstruction of electric supply in Baku in December 1997. In reply to the request, project formulation team was dispatched by Japan International Cooperation Agency (JICA) in October 1998, and it confirmed the current situation of the distribution system in Baku and the contents of application for the technical corporation. Then, preliminary study team and counterpart organization, Baku City Executive Power (BCEP), signed the Scope of Work (S/W) and the Minutes of Meeting (M/M) related to the Study in March 17, 1999.

For the Study implementation, the Joint Venture Study Team is composed of Nippon Koei Co., Ltd. and KRI International Corp., which was appointed by JICA.

(2) Objective and scope of the Study

The main objective of the Study is to formulate the Master Plan for rehabilitation and reconstruction of electric power distribution system in Baku (the Master Plan), to select an urgent and important project (the priority project), and to conduct the basic design level study for the priority project.

Target of the Study is the distribution network facilities owned and managed by Baku City and its related facilities both located in six administrative districts (the Study area) in the central part of Baku including Sabail, Yasamal, Nasimi, Narimanov, Nizami and Khatai. Distribution network facilities include 10/6 kV medium voltage lines, 0.4 kV low voltage lines, transformer stations, monitoring and controlling facilities of BEN. Related facilities mainly include 110 kV and 35 kV substations and high voltage lines of Azenerji, which supplies energy to BEN.

(3) Privatization Process

On 14 June 2000, the Presidential Decree on the restructuring of energy distribution sector through establishing JSC BEN was issued again in view of sound energy supply operation for Baku citizens, and the private operation of energy distribution shall be forwarded hereafter. The Decree decides to re-incorporate the functions, which were once separated and to establish the organization setup that is close to the former BEN (i.e. before re-organization explained above). Corporate registration at the Ministry of Justice has been already finished, and the tender for transferring management/operation concession to private proponents is being called.

"Privatization" here is to transfer management/operation concession (energy supply/sales, facility O&M, billing/collection and so on) to private proponents, and all the stocks of JSC BEN are to be held by the government at the initial stage. Resultantly the distribution facilities, which had been hold by BCEP, are to be transferred to the government. JSC BEN has been therefore established as the governmental corporation. It is envisaged that JSC BEN shall be in the position to instruct, control and monitor the management and operation of private proponent.

1.2 Socio-economic Situation

(1) Geography and population

Azerbaijan, located on the south-eastern part of the Caucasus region, covers an area of 86,600 km^2, a quarter of the size of Japan. The capital city is Baku located in the Absheron Peninsula. Azerbaijan is well-endowed with various natural resources including oil, natural gas, minerals and fertile agricultural land. It is one of the oldest oil-producing regions in the world.

Azerbaijan's population in 2000 is estimated to be about 8.0 million. From 1995 to 1999, an average annual growth rate was 0.95% per year. The population in urban area is 4.1 million in January 1999, comprising 51.7% of the total. Another important point is that a large number of refugees from the conflicted area has been internally displaced in and flown into Azerbaijan. The United Nations Development Program (UNDP) estimated the number of refugees and IDPs (internally displaced persons) at about 1 million. The State Committee of Statistics (SCS) made a different estimate at 0.79 million. These are equivalent to 10 to 13% of the total population.

It is known that Baku is characteristic of the continental climate and dried with little rainfall. The lowest and highest temperature in the past were respectively recorded at -13°C and 41°C.

(2) Socio-economy

In 1999 nominal GDP of Azerbaijan amounted to AZM 16,414 billion or US$ 4.0 billion. GDP per capita was AZM 2,056 thousand or US$ 496. The economic recovery since 1996 has been continuing until 1999. An average annual growth rate in constant price during this period was 6.1% per year. Real GDP in 1999 (at 1995 price level), however, had just recovered to around 86% of that in 1993, it is recognized that an economic drop after the independence was immense.

The source of national economic growth since 1996 has been expanding foreign direct investments into oil sector. This has also stimulated demands in such sectors as construction, services (especially commerce), and transport. Traditionally important agricultural production has remained steady except the output loss in 1997 due to unseasonable weather. The government expects that effects of production increase in oil related activities gradually extend into a wide range of other production activities.

However, the performance of industrial and manufacturing sectors has been still deeply stagnated. During the FSU era, Azerbaijan had been playing an important role in industrial production including oil related machinery and equipment, petro-chemistry, electric appliances, and aluminum. Industrial output fell dramatically during the early 1990s (by 70% between 1991 and 1995). The industrial sector only began to recover its gross output value in 1997, with an increase of 0.3% over 1996 level.

In 1996, Azerbaijan prepared and started implementing its first comprehensive Public Investment Program (PIP), which is to cover next three years with annual reviews. The present PIP for 1998-2000 period emphasizes infrastructure investments with a view to attract further foreign investment. The concern has been especially given to energy, water resources and irrigation, and transport sectors. In all those sectors, the rehabilitation and reconstruction of related existing facilities are mainly focused.

(3) Policy for electricity sector development

The policies concerned for energy sector in Azerbaijan are to ensure the low level of energy tariff, efficient operation of energy supply, and efficient use of energy. To attain these goals, target items including active participation of private sector in electricity sector to promote competition, financial soundness/independence of Azenerji, establishment of the market rules, regulatory/legal framework, and incentives to enhance private investment, prioritization of investment projects for rehabilitation of the existing facilities, liberalization of the energy market, public awareness promotion, reduction of fuel consumption, and reduction of network losses are raised

(4) Baku City

The Baku City, the capital city of Azerbaijan, functions as the center of administrative, economic, commercial and cultural activities of Azerbaijan. Most international transactions in Azerbaijan take place through Baku. The city embraces the most part of the Absheron peninsula, sticking out toward east on the western side of Caspian Sea.

The total population of Baku in 1998 is reported to be 1,789 thousand. Also, it is widely recognized among public officials that actual population in Baku is somewhere between 2.5 and 3.0 million. However, there has been no attempt to check this big discrepancy.

Total population of Baku City increased from 1,706 thousand in 1989 to 1,789 thousand in 1998, equivalent to an increase of 4.8% or 0.5 % per year on average. The Study area, on the contrary, experienced a decrease of population from 1,091 thousand down to 1,014 thousand, equivalent to a 7% decrease or a 0.8% per year decline. These tendencies could be explained by rising prices of apartments in the central part of Baku and resultant move of younger generations to suburban areas and higher fertility of the population in the outlying districts.

The Study area, comprising six districts, accounts for 57% of the total population, whereas in area its share is only 6%. As a result the population density in the Study area at 7,800 persons per square kilometer is 20 times that of outside the Study area (386 persons per square kilometer). Within the Study area, Nasimi and Yasamal are most densely inhabited. There are 90 thousand refugees and 133 thousand IDPs living in Baku with a total of 223 thousand people under these categories. This is equivalent to 12% of the total population of Baku. Refugees living in the Study area accounts for 61% of all the refugees, while IDP in the Study area are 61% of the total, while IDP in the Study area are 46% of the total.

The Study area produces 63% of the industrial production in Baku. The three districts of Sabail, Nizami and Khatai are the major industrial districts in the Study area. It is found that most investment took place within the Study area, especially in Sabail district accounting for 72 % of all types of investment and 78 % of construction investment. This is due to that the oil-related activities are heavily concentrated in the said district.

1.3 Present Situation of Electric Power Sector

Azenerji is monopolistic energy supply operator in the country covering power generation, transmission and distribution. Azenerji also supplies steam and heat produced in the Combined Heat and Power plant (CHP) to factories and local heat supply organizations. In the three Cities of Baku, Sumgait and Ganja, the Cities purchase the energy from Azenerji and distribute it to consumers. A dual energy distribution system functions in these three cities, under which the energy is directly distributed by Azenerji to bulk consumers, especially large factories, whereas the rest distributed by the municipal governments.

(1) Generation facilities

The power generation capacity in Azerbaijan is 5,071 MW, comprising 4,224 MW by thermal power generation and 847 MW by hydropower generation. There are three types of power generation plants: thermal power plants and CHP with natural gas and heavy oil as fuel, and hydropower stations. The thermal power plants include the Az-Gres, Ali-Bayramli and Severnaya thermal plants. There are 4 CHPs: Baku-1, Baku-2, Sumgait-1 and Sumgait-2.

(2) Transmission facilities

The Azerbaijan's energy transmission system was developed as a part of the Trans-Caucasian Integrated System constituting the USSR's European System. The system is connected with the Russian System with 500 kV and 330 kV lines and integrally operated except in Armenia. The Absheron Peninsula, the central demand area of Azerbaijan, is situated at the end of the Trans-Caucasian Integrated System. The existing transmission system is composed of 500 kV (694 circuits/km), 330 kV (1,025 circuits/km), 220 kV (1,210 circuits/km), and 110 kV (4,770 circuits/km). The Trans-Caucasian Integrated System is shown in Figure 1.3-1.

The substations include 1 of 500 kV substation, 5 of 330 kV substations, 8 of 220 kV substations and 175 of 110 kV substations. Energy supply to consumers is made from 110 kV, and through 35 kV, 20 kV, 10 kV and 6 kV distribution lines. The transformer capacities are 800 MVA for 500/220 kV, 1,915 MVA for 330/220-110 kV and 3,001 MVA for 220/110 kV.

(3) Distribution facilities

The high voltage distribution network is composed of 35 kV, 20 kV, 10 kV and 6 kV lines. The low voltage distribution networks is composed of 380/220 V lines. The line lengths is 6,300 km for 35 kV, 38,100 km for 10-6 kV, and 58,600 km for low voltage. The substations include 620 of 35 kV and 17,500 of 20-6 kV. The values below do not include the distribution lines owned by the three cities of Baku, Sumgait and Ganja.

(4) Energy balance

The peak load in Azerbaijan in 1999 was 3,536 MW, with total energy generation of 18,064 GWh and import amounts of 752 GWh. Energy sale was 15,003 GWh, of which 4,506 GWh (30 % of total energy consumption) is wholesale energy. Residential use accounted for large part in total energy consumption, and energy consumption of wholesale and residential sector reached 71 % of total consumption. On the other hand, industrial demand only accounts for 13 %, drops to the less than half level in 1994. Energy losses, based on the amounts input in this country, comprise of in-house use 5.4 %, and transmission/distribution loss 14.8 %, with totaling to 20.2 % in 1999. This value, however, does not include distribution loss of the three retail sale cities (5.6 % in 1998).

(5) Power tariff

The tariff regime in Azerbaijan is a simple one, applying single rate for each customer group, comprising of AZM 72/kWh for wholesale, AZM 80 for residential, AZM 340 for commercial, and AZM 265 for non-industry and resulting in a substantial cross-subsidization among the consumer groups. This tariff regime was revised again on July 1, 2000, and to be uniform (AZM 130/kWh) for every group except the wholesale and residential customers. Another issue in operating energy supply has been a quite low level of collection rate of energy charge. Collection rate in 1999 was only 32.4 %, being largely explained by poor performance of retail seller's repayment (12.9 %).

(6) Development plan

The Power Generation Expansion Plan was prepared in 1995 for Azenerji under TACIS program to formulate "Middle-term Investment Plan". This plan covers a period of three years from 1997 to 1999. Development of power facilities during this period has been implemented based on this plan, according to the Azenerji's annual report 1998.

1.4 AZERENERJI'S Power Supply to Baku City

In Baku, some non-residential consumers are served directly by Azenerji with power through 35 kV, 20 kV, 10 kV and 6 kV medium voltage distribution lines. Azenerji wholesales in bulk the power stepped down to 10 kV and 6 kV at the 110 kV and 35 kV substations to BEN.

(1) Organization of Azenerji

The area under the control of BEN is the Absheron peninsular except Sumgait City, and the two regional offices of Azenerji are managing the energy supply and O&M for transmission/distribution facilities in this area.

(2) Transmission and substation facilities

The line length from 500 kV to 110 kV amounts to 1,404 km, and all the lines are overhead. There are 41 Substations, and total capacity of transformers amounts to 5,103 MVA mainly comprising of 110 kV substations of 2,557 MVA.

(3) Distribution system

The medium voltage distribution system of Azenerji is composed of 35 kV, 20 kV, 10 kV and 6 kV facilities, and supplies energy other customers including factories as well as city retail seller. Total length of medium voltage distribution lines is 1,075 km, comprising of 135 km underground lines (12.5 %) and the overhead lines for the rest. Transformer to drop the voltage from 35 kV to 10-6 kV accounts for the largest number among all, with its total capacity of 1,617 MVA and 259 MVA for the other voltages.

(4) Peak load and load curve

The daily load curve in winter of 1998 in Baku is estimated from referring to energy amounts supplies through 220 kV transmission lines, those forwarded through 110 kV into Sumgait City, and generation amount in Baku area, with the results shown in Figure 1.4-1. According to this, the peak load on that day was 990 MW, with the daily load factor of 80 %. And, total energy supply into Baku City amounts to 5,470 GWh and annual load factor is estimated as 63.1 %.

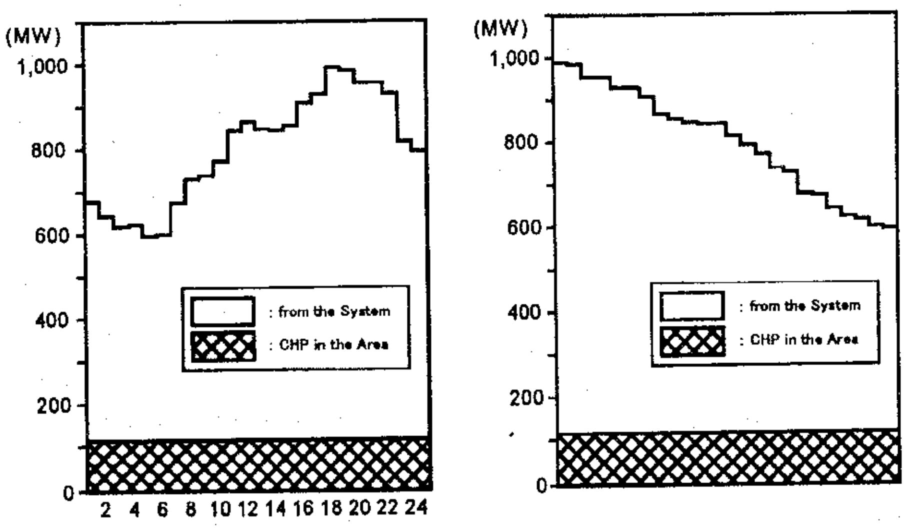


Figure 1.4-1 Daily Load Curve in Baku City (Dec. 16 1998)

(5) Annual load factor

The above mentioned annual load factor is derived by combining Azenerji's own demand mainly comprising of industrial demand (around 70%) and transportation demand (around 14%), and BEN's demand represented by residential demand (accounting for 80% in 1998). Taking into account the difference in time of peak occurrence and the impact of seasonal energy use, annual load factor for Azenerji's own demand is assumed as 80 % and for BEN's demand as 55 % in this Study. Then, the peak load for each is derived as 235 MW and 755 MW respectively.

(6) Energy sales amounts

Energy sales amount in Baku in 1998 was 4,953.4 GWh, comprising 34.7% of total sales amount of Azerbaijan. Excluding the wholesale amount to BEN, the figure amounts to 1,634.8 GWh. Although the average annual growth rate of wholesale amount to BEN represents very high figure, retail sales amount of Azenerji regional branch which has little residential customer has been less grown due to the hovering in industrial activity.

(7) Losses

The transmission and distribution loss by Azenerji in Baku City is thus estimated as 516 GWh in 1998, equivalent to 9.4 % of total energy supply to Baku, and 3.0 % of total supply to Azerbaijan. This value also accounts for 17.7 % of total transmission and distribution loss by Azenerji (2,911 GWh).

(8) The number of customer

Total number of customer in 1998 amounted to 596, comprising industrial customer of 62.8 %, non-industrial customer of 11.4 %, and commercial customer of 10.6 %. Non-industry category comprises public facility including schools, hospitals, athletic facility, and governmental and local governmental. It should be noted, however, that public facilities for general resident is covered by BEN. While, the facilities in Azenerji's "non-industry" category are mainly schools and hospitals for military personnel.

(9) Energy sales revenue and charge collection

Collection performance by Azenerji has been poor, and represented by the collection rates of 49.5 % in 1998 and 50.1 % in 1999. Despite the economic stagnation, industrial sector has shown high repayment performance with around 73 %. However, the same rate by BEN, which is largely responsible for residential customer goes no further than recording around 20%, thus worsening the entire collection performance.

1.5 Present Situation of Energy Supply by BEN

Energy supply in Baku City is managed by the Baku Electric Network (BEN). When JICA's preliminary study team visited, BEN had all necessary functions and comprehensive responsibility for energy distribution business. Re-organization of BEN and its supervising agency Department of Engineering Communication (DEC) was, however, undertaken in May 1999. Due to this reform, remaining BEN's role or function had been downsized to the operation and maintenance of 10 kV, 6 kV and low voltage distribution facilities.

(1) Medium voltage distribution line

Medium voltage distribution lines under BEN's management amount to 1,448 km in length for underground lines and 732 km for overhead lines. A large part of underground cables are directly laid. Though a radial system is applied to some portions of medium voltage distribution system, a loop system is mainly applied. Although 10 kV system is composed of double circuits to secure supply reliability, single circuit is largely seen in 6 kV system except the feeders from Azenerji's substations.

(2) Transformer stations

Transformer stations in the Study area are classified into the three installation types including (i) ground-mounted type (standing independently and close to building), (ii) in-building type, and (iii) ground-mounted cubicle type. The relative proportion of those three types of stations in the Study area is 69.6 %, 7.3 % and 23.1 % respectively. There are 2,281 transformer stations managed by BEN as of January 1999. The numbers of transformers and total capacity of transformers are 3,166 and 1,360 MVA respectively. Although most of existing circuit breakers are minimum oil content type, bulk oil type circuit breakers have been still existing in a few transformer stations.

(3) Low voltage distribution line

The existing low voltage (LV) distribution feeders are categorized into three types, including overhead wire feeder, underground cable feeder and house flank feeder. Both aluminum and copper conductors are used for underground cable. For overhead feeder, bare conductors are usually used.

(4) Load Dispatching Equipment

The main Load Dispatching Center (LDC) of BEN is located on the top floor of its head office, and consists of the graphic panel, dispatching desk, computer system, and telecommunication equipment. Because the back wiring of switches on the panels is not connected at present, it is not possible to perform remote control and supervise the distribution network with the panels. Indication of position of the switchgears in the network is altered manually by the dispatching center staff. The computer is now used to collect and manage the data on O&M for distribution facilities in an off-line basis. Telephones with exclusive lines are installed in parallel on each dispatching desk and they can directly connect to the appropriate points by selection switches on the desks. These telephones also can link to the public telecommunication network.

(5) Power supply to Baku

ESE's branch units for billing and collecting electricity charge are established in each district. However, for the central area of the city, only total amount of energy purchased from Azenerji is available. Table 1.5-1 shows the amount of energy purchased by area in the past six years. The notable characteristic of energy demand is that the demand in winter grows around twice as that in summer. The monthly energy purchased is also shown in Figure 1.5-1.

Table 1.5-1 Amount of purchased energy (Unit : GWh)

Area	1993	1994	1995	1996	1997	1998	1999	Rate of change (1993-99 : %/year)
City Area	1,248.1	1,255.3	1,213.9	1,389.2	1,515.0	1,680.1	1,773.3	6.0
Nizami	134.8	146.8	143.7	161.5	191.0	210.9	213.4	8.0
Khatai	218.5	223.7	221.9	245.6	261.8	311.5	356.1	8.5
Others	658.3	719.2	718.0	849.4	980.4	1,163.9	1,274.2	11.6
Total	2,259.6	2,345.1	2,297.5	2,645.7	2,948.2	3,366.4	3,617.0	8.2

(Source: ESE)

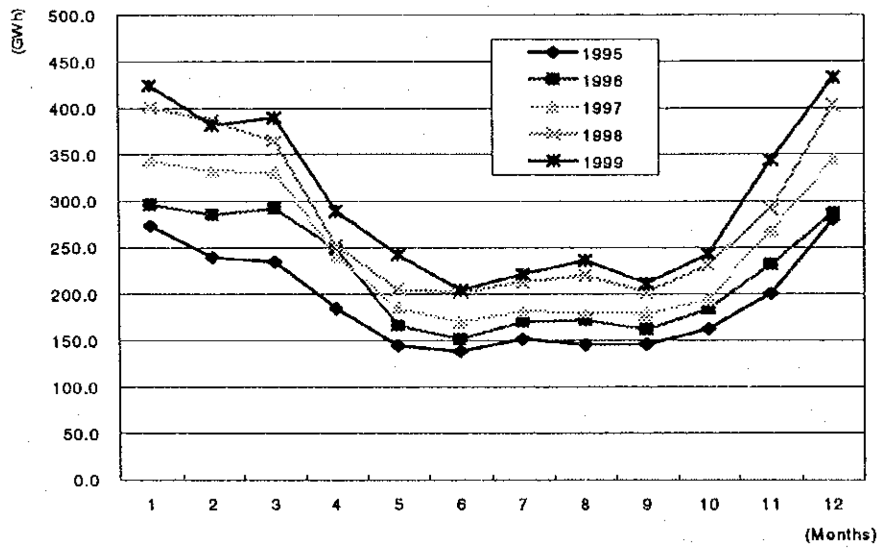


Figure 1.5-1 Monthly fluctuation of energy purchase from Azenerji

(6) Energy consumption of BEN's customers

The total energy consumption by BEN is shown in Table 1.5-2. Household and commercial categories have led the fast growth with average annual growth rates between 1995 and 1999 at 21.6 % per year and 23.2 % per year respectively. Especially the residential consumption had a great influence, due to its dominant share. This rapid increase in residential power consumption would be a result of an increasing energy use by rapidly prevailing electricity appliances, especially electricity stoves in winter. This has resulted from the decline in capability of heating energy supply facilities.

Table 1.5-2 Energy consumption by type of BEN's consumer

Category		Amount of energy (GWh)			Rate of change (%/year)	
		1995	1998	1999	1995-98	1998-99
Household		1,101.5	2,247.8	2,455.3	26.8	9.2
Industry		180.3	157.3	130.5	- 4.4	-17.0
Non-industry		345.6	285.9	304.3	- 6.1	6.4
Others		77.5	119.0	111.5	15.4	-6.3
Total		1,704.9	2,802.5	3,001.7	18.0	7.1
Loss	In GWh	592.6	563.9	615.3	- 1.6	9.1
	In %	25.8	16.8	17.0	-	-

(7) Energy supply by BEN by district

Table 1.5-3 shows the amount of energy consumed by BEN's customers by district. Nasimi district had been covered by the BEN's Yasamal, Sabail and Narimanov district offices until April 1998. In May 1998 the Nasimi district was independently established. "Inspection" in the Table means an organization, which has been in charge of energy supply to particularly important public facilities of government, army, and police in the central city.

Table 1.5-3 Amount of energy consumed by BEN consumers (Unit : GWh)

District	Energy sold (GWh)				Rate of change (%/year)		
	1993	1997	1998	1999	1993-97	1997-98	1998-99
Study area	747.9	1,191.3	1,407.6	1,450.2	12.3	18.2	3.0
Sabail	174.0	263.9	250.3	212.2	11.0	-	-15.2
Yasamal	129.6	252.9	278.2	249.6	18.2	-	-10.3
Nasimi	-	-	151.5	250.7	-	-	65.5
Narimanov	153.5	284.0	271.3	234.2	16.6	-	-13.7
Nizami	111.4	164.8	186.1	195.5	10.3	-	5.1
Khatai	179.3	225.8	270.2	308.0	5.9	-	14.0
Outside Study area	567.4	916.3	1,220.2	1,398.1	12.7	33.2	14.6
Inspection	322.1	177.3	174.7	153.4	-13.9	-1.5	-12.2
Total	1,637.4	2,284.9	2,802.5	3,001.7	8.7	22.7	7.1

1.6 Current Issues of Power Supply by BEN

Brief explanations are presented for the following major issues:

(1) Deterioration of distribution facilities

The most serious problem of BEN's distribution facilities is their heavy deterioration including transformers, switchgears and cables.

(a) Underground cable

Total length of medium voltage distribution lines is about 900 km in the Study area, of which underground cables accounts for 93 %, with a total length 840 km. It is noted that the cables laid in early 1900s are still in use. Energy supply stoppage occurred 2,880 times in 1998 in the entire Baku City, due to underground cable accidents caused by insulator damage, over-load and improper joint connection.

(b) Transformer Station

It is observed that 2,961 units of transformer are installed, of which about 1,000 units (34 %) have been used more than 25 years. According to the transformer repair shop records, 51 % of the transformers brought into repair shop had something wrong with their winding. Deterioration or over-loaded operation of the transformers is considered as main causes of disorder. Secondly, disorder is caused by penetration of water into transformer due to waterproof gasket deterioration. Leakage of oil from transformers is often observed.

Small number of bulk-oil type circuit breaker is still remained and the rest are minimum-oil type circuit breaker. Though these types of circuit breaker has a good performance, they need to take relatively tight maintenance and inspection on insulating oil, and have higher possibility of firing.

(2) Lack of important facilities

Through site investigations and data collection, the Study Team identified the lack of important facilities. Major instances include a shortage of switchgears resulting in that plural circuits of feeder are connected to one switchgear at low voltage panel and a lack of materials to protect transformer.

Most of existing ammeters are damaged and not in a working order. Furthermore, no other instruments are equipped. Therefore, it is difficult to grasp an operating condition of distribution system, bringing about an overloaded operation of transformers and damage for underground cables as a result.

(3) Shortage of materials for maintenance and spare parts

Power fuses are important protection devices against over-current of transformers, however, it is observed that wires instead of fuses are used to directly connect both terminal due to a shortage of spare parts. In addition, low voltage fuses are normally provided in low voltage distribution panels. Site investigation reveals that in almost all distribution panels, wires instead of fuses are used. These practices results in cable damages and over-loading of transformers.

(4) Improper installation and maintenance

Connection works of medium and low voltage lines are manually conducted instead of using cable connection materials. It is also observed that insulation tapes peel off and live conductors are exposed. This may cause injuries to maintenance staff.

(5) Energy losses

One of important issues of the distribution network of BEN is the high level of losses, with loss rate of 17 % in 1999. Losses comprise of relatively smaller portion of technical loss and considerable portion of non-technical loss. Technical loss is a matter of hardware, requiring a large amount of investment to reduce. On the other hand, non-technical loss is accounted for by institutional factors including metering, billing, and collection. Reduction of non-technical loss usually requires relatively small amount of investment, therefore, immediate action to improve will be desired.

(6) Energy charge collection performance

On top of non-technical loss issue, poor charge collection performance is more negative issue. Table 1.6-1 summarizes energy sales revenue and charge collection performance during 1995-1999. Ratio of payment against claimed amount has been in the order of around 30% and annual account receivable amount has been on average equivalent to some 8 months of average monthly sales revenue.

Table 1.6-1 Energy sales revenue and charge collection performance

Year	1995	1996	1997	1998	1999
Sold Energy (GWh)	1,704.9	2,008.2	2,284.9	2,802.5	3,001.7
Claimed Amount (in million AZM)	137,999.6	158,989.1	212,102.3	276,553.4	272,289.9
Paid Amount (in million AZM)	44,254.9	54,487.1	78,339.3	77,041.1	76,866.4
Balance (in million AZM)	93,744.7	104,502.0	133,763.0	199,512.3	195,423.5
Ratio of paid/claimed amount (%)	32.1	34.3	36.9	27.9	28.2
Account receivable equivalent to monthly sales (months)	8.2	7.9	7.6	8.7	8.6

(Source: BEN/ESE)

(7) Financial Performance of BEN

Financial performance of BEN has worsened. Major factors to account for its sluggish financial performance include (i) small margin between purchase price and low level of average retail price for customers (80 % of total energy sales is made of residential customers, which lowest tariff is applied), (ii) an increase in energy supply to charge exempted user including refugee, (iii) poor performance of charge collection.

II. MASTER PLAN STUDY

II. MASTER PLAN STUDY

2.1 Existing Development Plan for Baku City

There are two kinds of development plan for the distribution network of Baku. One is the long-term development plan, which was prepared in 1989 during the former Soviet Union era, covering the transmission and distribution network improvement plans for Baku central. The other is the 3 years development plan from 1996 to 1998 of which BEN narrowed down its objective area and formulated, based on the long-term plan.

The long-term development plan was based on the power demand forecast up to 2005 to improve power supply reliability and reduce losses. The plan focused on reinforcement of transmission line and upgrading the distribution system voltage from 6 kV to 10 kV.

The 3 years plan estimated the total cost of AZM 232.7 billion (equivalent to about US$ 60.1 million with average rate in 1998). It emphasizes rehabilitation and replacement of obsolete facilities. So far, only AZM 9.0 billion (3.9 % of the total costs) was urgently provided to BEN from government fund (Privatization Fund), and this plan has been mainly financed by BEN's own budget. Roughly 37.24 billion AZM has been disbursed, amounting to only around 16.0% of the entire plan as of end of 1999.

2.2 Distribution Facilities in the Study Area

It is necessary to grasp the detailed situation of the existing facilities constituting the network to formulate the Master Plan for the rehabilitation and reconstruction of distribution network (the Master Plan). In this Study, the detailed survey has been undertaken for transformer stations and medium voltage (MV) distribution lines. Also in view of facilitating the analysis and examination afterwards, the information/data studied has been incorporated into a basic database. The feature of the existing facilities in the Study area is as follows:

(1) Transformer stations

The distribution facilities by each district are as shown in Table 2.2-1. Against the total facilities of BEN, it is known that 48 % of transformer station and 65 % of total transformer capacity are installed in the Study area. Average capacity factor of all transformers installed in the Study area is estimated as 47.8 %, with the figure by each district shown in Table 2.2-2.

Table 2.2-1 Facilities of transformer stations

	Sabail	Yasamal	Nasimi	Narimanov	Nizami	Khatai	Total
Transformer station	149	247	215	182	111	197	1,101
Transformers	229	401	350	279	177	314	1,750
Capacity of TR (MVA)	112.1	207.2	168.8	134.4	87.0	171.4	880.9
MV switchgears	813	1,492	1,311	965	627	1,015	6,223

Table 2.2-2 Estimate for average capacity factor of transformer

		Sabail	Yasamal	Nasimi	Narimanov	Nizami	Khatai	Total
Demand	(GWh)	280.2	322.8	321.7	304.8	223.6	371.3	1,824.4
Peak demand	(MW)	58.2	67.0	66.8	63.3	46.4	77.1	378.7
Capacity factor	(%)	57.6	35.9	43.9	52.3	59.3	50.0	47.8

(2) MV distribution lines

The existing MV line facilities by each district are shown in Table 2.2-3, and the ratio of double-circuit line in the MV system is as shown in Table 2.2-4. The underground line length by the laying year is also presented in Appendix 2.2-1. As 6 kV system has been in principle developed and expanded with single-circuit, the ratio of double-circuit line has been very low. On the other hand, the standard of 10 kV system has become in principle double-circuit line to ensure the reliability. As the electrification for the whole Khatai district was relatively late, and the 10 kV system has been initially adopted, there are many sections of double-circuit line. In other area, it is considered that the ratio of double-circuit line has been lower for 10 kV system, as the existing 6 kV system has been diverted as it is when in adopting 10 kV system at first time.

Table 2.2-3 MV line facilities

	Sabail	Yasamal	Nasimi	Narimanov	Nizami	Khatai	Total
Nos. of lines	218	340	296	240	149	150	1,393
Circuits	260	420	344	273	182	247	1,722
Cable joints	123	149	178	168	35	31	684
Length of line (km)	96.03	162.56	122.19	114.98	80.87	81.30	654.93
Length of cable (km)	120.50	206.90	146.20	109.56	100.61	124.17	827.94

Table 2.2-4 Extent of double-circuit line for MV distribution line (%)

	Sabail	Yasamal	Nasimi	Narimanov	Nizami	Khatai	Total
6 kV line	5.4	8.9	7.5	4.4	50.0	31.3	7.4
10 kV line	47.9	48.4	38.6	32.5	21.8	68.7	42.6
Total	19.3	23.5	16.2	13.8	22.1	64.7	23.6

2.3 Identification of Target Distribution Facilities

Although the Study area has relatively small size of around 130 km^2, the amount of distribution facilities constituting the network is extensive. In this respect, it is important to set the criteria to identify the facilities to be rehabilitated.

(1) MV underground lines

Most of the MV distribution lines in the Study area are underground lines, and overhead lines account for very little particularly in the suburban area of the Study area. For the underground line to be identified, the following items have been examined. The priority order for the identified lines is in accordance with the order specified below and the laying year of the cable.

(a) The cable laid before 1960

(b) The cable with more than two joints

(c) The use of 6 kV cable in the 10 kV system

The underground cable lines identified by the above selection criteria is shown in Table 2.3-1, and the details are provided in Appendixes 2.3-1 (1)-(6). The oldest underground lines in Baku City are those laid in 1900 for 3 sections amounting to 1,413 m in Sabail district. The second oldest, laid in 1910, are still left for 7 sections amounting to 4,160 m in Sabail district and 7 sections 3,356 m in Nasimi district.

Table 2.3-1 Underground lines to be rehabilitated (km)

	Sabail	Yasamal	Nasimi	Narimanov	Nizami	Khatai	Total
(a) laid before 1960	38.21	45.33	44.08	42.40	5.40	1.81	177.23
(b) more than 2 joints	7.62	8.88	10.97	6.67	3.21	4.57	41.92
(c) using 6 kV cable	-	1.58	1.62	3.23	7.36	-	13.79
Total	45.83	55.79	56.67	52.20	15.96	6.38	232.94
Ratio against the existing cable line length (%)	47.7	34.9	46.4	45.5	19.8	7.8	35.6

(2) MV Switchgears

For the part of the existing circuit breakers, the bulk-oil type breakers has been still used. However, the rest of all are minimum-oil content type breakers. The vacuum and SF 6 gas type breakers widely used over the world are not used at all. According to BEN, when bulk-oil type breaker becomes out of order, replacement with minimum-oil content type has been done time to time. No scheduled replacement of all the bulk-oil type has been practiced with reference to its installment year. Therefore, it is impossible to identify the switchgears to be rehabilitated in accordance with the year of installment, but the following two items are examined for their identification. The priority order for rehabilitation of transformer stations is determined by referring to the laying year of underground cables connected.

(a) Switchgears in the transformer station using the bulk-oil type circuit breakers

(b) Switchgears connected to the underground cables laid before 1960

The outlines for the transformer stations equipped with the MV switchgears identified for rehabilitation through the above criteria is shown in Table 2.3-2, and its details in Appendixes 2.3-2 (1) - (5). As evident, since the time when the distribution network was established is relatively delayed in Khatai district compared with the other area, no transformer stations is identified.

Table 2.3-2 MV switchgears (transformer stations) to be rehabilitated

	Sabail	Yasamal	Nasimi	Narimanov	Nizami	Khatai	Total
The number of T/S using bulk-oil type circuit breaker	16	12	10	2	-	-	40
The number of T/S connecting to the underground cable laid before 1960	34	67	59	52	10	-	222
Total	50	79	69	54	10	-	262
Ratio against the existing transformer stations (%)	33.6	32.0	32.1	29.7	9.0	0.0	23.8

(3) Transformers

Total 328 units of transformer (10.4 % of the existing ones) were brought into repair shop during 1998. Inefficient insulation was observed most as reason of disorder, accounting for 37.8 %, and including those which needed repairing the part of the coil without replacing the whole coil. Those scrapped accounted for 8.5 % and those wholly repaired did for 6.4 %. As known from the record, there have been many disorders requiring considerable repairing, and the progress of overage as well as the impact of overload is supposed.

However, as the track record of purchase, installment, repair and accident for each transformer has not been managed, and therefore it is difficult to identify the transformers for rehabilitation in accordance to the used year. Therefore, the number and capacity of transformer to be rehabilitated is identified based on the transformers in the transformer stations using MV switchgears identified, and summarized in Table 2.3-3.

Table 2.3-3 Transformers to be rehabilitated

Item	Number of units	Capacity (kVA)
20 - 400 kVA	219	74,495
560 - 630 kVA	149	92,190
750 - 1000 kVA	6	5,750
Total	374	173,435

(4) LV circuits

For both LV switchgears and lines constituting LV circuit, as in the case of transformers, only LV circuit in the transformer stations using MV switchgears to be rehabilitated is targeted. The volume of LV feeders and the watt-hour meter installed in the customer is estimated based on the average laying number.

2.4 Facility Plan for Formulating the Master Plan

(1) System voltage augmentation from 6 kV to 10 kV

Provided that the system voltage augmentation from 6 kV to 10 kV, more than 2.5 times of current carrying capacity can be obtained with the same cable size. Since the Study area encompasses the central area of Baku City with higher demand density, the system voltage augmentation to 10 kV in the near future will benefit the said area. In the Master Plan Study, however, voltage augmentation from 6 kV to 10 kV is not taken into account, because the transformers and switchgears in Azenerji's 110 and 35 kV substations (not included in the scope of the Study) have to be upgraded or replaced in case of voltage augmentation to 10 kV.

(2) MV underground lines

In the present distribution network, there are many single-circuit lines for 6 kV system. For 10 kV system, however, the establishment of the system with double-circuit line is being promoted. Therefore, 10 kV system has been presenting more reliable supply than 6 kV has done. Underground distribution system has been usually adopted in the urban area where the demand is very high. For the system structure, three-circuit called "spot network system" and double-circuit called "main line-spare line system" has been generally adopted. Accordingly, the double-circuit lines will be, in principle, structured in this plan.

Most of the underground lines for rehabilitation are 6 kV lines. The necessity of voltage upgrade in correspondence to the demand increase will be possibly realized. In this case, if the cable will be replaced afresh, the laying works might trouble the neighboring residents and transportation, and bring about big additional cost. As the price difference between 6 kV and 10 kV cables is small, and laying works cost between them is almost same, underground cable with rated voltage of 10 kV is adopted for newly laid cable.

(3) MV switchgears

In the present MV distribution system, all lines are directly connected into the transformer stations. To minimize the cost, however, the usage of expensive circuit breaker for line protection has been limited and installed at the sending side of line with the cheap disconnecting switch installed at receiving side. Then, the Study Team discussed the system configuration adopted with BEN. As BEN has experienced the accident caused by the trouble at the cable joint point, and is not supportive for the adoption of system requiring more cable connections than before at this time, despite its lower cost.

Accordingly, the currently adopted system configuration is followed in the Master Plan. In other words, the circuit breaker for fault detection and cut-off the fault section from the system will be installed at the sending end of the line, and a remote-controlled load break switch which functions to cut the load current is adopted at the receiving end.

(4) Transformers

For the transformer, though the oil-immersed transformer is considered as a standard, the molded dry type transformer is adopted for the "close to other building type", "rented room type", and "compact type" transformer station to prevent neighboring residents from a fire and its poisonous gas caused by transformers. Transformer capacity includes 400 kVA, 630 kVA and 1,000 kVA.

(5) Renovation of Transformer Station Building

The transformer station building has been designed based on the size of bulk-oil type or minimum-oil content type circuit breaker, with a standard of single circuit for 6 kV system. Therefore, the room or switchgear room is too small to install the switchgears for double circuit, and even relatively small vacuum type or SF6 gas type circuit breaker. In addition, since the Study area is urbanized area, it is often difficult to expand the station building, and find the alternative location except for the transformer stations in the green-belt area and the parks.

However, it was indicated that there are many ground-mounted type (standing independently) transformer stations, which are available without expanding the building, if the partitioning layout for its equipment room is changed. To the contrary, the ground-mounted type transformer stations, which adhere to other building and borrow a space of other building do not provide enough space for installing the circuit breakers. For these kinds of transformer stations, adjustments including pulling only one line into the station and alternation of system configuration are needed in the stage of detail design.

(6) LV switchgears

Under the current system, the LV distribution panel is installed for each transformer. The same system is adopted in the Master Plan. The average number of feeders to be drawn from one low voltage panel is supposed as 8 lines, and 6 lines for ground-mounted compact type transformer station.

2.5 Master Plan

2.5.1 Procurement Equipment and Materials

(1) Materials for underground cables

The total number of lines is 485, against the number of sections of underground distribution lines to be rehabilitated of 469. In other words, the ratio of double circuit system is very low as 3.4%. In order to improve the reliability of energy supply of 6 kV system up to the equivalent to the existing 10 kV system, we plan, as a basic principle, the rehabilitation scheme of the underground cables within the rehabilitation area to constitute as the double circuit configuration. To meet with this requirement, it is necessary to procure cables of 493.6 km.

In view of loss reduction, the cables to be procured will be 6/10(12) kV cross linked polyethylene insulated (XLPE) vinyl sheathed cables of aluminum conductor of 3x240 mm^2 and 3x150 mm^2. The former will be used for the lines constituting main and the loop system and the latter will be used to branch lines. Furthermore, to specify size/scope of the project, the ratio of procurement for each kind is assumed as 70% and 30%. The length per one drum is decided as 400 m for the former and 500 m for the latter (the volume of the accessories are also based on these figures) in considerations of inland transportation route from Georgia and of cable-laying works in congested road condition in the city,.

(2) MV switchgears

As MV switchgears, we plan to use the following switchgear panels. For switchgears for distribution lines and for bus tie circuits, motor driven types will be applied, in consideration of future application of auto-dispatching system. Current transformers will be applied to the outgoing feeders and transformer circuits.

(a) Outgoing feeders: SF6 gas or vacuum circuit breakers (600A rating)
(b) Incoming feeders: SF6 Load Break Switches (LBS, 600A rating)
(c) Bus-tie: SF6 LBS (2000A rating)
(d) PT circuits: PT (Potential Transformer) and Voltmeters
(e) Transformer circuits: SF6 LBS and Power Fuses

As a basic principle, double-circuits will be connected to each of transformer stations, however, the existing transformer stations are very narrow in space and it is difficult to install switchgear panels corresponding to double circuit configuration. Accordingly, in the Master Plan, one circuit of parallel double circuits will be connected for those transformer stations. The number of switchgear cubicle to be rehabilitated based on this supposition, is as follows:

Table 2.5-1 Switchgear panels to be Installed

Kinds	No. of Boards
Circuit Breaker panel	877
LBS panel	877
Bus Tie panel	201
PT panel	402
Transformer circuit panel	374

(3) Transformers

The transformer capacity type for rehabilitation amounts to 11 types. It is not intended to renew the existing transformers of the same capacities, but this plan determines three capacity types (1000 kVA, 630 kVA and 400 kVA) of transformer, and total capacity to be procured in consideration of increase in power demand and supply reliability. The rate of demand increase in the Study area is 15.7% over next 10 years. On the other hand, since the standard number of transformers which are installed in transformer stations within the Study area is two, it is desirable to keep utilization factor of transformers under 50% in order for supply reliability to comply with N-1 standard. From these considerations, the plan for transformer is prepared as in Table 2.5-2.

Table 2.5-2 Numbers and capacities of transformers to be installed under the Master Plan

	1000 kVA	630 kVA	400 kVA	Total (MVA)
Transformers to be procured	36	196	142	216.3

In 262 transformer stations to be rehabilitated, there are 26 "close to other building type", 57 "rented room type", and 13 "compact type" transformer stations. For these transformer stations, molded dry type transformers will be applied.

(4) LV distribution panels and LV line materials

For secondary side of each transformer, one LV distribution panel will be installed. Since it is necessary to increase transformer capacity in accordance with demand increase, the current carrying capacity of each LV feeders will be selected to meet with capacities of 1000 kVA transformers except for compact type stations. Since numbers of transformers installed in transformer stations are standardized to be two sets, except for compact type stations, bus tie switches will be installed to mutually connect two LV panels in order to avoid power failures during transformer faults.

Concerning power cables of LV distribution lines, 0.6/1 kV "cross linked polyethylene insulated (XLPE) vinyl sheathed steel armored cable of aluminum conductor" and ABC cable will be applied to underground cable lines and house flank cable lines respectively. As for cable sizes, two kinds of $3\times240+1\times95$ mm^2 for main circuits and $3\times150+1\times70$mm^2 for other circuits for underground lines, and $3\times150+1\times70$ mm^2 for main lines and $3\times70+1\times70$ mm^2 for other circuits for house flank lines will be applied.

2.5.2 Rehabilitation and Reconstruction Plan of Distribution Network

The priority order of the underground lines for rehabilitation by each district is in principle judged by the laying year of the underground cables. On the other hand, the cable length by the laying year presented in Appendix 2.2-1 differs largely among the district in the Study area. Provided that the Master Plan over 10 years for each administrative district is independently formulated under such situation, the extent of overage of the targeted facilities for rehabilitation might differ from district to district.

To formulate the Master Plan covering the entire Study area by avoiding such contradiction, the Master Plan will be worked out so as to achieve its equality over the entire Study area and over 10 years. Then, the Master Plan will be conveniently divided into each Study area district. This will not only make it possible to provide the funds to be invested will be, with more priority, directed to more superannuated facilities, but also will contribute to effects that the consistency between the Master Plan and the plan targeted for particular narrow area including basic Study will be easily recognized.

Further, years of rehabilitation implementation of objective facilities are allocated based on numbers of transformer stations and length of MV underground cables. Number of switchgears and number/capacity of transformers are counted to meet the actual status of allocated transformer stations and underground cables.

Table 2.5-3 shows yearly plan for facilities to be rehabilitated in coming ten years which is studied based on the above criteria. Furthermore, implementation years of rehabilitation per administrative districts are indicated in correspondence to the implementation years shown in the "Priority" column in Appendixes 2.3-1(1)-(6) and 2.3-2 (1)-(5).

Table 2.5-3 Yearly rehabilitation plan

Year	Underground Cable		Transformer station		
	No. of lines	Length of lines	No. of station	No. of transformer	Transformer capacity
1	51	23.4 km	27	42	20.8 MVA
2	52	23.0 km	27	40	19.1 MVA
3	50	23.8 km	26	37	16.9 MVA
4	46	22.9 km	26	36	17.5 MVA
5	57	23.2 km	26	34	15.8 MVA
6	49	23.6 km	26	36	17.5 MVA
7	41	23.4 km	26	32	15.1 MVA
8	46	22.8 km	26	31	13.1 MVA
9	31	22.8 km	26	46	20.3 MVA
10	46	24.1 km	26	40	17.4 MVA
Total	469	232.9 km	262	374	173.4 MVA

2.6 Load Dispatching System

The objective facilities of this Study were the 10 kV and 6 kV distribution system, which were managed by BEN as of March 1999. However, the distribution facilities of 35 kV, 10 kV and 6 kV system previously managed by was decided to be transferred to BEN. As a result, the load-dispatching system needs to be upgraded to additionally cover those facilities. Unlike to the plan for distribution network, a load dispatching system plan without covering up-stream system will not ensure supply reliability over the entire supply area. Accordingly, the automatic load dispatching system scooping 35 kV system from Azenerji is examined.

(1) System configuration of the central load dispatching center

The existing central load dispatching center (CLDC) consists of only a large supervisory and control board and the system has not been functioned due to its deterioration. Therefore, the new system is recommended to establish to achieve a reliable system, while all existing one is removed. The basic concept of the new

CLDC is (1) an automatic distribution dispatching system, which cover the 35 kV substation equipment as well as the 10 and 6 kV distribution facilities, (2) use of a computer to constantly supervise status of the equipment and (3) a function of automatic restoration.

The recommended system is composed of (a) distribution network supervisory control unit, (b) Substation supervisory control unit, (c) dispatcher terminal and (d) display panel, and its configuration is designed in Figure 2.6-1.

(2) Equipment in transformer station

The switchgears in transformer stations are objective to be handled by remote control operated from CLDC. The remote control is made through microwave network with 400 MHz band UHF. Each motorized cubicle is connected to the Remote Terminal Unit (RTU) to ensure the remote control from CLDC.

(3) Equipment in 35 kV substation

In order to make a remote supervision and control to the 35 kV substation, which will be newly managed by BEN, the switchgears in the 35 kV substations need to accommodate the remote control operation. Because those 35 kV substations are not covered by this Study, the actual situation of the equipment is not clearly known. From the survey on some substations, however, satisfactory functions are not attached except in recently replaced switchgears. Accordingly, BEN needs to prepare the rehabilitation plan for the said 35 kV system and add into the Master Plan in the future.

2.7 Energy Demand Forecast for the Study Area

Energy power consumption by BEN's customer is forecast by year and district until 2010. Both annual consumption in GWh and peak demand in MW are forecast. The forecast for energy power demand will provide a basic condition for power distribution system planning.

(1) Methodology

Energy demand by BEN's customer is forecast by three categories: "residential", "industrial" and "other". Two scenarios are set for residential energy demand forecast: "High growth scenario" and "Save-energy scenario". Different assumptions were applied in the energy consumption per capita.

"High growth scenario" assumes that the present tariff collection system be maintained until 2010. The per capita energy consumption rate will increase as a result of income rise. No reduction is assumed in inefficient energy use.

"Save-energy scenario", on the contrary, assumes that an improvement be made in the present energy tariff collection system resulting in promoting more efficient energy use. Energy consumption per capita will approach the world level. The impact of income rise would be surpassed by energy tariff revision. Energy demand for heating in winter, however, is a need specific to Baku and added to the normal energy demand.

Energy consumption for "industrial" and "other" uses is assumed to grow with the assumptions including the rate of economic growth (6.0%/annum: referring to long-term outlook by international organizations) and demand elasticity against the rate of growth (1.0). These energy users are generally considered more cost-conscious and using energy efficiently. There would not be much room for reducing wasteful use. In order to expand their activities, it would be inevitable for them to increase energy use.

Loss in 2010 is set at 10% of the purchased energy for all the districts, including both technical and non-technical losses, except in Nizami district. The loss rate in Nizami was 8.4% in 1999, already lower than 10%. Peak demand for each district is estimated with a annual load factor at 0.55.

(2) Result

It would be realistic to assume that some kind of institutional reform programs be implemented for various kinds of public services including energy supply by 2010. Therefore, "Save-energy scenario" is adopted for the facility planning purpose. The forecast energy consumption by BEN's customer is shown in Table 2.7-1.

Table 2.7-1 Result of energy demand forecast

Item	1999	2010	Rate of change (%/year)
A. Study area			
BEN's sold energy (GWh)	1,519	1,905	2.1
Residential consumption (GWh)	*1,253*	*1,398*	*1.0*
Industrial consumption (GWh)	*36*	*68*	*6.0*
Other consumption (GWh)	*231*	*438*	*6.0*
Loss (GWh)	305	206	-3.5
BEN's purchased energy (GWh)	1,824	2,111	1.3
Peak demand (MW)	379	438	1.4
B. Outside Study area			
BEN's sold energy (GWh)	1,483	1,757	1.6
BEN's purchased energy (GWh)	1,793	1,953	0.8
Peak demand (MW)	372	405	0.8
C. Total in Baku City (A+B)			
BEN's sold energy (GWh)	3,002	3,662	1.8
BEN's purchased energy (GWh)	3,617	4,064	1.1
Peak demand (MW)	751	844	1.1

Note: Demand outside the Study area includes that classified as " inspection ".

2.8 Implementation Plan and Cost Estimate

2.8.1 Implementation plan

(1) Rehabilitation of distribution facilities

An implementation of the Master Plan for rehabilitation and reconstruction of distribution network over next 10 years requires a large amount of investment fund. Accordingly, financial assistance by foreign governments and international assistance organization is deemed as necessary to smoothly implement the Master Plan. In this Study, the cost estimate and evaluation for the Master Plan project are made based on the condition that the financial assistance from foreign sources is available, and that the Master Plan project is implemented over next ten years in three phases. Among the total plan over ten years, the first four years is termed as the first phase, with next three years as the second phase and the remaining 3 years as the third phase. The facilities identified for rehabilitation and major procurement equipment and materials in each phase are shown in Table 2.8-1.

Table 2.8-1 Rehabilitation facilities and procurement in each phase

	Phase I	Phase II	Phase III	Total
Facilities to be rehabilitated				
MV line length (km)	93.1	70.1	69.7	232.9
Transformer stations (No.)	106	78	78	262
Major equipment/materials to be procured				
Cables : MV (km)	197.3	148.7	147.8	493.8
: LV (km)	246.9	153.2	183.9	583.9
Transformer capacity (MVA)	90.7	59.5	66.1	216.3
MV switchgear : CB panel	370	276	231	877
: LBS panel*1	603	438	411	1,452

Note*1: including bus-tie, transformer panel

The locating relation between the underground lines and transformer stations to be rehabilitated during the first phase is shown in Figures 2.8-1 (1)-(5), with that in the second in Figures 2.8-2 (1)-(5) and that in the third in Figures 2.8-3 (1)-(5). The existing facilities is indicated in blue for 10 kV and in green for 6 kV, and the facilities to be rehabilitated is indicated in red with those completed in black in each phase.

(2) Load dispatching facilities

Implementation of the rehabilitation plan for load dispatching facilities little by little in accordance to distribution network plan will be rather inefficient, and will not make an economic sense. It is planned that the implementation of the rehabilitation plan for load dispatching facilities will start when the second phase of the distribution network plan starts, and will be divided into two phases. The major procurement equipment and materials for the load dispatching system are shown in Table 2.8-2. The 35 kV substations are out of our scope of our investigation. Then, the number of 35 kV substation and the equipment to be remotely supervised and controlled is unknown and unable to be listed. The circle in column indicates a necessity of addition, modification and alternation of the software for the equipment installed in the second phase.

Table 2.8-2 Major facilities for load dispatching system

	Phase I	Phase II	Phase III	Total
Central Load Dispatching Center				
Distribution network supervisory control unit (main)	—	1	○	1
Distribution network supervisory control unit (backup)	—	1	○	1
Dispatcher terminal	—	3	○	3
Large size screen type display	—	1	○	1
Distribution network diagram display panel	—	1	○	1
Substation SV/TM display panel	—	1	○	1
Radio communication control equipment	—	1	—	1
Substation supervisory control unit (master unit)	—	1	○	1
Training terminal	—	—	1	1
Office terminal	—	—	3	3
Transformer Station				
RTU	—	184	78	262
35 kV substation				
Substation supervisory control unit (sub unit)	—	—	—	—

Note: Rehabilitation work of load dispatching system is to be started at the phase II

2.8.2 Procurement of Equipment and Materials

(1) Distribution facilities

Procurement of medium voltage switchgears is particularly problematic. The problem here is not in the availability with required specification, but the size of switchgears. Most of the transformer stations houses were designed so as to correspond to the distribution system comprising of single circuit. Therefore, those transformer stations are too small to accommodate the medium voltage switchgears for the system upgraded by double circuit, and need to be sufficiently expanded.

As a result of examination, the international competitive bidding, which can procure the switchgears requiring partly renovation of transformer stations, is considered as valid. Even in this case, however, the layout of the transformer stations to be rehabilitated and bidding conditions is clearly shown and stipulated in the bidding document.

(2) Load dispatching facilities

Load dispatching system comprises of modern technology of electronics, tele-communication, and computer. Due to recent free competition, equipment performance has been rapidly progressing, all-purpose equipment is used to manufacture the distribution controlling equipment. Therefore, as in case of the equipment and materials for distribution facilities, a procurement through the international competitive bidding is supposed.

In this plan, to display the location of distribution lines on the electrical map is intended using the graphic information system (GIS). Presently, electrical map of the whole Azerbaijan is under preparation by assistance of the government of Japan. It is expected in view of facilitating the development of basic infrastructure of Baku City that the electrical map will be available by the time this load dispatching plan is implemented.

2.8.3 Unit Price for Cost Estimate of the Master Plan Project

Standard unit price table prepared by electricity business contractor is generally available for the cost estimation. However, the unit prices used by BEN are as of before the collapse of FSU, the equipment in the list is not appropriate for application in the Master Plan. Furthermore, procurement activity by international competitive bidding has not been practiced at all by BEN. Accordingly, the standard unit prices are prepared by the Study Team with reference to recent information on international competitive bidding and price quotations by manufacturing makers.

2.8.4 Contract Style

BEN has procured the necessary equipment and materials from both abroad and domestic providers with its own terms, and implemented project works for itself or consigned the contractor with the works. Also, the procurement of equipment and materials is sometimes included in the project works contract. As is already discussed, however, the equipment and materials needs to be procured in accordance with various conditions stipulated in the bidding document, and the unfamiliar installment and adjustment works with the latest technology for BEN and local contractor need to be undertaken. Therefore, it is considered as appropriate that the rehabilitation works for distribution networks including procurement is to be contracted to the experienced foreign contractor with turn-key basis. It is assumed, however, that Azerbaijan's local contractor shall cover the major parts of project works as sub-contract basis. Underground cables works in the central area of the city in particular require the active local participation, considering the difficulties in approval and permission procedures.

The cost for the project works undertaken by local sub-contractor in the Master Plan is estimated based on the past records. Cost estimate for public works including distribution network project in Azerbaijan is still practiced with the method applied during FSU period.

2.8.5 Project Cost

The project cost is estimated and summarized in Table 2.8-3. The cost for engineering consulting to undertake construction supervision followed by the detail design and bidding support is estimated as 8 % of the total direct project cost, and 10 % of the total direct project is allowed as contingency portion.

Table 2.8-3 Project cost summary (unit : '000 USD)

	First phase	Second phase	Third phase	Total
1) Distribution facilities				
Equipment/material (CIF)	28,942	19,641	20,020	68,603
Construction cost: foreign cost portion	5,625	3,858	3,970	13,453
Construction cost: local cost portion	4,503	3,163	3,328	10,994
Sub-total	39,070	26,662	27,318	93,050
2) Load dispatching facilities				
Equipment/material (CIF)	-	9,842	2,612	12,454
Construction cost: foreign cost portion	-	270	66	336
Construction cost: local cost portion	-	67	16	83
Sub-total	-	10,179	2,694	12,873
1) + 2)				
Equipment/material (CIF)	28,942	29,483	22,632	81,057
Construction cost: foreign cost portion	5,625	4,128	4,036	13,789
Construction cost: local cost portion	4,503	3,230	3,344	11,077
Sub-total	39,070	36,841	30,012	105,923
Detail design and construction supervision	3,126	2,947	2,401	8,474
Contingency portion	3,907	3,684	3,001	10,592
Total	46,103	43,472	35,414	124,989

2.9 Economic and Financial Evaluation

Project evaluation is devoted to ascertain the viability of the Master Plan project (the Project) targeted for the entire Study area in both economic and financial aspects through computation of economic and financial internal rate of return (EIRR and FIRR).

(1) Benefit of the Project

Project evaluation is carried out by comparing the likely events between "with project" and "without project" situations, and judged by incremental benefits (revenue) and costs as differences. The positive effect resulted from the Master Plan project is considered as "avoidance of unsurved energy supply". Unserved energy supply (decline of supply capability) due to frequent accidents of distribution facilities and resultant shortage in capacity (without the Project case) will be avoided, and properly supplied/sold to those who demand. Avoidance of unserved energy supply by the Project implementation, in this context, shall bring about an increase in consumable and salable energy compared to "without the Project" situation.

It is presumed that unserved supply rate against total energy demand projection will annually increase by 3.0 % each from 2001 without the Project (then, expanding to 30.0% in 2010). In case of the Project implementation where unserved energy supply is avoided, the cost of corresponding energy supply through network (calculated as USC 8.08/kWh) shall be borne in the entire economy. Without the Project, however, the consumer will be imposed to bear the cost of alternative energy generation (calculated as USC 17.42/kWh). Accordingly, it is considered that resources valued at US cent 9.24 shall be saved by an avoidance of unserved supply per kWh. This value represents the worth of resources saved by the Project implementation in the national economy as a whole, and is applied for an incremental consumable energy (avoidable unserved energy).

For financial analysis, the margin to BEN between the retail and wholesale tariff is, therefore, AZM 20.3/kWh, which is incremental revenue by salable energy (avoided unserved energy) per kWh.

(2) Economic evaluation

EIRR of the Project was computed as 27.9%. Comparison of EIRR with the cut-off rate (10 %) presents that the Project is judged to be economically viable.

Table 2.9-1 Results of sensitivity test for EIRR

Base case : Unserved supply rate (annual increase by 3% each)	26.9%
Unserved supply rate (minus 0.5% each annum)	22.0%
Unserved supply rate (plus 0.5% each annum)	31.7%
Construction cost : (minus 20%)	34.0%
Construction cost : (plus 20%)	22.0%

As a result of sensitivity test, even in the most conservative scenario where construction cost with 20 % up and unserved supply ratio with annual increase by 2.5 % each are realized, the Project still shows a strong viability, exceeding 10 % cut-off rate.

(3) Financial evaluation

Applying the present margin level to BEN, FIRR dose not show the positive value, meaning that the present value of total incremental benefit is computed as less than that of total incremental cost with any positive discount rates. The poor result of FIRR is mainly attributed to the extensively suppressed sales price and resultant small distribution margin to BEN.

2.10 Database System for Operation and Maintenance

To properly maintain and operate the distribution network, promptly correspond to facility accidents, and formulate efficient rehabilitation and expansion plan of distribution network, the information/data related to the distribution facilities/system has to be managed. In reply to this statement, the Study Team proposes the management method for information/data necessary for distribution system operation through the utilization of computer based database system.

Proposed basic database by the Study Team covers "Information/data required when the Master Plan for Rehabilitation and Reconstruction formulated in the Study will be periodically reviewed and modified by

BEN's own terms". Expected merits by utilizing the basic database include (i) Sharing of the uniform format for information/data input among BEN, (ii) prompt derivation of processed information, essential for reviewing and monitoring, and (iii) centralization and common sharing of information/data, and prevention of data from deteriorating and missing. Beyond this scope, however, it is ultimately expected that the basic database prepared by this Study will be customized by BEN for the purpose of enhancing its convenience in the medium and long-term period of course.

2.11 Measures against Environmental Issues

2.11.1 Issues Concerned with Underground Line Construction Works

The underground line construction works will be undertaken along with the streets and roads of the area where the office buildings or apartment complexes are heavily concentrated. Accordingly, noises and vibrations caused by construction machinery, and traffic congestion might exert negative influences to the surrounding local communities.

To minimize the occurrence of those issues, the underground line routes should be carefully selected from the places, where (i) cable length can be shortened, (ii) wide road and low traffic, and construction and maintenance works can be easily done, (iii) there are few crossing point with underground facilities such as water and gas pipe, (iv) there are few road crossing points, and (v) groundwater level is low and soil condition is firm and stable.

Since the objective area of the Master Plan is a densely populated and heavy traffic area, the problems such as (i) traffic obstruction, (ii) damages to the other underground facilities by excavation, and (iii) noise and the vibration to the local residents by the excavation. The measures to those issues caused by the underground line construction works include facility installment for safety, appropriate placement of traffic control and guard staff, adoption of excavation method ensuring little damage to the already laid stuff, public relation with neighboring residents, sound management of excavated sands, and so on.

2.11.2 Issues Concerned with Construction and Operation of Transformer Stations

The environmental problems to the local communities concerned with the replacement of equipment, renovation/construction works of the station house, and operation of the transformer station are explained as follows:

(1) Issues concerned with construction works

Planned outage will be inevitable in forwarding the renovation and construction works of the transformer station building, and replacement works of the equipment. As the target area of the Master Plan in particular is a center of City, with the office building and apartment complex heavily concentrated, there are a large number of resident living in this area and will be greatly affected by energy outage. Accordingly, the measures to minimize the number and time of stoppage, suggested in this plan include (i) utilization of temporary transformer station facilities, (ii) less newly construction and expansion of the station house, (iii) selection of the equipment requiring less renovation of the station house.

The acquisition of land for expansion or new construction of a transformer station building, except a transformer station where is erected in a park or green belt, is in difficult situation. A transformer station, where is in existing apartment, doesn't have any space for expansion. To solve these problems, it's necessary to rearrange the partition wall of each facility room in transformer station and size selection of MV switchgears is to be paid particular attention.

Most of the rented room type transformer stations face the public road, and some ground-mounted transformer stations adhered to the other buildings also do. For the replacement works of the facilities in the transformer stations, sufficient protection measures to prevent neighboring residents from accidents caused by transformer stations including temporary facilities as well as to minimize the traffic disturbance will be essential. As conceivable measures, the adoption of shut-up type equipment, establishment of protection fence, placement of guarding staff, sound public relation and so on will be required.

(2) Issues concerned with operation of the facilities after the Project completion

Although a noise of distribution transformer increases with its deterioration, the transformer is isolated with concrete walls and the noise, which leaks to external, is small. Actually, the complaint to BEN from the residents who are adjacent to the transformer station is few.

A transformer and switchgear that are containing oil inside are installed in the transformer station building made of concrete, except for the compact type station. Even if the oil leakage occurs in the station building, the oil flows into cable duct and does not leak out structurally. Therefore, it is considered that there is little possibility of the soil pollution by oil leakage.

Fire accidents have occurred in some existing distribution transformers. This has been caused by deterioration and over-load operation of the transformers. Since capacity of transformer, which is planned to introduce by the Master Plan, is selected with consideration of the demand increase and installation of a power fuse is also planned to protect the transformer, it is possible to minimize the fire accident of the transformer by the overload.

Since each facility room is divided with the concrete partition walls, a spread of fire can be prevented if the fire occurs. The molded dry type transformers, in which insulation oil is not contained, is also applied.

III. BASIC DESIGN LEVEL STUDY

III. BASIC DESIGN LEVEL STUDY

3.1 Selection of Priority Administrative Area

Basic design level study followed by the Master Plan is to prepare the design output to be utilized for the implementation of more concrete rehabilitation and reconstruction plan. Therefore, a clarification, basic design, cost estimate of targeted facility and formulating its implementation plan shall be covered. Initially, the prioritization among the Study area (six administrative districts) is conducted, before a selection of the highest priority project/area.

(1) Basic data for prioritization

Prioritization is examined from the viewpoints of (a) urgency for implementation of rehabilitation and reconstruction plan, and (b) impacts of the plan, and indicators such as supply capability, the extent of overage of the facilities, energy demand, public facilities, population and so on are set for comparison and evaluation. Each value for evaluation is customized to be the unit value per m2 to reflect the potential impact of the rehabilitation and reconstruction plan.

(2) Prioritization

A scoring method was applied for prioritization through those density indicators. The district with the highest value for an item is given 6 points, and the district with next lower value is given 1 point lowering score with continuously prioritized in a descending order. It is found that Nasimi district shows the distinctive result with followed by Sabail and Yasamal districts in all evaluation items.

3.2 Candidate Area for Priority Project

(1) Candidate area

Baku City has its own conceptual plan to rehabilitate the distribution network in the central part of the city, extending over the said three administrative districts. The necessity for urgent rehabilitation of this extending area is also pointed out by JICA's preliminary study team.

Actually, around 43 % of medical facilities and 32 % of total in the Study area (six administrative area) are concentrated in this area, although the area size (12.9 km^2) accounts for only 10 % of the total. Furthermore, this area has been an economic and political center of Azerbaijan. Also energy demand density in this area is extensively higher compared to other area. In addition, the distribution facilities in this area has used a considerable number of old cables installed in the age when the first 6 kV system were introduced in Baku City, and been relatively obsolete. Taking into account those situations, this central area of Baku City is selected as priority project/area with conformation by the counterpart.

(2) Dividing the area

To select the project/area for the basic design level study from the rehabilitation plan in the central area of Baku, which BEN strongly desires to promptly implement, can be judged a valid, considering the above examination results. However, it is difficult to identify the whole plan for this central area as an object of basic design level study since the Study period is rather limited. Accordingly, this priority area is further divided into each administrative district to derive three candidate priority project areas. This area dividing is judged to be consistent with the Master Plan concept, which targets each 6 administrative district.

3.3 Selection of the Highest Priority Project

The highest priority project as a target of basic design level study is selected among the three higher priority project/area. A series of works in Pre-Feasibility study including identification of facilities to be rehabilitated, cost estimate, and prioritization by economic evaluation has confirmed the viability and priority of the project. Based on the outcome, then, a discussion with counterparts has been made, and confirmed the highest priority of the selected project.

3.3.1 Distribution Facilities in the Priority Project Area

Based on the database for the existing transformer stations and underground cables, the MV distribution facilities in the priority project area are picked out, and shown in Table 3.3-1. It is known that 71% of total length of underground line in the entire Sabail district has been concentrated in this priority project area, with 57 % in Yasamal district and 44 % in Nasimi district.

Table 3.3-1 Distribution facilities by district in the priority project area

Facilities		Sabail priority area	Yasamal priority area	Nasimi priority area	Total
Transformer station (number)	6 kV	57	106	83	246
	10 kV	34	38	23	95
	total	91	144	106	341
Transformer (number)	6 kV	82	160	124	366
	10 kV	58	67	32	157
	total	130	227	156	513
Transformer capacity (MVA)	6 kV	36.8	79.0	59.4	175.2
	10 kV	37.4	35.3	26.1	98.8
	total	74.2	114.3	85.5	274.1
Underground cable length (km)	6 kV	46.0	76.2	49.7	171.9
	10 kV	39.1	42.6	15.1	96.4
	total	85.1	118.8	64.8	268.3

3.3.2 Identification of Objective Facilities

The scope of facility identification for Pre-Feasibility study is considered as MV distribution cables, buildings of transformer station, MV switchgears, transformers, LV switchboards and LV cables. The criteria for facility identification for rehabilitation have been in accordance with the one for Master Plan Study.

(1) MV underground cables

All MV distribution lines in the priority project area are underground cables. MV distribution lines for the Pre-feasibility study have been selected by the following criteria.

(a) All the distribution lines constituted by the cables laid before 1960 are replaced.

(b) More than 2 points of cable joint are observed, and the year of cable laying is varied among each cable.

Table 3.3-2 shows the length of the cables identified according to the above criteria. As known from the table, the underground cables laid before 1960 are only 6 kV cables. The cables laid before 1960, which constitutes 10 kV distribution system, were initially installed as the element of 6 kV system and used later as the part of 10 kV system.

Table 3.3-2 Underground lines to be rehabilitated

Item	Sabail Priority area	Yasamal priority area	Nasimi priority area	Total
6 kV underground line				
laid before 1960	25.2 km	40.5 km	30.2 km	95.9 km
more than 2 connection points	3.5 km	2.1 km	3.8 km	9.4 km
total	28.7 km	42.6 km	34.0 km	105.3 km
the number of section	54	100	75	229
10 kV underground line				
laid before 1960	0.3 km	-	0.1 km	0.4 km
more than 2 connection points	-	0.7 km	4.5 km	5.2 km
total	0.3 km	0.7km	4.6 km	5.6 km
the number of section	1	1	3	5

(2) Transformer stations

The identification of transformer stations to replace urgently the switchgears and transformers should be undertaken with more detailed site survey. For the purpose of Pre-feasibility study to select the project for basic design level study, however, one third of total transformer stations in the priority project area is considered as the target facility.

(3) Transformers

It has been difficult to identify the target transformer from its past record. It is because the record on the year of manufacturing, purchase, and installment of each transformer has not been sufficiently kept. Accordingly, considering the above situation, the number of transformers and the capacity to be replaced is set as one third of the total in the priority project area as done in the transformer stations.

(4) MV and LV switchgears

Based on the number of the existing lines in Sabail priority project area identified in Section 3.3.1 and necessary switchgears to make all lines double circuit, average number of switchgear per one transformer station is derived.

3.3.3 Cost Estimate

For the purpose of priority project cost estimate, the contents of rehabilitation and replacement have been supposed as follows:

(1) Transformer station house

It is considered as difficult to expand the transformer station house except for a part of them. Therefore, the layout reform to alter partition to install switchgears in transformer stations are focused, while not taking into account the newly construction of the station house.

(2) Transformers and switchgears

It is supposed that though all the transformers and switchgears in the identified transformer station for rehabilitation are to be replaced. Voltage augmentation from 6 kV to 10 kV is not considered. Then, the number of switchgear is adjusted to fit the number of line when estimating cost.

(3) MV and LV distribution line

It is supposed that the MV underground cables to be rehabilitated are replaced without altering the existing route, regardless whether they are single or double circuit.

(4) Project cost

The unit CIF prices for equipment and cable materials are derived with reference to the record of other distribution network rehabilitation projects. Remodeling work for transformer station house, removal and laying work for underground cable are supposed to be undertaken by the local contractors. Though the foreign supplier will be responsible for installment, adjustment and testing of equipment, it is presumed that these works are practically undertaken by the local contractors.

The priority project cost estimate, based on the above supposition and conditions, is derived as in Table 3.3-3.

Table 3.3-3 Breakdown of the priority project cost (thousand US$)

Item	Sabail priority area	Yasamal priority area	Nasimi priority area
Equipment and material cost (CIF)	7,921	12,377	9,460
Construction cost: foreign portion	2,272	3,537	2,730
Construction cost: local portion	1,175	1,807	1,442
Sub-total	11,368	17,721	13,632
Detail design and construction supervision	1,137	1,772	1,363
Total	12,505	19,493	14,995

3.3.4 Cost and Benefit for Economical Evaluation

(1) Project cost for evaluation

The costs for project evaluation comprises of the project cost estimate derived (disbursement schedule as 20-first year/50-second year/30%-third year) and incremental O&M cost (2.0 % of the project cost) incurred by newly established facilities by the project. Local portion is converted by composite conversion factor applied in Master Plan evaluation to derive economic cost.

(2) Benefit for evaluation

As in the case of Master Plan project evaluation, "avoidable unserved energy supply by the project implementation" is considered. Unserved energy, brought about by accidents of facilities and resultant capacity shortage without the project implementation, will be adequately supplied after the project implementation. Accordingly, the incremental energy supply is considered as a benefit.

(3) Demand projection for the priority project/area

Energy sales data is complied for each administrative district, it is impossible to grasp the demand (consumption) level for such optional area as the priority project area. In this study, therefore, energy demand for the priority area has been estimated based on the average capacity factor per transformer capacity in each priority project area. Annual load factor 55 % and power factor 90 % is adopted for estimating the peak demand.

(4) Unit rate of benefit

As explained in Master Plan project evaluation, the unit rate for benefit computation is derived in terms of the saving for resource mobilization (avoidable cost) realized by the improvement of supply capability. Therefore, US cent 9.24/kWh is adopted as unit rate of benefit for the project evaluation.

3.3.5 Sensitivity Test

Sensitivity test is undertaken to ascertain the extent of influence of major variants to the priority projects' EIRR, and examined by varying the project cost (plus and minus 20 %) and assumed rate of increase in unserved energy supply (plus and minus 0.5 %/year against base case).

3.3.6 Evaluation Result

The evaluation result in terms of IRR is shown in Table 3.3-4. In selecting the highest priority project/area, a priority project in Sabail area shows the highest IRR both in base case and each sensitivity scenario. Therefore, the project in Sabail district is selected as the highest priority project/area.

Table 3.3-4 Project evaluation result by EIRR

		Sabail Priority area	Yasamal priority area	Nasimi priority area
Base case		24.6 %	17.4 %	19.0 %
Sensitivity test				
1) Project cost	(- 20%)	29.8 %	21.3 %	23.1 %
	(+ 20%)	21.0 %	14.6 %	16.0 %
2) Supply interruption growth rate	(-0.5%/year)	21.0 %	14.6 %	16.0 %
	(+0.5%/year)	28.1 %	20.0 %	21.8 %

3.4 Detailed Survey in the Highest Priority Project Area

The Study Team carried out detailed survey to identify the facilities for rehabilitation in the highest priority project area. The Study Team applies the distribution system as of January 2000 to the basic design level study.

The detailed survey was carried out for the transformer stations, which were selected through the discussion with BEN considering the deterioration level of the facilities and its importance in the distribution system. The main purpose of the survey is as follows.

(a) Confirmation of the current situation of the transformers and switchgears

(b) Confirmation of the layout of the station houses

(c) Confirmation of the surrounding situation of the station houses, especially width of carrying in road, establishment space for the temporary facilities, work space for the construction

(d) Possibility of the land acquisition for expansion of the station buildings

The purpose of the survey on MV distribution lines is to prepare the single line diagram and route map in the highest priority project area. The Study Team also carried out the detailed survey for the actual situation of LV lines connected to major transformer stations.

3.5 Identification of Facilities for the Basic Design Level Study

The criteria adopted for identifying the facilities in the basic design level study are basically same as those in the Master Plan Study. However, more concrete identification of the facilities is undertaken upon the strong request by BEN, with reference to a discussion with the counterpart.

3.5.1 Approach for the Facilities Identification for Rehabilitation

The criteria to identify the distribution facilities for rehabilitation are explained as follows:

(1) MV distribution lines

The criteria to identify MV distribution lines for rehabilitation are same as those in Pre-feasibility study. However, if it is judged as necessary to simultaneously rehabilitate the cable lines connected with the identified transformer stations, corresponding lines are also included in rehabilitation target. "Rehabilitation" here means the "replacement" of the underground cable.

(2) MV switchgears

The same criteria explained in Section 2.3 are basically adopted. To enhance the rehabilitation effect, however, the rehabilitation of the switchgears in the transformer stations to which the identified underground lines are connected. "Rehabilitation" here means the total "replacement" of the switchgears.

(3) Transformer stations

The transformer stations to be rehabilitated include those of which MV switchgears are to be replaced. The contents of rehabilitation scope a partitioning layout change in the facility rooms to accommodate the vacuum and SF6 gas type switchgears, and resultant alternation for transporting entrance and repairing house itself including its roof.

(4) Transformers

All the transformers installed in the transformer stations, of which MV switchgears are replaced, are replaced. The transformers dismantled are to be diverted to other transformer stations after the inspection and repairing in the transformer repair shop. To protect neighboring residents, which live near the "close to other building type", "rented room type" and "compact type" transformer stations, from a fire and its poisonous gas, the molded dry type transformer will be installed in those types of stations.

(5) LV switchgears and distribution lines

All the low voltage switchgears installed in the transformer station, of which MV switchgears are replaced, are totally replaced. The LV lines pulled out from the LV switchgears are also rehabilitated, however, the scope in this plan is limited to procurement of related facilities and materials, and BEN will follow the replacing work for LV lines on its own terms.

3.5.2 Rehabilitation Facilities Identified

(1) Voltage augmentation from 6 to 10 kV in central area of Baku

As an emergent correspondence to the landslide disaster, which occurred in Baku on March 2000, BEN has separated the transformer station in the central area from 6 kV system and converted to 10 kV system to continue the energy supply. No.119 substation of Azenerji has been playing the important role in power supply to the central area of city, but of which location is distant from the central area. It is also indicated by the study that the cable has been severely deteriorated (laid in early 1930's), and has been frequently replaced due to the fault.

On the other hand, 10 kV system has been supplied from relatively new No.116 substation of Azenerji near the old castle walls and Patamdar 110 kV substation, and has sufficient capacity in transformers and cables. Under such situation, BEN has strongly desired the permanent conversion into 10 kV system for the part, which was temporarily changed to 10 kV system.

The area surrounded by the old castle walls and its surrounding area is characterized with higher demand density among the priority area in Sabail district. BEN's request is accepted, because the permanent conversion into 10 kV system at this time is considered to provide an economic sense in terms of demand density and avoiding extra investment to correspond to the future increase of demand.

The cable route layout for the concerned part as of January 2000 and that after permanent configuration to 10 kV system are shown in Figure 3.5-1. Single line diagram of 10 kV system after voltage augmentation is also shown in Figure 3.5-2. Appendixes 3.5-1 and 3.5-2 detailed the identified transformer stations and underground lines respectively, with summarized in Table 3.5-1.

Table 3.5-1 Rehabilitation facilities related to voltage augmentation (Phase I)

Item	Existing	Rehabilitation
Distribution line		
1. Number of line	24	23
2. Line length	9.8 km	7.0 km
3. Cable length	9.8 km	10.4 km
Transformer station		
1. Number of transformer station	17	17
2. Number of transformer	25	27
3. Capacity of transformer	12.9 MVA	15.9 MVA

(2) Other rehabilitation and reconstruction plan

Candidate underground lines for rehabilitation are scattered through the whole Study area, but differ in their system configuration. Based on this difference, the rehabilitation plan are largely divided into three plans and suggested to BEN.

(a) Overage 6 kV and 10 kV system are mixed in the eastern area around substation No.116 (35/10 kV) as in other area. In this area, 10 kV system has covered larger area in power supply and 6 kV system is rather scattered. Accordingly the voltage augmentation for smaller number of 6 kV transformer to 10 kV system is suggested.

(b) Power supply is made through only 6 kV system in the northern and surrounding area of the old castle wall. Accordingly, the rehabilitation plan in accordance to the existing system voltage is prepared.

(c) Except a part of the north-western area, 6 kV and 10 kV system are mixed and relatively new facilities are equipped in the western area. Since only 6 kV system is utilized in the north-western area, the same consideration is taken as in (b).

For the above suggestions, the discussion with BEN was held. BEN agreed with the Study Team's suggestion (b) and (c). Regarding (a), however, BEN requested the rehabilitation with maintaining 6 kV system, upon the condition that the voltage augmentation to 10 kV around the old castle wall may pose a lack of transformer capacity in No.116. The Study Team accepted to exclude the said area from the scope by the following reasons with BEN's agreement:

- The rehabilitation as 6 kV system needs much higher project costs than the plan suggested by the Study Team.
- As the cables to be rehabilitated in this plan are overlapped with the existing 10 kV system, the role of these cables will not be sufficiently fulfilled if a voltage augmentation is made in the future.

The location of underground lines and transformer stations for rehabilitation is indicated in Figure 3.5-3. Single line diagrams after rehabilitation are shown in Figure 3.5-4 (1)-(2). Major rehabilitation facilities are also shown in Table 3.5-2. Those transformer stations and underground lines are detailed in Appendixes 3.5-3 and 3.5-4 respectively.

Table 3.5-2 Facilities for 6 kV system rehabilitation (Phase II)

Item	Existing	Rehabilitation
Distribution line		
1. Number of line	18	19
2. Line length	10.2 km	10.4 km
3. Cable length	10.5 km	18.2 km
Transformer station		
1. Number of transformer station	18	18
2. Number of transformer	27	27
3. Capacity of transformer	13.9 MVA	17.0 MVA

3.6 Basic Design

The design criteria of this plan are as follows:

(a) Applying the technical level of BEN
(b) Considering the easiness of operation and maintenance
(c) Applying the design and facilities that are adjusted to the existing facilities
(d) Ensuring high safety and reliability level
(e) Securing of economy (Effective use of existing building)
(f) Establishment of flexible distribution system corresponding to expansion in the future

3.6.1 Standard to be Applied

International Electro-technical Committee (IEC) standard is applied to technical specifications of each facility such as design, manufacturing, factory inspection. Standard frequency is set as 50 Hz, with standard voltages of 6.0 and 10.0 kV. Electricity system applied is the isolated neutral for MV system and earth neutral one for LV system.

3.6.2 Transformer Station and Switchgears

In general, ground-mounted type transformer station has enough space in each equipment room. Therefore, it is possible to properly install the new equipment only by rearranging the existing partition layout. On the other hand, the transformer station built adjacently to other buildings usually has a problem in spacing. Against such transformer stations, the change in system configuration will be considered. For the in-building type transformer station, the expansion of the house is hardly possible. Therefore, the change in partition layout or system configuration will be considered.

MV switchgear cubicles consist of the following panels. Bus-tie will not be equipped to the transformer station to which only single circuit is connected. Instrument transformer for earthling fault detection will be equipped to the transformer station equipped with circuit breaker panel.

- SF6 gas type circuit breaker (for out-going feeders)
- SF6 gas type load break switch (for in-coming feeder)
- SF6 gas type load break switch (for bus-tie)
- SF6 gas type load break switch with power fuse (for primary side of transformer circuit)
- Instrument transformer (for earthling fault detection device)

The specification of all the switchgears, which will be installed in this plan, shall meet the application of remote control from the load dispatching center in future.

3.6.3 Project Implementation Setup

(1) Organizational setup

As a result of the re-organization of DEC in May 1999, the roles of BEN have been limited to O&M for 10/6 kV and LV distribution facilities. However, the Presidential Decree on the privatization of electricity distribution sector through establishing Joint Stock Company BEN (JSC BEN) was issued on 14 June 2000. The Decree decides to re-incorporate the functions, which are once separated and to establish the organization setup that is close to the former BEN (i.e. before the said re-organization in May 1999). Accordingly, JSC BEN has been established with all the necessary functions for the implementation of the project raised in this study.

As of now, there has been some points yet to be confirmed, including how the organizational setup inside JSC BEN is established for the implementation of the project and O&M, and how the responsibility allocation with distribution operator to be selected by tender will be established. At this time, on the condition that those functions related to the project implementation have been incorporated into JSC BEN, the organization setup for the project implementation based on the past structure (after re-organization in May 1999) is shown below:

Table 3.6-1 Project implementation setup

Project Supervising, Monitoring, Reviewing	BEN – Head Quarter
Procurement of Material, Equipment	Technical Procurement Department (BEN)
D/D, Construction, Installment Works	Energy related division in MRCIAE (DEC)
Operation, Maintenance, Repairing Works	City and Suburb Electric Networks: BEN

Note: The above functions are incorporated into Joint Stock Company BEN.

(2) Budgeting allocation by BEN for the project

As of now, the budgeting plan by BEN's own fund for this priority project has not been indicated nor will be available in the near future. The transition process into full-operation as Joint Stock Company BEN has just started, and the business plan, organization setup, and financing plan of the newly established corporation has not been prepared. Accordingly, it is hardly expected that BEN under the present situation formulate any own fund allocating and financing plans for this priority project.

(3) Personnel and technological level

The section, which is directly and technically concerned with the project implementation, is DSC, which used to be a part of BEN before re-organization in May 1999 (i.e. energy related section in MRCIAE of DEC after the said re-organization). The staff in this section will be mainly responsible for detail designing study and implementation (construction and installation works) for the project, and is staffed with around 125 persons. The working group will provide the cooperation for project management and operation assistance.

BEN has enough experiences in construction and installment works for distribution facilities.

BEN executed the replacement works for 53 km of MV (29 km) and LV (24 km) underground cables and 148 transformers within the year 1999. Therefore, the technological level of BEN is judged to be valid for the project implementation.

3.7 Implementation Plan

(1) Approach of construction

Every equipment and materials, which constitute BEN's distribution network, have been those manufactured in the FSU countries, and BEN has not experienced using ones from the western countries. The equipment and materials, which are to be adopted in this plan, are as follows:

Table 3.7-1 Equipment and materials for distribution network

Items	Existing facilities	Facilities for rehabilitation
a) MV circuit breaker	minimum oil content type	SF6 gas type
b) Other MV feeder	disconnecting switch (DS)	SF6 gas type load break switch (LBS)
c) Switchgear for transformer's circuit	DS and power fuse	SF6 gas type LBS and Power fuse
d) MV underground cable	oil impregnated paper insulated cable	XLPE insulated PVC sheathed cable
e) LV underground cable	oil impregnated paper insulated cable	XLPE insulated PVC sheathed cable

So far, BEN has procured the equipment and materials necessary for rehabilitation works, and local contractors selected through tenders or BEN itself has undertaken installing, adjusting and laying works. Local contractors as well as BEN have high technical skills and are considered as sufficiently qualified for the implementation of this plan. However, the equipment and materials to be procured for this plan are not familiar with them. Accordingly, the implementation works by only local contractors are not fully recommended.

In this plan, to ensure that the equipment suitable to local situation are procured under the condition stipulated in the tender document, and that those equipment are responsibly installed, adjusted and inspected, the turn-key contract, where fully experienced foreign contractor will be responsible for all the related works, is recommended.

As laying works of MV and LV cables in particular are practically same as usual, this portion will be excluded from the scope of foreign contractor's responsibility and be implemented under BEN's responsibility. However, since the cables adopted in this plan is also new to BEN, the foreign contractor will arrange the technical training staff to facilitate technological transfer particularly for cable connection and cable terminal treatment.

Considering that BEN has not experienced any projects under the foreign financial assistance, the use of the experienced engineering consultant will be required. The consultant will be required to provide supports on the regular reporting on the progress of the project works to the donor organization, trouble shooting, approval processing as well as general construction supervision.

(2) Construction circumstance and things to be noted

The following points need to be taken into consideration to implement this plan:

(a) For the target area, which has a large number of residents, and economically and politically important facilities and offices, the energy cut or power outage due to repairing works of transformer stations will affect the socio-economic activity, and should be minimized. Then, it is crucial to prepare detailed implementation plan, and have sufficient pre-discussion and confirmation on the implementation schedule among BEN, engineering consultant and contractors.

(b) It is considered difficult to conduct timely replacement of the equipment by foreign contractors in good accordance with cable laying works by BEN. In this plan, supposing that the works for transformer stations and those for underground cable laying are undertaken independently.

(c) In general, underground cables are directly laid in the ground of sidewalks or roads. However, the buildings are extensively congested with rare roads vested with sufficient space in the target area.

(d) In laying works for the underground cables, by regulation, bricks or blocks are laid to identify the lying point of the cables. For MV cables, it is planned that concrete plates will be laid to protect the MV cable and XLPE cables without steel armor will be procured in view of minimizing the cost. For LV cables, since a large number of LV cables will be installed, it is difficult to install the concrete plate for protection at the same manner of the MV cables. Accordingly, it is planned that steel tape armored cables will be procured same as previous manner.

(e) Against the issues anticipated in Section 2.11, thorough consideration and measures should be taken.

(3) Construction supervision plan

As a major process to the privatization of energy distribution operation, the presidential decree was issued on June 14 2000. As a result, BEN was transformed into JSC BEN, which handles a series of energy distribution business comprising of planning, construction and operation of distribution facilities. BEN has so far been responsible for formulating and implementing the rehabilitation and expansion plan of the distribution facilities, and it is reasonably judged that BEN has sufficient capability to manage construction supervision of the implementation of this plan.

Since bidding preparation to provide the management/operation concession of BEN is currently underway, such matters how Azerbaijan Government, JSC BEN and management company will engage in the implementation of the facility rehabilitation plan are not yet clear. However, though management/operation concession is awarded to the private proponents, the ownership of the distribution facilities remains in Azerbaijan government. For the purpose of introducing and utilizing the public funds from international organizations/foreign governments, a clear responsibility demarcation in forwarding the rehabilitation plan needs to be assured, and impartial project implementation setup needs to be established. In these respects, JSC BEN is required to function as an implementing agency responsible for the rehabilitation and reconstruction plan of distribution.

It is imperative that JSC BEN organizes the special team for implementing this plan, and undertakes the construction supervision works under the cooperation of engineering consultant. Moreover, this team is required to take responsibility for obtaining various permits/approvals, laying works for underground cables undertaken by Azerbaijan side, arranging matters concerned with the governmental authorities, assisting the foreign contractors, and managing equipment and materials provided.

(4) Procurement plan for equipment and materials

It is assumed that procurement of equipment and materials applied to this plan will be carried out under international competition. Conditions of international competition defer among the countries of the foreign governmental authorities, which offer financial assistance. Regarding the preparation of the Tender Document, it should be noted that (i) effective utilization of the existing facilities, (ii) saving of expenses, and (iii) reduction of work period for renewal of equipment of the transformer stations. Major equipment and materials to be procured are shown in Appendix 3.7-1.

(5) Works undertaken by the counterpart's side

In the rehabilitation and reconstruction plan of the distribution network, the scope which will be covered with financial cooperation from foreign governments comprise of (i) procurement of equipment and materials from international markets essential to implement the plan, (ii) transportation to Baku City, (iii) transport insurance cover, (iv) erection, adjustment and inspection of the transformer facilities, (v) newly construction, repair, and renovation of transformer station house, and (vi) construction insurance cover except for laying works for cable lines. Local procurement of necessary materials is also included. On the other hand, the works to be covered by Azerbaijan side will be laying works of MV and LV underground cables and storage control of supplied equipment and materials.

(6) Implementation schedule

It is assumed that this plan is implemented by dividing into two phases. In the first phase, the rehabilitation intending to ensure the permanent 10 kV system around the old castle walls. In the second phase, the remaining rehabilitation works portion will be undertaken.

(7) Project cost estimate

It is assumed that this plan is undertaken under the financial cooperation by foreign governmental institutions. Total amount of the project cost is estimated as about USD 14.95 million. The breakdown of the cost, which needs preparation both by the donor countries and Azerbaijan is as follows:

(a) The scope to be covered by foreign donor countries (USD million)

Category	Phase I	Phase II	Total
(1) Equipment and materials	4.81	5.24	10.05
(2) Construction works	1.18	1.34	2.52
(3) Detail design and construction supervision	0.84	0.66	1.50
Total	6.83	7.24	14.07

(b) The scope to be covered by Azerbaijan side (USD million)

Category	Phase I	Phase II	Total
Cable Laying Works	0.39	0.49	0.88

(c) Estimate conditions

(i) Base year/month: August 2000

(ii) Exchange rate: USD 1 = AZM 4,456 = Yen 105.5

(iii) Construction period: Two phases with the tentative schedule summarized in Figure 3.7-1

3.8 Effects of the Project and Recommendation

(1) Effects of the Project

The target of this plan is the central area of Baku City, with the highest demand density, where the first distribution system in Azerbaijan was developed. The distribution facilities are heavily overage and obsolete, 55 % of total 6 kV underground cables were laid before 1960. Recently, energy supply hindrance caused by faults of distribution facilities has been considerably increased. Unless the rehabilitation and reconstruction plan for the distribution network is forwarded, the supply capability will dramatically drop with bringing about impediments in the life of population, and incurring social problems.

It is more or less estimated that about 9 million persons reside in the said area. Furthermore, there are many number of central/regional governmental offices, international organization and foreign governmental branch offices, public facilities, shops, private business offices, bringing the resident in other area into this area for working purposes. Those persons are also considered as the direct beneficiary of the stable energy supply by this project.

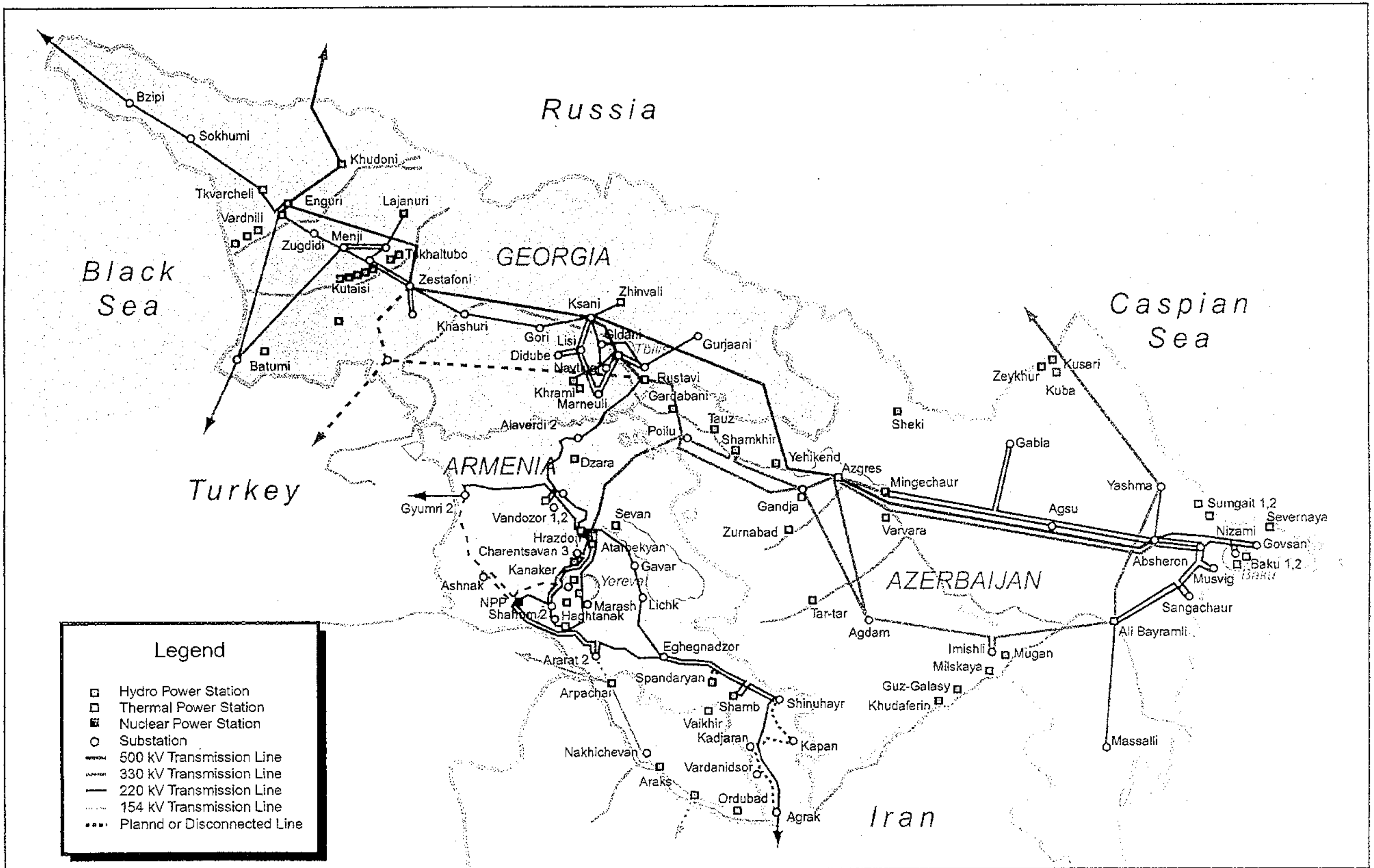
This rehabilitation project is expected to ensure a stable socio-economic life for those population or communities, and even to reduce the technical loss through construction of double circuit system and upgrading and unifying the cable size into the larger one.

(2) Recommendation

Since the distribution facilities in the target area are extensively obsolete, BEN strongly requests an urgent implementation of rehabilitation plan. In addition to the said direct beneficiary, it is considered that the entire national population will recognize indirect benefits by the project implementation, because a great number of office and facility, which function as the center of politics, economy, and culture in Azerbaijan is situated in this area. Therefore, this project is judged as presenting sufficiently positive effects and viability.

Regarding O&M for the distribution facilities after the project completion, as BEN has already long experience in undertaking O&M for the distribution facilities in Baku City, any problems, which need to be addressed, has not been observed. Therefore, urgent implementation of this project is recommended here.

FIGURES



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Рисунок No. 1.3 - 1
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Title / Название Рисунка Transcaucasian Integrated System
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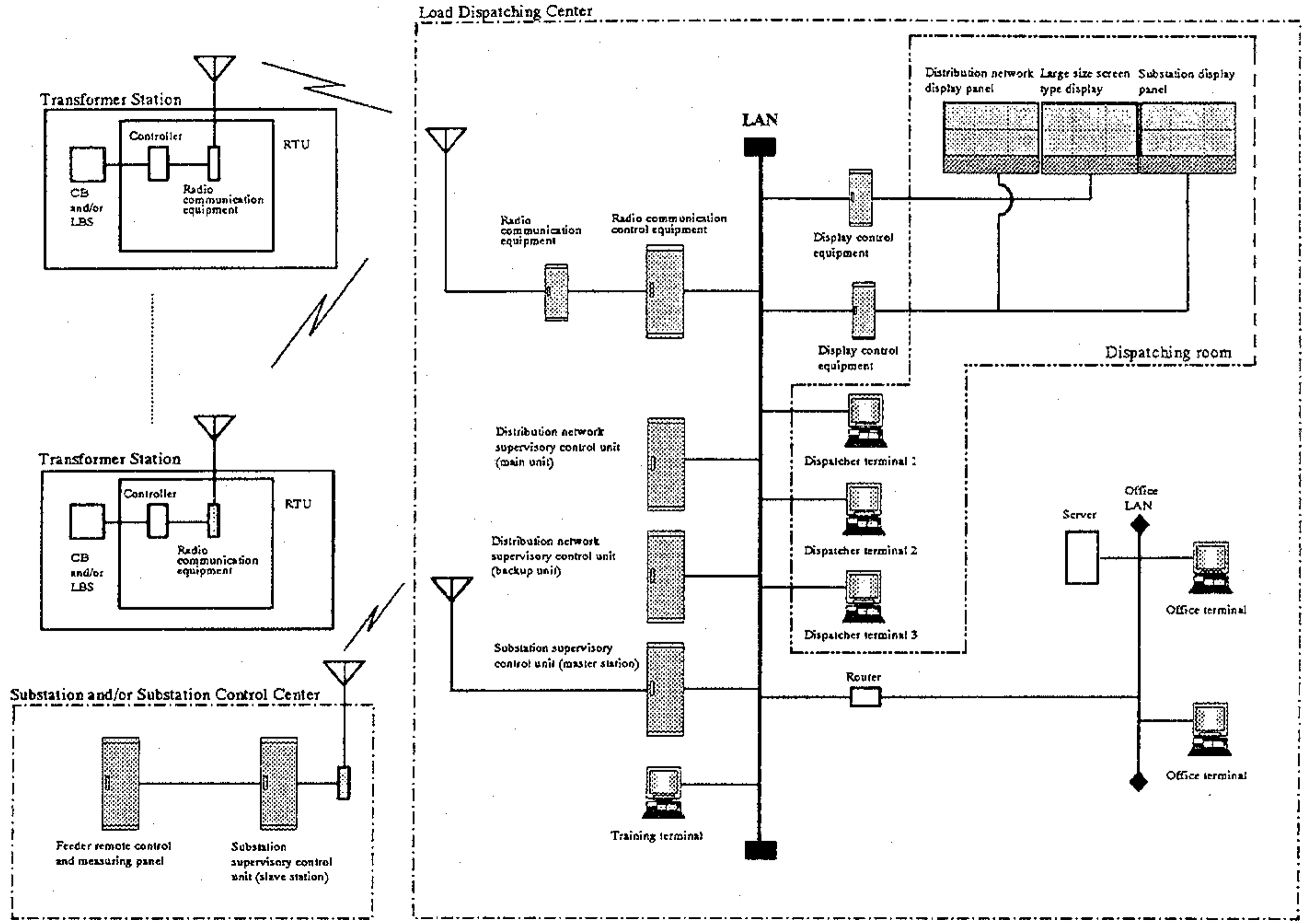
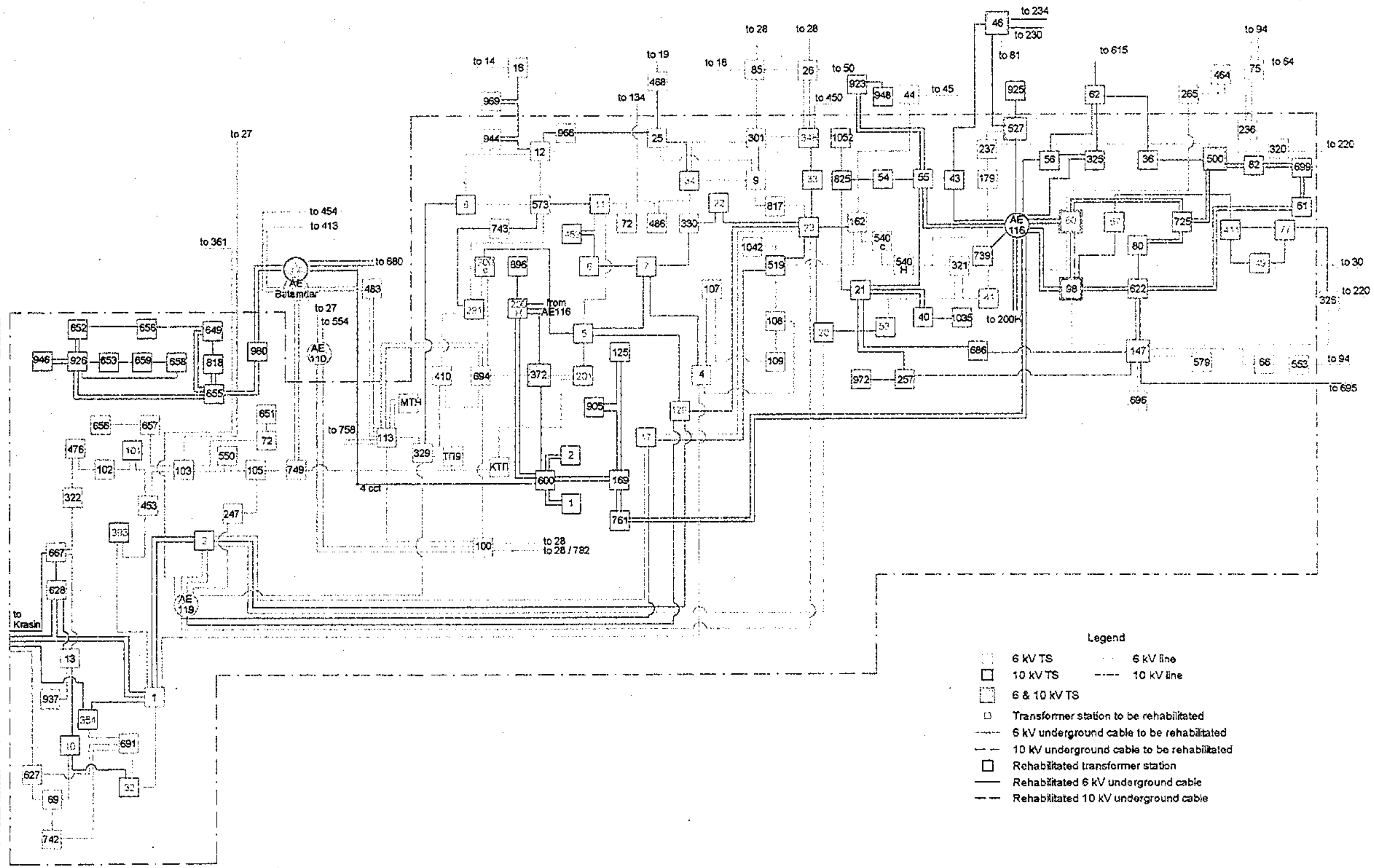


Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku **Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку**	**Figure / Рисунок No.** 2.6-1
Baku Electric Network **ПО "БАКЭЛЕКТРОСЕТЬ"** / **Japan International Cooperation Agency** **Японское Агентство Международного Сотрудничества**	**Title / Название Рисунка**
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. **Совместное предприятие НИППОН КОЕЙ и KRI Интернешнл Корп.**	Automatic distribution dispatching system



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Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ" / Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Title / Название Рисунка Rehabilitation and reconstruction plan up to 2004 in Sabail (Phase I)
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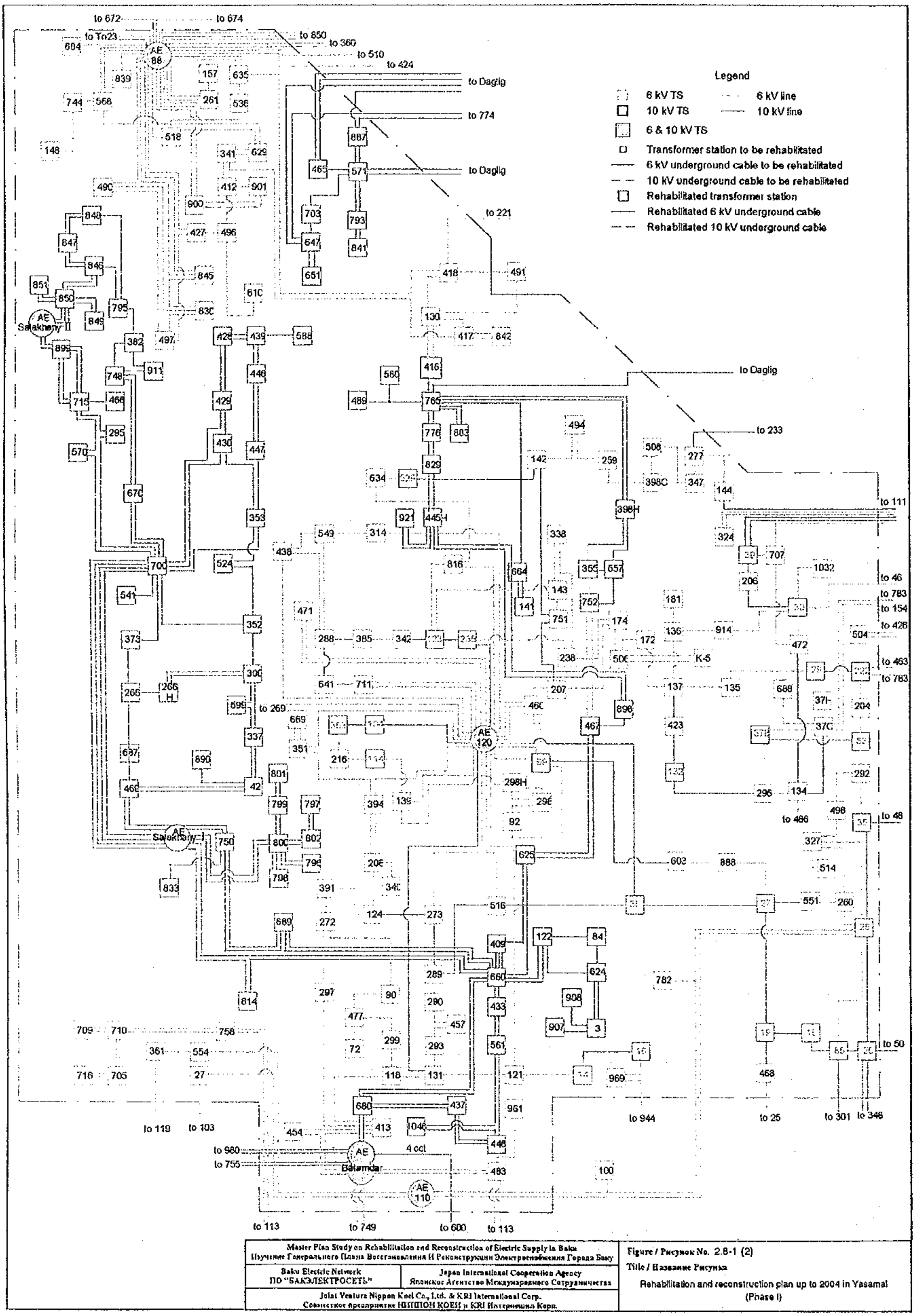

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Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Title / Название Рисунка Rehabilitation and reconstruction plan up to 2004 in Yasamal (Phase I)
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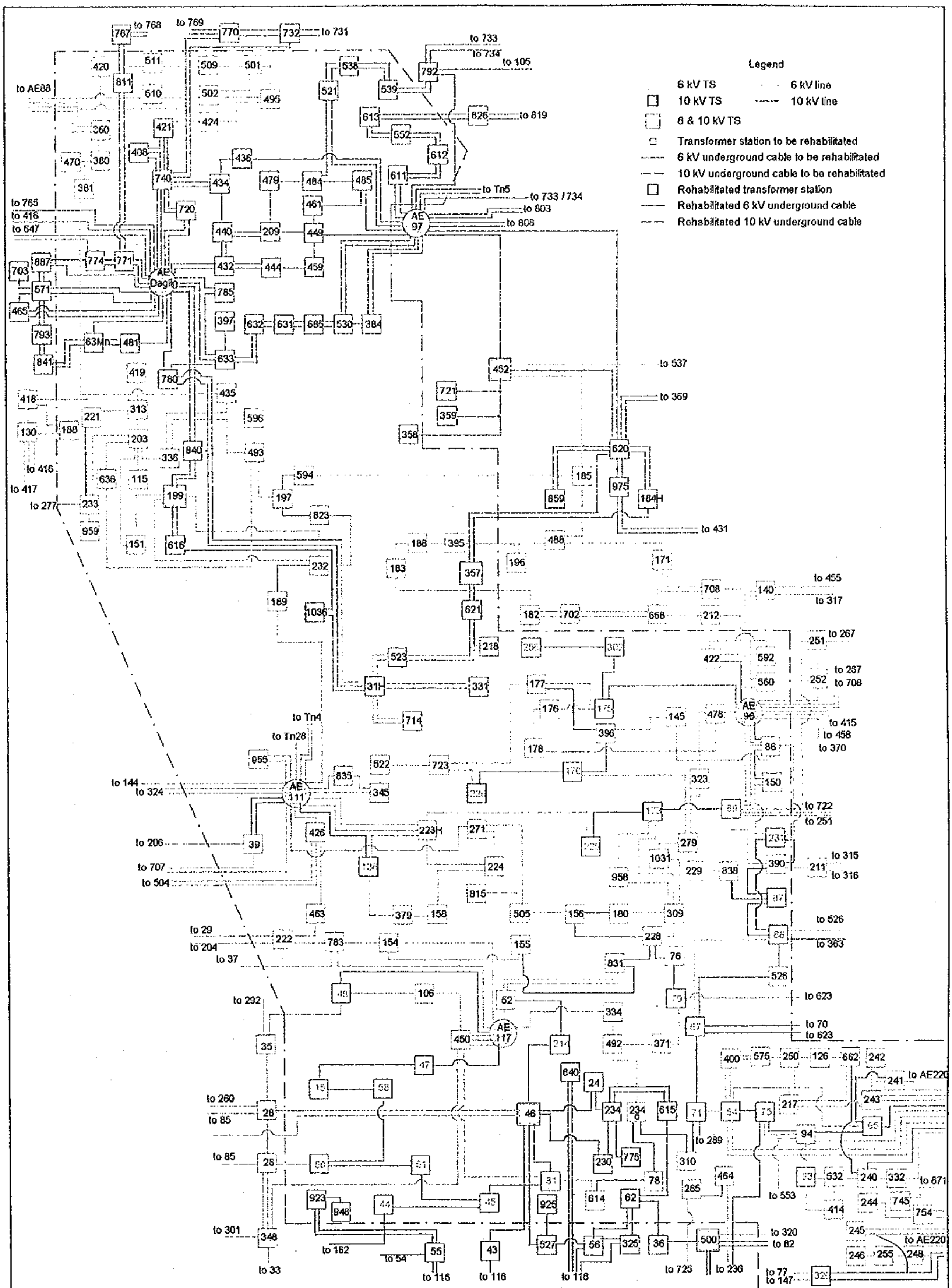

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Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	
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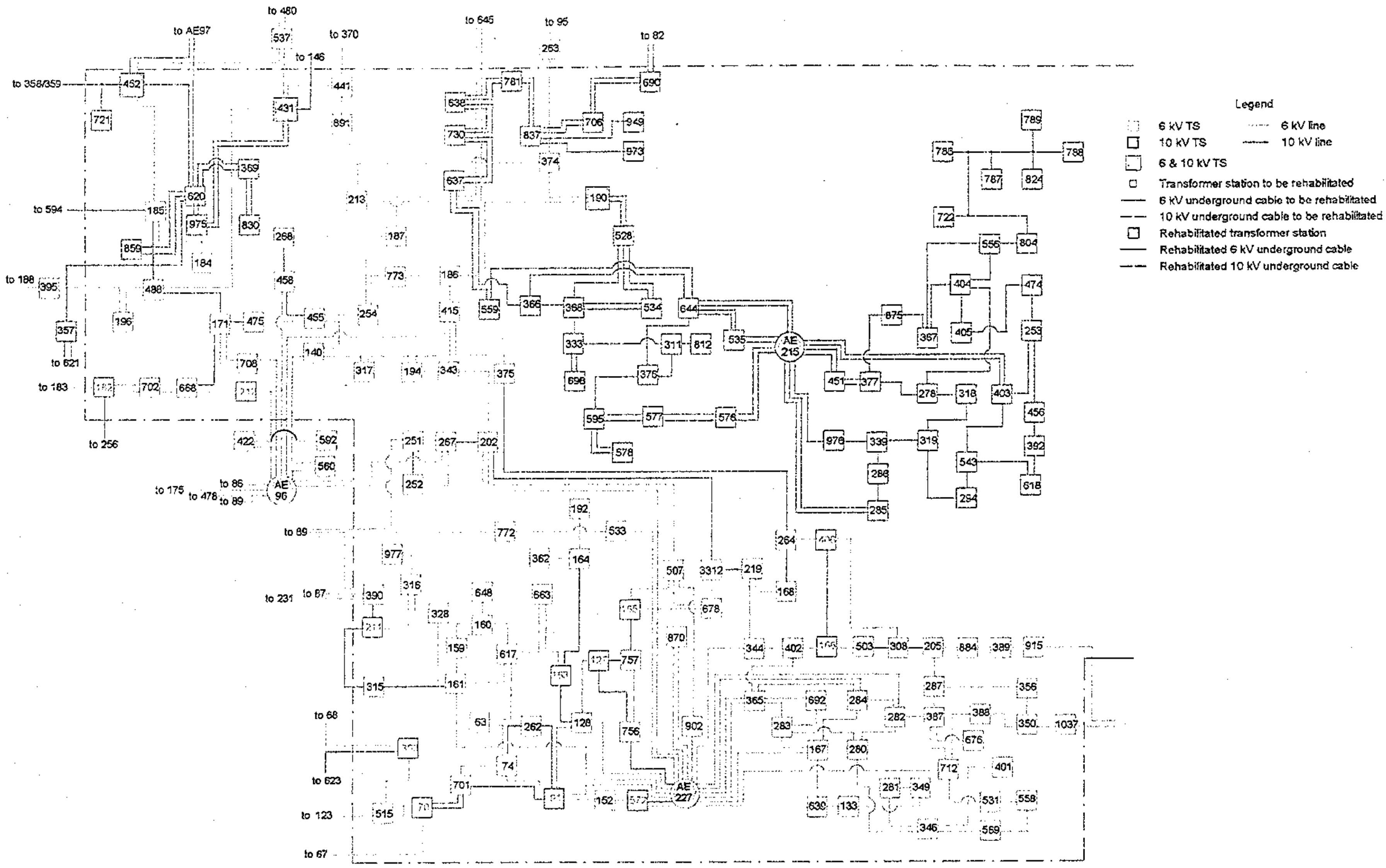

Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku
Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку

Baku Electric Network
ПО "БАКЭЛЕКТРОСЕТЬ"

Japan International Cooperation Agency
Японское Агентство Международного Сотрудничества

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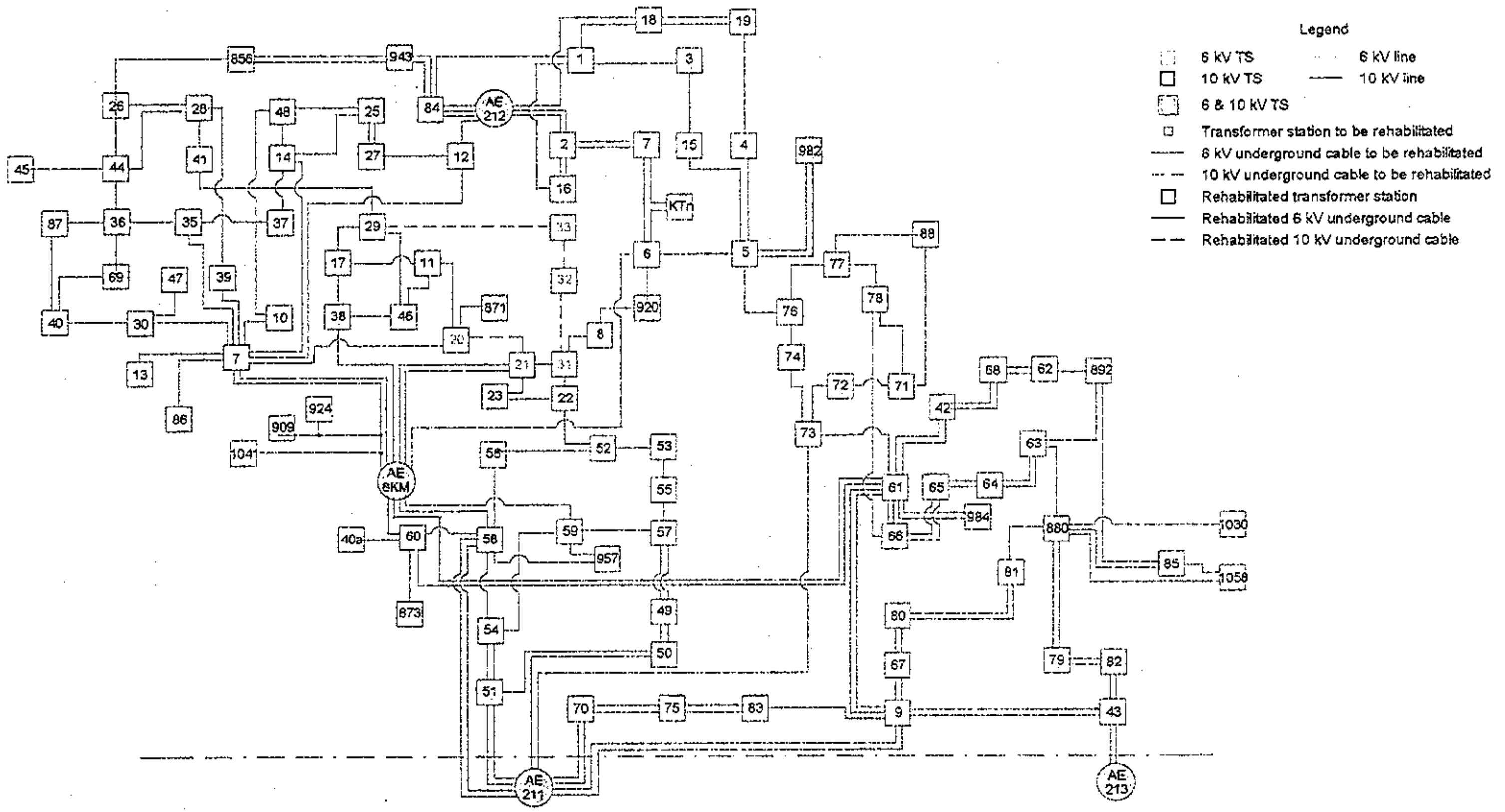
Rehabilitation and reconstruction plan up to 2004 in Narimanov (Phase I)



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку	Figure / Рисунок No. 2.8-1 (5)
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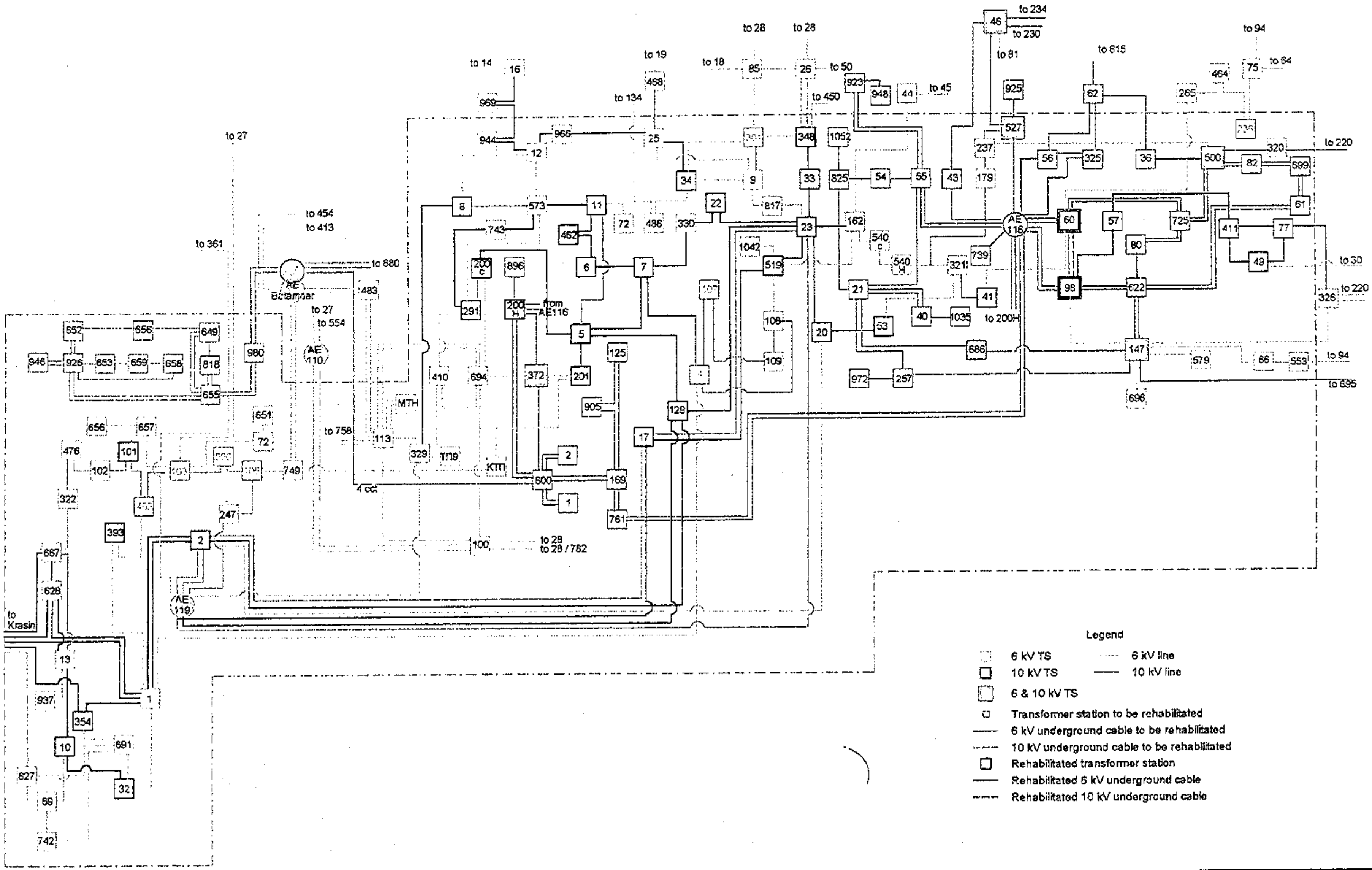
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.	Rehabilitation and reconstruction plan up to 2004 in Nizami (Phase I)



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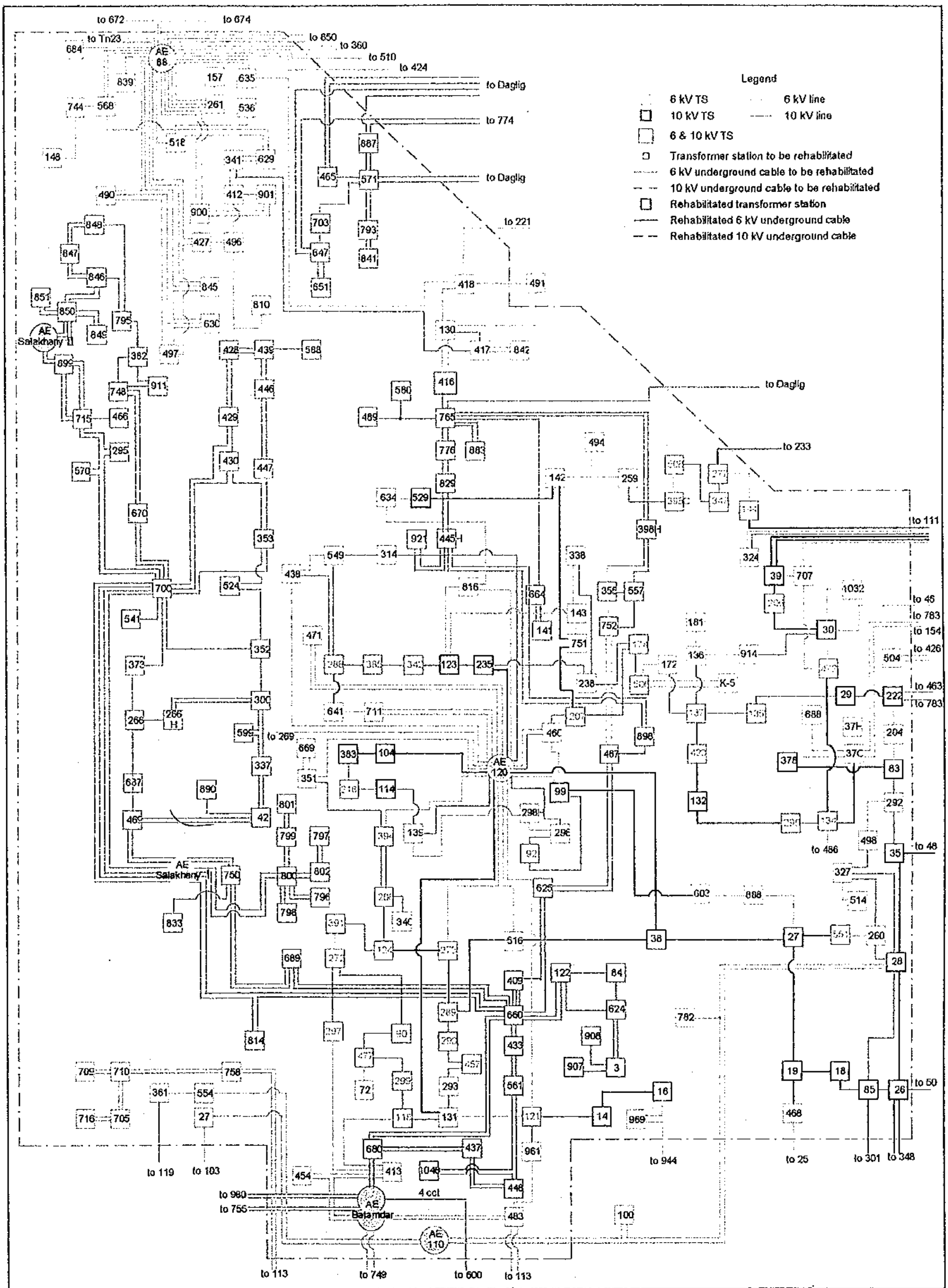
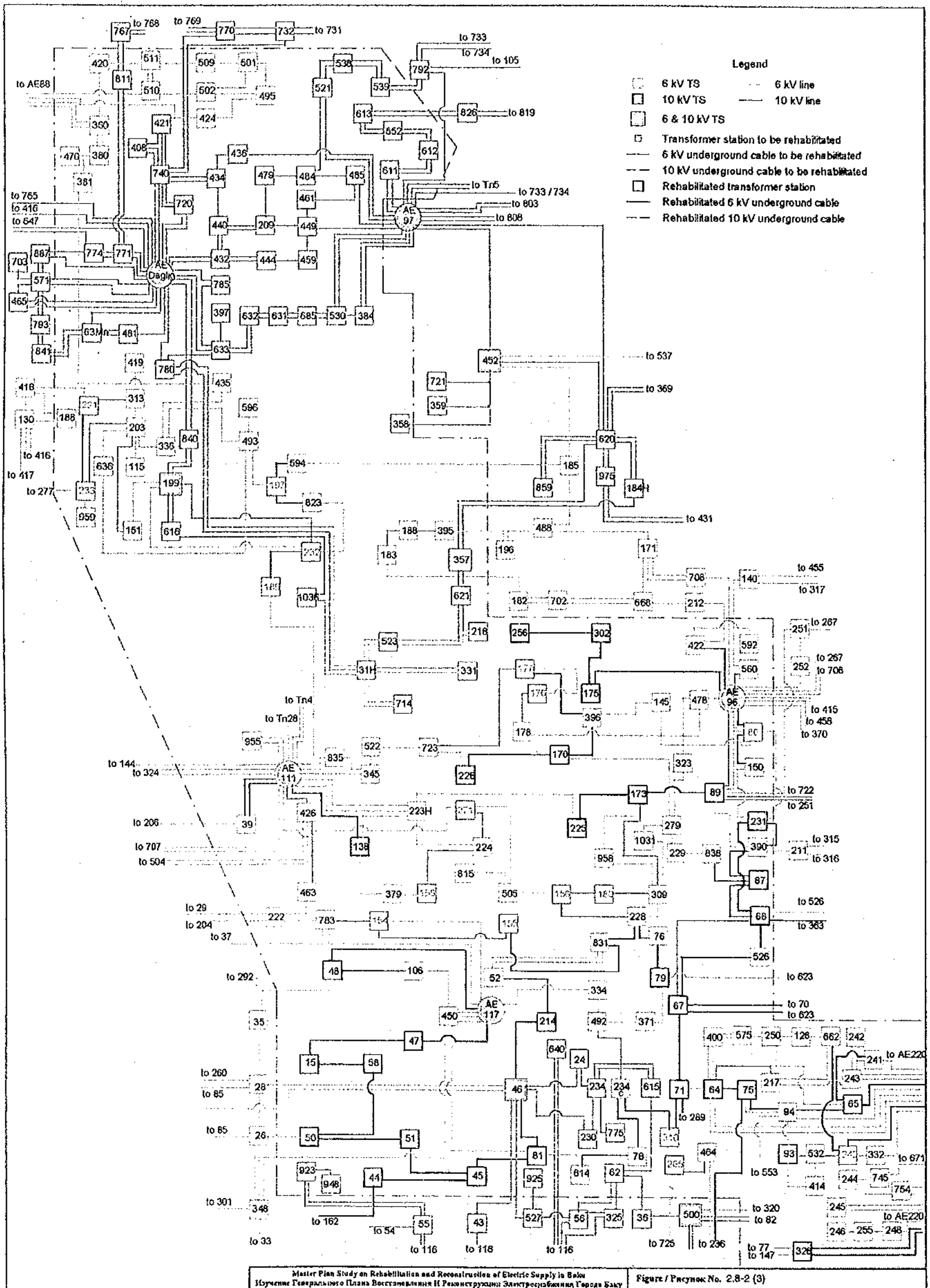
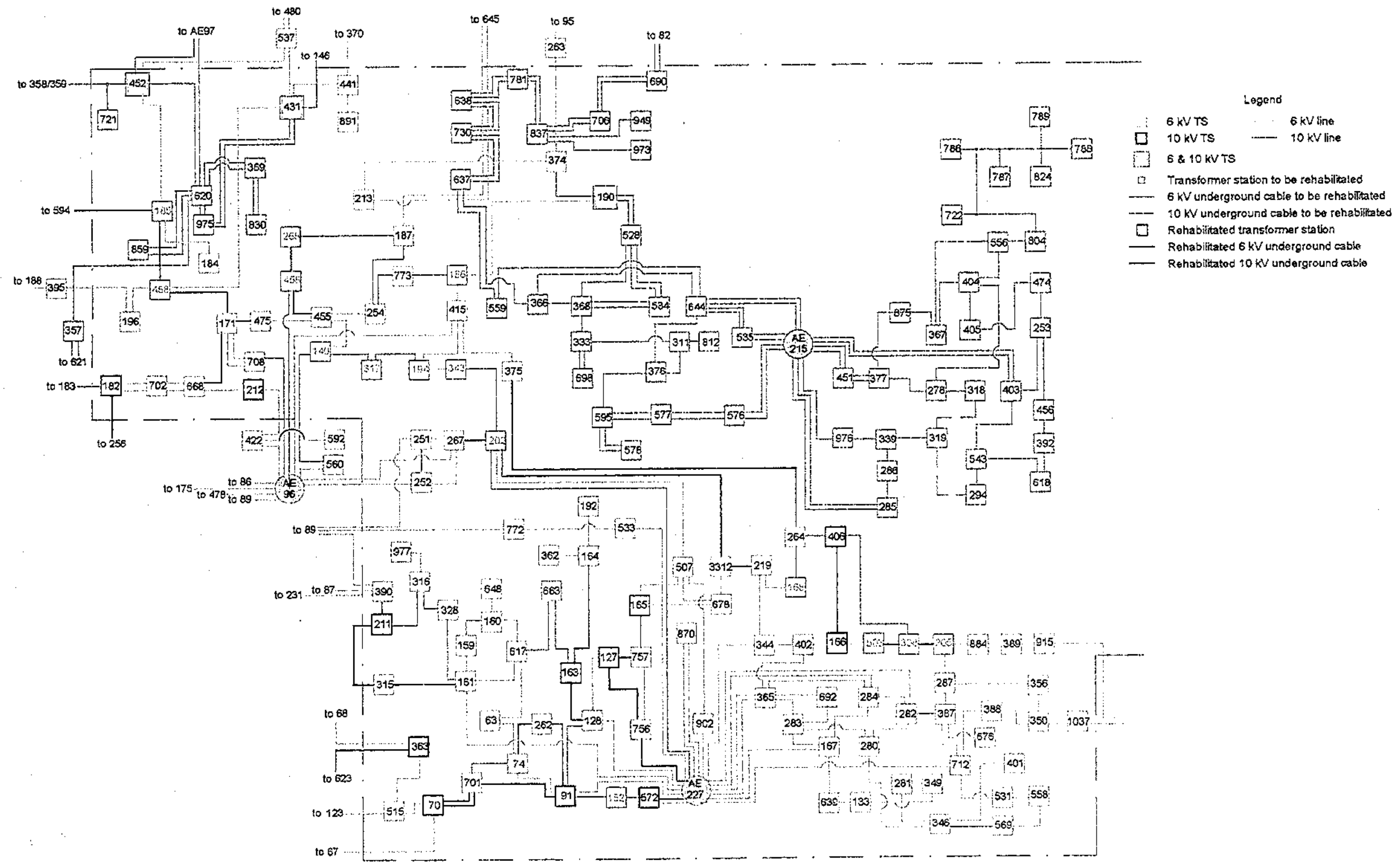
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.	Rehabilitation and reconstruction plan up to 2007 in Sabail (Phase II)



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Рисунок No. 2.8-2 (2) Title / Название Рисунка
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Rehabilitation and reconstruction plan up to 2007 in Yasamal (Phase II)
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.		



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку	Figure / Рисунок No. 2.8-2 (3)
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ" / Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Title / Название Рисунка Rehabilitation and reconstruction plan up to 2007 in Nasimi (Phase II)
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.	



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku
Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку

Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества

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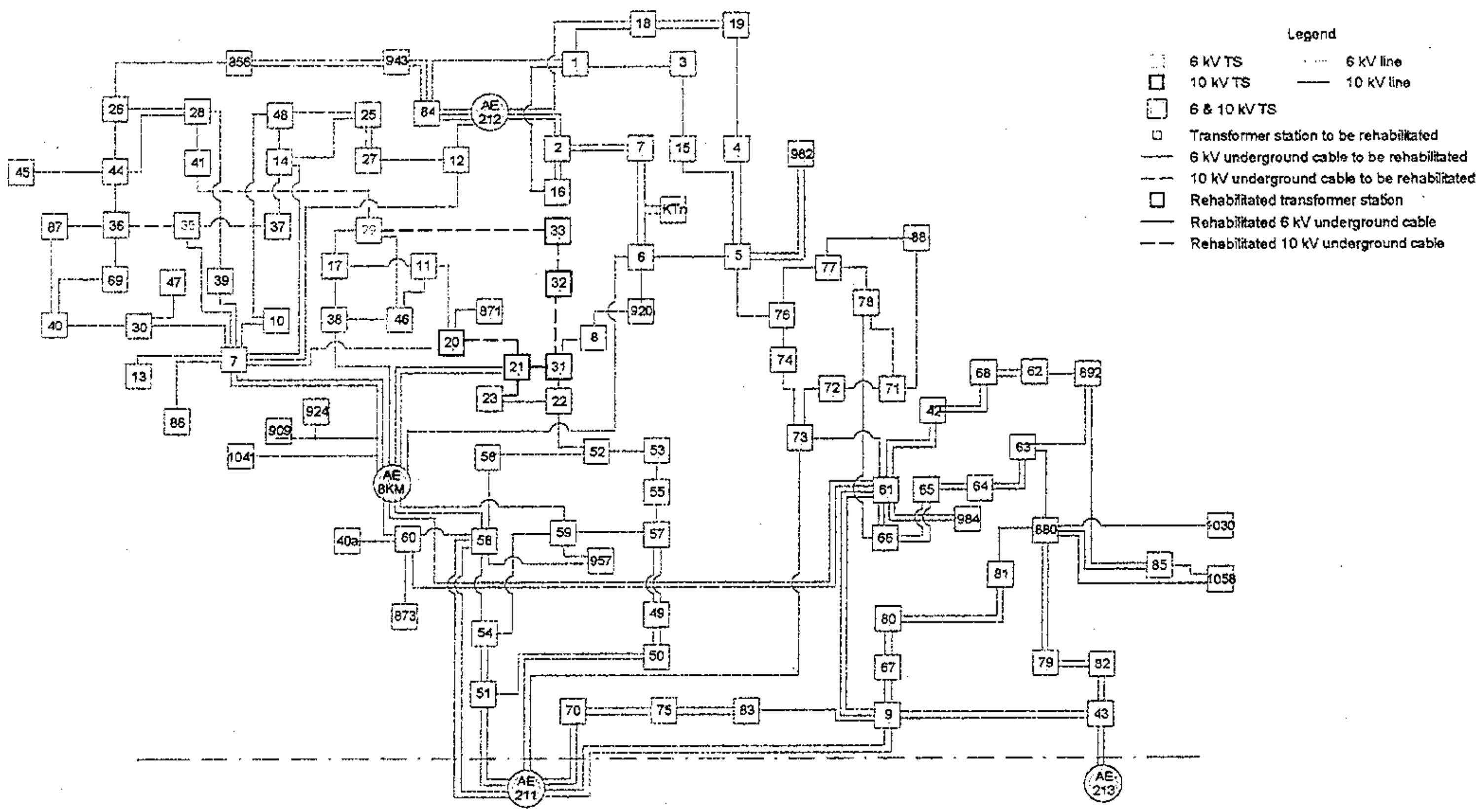
Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.

Figure / Рисунок No. 2.8-2 (4)

Title / Название Рисунка

Rehabilitation and reconstruction plan up to 2007 in Narimanov
(Phase II)



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Рисунок No. 2.8-2 (5)
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Title / Название Рисунка Rehabilitation and reconstruction plan up to 2007 in Nizami (Phase II)
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.		

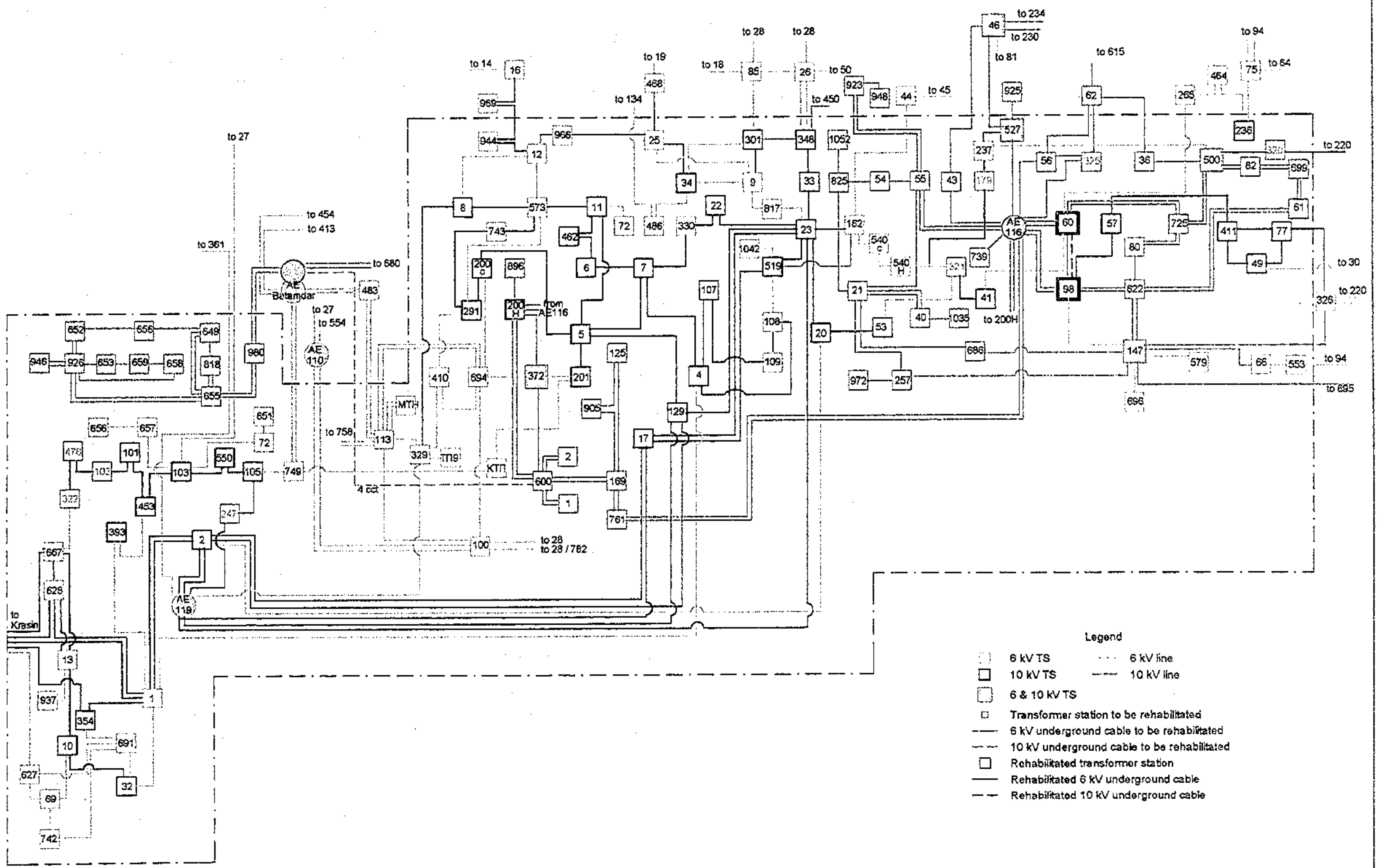


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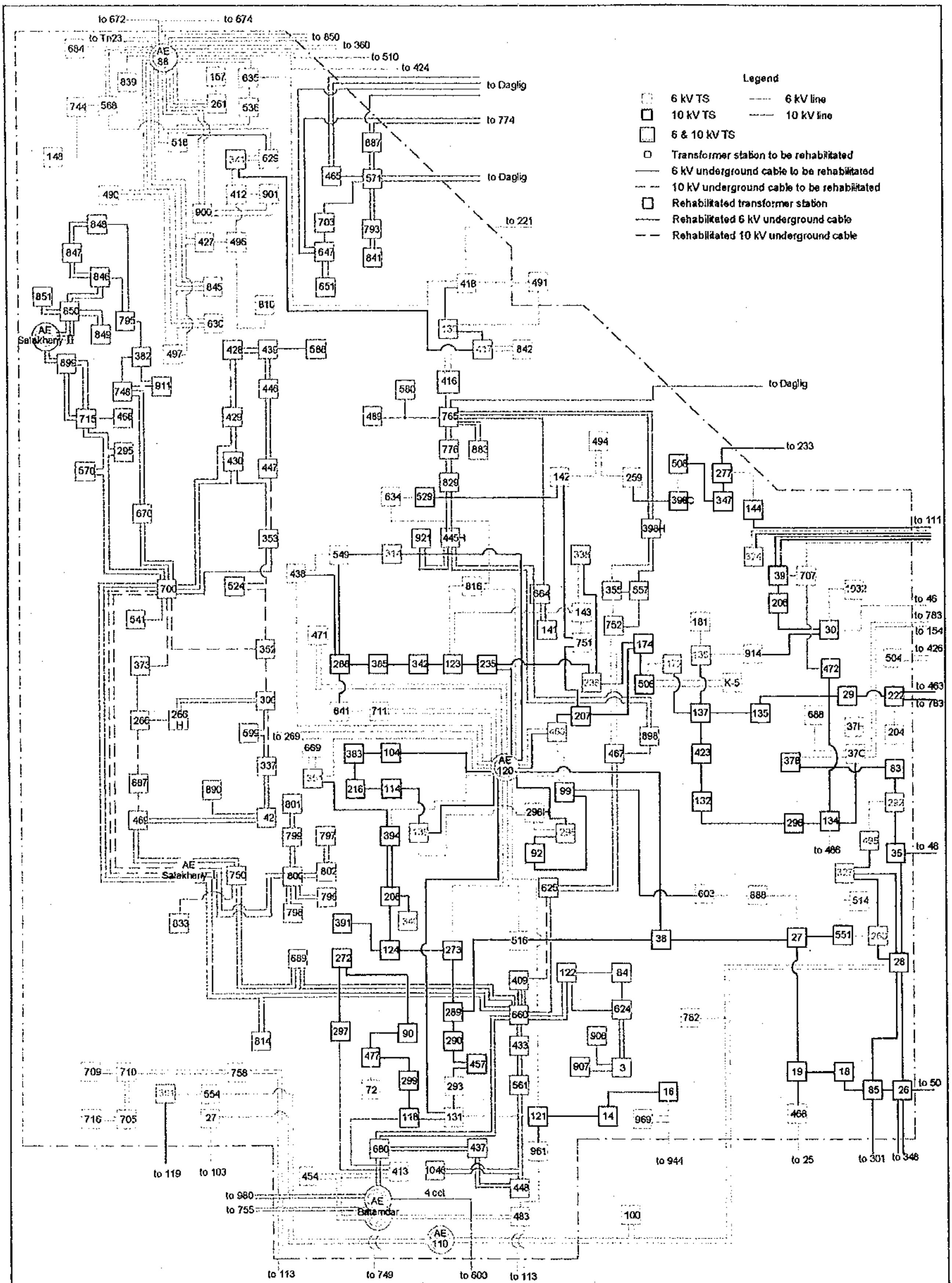
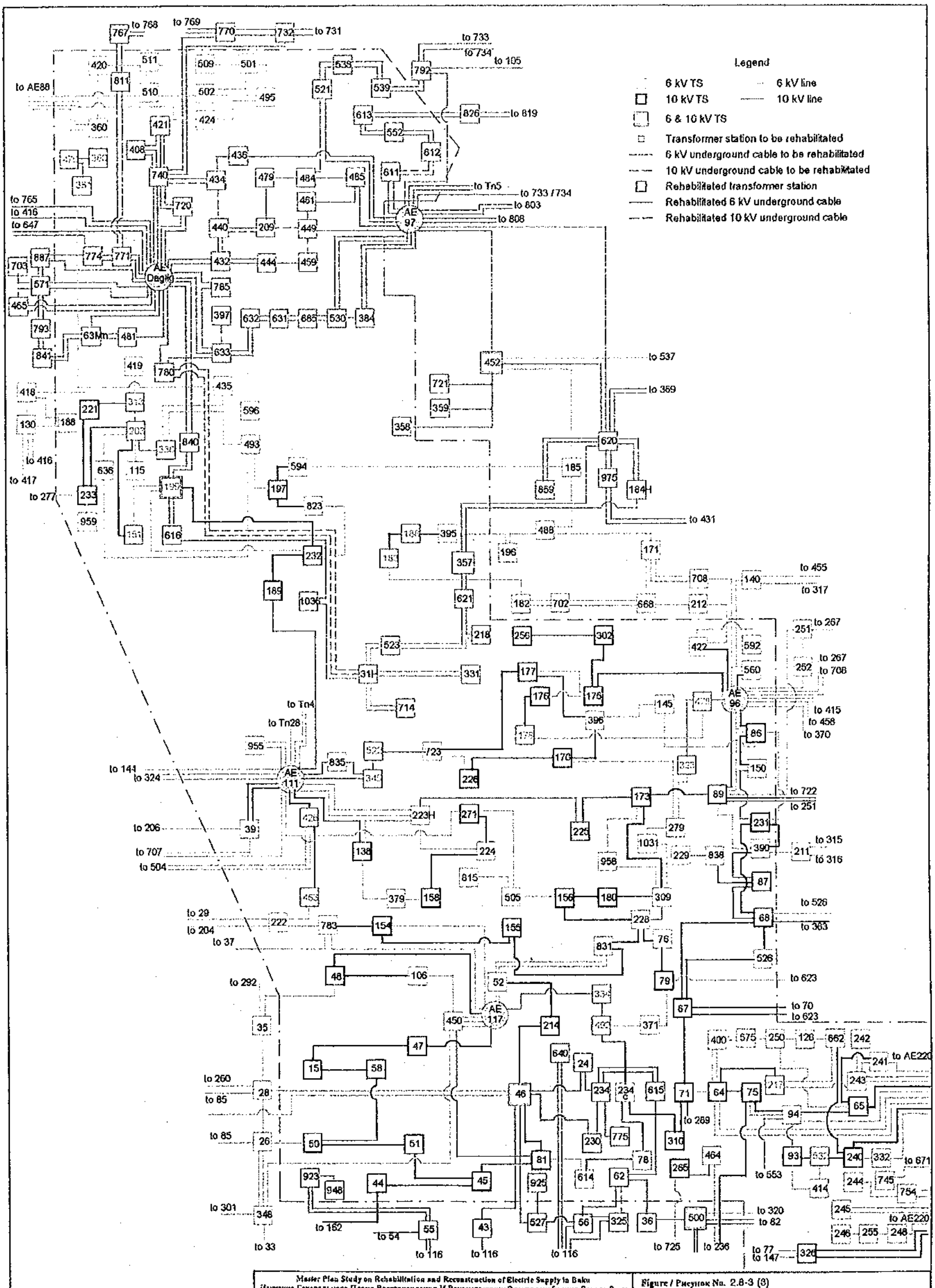
Figure / Рисунок No. 2.8-3 (1)

Title / Название Рисунка

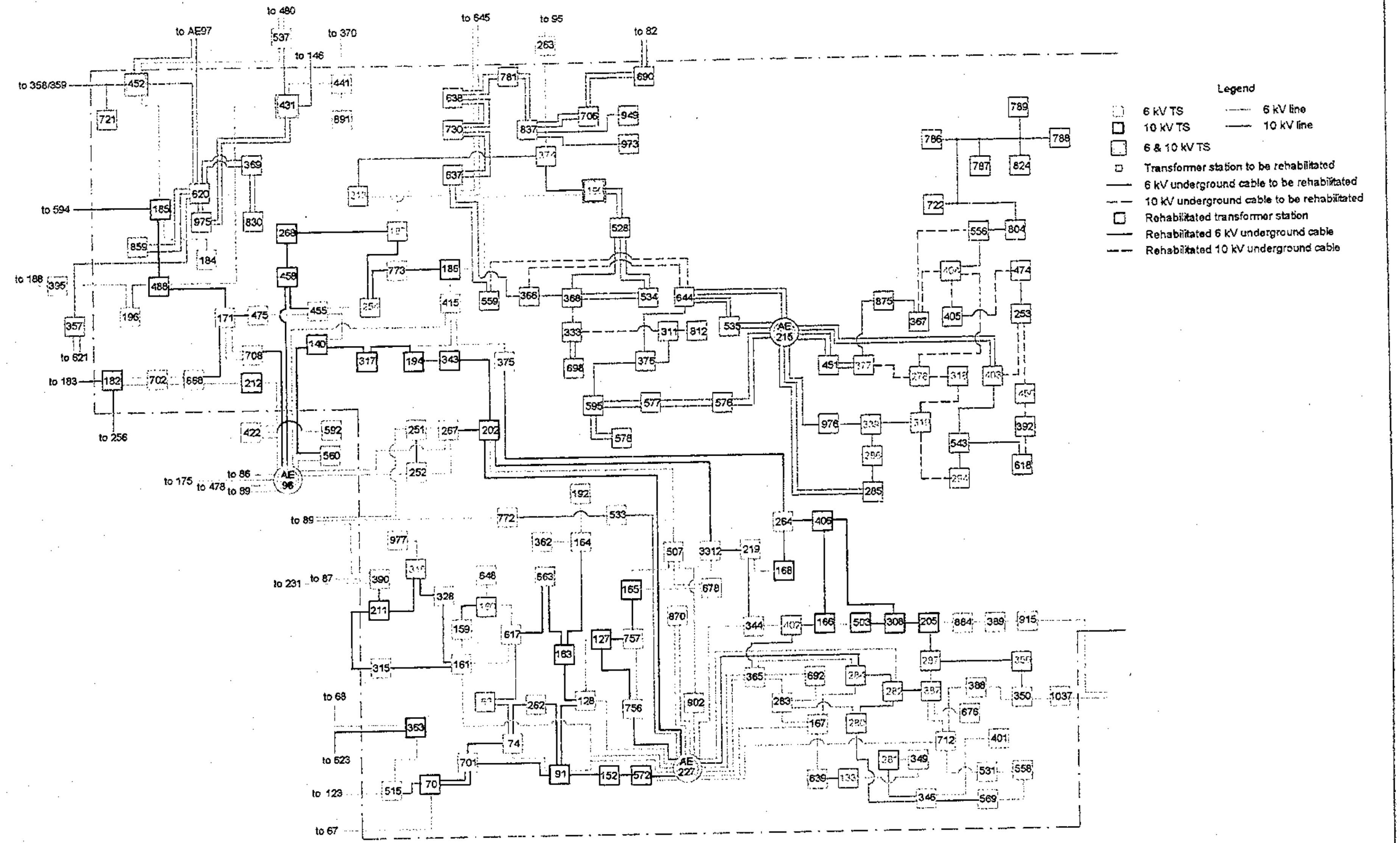
Rehabilitation and reconstruction plan up to 2010 in Sabail
(Phase III)



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Рисунок No. 2.6-3 (2)
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Title / Название Рисунка Rehabilitation and reconstruction plan up to 2010 in Yasamal (Phase III)
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.		



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Рисунок No. 2.8-3 (3) Title / Название Рисунка Rehabilitation and reconstruction plan up to 2010 in Nasimi (Phase III)
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернэшнл Корп.		



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Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку

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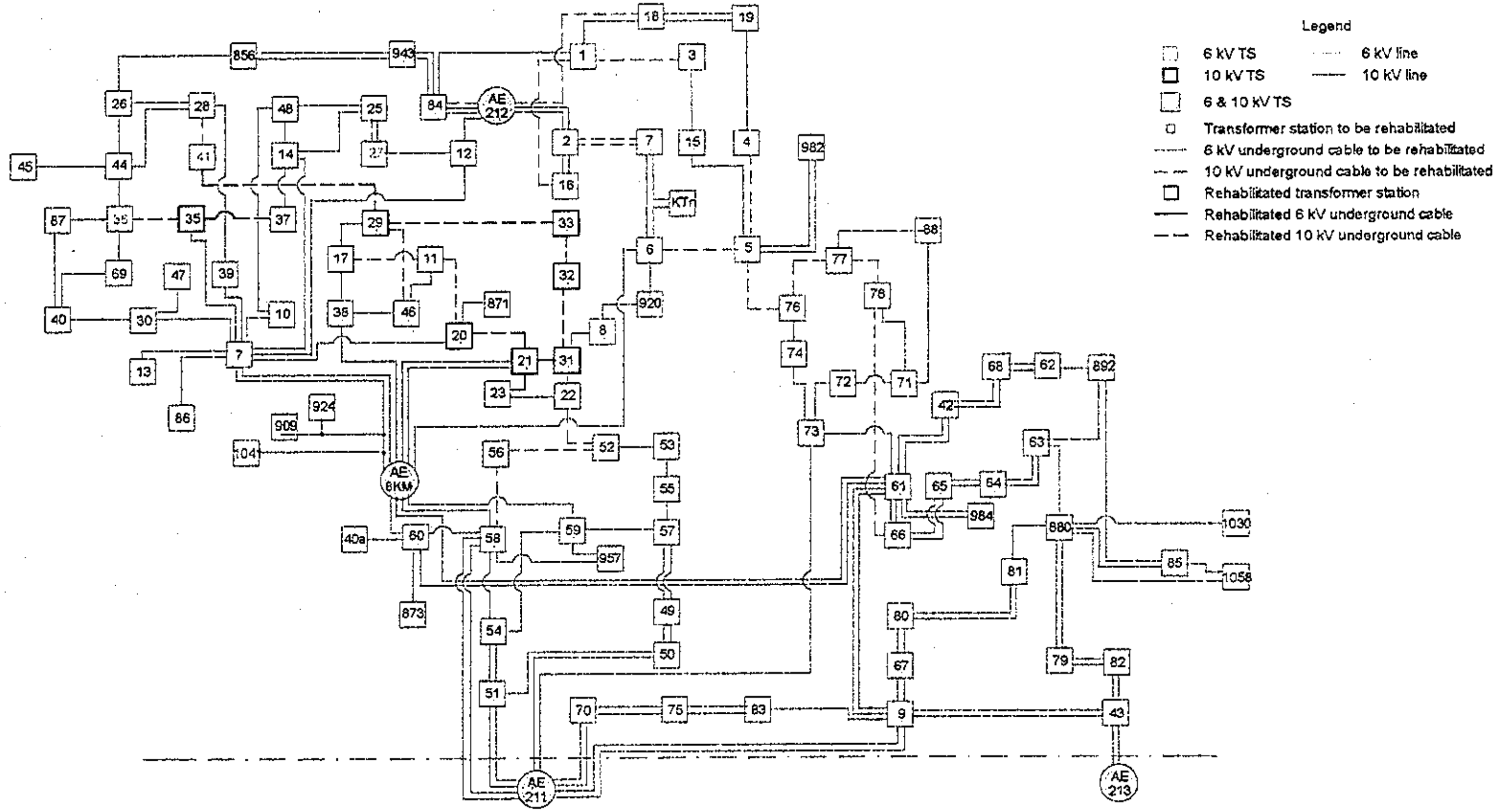
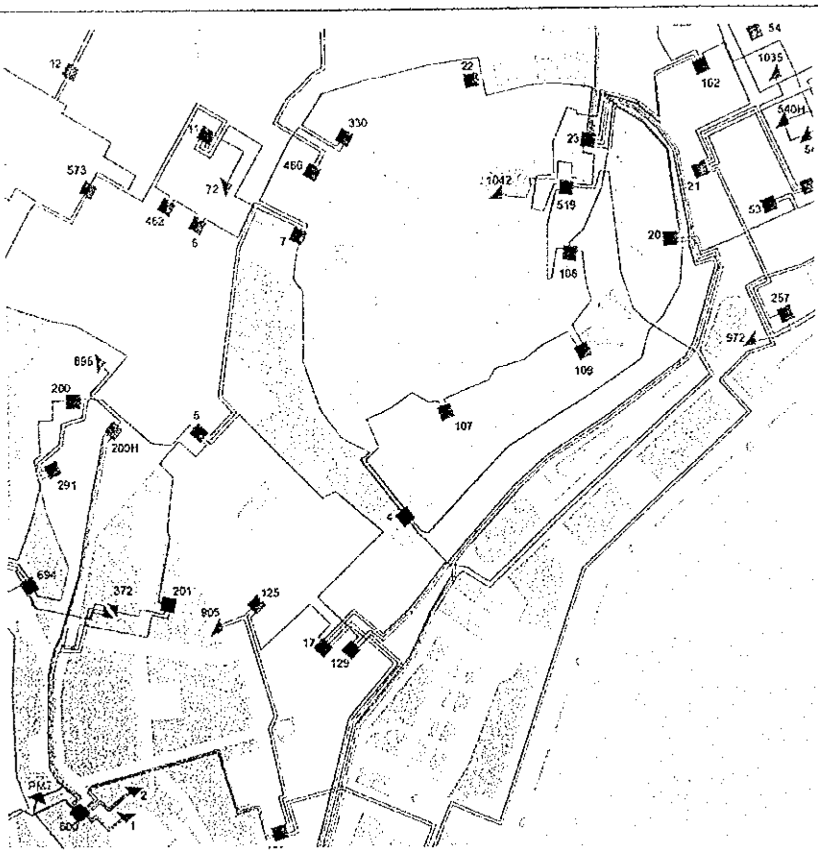
Figure / Рисунок No. 2.8-3 (4)

Title / Название Рисунка

Rehabilitation and reconstruction plan up to 2010 in Narimanov (Phase III)



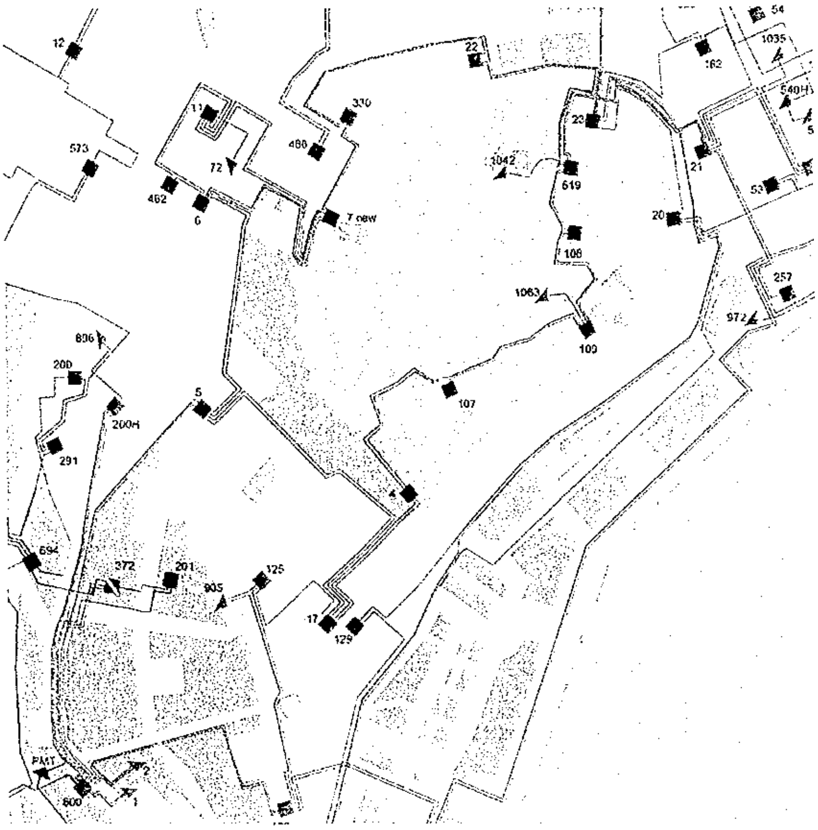
Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Рисунок No. 2.8-3 (5)
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Title / Название Рисунка Rehabilitation and reconstruction plan up to 2010 in Nizami (Phase III)
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.		



Legend

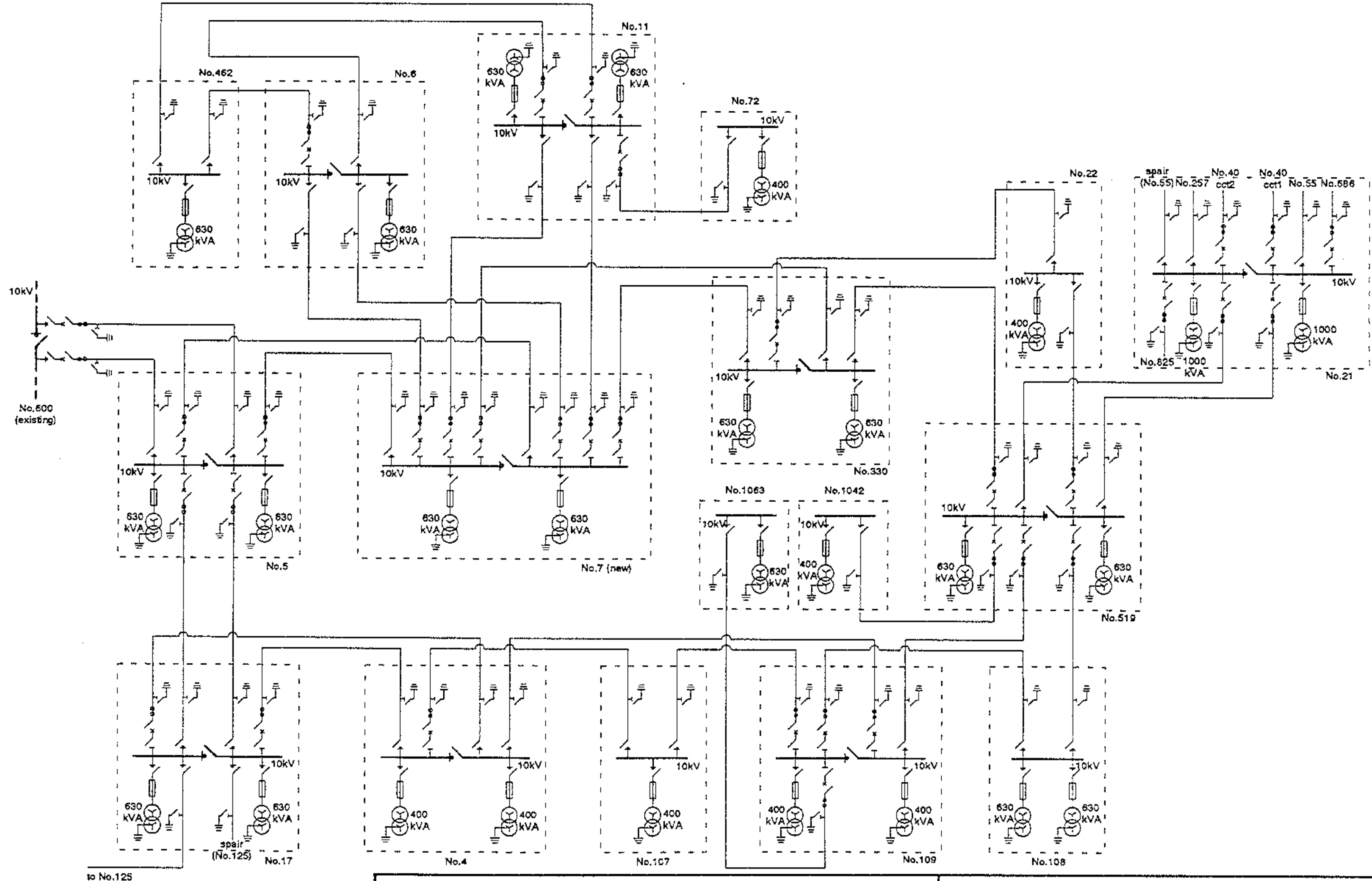
- 10 kV and 6 kV transformer station
- 10 kV transformer station
- 6 kV transformer station
- 10 kV transformer station planned
- 10 kV compact type transformer station
- 6 kV compact type transformer station
- 10 kV compact type transformer station planned
- 10 kV underground cable line
- 6 kV underground cable line
- 10 kV underground cable line planned

Existing System



Voltage augmentation plan
from 6 kV to 10 kV

Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку	Figure / Рисунок No. 3.5-1 Title / Название Рисунка
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ" / Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	Voltage Augmentation Plan in Baku Central
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.	

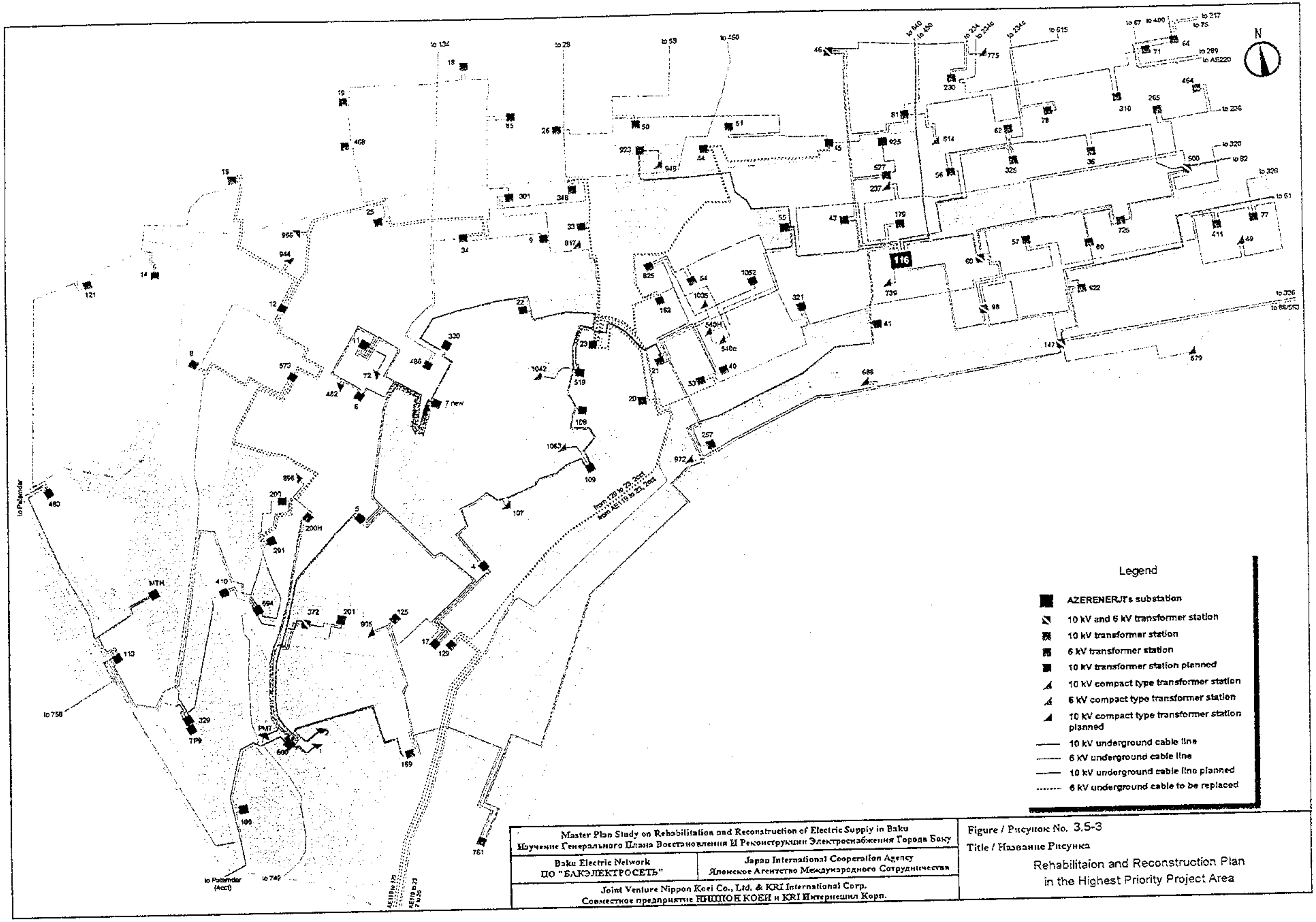


Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку	
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.	

Figure / Рисунок No. 3.5-2

Title / Название Рисунка

10 kV system after voltage augmentation plan (phase I)



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku
Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку

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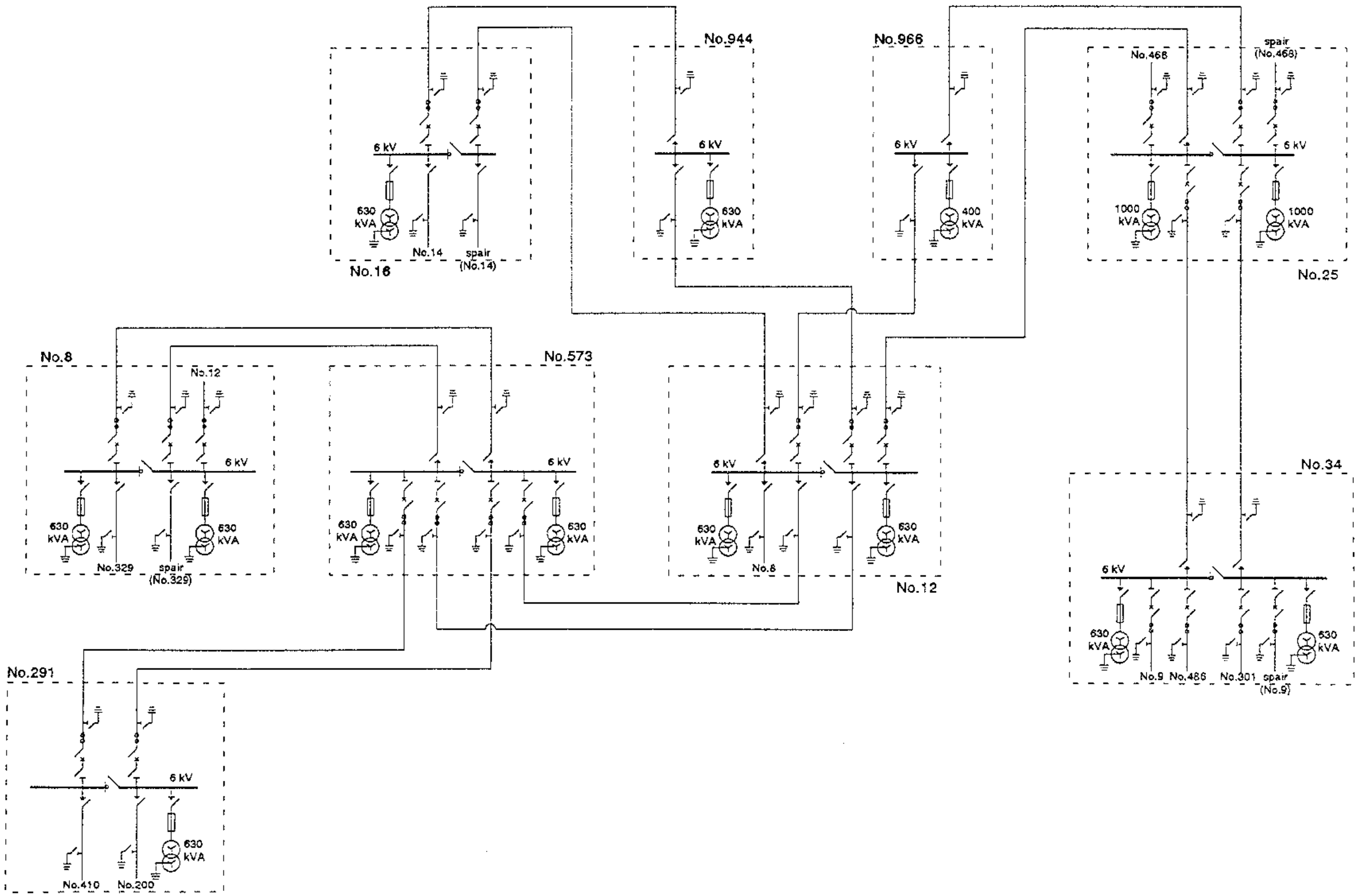
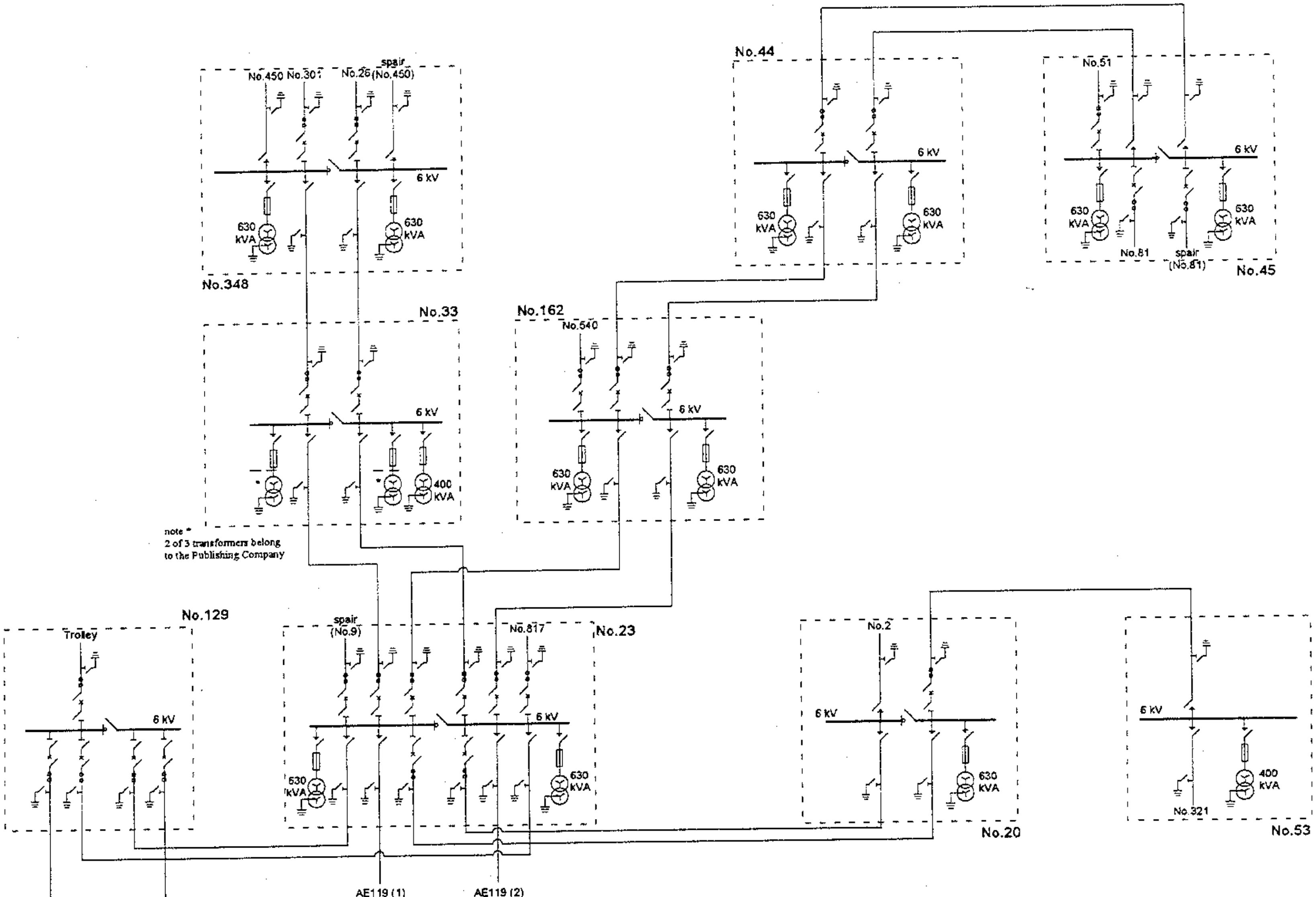
Figure / Рисунок No. 3.5-3

Title / Название Рисунка

Rehabilitaion and Reconstruction Plan in the Highest Priority Project Area



Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku **Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку**	Figure / Рисунок No. 3.5-4 (1)
Baku Electric Network **ПО "БАКЭЛЕКТРОСЕТЬ"** / **Japan International Cooperation Agency** **Японское Агентство Международного Сотрудничества**	Title / Название Рисунка 6 kV system after rehabilitation and reconstruction (1) (phase II)
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. **Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.**	



note *
2 of 3 transformers belong to the Publishing Company

note:
The cables between No.23 and AE119, and between No.129 and AE119 will be replaced.

Master Plan Study on Rehabilitation and Reconstruction of Electric Supply in Baku Изучение Генерального Плана Восстановления И Реконструкции Электроснабжения Города Баку		Figure / Рисунок No. 3.5-4 (2) Title / Название Рисунка 6 kV system after rehabilitation and reconstruction (2) (phase II)
Baku Electric Network ПО "БАКЭЛЕКТРОСЕТЬ"	Japan International Cooperation Agency Японское Агентство Международного Сотрудничества	
Joint Venture Nippon Koei Co., Ltd. & KRI International Corp. Совместное предприятие НИППОН КОЕИ и KRI Интернешнл Корп.		

Figure 3.7-1 Construction Schedule