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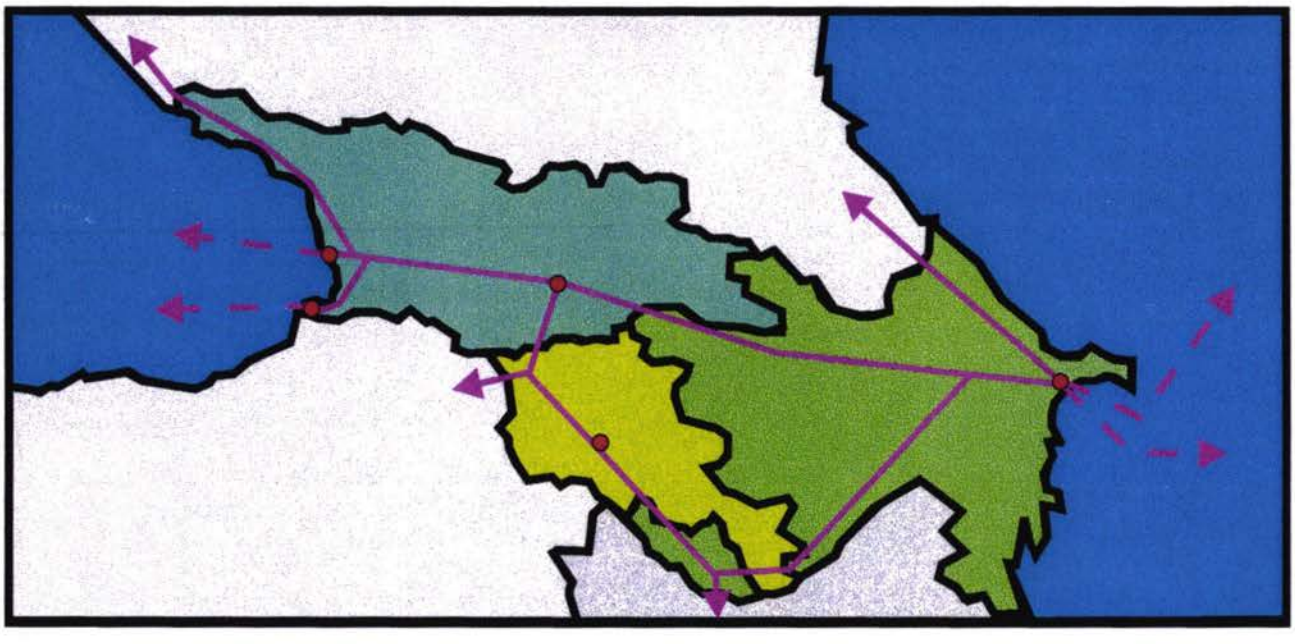
Joint Venture(s) for the Caucasian Railways



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Contents

Abbreviation list:

AC	Alternating Current of electrical power
AGC	European Agreement on Main International Railway Lines
AGTC	European Agreement on Important International Combined Transport Lines and Related Installations
AGZD	Azerbaijan State Railways
AICCF	International Railway Congress Association
AIM	Agreements for the International Carriage of Goods
AIOC	Azerbaijan International Operating Company (Oil production)
AIV	Agreements for the International Carriage of Passengers and Luggage
ARM	Agreement for the Communication of Traffic Restrictions for the International Carriage of Goods by Rail
ARM	Armenian Railway
ATP	Agreement on the international carriage of perishable foodstuffs and on the special equipment to be used for such carriage
BIS	Baku International Seaport
BOLT	Build - Operate - Lease - Transfer
BOT	Build - Operate - Transfer
BUS	Transformer station of railway power supply
BWRS	Baku Wagon Repair Plant
CECA	European Community for coal and steel
CEH	European Timetable Conference for Passenger Trains
CEM	European Timetable Conference for Goods Trains
CEV	European Passenger Tariffs Conference
CFS	Container Freight Station
CIM	Contracts for International Carriage of Goods by Rail
CIS	Commonwealth of Independent States
CIT	International Rail Transport Committee
CIV	Contracts for International Carriage of Passengers by Rail
COTIF	Convention for the International Carriage by Rail
CSC	Caspian Shipping Company
DB AG	Deutsche Bahn AG (German Railways)
DC	Direct current of electrical power
DCU	Uniform Regulations for Rail Transport
DEG	Deutsche Investitions- und Entwicklungsgesellschaft mbH (German Society for Investment and Development Ltd.), Cologne, Germany
DEM	Deutsche Mark (= German currency)
DIN	German Regulations of Standardisation in the Industry
DM	Deutsche Mark (= German currency)
DMU	Diesel Motor Unit
Dpt.	Department
DR	type of inspections of locomotives, wagons, coaches and EMU/DMU
DSA	European Prestressed Concrete Sleepers (type of sleepers)
DSS	Decision Support System
EBRD	European Bank for Reconstruction and Development, London, UK

EC	European Community
ECE	Economic Commission of the UN for Europe
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange for Administration Commerce and Transport
EDP	Electronic Data Processing
EEC	European Economic Community
EMU	Electric Multiple Unit
ESCAP	Economic and Social Commission for Asia and the Pacific
EUROP	Agreement for the Common use of Wagons
FADA	Traffic controller installations
FESA	Permanent line-side radio installations
FSU	Former Soviet Union
FTOS	Freight Transport Operation System
FZ	Financial co-operation programme (in Germany)
GDP	Gross Domestic Product
GDR	former German Democratic Republic
GOST	State Organisation of Standardisation of the former Soviet Union
GRID®	American management training system
GRZD	Georgian Railways
HERMES	German State Guarantees for Suppliers
HQ	Headquarters
HV	High Voltage
ICC	Information and Computer Centre
ICE	Inter-City-Express(-Train)
IMF	International Monetary Found
IRR	Internal Rates of Return (of investments)
ISO	International Organisation of Standardisation
JV	Joint Venture
KfW	Kreditanstalt für Wiederaufbau (= German Bank for Reconstruction), Frankfurt/Main, Germany
KR	type of repairs of locomotives, wagons, coaches and EMU/DMU
LIF	General List of Frontier Points for Rail Transport
LOI	Letter of Interest
LOU	Letter of Understanding
LV	Low Voltage
MBC	Motorised coaches
MESA	Mobile railway radio installations
MIS	Management Information System
MPS	Ministry of Railway Transport of the former Soviet Union
MTT	Uniform Transit Tariff of the OSShD
MV	Medium Voltage
nm	nautical miles
OCC	Operations Control Centre (of the railways)
OCS	Overheadline catenary system of power supply
OCTI	Central Office for International Carriage by Rail (in Bern, Switzerland)
OR	type of overhauls of wagons, coaches and EMU
OSShD	Organisation for the Co-operation of Railways
PC	Personal Computer

PCM	Personal Computer assisted Management
PFCCS	Processing and Freight Cost Calculation System
PIEx	Common Regulations for the International Carriage of Express Parcels
PIM	Common Regulations for the International Carriage of Goods
PIV	Common Regulations for the International Carriage of Passengers and Luggage
Pkm	Passenger-kilometre
POD	Port of Discharge
POL	Port of Loading
PPW	Regulation for the Use of Wagons in International Rail Transport
resp.	respective
RIC	Regulations for the International Carriage of Containers by Rail
RIC	Regulations for the Reciprocal use of railway carriages and luggage vans for International Transport
RID	Regulations for the International Carriage of Dangerous Goods by Rail
RIEx	Regulations for the International Carriage of Express Parcels by Rail
RIP	Regulations for the International Carriage of Private Wagons by Rail
RIV	Regulations for the Reciprocal use of Wagons for International Transport
RoRo	Roll-on-Roll-off
RSM	General Summary of Special Regulations for the International Goods Traffic
SBB	Swiss Federal Railway
SCADA	Supervisory, Control and Data Acquisition System
SMGS	Conventions to International Railway Transport of Goods
SMPS	Conventions to International Railway Transport of Passengers
SNCB	Belgian Rail
SNCF	French National Railway Society
SZD	former Soviet Railways
TCLE	Trans-Caucasian-Logistic-Express
TECF	Tbilisi Electro-Locomotive Construction Factory
TEU	Twenty feet container Equivalent Unit
TEWRS	Tbilisi Electro-Wagon Repair Plant
TEWS	Tbilisi Electro-Wagon Repair Plant
TIEx	Agreements for the International Carriage of Express Parcels
Tkm	Ton-kilometre
TO	type of overhauls of locomotives, wagons, coaches and EMU/DMU
TQM	Total Quality Management
TR	type of repairs of locomotives, wagons, coaches and EMU/DMU
UIC	International Union of Railways
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UTI	International Transportation Units
VAT	Value Added Tax
ZÜV	System for the supervision of train running

Chapter 1

Present technical conditions of railway infrastructure and rolling stock

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1 Present technical conditions of railway infrastructure and rolling stock

The present condition of the railway network of Armenia, Azerbaijan and Georgia, involving a total track length of approx. 4,760, km is the result of stagnation and the breakdown of the Soviet Union.

Already more than 100 years ago, the railway came into being in this region, when in 1872 (in 1865 routing and start of construction) the first line was put into operation from Russia to Tbilisi. In 1883 it was connected with Baku. In 1895 the construction of the Tbilisi - Alexandropol (today Gyumri) - Kars (today situated in Turkey) line was started which was extended to Yerevan in 1902.

In the years after World War II, these railways received a fresh impetus as regards equipment and technology owing to comprehensive investment made. Thus, a type of superstructure was laid which was fit for the operation of heavy goods trains. The capacity of the routes was increased by electrification and conversion to automatic or semiautomatic section blocks, the adoption of electric interlocking cabins and use of powerful vehicles in goods and passenger traffic. But for about 10 years now, a period of stagnation in technical innovation and neglect of maintenance has prevailed, owing to a lack of financial funds and materials. This development was aggravated extremely after the breakdown of the Soviet Union, resulting in a deplorable state of railway premises and rolling stock, which the consultants found upon their arrival and which has to be overcome in the next few years if these railways are to fulfil their appropriate role in the TRACECA transport corridor in future.

The outcome of the analyses dealing with the deficit of system components of the railway network presented hereinafter are the result of a close co-operation with the managing staff of the Armenian, Azerbaijan and Georgian Railways. The experts of the EU informed themselves by visual inspection about the technical state of the installations and vehicles on site, thus familiarising themselves with the problems faced by the lower management level.

In the course of this analytical activity, intensive working contacts were established with Tacis Co-ordinating Units and the TRACECA Co-ordinator Caucasus.

In addition, special importance was attached to the contacts established with TRACECA projects which are connected with the subject dealt with in this case, among them the following projects:

- Forwarding - Multi-modal transport systems
- Infrastructure maintenance 1 - Railways: Pre-investment study and pilot train Baku - Tbilisi - Batumi / Poti
- Rolling stock maintenance - Railways
- Transport legal and regulatory framework

The task of the investigations relating to the present condition of the network was a deficit analysis on the basis of which the investment plan for the railway infrastructure is to be derived.

The investigations into the present condition of the network were carried out for the track, bridges, signalling and communication, power supply, stations, container terminals and rolling stock areas. Information on the results available so far is presented hereinafter.

1.1 Track and bridges

1.1.1 Caucasian railways in general

The following table shows the track lengths of all Caucasian railways:

Tab. 1.1.-1: Survey of the main track lines in service of all Caucasian railways

designation	ARM	AGZD	GRZD
	km		
main track lines in service	798	2,123	1,839
total	4,760		

1.1.1.1 Rails

The track material mostly applied is supplied by the Russian industry. The rail profiles used primarily on the main lines are:

R 65 = weight per metre of 65 kg - used on about 73% of the overall track length,
R 50 = weight per metre of 50 kg - used on about 26% of the overall track length and
R 43 = weight per metre of 43 kg - used on about 1% of the overall track length.

The rail quality used in the Caucasian railways is of the self-hardening and heat-treated type, which are rails of the familiar UIC qualities, and cover a strength range of about 800 to 1,200 N/mm^2. Self-hardening rails dominate the market and practically all current applications can be covered with these rails. Carbon manganese steels are used in all cases here and they correspond with UIC - standards. The contents range is as follows:

carbon	0.40 % - 0.82 %
manganese	0.70 % - 2.10 %
silicon	0.10 % - 0.50 %

The rails used by ARM, GRZD and AGZD comply with the above mentioned conditions.

1.1.1.2 Sleepers

The density of the sleepers in straight line is up to 1,840 sleepers per km. In curves the density increases from 1,840 till 2,000 per km and corresponds to an average sleeper spacing of 0.54 resp. 0.50 m. In addition to timber sleepers, concrete sleepers were also laid. The timber sleepers are laid in mountainous regions, especially in small curves =< 200 m and stations. The timber quality is pine wood treated with impregnation means. The timber sleepers are processed by the "Impregnation Plant" at Gori (Georgia). The average life time is up to 15 years, for both timber and concrete sleepers tracks. This life time could have been achieved under the condition of a consistent fully scheduled maintenance starting the year after the renewal.

1.1.1.3 Rail fastening

Rail fixing to the concrete sleepers consists of:

- base plate with rigid clip,
- base plate is fastened on the concrete body by an anchor bolt turned a quarter in a chamber

This kind of rail fastening, used in all Caucasian countries, is not in line with current practice in West European countries. It causes the loss of frictional connection due to vibration upon wheel/rail contact, which damages the fixing chambers of the anchor bolt. In order to keep these rail fastenings in good condition, a permanent, carefully carried out track maintenance is required, which has never materialised because of a lack of the necessary spare parts.

Rail fixing to the timber sleeper consists of spikes with base plate. However, this fastening system is not suitable either because the rail / wheel contact vibrations loosen the fixing devices. In view of this inappropriate rail fastening to the timber sleeper, all efforts for an improvement are being undertaken, i.e. with coach screws, particularly in curves. The high percentage of laid timber sleepers and the insufficient rail fixing to these sleepers gives a first unfavourable impression of the track quality.

1.1.1.4 Switches

There are 4,453 switches on the investigated main lines, including the switches of the main station tracks and sidings. All of them are directly or indirectly connected with the main line. They are marked as R 65, R 50 and R 43 (construction mark rail 65, 50 and 43) and a branch track radius of 1:11 or 1:9 respectively (1:11, 1:9 angle of inclination as geometric mark). The turnouts on the investigated line are equipped with foundered monobloc of the same steel quality as the rails, there are not others, such as built up common crossings with one curved rail or cast common crossings with one or both rails straight. The geometric marks and construction of the switches used in the Caucasus region generally correspond with switches used in Western

Europe. The following table shows a summary of installed switches of all Caucasian railways.

Tab. 1.1-2: Installed switches of all Caucasian railways.

no.	designation	ARM	AGZD	GRZD
1	Set of switches R 65 1:11	79	714	1641
2	Set of switches R 65 1: 9	19	17	19
3	Set of switches R 50 1:11	294	361	116
4	Set of switches R 50 1: 9	600	225	119
5	Set of switches R 43 1:11	10	8	21
6	Set of switches R 43 1: 9	52	38	120
	total	**1,054**	**1,363**	**2,036**
	to renew			
	set of switches R 65 1:11	152	697	495
	Set of switches R 65 1:9	0	0	0

1.1.1.5 Level crossings

There are 144 level crossings on the investigated lines. The table below shows the inventory of level crossings of the Caucasian railways.

Tab. 1.1.-3: Overall view of the existing level crossings

no.	designation	ARM	AGZD	GRZD
1	Level crossings	84	30	30
2	total	144		

1.1.1.6 Ballast

The table below informs about the results of laboratory tests of the stone quality at ARM and AGZD quarries.

Tab. 1.1-4: Laboratory tests of broken stone quality of the railways own quarries

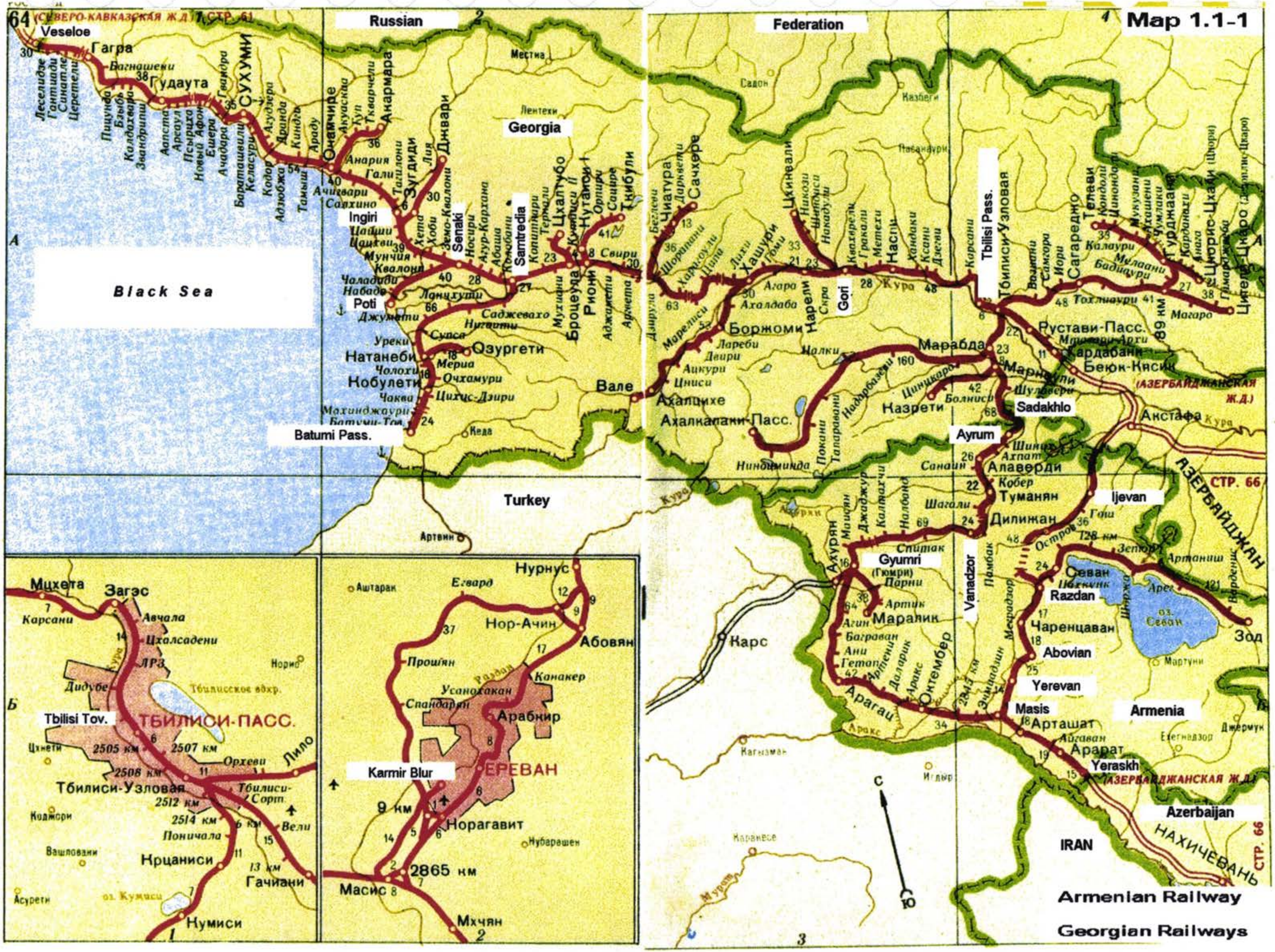
no.	designation	ARM	AGZD	GRZD
1	resistance	1,400 kg/cm^2	1,400 kg/cm^2	no information
2	unconsolidated material	5 %	12 %	no information
3	fine grain and clay	0.6 %	0.2 %	no information
4	frost resistance	MP3 - 25	MP3 - 50	no information
5	water absorption	0.95 - 1.56		no information
6	piled density		1.55 t/m^3	no information

Visual inspections, however, show that gravel, stone chips and other unsuitable stone material were used, although the right stone quality was available. Most parts of the ballast bed on the main line are in a very bad condition because there has been no periodical ballast-cleaning, a condition which was aggravated still by climatological erosion, sand drifts and traffic pollution. A high percentage of fine granulation fraction contained in the ballast (failure of wash equipment) and the above mentioned factors lead to a rapid pollution, so that the ballast loses its dynamic absorption, elasticity, water permeability, aeration and electrical insulation properties. Due to the lack of a side-path, sleeper ends are not supported by ballast. Thus, the ballast cannot distribute the wheel load from moving vehicles over the sub-ballast as evenly as possible, and provide adequate resistance to both longitudinal displacement and lateral shift.

1.1.2 Armenian Railway (ARM)

The total length of the main lines is 798 km (see Map 1.1-1). The railway is located mainly in mountainous terrain, well above sea level (a.s.l.), which results in the following distribution:

500 - 1,000 m a.s.l. - 30.7 % = 245 km,
1,000 - 1,500 m a.s.l. - 30.7 % = 245 km and
1,500 - 2,000 m a.s.l. - 38.6 % = 308 km.


Map 1.1-1
Russian
Federation
Georgia
Black Sea
Turkey
Armenia
Azerbaijan
IRAN
Veseloe
Ingiri
Poti
Senaki
Samtredia
Batumi Pass.
Gori
Tbilisi Pass.
Sadakhlo
Ayrum
Ijevan
Gyumri
Vanadzor
Razdan
Abovian
Yerevan
Masis
Yeraskh
Karmir Blur
Tbilisi Tov.
Гагра
Гудаута
СУХУМИ
Очамчире
Зугдиди
Натанеби
Кобулети
Озургети
Вале
Ахалцихе
Ахалкалаки-Пасс.
Боржоми
Марабда
Марнеули
Казрети
Рустави-Пасс.
Кардабани
Акстафа
Алаверди
Туманян
Дилижан
Севан
Чаренцаван
Арташат
Арарат
Карс
Мцхета
Загэс
ТБИЛИСИ-ПАСС.
Тбилиси-Узловая
Нурнус
Абовян
ЕРЕВАН
Норагавит
Масис
Мхчян
Armenian Railway
Georgian Railways

Determined by the mountainous terrain, the alignment of the network includes 302 km of curved sections, of which 82 km are less than r = 300 m and 62 km between r = 300 and 350 m. The track network of Armenian Railway consists of four main parts, as follows

- Yerevan - Masis -Gyumri - Ayrum - border station GRZD,
- Masis - Yeraskh border station AGZD,
- Masis - Razdan - Ijevan - Betonit to border point to AGZD and
- Razdan - Sevan - Sotk (link line).

The following table shows all operational track lines with their equipment as single or double track line.

Tab 1.1-5: Operating tracks of selected ARM[1] lines

from station	to station	from km	to km	Length km	Remarks
Yerevan	Masis	2,877	2,863	14	double track
Masis	Gyumri	2,863	2,723	140	single track
Gyumri	Ayrum	2,723	2,579	144	single track to border point to Georgia
Masis	Yeraskh	595	542	53	single track
Masis	Nurnus	16 +38	-	54	single track
Nurnus	Sotk	33	205	172	single track
Razdan - Ijevan	Barchudarli	128	28	100	single track to border AGZD
Armavir	Arshalois	1	14	14	single track
Gyumri - Artig	Maralik	1	38	38	single track
Gyumri	Akhurian	1	13	13	single track
Ani	Ani-Pemsa	1	5	5	single track
Noragavid	Karmir Blur	0	6	6	single track
Noragavid	Yerevan	2,871	2,877	7	single track
Masis	Nor - Hadshun - Abovian			5	reversing triangle

[1] Source: Railway Department ARM

1.1.2.1 Composition of the track lines

The tracks are Russian gauge 1,520 mm, with a normal tolerance of + 6 mm and - 4 mm. The largest part of the main tracks is made up of single track lines, with the exception of the Yerevan - Masis track line which is constructed as a double track. All lines are electrified by 3.3 kV direct circuit (DC) and are frequented by freight and passenger traffic. The length of the main track lines in operation is 798 km. In addition to these km of track length, there are the station and marshalling yard tracks of 450 km in length. Switches 1:11, 1:9 are numbered at 475, forming the connection from and to the main lines and there are a further 579 switches at stations. Heating is not installed and in winter time, when ice and snow block the switches, people of the districts have to clear away ice and snow, using small tools and steel bars only.

The main lines are equipped with switches as follows:

475 sets, comprising	R 65	switches 1: 11 - 68 sets,	1: 9 - 19 sets.
	R 50	switches 1: 11 -294 sets,	1: 9 - 76 sets
	R 43	switches 1: 11 - 10 sets,	1: 9 - 8 sets.

The stations are equipped with switches as follows:

579 sets, comprising	R 65	switches - 11 sets,
	R 50	switches - 524 sets,
	R 43	switches - 44 sets,

A distinction between mark 1:11 and 1:9 was not made (source: Railway Department ARM). The switch constructions are of Russian production.

The ratio of timber and concrete sleeper is figured at 70% : 30% at present, which amounts to 1,027,808 timber and 440,496 concrete sleepers.

There are 84 level crossings on the investigated lines, 21 of which are protected and 63 are unprotected level crossings.

1.1.2.2 Bridges and tunnels

The ARM track network, located mainly in mountainous terrain, is inevitably fitted with all kinds of engineering structures, including tunnels. There are 5 tunnels located on the main lines, their lengths are quoted at 1,200 m and 4 tunnels with 300 - 400 m. In addition to these tunnels, there are galleries which serve as a protection against falling rocks and there are viaducts of different lengths. No information is available about the condition of the individual tunnels and safety constructions as mentioned above nor any details about their location. That is amazing as the tunnels and safety equipment require an increased level of maintenance and special investigations, to check the water outlets and damaged brickwork lining in some parts of the tunnels or similar constructions.

The bridges, which were mainly imported, are listed in Annex 1.7-2 informing about the location (km), the type of construction, the length in metres and the stations between which the bridges are situated. Annex 1.7-2 presents 12 bridges - multispan bridges - with a total length of 958 m. Constructions such as culverts, arched stone and concrete drain pipes up to 2.00 m span are not quoted. The year of construction of all types is stated by ARM as between 1898 - 1912. Some bridges were reconstructed between 1960 and 1985 (see bridge list No. 1, 3, 11 and 12). The technical administration of the engineering structures is within the responsibility of the Ministry of Transport.

1.1.2.3 Ballast

The main line is constructed on a 30 to 35 cm ballast bed corresponding to the standard design. The gauge standard is 25/60 mm. At present ARM exploits one quarry, which is located in Ayrum, near the border to Georgia. Laboratory tests and investigations confirm that basalt, diorite and porphyrite were used in conformity with the requirements of GOST 7392-52 and TU 159-53 MSPM for the production of track ballast. The broken rock from the Ayrum plant is of high quality. No information was available about the daily production.

1.1.2.4 Standard cross sections

The instructions contain drawings of standard cross sections for single and double track lines. They have not been respected - whatever the reasons might have been.

During an inspection ride the following defects had been stated:
The widths of the embankment crowns and cuts are insufficient, side paths and de - watering facilities are lacking. The inclinations of the slopes and cuts are rather accidental and very irregular because they are not determined by construction. Especially on the mountain lines (70% of all lines), the cross sections are so narrow that the load limit gauge may not be exceeded, even insignificantly.

1.1.2.5 Subsoil

The subsoil acquires support capability for accepting the static and dynamic forces arising from train traffic only if its elastic modulus is $E>800kp/cm^2$. This value should be available in most parts of the track line we saw during our visits. With the exception of the Yerevan - Masis track line with a sections where a muddy patch was identified in the ballast. This section has to be drained well because the ground water-level is the same as the ballast bed. The ground water level has to be depressed.

1.1.2.6 Technical layout data and specification of track geometry

The evaluation of the longitudinal profile, for the main lines of ARM, resulted in following data:

- maximum axle load 23 t
- minimum radius on the main lines 250 m, branch tracks connected with R = 120 - 80 m, operation by special locomotives of the CM 3 and DGM 4 types.
- gauge 1,520 mm, minimum 1,516 mm, maximum 1,540 mm
- maximum super elevation 150 mm, with parabolic transition curves
- maximal vertical gradient 38 ‰
- vertical or levelling curves 300 - 3,000 m
- distance between centres of lines 4,100 mm, between Yerevan - Masis
  distance between centres of lines in stations 5.300 mm
- average sleeper spacing 0.54 m with 1,840 sleepers/km, 0.50 m in curves up to 2,000 sleepers/km.

1.1.2.7 Railway stations and their further facilities

The buildings and the other structures such as platforms, loading plants and other facilities of intermediate stations and operating control points on the main lines have to be restored, on a large scale. The aftermath of the 1989 earthquake and its destructive power still becomes apparent in the collapsed constructions which have not been restored yet. It has to be said in this connection that the passing sidings of the single track main line have to be replaced. For more details, please refer to section 1.4.

1.1.2.8 Track maintenance and track renewal

The institutions responsible for track maintenance and track renewal are the Department of permanent way management and maintenance, the Permanent way districts and the Permanent way workshops.

1.1.2.8.1 Department of permanent way management and maintenance

The maintenance and renewal measures are managed, monitored and officially accepted by the head office in Yerevan. The following methods are applied to carry out these complex tasks:

- Inspection and auditing;
- Checking and authorising the work plans;
- Making the resources available and monitoring that they are properly used.

As an example, the annual deployment plan for 1996 is presented in Annex 1.1-1. The annual deployment plan includes all construction engineering measures for the maintenance and upkeep of around 800 km of through track. This programme only represents an emergency programme and has little connection with the scheduled maintenance and renewal of tracks and the accompanying technical equipment. As an example, the track renewals planned for 1996 are indicated as 12 km, however the minimum would be 55 - 60 km, given a lifetime of rails in the track of 15 years. The rail lifetime of 15 years is absolutely customary in the case of the railways in the Caucasus.

1.1.2.8.2 Permanent way districts

The permanent way districts are responsible for:

- drawing up the annual extent of work for the track upkeep,
- carrying out the work plan authorised by head office,
- renewing sections on up to 400 m of track length,
- constant monitoring of the track sections and crossovers for the correct geometrical position and visible damage,
- introducing immediate measures in case of operational dangers,
- supervising the work being carried out,
- regularly inspecting the railway line by the line supervisor,
- monitoring staff size,
- training personnel for the various tasks,
- controlling growth and weeds,
- keeping the structure clearance open,
- looking after the upkeep of the drainage works, passageways, deep drains and open ditches in accordance with their function.

ARM has set up five permanent way districts for the management of all of these tasks. The following table gives an overview of the permanent way districts and their current staff size. The Ijevan permanent way district only has a skeleton crew at present, because the relations with the AGZD have been interrupted for political reasons. The permanent way districts are responsible for a line length of between 71 and 217 km, which depends on the operating facilities, the passenger and shunting yards and special demands on the permanent way.

Tab. 1.1-6: List of ARM permanent way districts

No.	District	Staff 1996	Track length	Remarks
1	Vanadzor	132	107 km	
2	Gyumri	164	189 km	
3	Yerevan	183	206 km	
4	Sevan	137	217 km	
5	Ijevan	23	71 km	
6	Permanent way workshop Masis	17		total railway system
	total	656		

The following table shows the important services that were provided by the permanent way district in September 1996.

Tab. 1.1-7: Scope of services of the Yerevan permanent way district in September, 1996

No.	Description of the Work	Unit	Quantity	Hours
1	Joint setting, alignment, height equalisation in the tracks	km	30	19,637
2	Working on the switches, track gauge setting, alignment	run. metre	2,160	2,666
3	Working on the tracks, changing iron mountings, spacers	km	6	863
4	Alignment of curved track with hydraulic alignment winches	run. metre	4,860	521
5	Regulating the ballast bed	run. metre	6,900	457
	total			24,144

1.1.2.8.3 Equipment of the permanent way districts

The upkeep areas of the permanent way districts are divided into line districts. The average number for each permanent way district is 4 line districts, the responsible managers of which are chief supervisors in each case. Every line district is divided into 3 line regions, which are responsibly managed by line supervisors The line regions have 3 work groups, with 15 workers each, at their disposal to carry out the track upkeep. The size of the work groups varies and depends on the technical equipment of the line region. The minimum size of a work group is 5 workers. The factors that determine the size of the work group are:

- number of line kilometres
- number of switches
- status and special facilities of the train stations
- drainage works
- steep lines and safety installations on cliffs
- number of curving areas and size of the radii

In order for the requirements of effective track upkeep to be met, ARM needs basic equipment of maintenance tools and machines to be made available for 5 permanent way districts x 12 line district regions = 60 regions. There is no need to draw up an inventory, as such inventories do not exist in reality.

1.1.2.8.4 Permanent way workshop

The permanent way workshop is responsible for track renewals of more than 400 m. It receives the annual deployment plan from the head office for carrying out this work. The workshop is to estimate the annual work in accordance with the quantity stipulations, and these estimates are then presented to head office for authorisation with the planned execution times. The permanent way workshop in Masis is managed like a private enterprise.

1.1.2.8.5 Equipment of the permanent way workshop

The efficiency of a permanent way workshop depends on the organisation of the work schedule, the blue and white collar staff available and the construction machine equipment. The permanent way workshop is not efficient with a current staff size of 17 employees (as of September, 1996) and the inventory of railway track machines listed in Annex 1.1-2. In column 7, Annex 1.1-2 shows that neither an investigation of principles nor of deadlines has taken place. The condition of the railway track machines that are available is commensurate. Column 7 shows that a majority of the machines and devices have to be replaced.

1.1.3 Azerbaijan State Railways (AGZD)

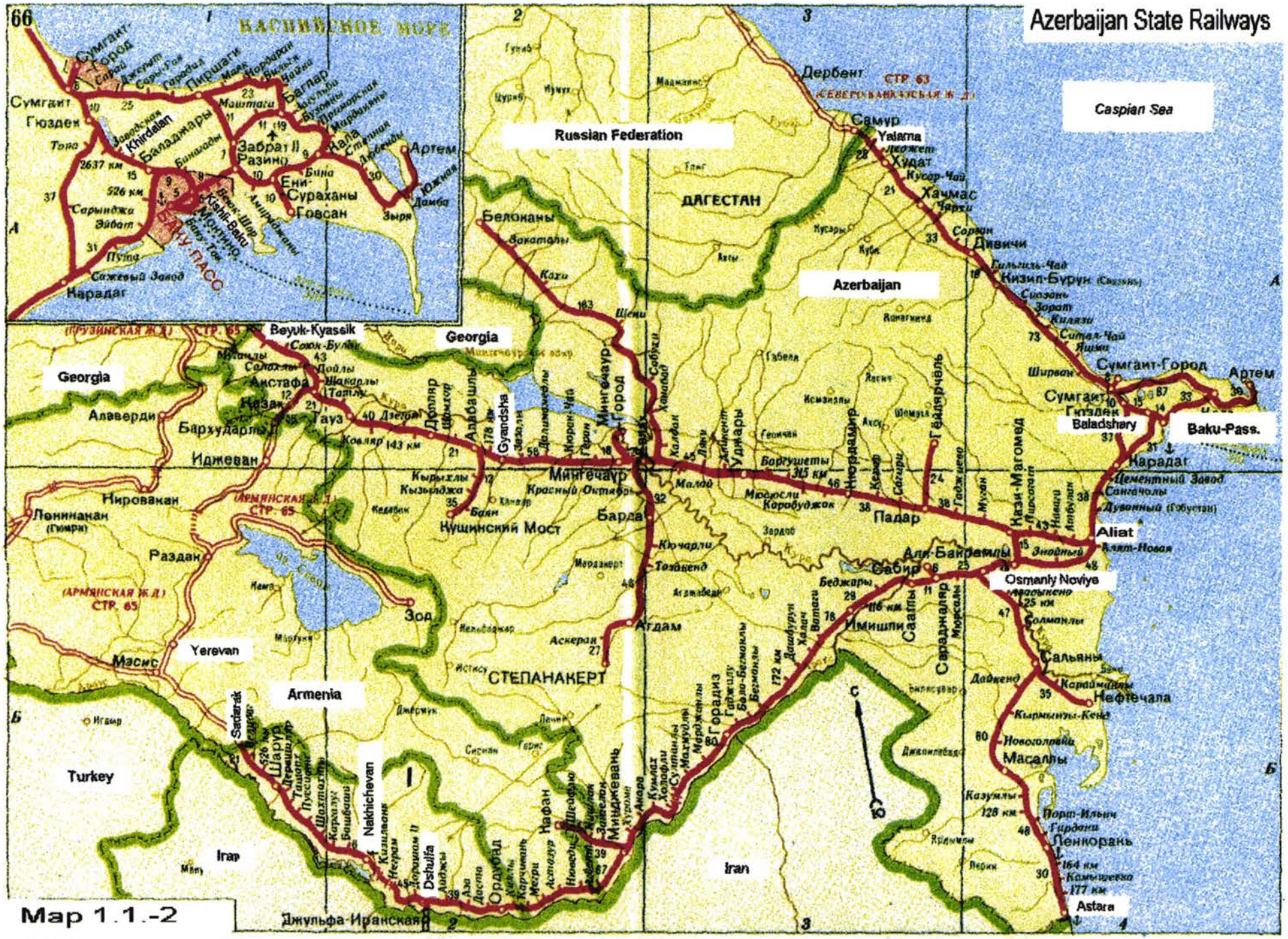
The AGZD operates 4 main lines in its railway system; these are (see Map 1.1-2):

- Baladshary - Beyuk-Kyassik - border to Georgia.
- Baku - Yalama - Russia.
- Osmanly - Astara - (Iran).
- Aliat - Sadarak. Presently in operation up to Goradis.

The lines are listed in the following table with their lengths and operating mode.

Tab. 1.1-8: Main operating lines of AGZD

No.	Line Designation	Length	Double Track	Single Track
		km		
1	Baladshary - border GRZD	487	487	0
2	Baku - Yalama	206	206	0
3	Osmanly - Astara	184	0	184
4	Aliat - Sadarak	541	70	471
	total	**1,418**	**763**	**655**


Azerbaijan State Railways
Caspian Sea
Russian Federation
Georgia
Azerbaijan
Armenia
Turkey
Iran
Yerevan
Baku-Pass.
Astara
Nakhichevan
Джульфа-Иранская
Мар 1.1.-2

1.1.3.1 Composition of the track lines

1.1.3.1.1 Types of rail on the main lines

The following table contains an overview of rail types used on the main line sections.

Tab. 1.1-9: Types of rail on the main lines[2]

No.	Line Designation	Length	R 65	R 50
		km		
1	Baladshary - border GRZD	487	487	0
2	Baku - Yalama	206	206	0
3	Osmanly - Astara	184	112	72
4	Aliat - Sadarak	541	362	179
	total	**1,418**	**1,167**	**251**

1.1.3.1.2 Switches

The direct switches from and to the main through-tracks are distinguished according to rail type and inclination. The following table provides information on the type and number of switches.

Tab. 1.1-10: Overview of the switch types on the main tracks of AGZD

No.	Switch type	R 65		R 50		R 43	
		1:11	1:9	1:11	1:9	1:11	1:9
1	Baladshary - GRZD	412	6	156	52	3	3
2	Baku - Yalama	243	4	72	5	0	0
3	Osmanly - Astara	7	0	14	32	0	30
4	Aliat - Sadarak	52	7	119	136	5	5
	total	**714**	**17**	**361**	**225**	**8**	**38**

[2] Source: Baku Railway Headquarters

1.1.3.1.3 Rail fastening

The fastening of the rails to the sleepers is of Russian origin, as described in section 1.1.1.3. It is unsuitable for a sturdy and lasting permanent way and does not meet the customary West European standards.

1.1.3.1.4 Bridges and tunnels

Tunnels are not constructed on the main line Baku - border point to Georgia and vice versa. On that line in total 985 bridges are installed. These constructions are divided into bridges of lengths up to:

25 m	-	680 constructions,
100 m	-	57 constructions and
> 100 m	-	5 constructions.

243 constructions are culverts, arched stone and concrete drain pipes up to a span of 2.00 m. The year of construction of all types is between 1883 - 1904. In Annex 1.7-3 the bridges of great importance are enumerated. This list only contains bridges with a length of more than 25 m and up to 100 m. All bridge construction methods are presented as arched stone bridges, reinforced concrete bridges and metallic decks assembled by rivets or bolts. Most of the bridges are well maintained and in a satisfactory condition. Some bridges are in critical condition and need major repair or renewal.

1.1.3.1.5 Subsoil

The regulations for the substructure, the track formation and the structure of the standard cross section were neglected or not observed in the construction of the railway lines. The result is that side paths are lacking, drains are not provided or are not capable of functioning because of inadequate maintenance. The Osmanly - Astara line is occasionally flooded because of the location of the line along the Caspian Sea. The floods lead to heavy damage to this line. This in turn causes the intermittent stoppage of rail traffic on the Osmanly - Astara line. The track grating is predominantly laid in sand or stone chips there.

1.1.3.2 Track maintenance and track renewal

The AGZD has a well-structured system of control and monitoring of railway facilities at its disposal. This starts with the head office in Baku and the subordinated offices down to the line runners in the permanent way districts. The areas of responsibility are clearly established, and the task are laid down. The hierarchical structure is as follows:

- Head office in Baku,
- 15 permanent way districts,
- 5 permanent way workshops,
- 1 rail welding workshop,
- 1 depot for the maintenance and repair of railway track machines.

1.1.4 Georgian Railways (GRZD)

1.1.4.1 Main operating lines of GRZD

The GRZD operate four main lines in its railway system; these are (see Map 1.1-1):

- Poti - Senaki - Samtredia - Tbilisi - Gardabani - border to AGZD,
- Batumi - Samtredia,
- Tbilisi - Sadakhlo - border to ARM,
- Senaki - Ingiri - Otshamtshire - Veseloe - border to Russia (presently in operation only up to Ingiri).

The lines are listed in the following table with their lengths and operating mode.

Tab. 1.1-11: Main operating lines of GRZD[3]

No.	Line Designation	Length	Dbl. Track	Sin. Track
		km		
1	Poti - Senaki - Tbilisi border to AGZD	358	281	77
2	Tbilisi - Sadakhlo - border to ARM	68	9	59
3	Batumi - Samtredia	106	0	106
4	Senaki - Ingiri - Veseloe - border to Russia	234	0	234
	total	**766**	**290**	**476**

[3] Source: Tbilisi Railway Headquarters

1.1.4.2 Composition of the track lines

1.1.4.2.1 Types of rail on the main lines

The existing permanent way of the lines indicated in the table above is detailed in the following table: A distinction is made here as to the types of rail, namely the rails of the type R 65 and R 50. The rails of type R 43 do not exist on the main lines any longer.

Tab. 1.1-12: Types of rail on the main lines

No.	Line Designation	Length	R 65	R 50
		km		
1	Poti - Senaki - Tbilisi - border to AGZD	358	317	41
2	Tbilisi - Sadakhlo - border to ARM	68	44	24
3	Batumi - Samtredia	106	76	30
4	Senaki - Ingiri - Veseloe - border to Russia	234	234	0
	total	**766**	**671**	**95**

1.1.4.2.2 Switches

The direct switches from and to the main through-tracks are distinguished according to rail type and inclination. The following table gives information on the type and number of switches.

Tab. 1.1-13: Overview of the switches types on the main tracks

No.	Crossover Type	R 65		R 50		R 43	
		1:11	1:9	1:11	1:9	1:11	1:9
1	Poti - Tbilisi - border to AGZD	1,475					
2	Tbilisi - Sadakhlo - border to ARM	6	5	24	39	12	19
3	Batumi - Samtredia						
4	Senaki - Ingiri - Veseloe - border to Russia	160	14	92	80	9	101
	total	**1,641**	**19**	**116**	**119**	**21**	**120**

1.1.4.2.3 Rail fastening

The fastening of the rails to the sleepers is of Russian origin, as described in section 1.1.1.3. It is unsuitable for a sturdy and lasting permanent way and does not meet the customary West European standards.

1.1.4.2.4 Bridges and tunnels

GRZD `s track network is equipped with all kinds of artificial constructions as well as tunnels. There are 5 tunnels located on the main line whose lengths differ between 50 and 4,000 m. The tunnels need an increased maintenance and special investigations to check the water outlets and damaged brickwork lining in some parts of the tunnels. The most imported bridges are listed in Annex 1.7-3. The annex presents 80 bridges with a total length of 7,530 m. Constructions as culverts, arched stone and concrete drain pipes up to 2.00 m span are not quoted. The year of construction of all types is between 1896 - 1907. Most of this bridges are in satisfactory conditions. They need, in addition to a full scheduled maintenance, some bridge renewals. All bridge construction methods are arched stone bridges, reinforced concrete bridges and metallic decks assembled by rivets or bolts.

1.1.4.2.5 Subsoil

The substructure, track formation and standard cross section were not taken into account to any great extent during the construction of the railway lines. The result is that drains are not provided or are not capable of functioning because of inadequate maintenance. The track renewals that have been carried out for decades changed the height of the tracks at the cost of the edge paths set up earlier, due to an inadequate ballast renewal. They are covered up with old ballast today. The consequences are worn out spaces between adjacent sleepers and the exposure of the sleeper ends. This in turn leads to inadequate passage of the dynamic forces into the subsoil and to the early destruction of the sleepers and the rail fixtures. The Tbilisi - Sadakhlo - border to Armenia line has become a slow-travel route on the whole because of the poor substructure, the ballast bed and the destroyed sleepers. The speeds of 70 km/h for freight trains and 80 km/h for passenger trains that were previously permissible have been reduced to 25 km/h for the entire line.

1.1.4.3 Track maintenance and track renewal

The GRZD has a well-structured system of control and monitoring of railway facilities at its disposal, as do all railway administrations in the Caucasus. This starts with the head office in Tbilisi and the subordinate offices down to the line runners in the permanent way districts. The areas of responsibility are clearly established, and the task are laid. The hierarchical structure is as follows:

- Head office for railway facilities in Tbilisi,
- 11 permanent way districts,
- 2 permanent way workshops,
- 1 rail welding workshop and
- 1 impregnating plant for wooden sleepers.

1.2 Signalling, telecommunication and data processing

1.2.1 Caucasian railways in general

The facilities of the signalling and telecommunication system were inspected within the framework of this project. Priority was attached to the condition and functioning of the installations used. In addition, a check was conducted on whether the condition of the signalling and telecommunication installations could ensure a safe running of trains in passenger and goods transport.

Objective difficulties result from the disintegration of the former Soviet Union and the resulting level of competence of the individual railway administrations in fulfilling the transport tasks of the railways as well as the technical condition of the installations. Supplying all technical departments with the necessary spare parts is a priority for all railways in the region.

Furthermore, the use of resources available in the individual countries was scrutinised.

Attention also focused on the organisation of maintenance and the demand for spare parts required for signalling and telecommunication installations. Training and instruction of staff for the maintenance of the new equipment was also taken into consideration. One of the priorities was the supply of the maintenance staff with equipment and the vehicles required.

It emerged from the examination that all installations which have to be reconstructed would later not only have to meet the present requirements but also provide for an extension of the telecommunication network. This was taken into account upon determining the financial funds required.

Thus short-term measures are envisaged to make available signalling and telecommunication installations without delay. Medium-term and longer-term measures considering the increased demands of the transport volume are scheduled for the period of the next 5 - 10 years.

The financial funds required for a period of:

- 1st priority (2 years)
- 2nd priority (5 years)
- 3rd priority (10 years)

were broken down. In the cost survey chapter this will be explained in greater detail.

The prices used by the individual railways were applied as the basis for costing. In the case of installations for which prices could not be established, the prices applicable to German installations were used for costing.

The railways concerned made available documentation for determining the spare parts required for the individual equipment of the signalling and telecommunication systems. The priorities of spare part supply for equipping systems have been compiled in a table. They formed the basis for establishing the financial requirements for urgent measures.

1.2.1.1 Signalling installations

The operability and the technical condition of the following facilities required for the running the railway were examined.

For the signalling installations:

⇒ interlocking cabins
⇒ facilities of the automatic section block
⇒ signals
⇒ switch drives
⇒ presence-of-trains indicating equipment
⇒ cable equipment
⇒ level crossings
⇒ electrical supply facilities

Annexes 1.2-3, 1.2-6 and 1.2-10 only cover stations of the Caucasian railways main lines.

1.2.1.2 Telecommunication installation

The operability and the technical condition of the following facilities required for the running of the railway were examined.

For the telecommunication installations:

⇒ telephone connections
⇒ dispatcher system
⇒ radio installations
⇒ electric power supply facilities
⇒ telegraph installations
⇒ circuits (cable equipment, overhead lines).

The desolate condition of the telecommunication connections within the railways and between adjacent railways has become a priority.

The issue of how to achieve a common level of equipment for the telecommunication channels has been considered within the framework of the project. It will be imperative to use such equipment at the border stations of the railways which will ensure an exchange of information between one another. Using optical fibre cables, laid along the line, was considered as an alternative to the cable ducts existing now. In this connection, both underground laying and suspension of an appropriate optical fibre cable along overhead line poles were considered. The cost analysis compares the various types of laying.

1.2.1.2.1 Technical data and present condition of the signalling installations

Panel operated signal boxes of Russian construction, type BMRZ, BSZ, SZ and MRZ from the period between 1961 - 1994, are used for operation at the stations. The routes are set up by means of entrance and exit buttons. After terminating the train run, the route is released automatically. In the event of an accident occurring, auxiliary releases are possible. On open line sections, an automatic section block is available. Light signals are used for signalling. The switches are repositioned electrically. The presence-of-trains indication required for the automatic block is passed on through track circuits 220 V/50 cps. The presence-of-trains indicating equipment works on the basis of 50 cps track circuits for the automatic vehicle-on switch and track section indication. In the area of the Caucasian railways, there is a comprehensive presence-of-trains indicating system. The electric power supply of the signalling system is provided through an overhead line which is fixed to the catenary supports.

The reproductive life span of the equipment used is detailed in the following table.

Tab. 1.2-1: Reproductive life span of signalling installations

no.	equipment	period
1	cable equipment	30 years
2	light signals	35 years
3	switch drives	16 years
4	presence-of trains indicating equipment	20 years
5	panel operated signal boxes	25 years
6	relay systems of the automatic block	28 years

The technical condition and the operability of the installations of station and line equipment is not satisfactory enough to ensure a safe operation of trains. The trains are run mainly by means of radio service onboard the trains and by operation measures. The necessary replacement of worn-out signalling equipment has been carried out only to a small extent during the last few years. The installations have always been repaired using the available means only. Yet, with the increasing age of the equipment employed, we have to proceed from an aggravation of the condition and

an increase in the frequency of equipment failing. We were not able to include a survey of the faults of the signalling equipment over the past years. An evaluation of faults due to equipment and copper components having been stolen was not made. After the transport volume declined, the utilisation of the tracks and stations dwindled, too.

The relay systems of the stations are serviced and defective components are replaced if spare parts are available.

Signals

Investigating the outer condition of the signals and dwarf signals, you are able to detect corrosion of the poles and signal panels caused by external influences. The visibility of some signals is limited for the staff of locomotives. Yet, this is also caused by the bad condition of the signal lenses predominantly used. Functioning of the equipment is also affected by damages caused by third parties as well as by theft of necessary components, e.g. the relay systems of the block cupboards of the automatic block and the branch cables at the signal poles and the lines for the electric power supply of the equipment of the automatic section block.

Switch drives

The state and the operability of the existing electric switch drives are predominantly affected by the bad condition of the switches. The existing track system does not ensure the quiet position required for the switch drive to operate. And as a result of corrosion, the external condition of the switch drive is only satisfactory. Electric motors, switch relay systems and internal wiring have reached the limit of service life in approx. 60 % of the switch drives.

Presence-of-trains indicating equipment

The proper condition of the track system forms the basis for a trouble-free functioning of the track circuits. Owing to the bad insulating resistance of the tracks and switches, the track circuits fail time and again. The functioning of the equipment is also affected by them being damaged by third parties and theft of the required components, e.g. inserts of chokes, connectors and connection ropes. Theft of track circuit equipment is to be prevented with the help of additional expenditure, using concrete rings to house the choke transformers, which are buried up to the upper ground level. The chokes used and the ropes and connectors required for connection to the track are in a bad condition. The operability of the insulated rail joints is severely restricted owing to their condition.

Cable equipment

The cables supplying electric power to outdoor installations are buried. The cable connecting stands installed in buildings are in a good condition. Distribution boards are used for the connection of the individual branch cables and the connection of the main cables among each other. The condition of the distribution boards and the

track connecting boxes is not satisfactory. Failing of the outdoor installations is still favoured by this circumstance.

Level crossings

All level crossings are manned. In the case of an irregularity or total failure of an automatic gate installation occurring, the installation is operated manually. The reasons for irregularities of the gate installations most frequently quoted were outside interference, i.e. removal of signal bells and light signal lenses or road signals. A further priority affecting the functioning is the electric motor required for actuation.

1.2.1.2.2 Technical data and present condition of the telecommunication installations

Overhead lines and cables are employed as transmission medium. Steel and copper lines of various sizes (3, 4 and 5 mm ∅) are used for the overhead lines.
Cables of the MKPAB 7 x 4 x 1,05 + 5 x 2 x 0,7 + 1 x 0,7 type are used in the cable equipment.

Transmission systems

The following systems are mainly used for transmission:

- K-60 60 channels 12 - 252 kpcs
- B-3-3 3 channels 4 - 32 kpcs
- B-12 12 channels 36 - 143 kpcs
- K-24T 24 channel

Telephone system

Manual exchanges of the M-60, MPU-20-3 and MPU-80-7 types are employed to make connections. Exchanges of the ATC type, year of construction: 1949, KASS-8 and KASS-22-35, are used as automatic exchanges.

Telegraph system

The following equipment is used in the telegraph system:

- T-63
- STA-CTA-67
- F-1100 and F-2000

The equipment used was installed between 1965 and 1990. The existing equipment of the T-63, STA-CTA-67 type is scarcely operable owing to its technical condition. Equipment of the F-2000 type is strongly restricted in its functioning due to a lack of spare parts. The supply with paper and ink ribbon has been identified as a priority.

Dispatcher system

The following dispatcher systems exist in the area of the railway:

- train dispatcher
- car dispatcher
- dispatcher of the repair staff
- energy dispatcher.

The existing installations were fitted in the period between 1970 and 1990.

The existing equipment was installed in the period between 1970 and 1990. Owing to financial constraints, the equipment was not regularly serviced and worn-out components were not replaced - as would have been necessary.

Radio service on the trains

Radio service on trains is used for the communication between the stations and the locomotive crew. Systems of the 43 RTS-A2-4M type are used predominantly. The radio system is operated with a frequency of 50 - 154 MCPS in Simplex operation.

The effective radius of the stations is:

- between station and locomotive 8 - 12 km,
- between locomotives 2 - 3 km.

The unstable connections of the telegraph system are regarded as a priority. All channels are established by means of overhead lines and cables. The couplers required for the connection of the cables leak in part. This condition affects the operability of the channels.

The radio service on trains provides for the connection between stations and traction vehicles. In addition, traction vehicles which are on open line may be contacted by the operating staff of the stations. Furthermore, mobile radio sets are available for the staff of the formation area. The existing equipment is operational, yet has a lower quality of transmission.

1.2.1.3 Data processing - Present state of computer applications by the Caucasian Railways

In the times of the Soviet Railways the Azerbaijan and Trans-Caucasian Railways possessed information and computer centres (ICC's) in Baku and Tbilisi. How, where, and when to use this computer technology was determined by the Central Administrative for Computer Technology of the competent ministry, MPS. The investments to be necessary were also made available from centralised funds. The ICC's of the railway administrations were connected with the main computer centre of the MPS and of neighbouring ICC's by means of temporary, dedicated lines via which data on certain projects were exchanged off-line. At present there are connec-

tions like these with the Moscow large computer centre and with the ICC of the Rostov/Don railway administration. The computer equipment dates from the years 1984/85 (uniform computer system types EC 1036, 1046 - IBM 360 licenses). The Armenian Railways was only a railway office and did not possess a computer basis.

On occasion of the 15th conference of the Council for Railways of the CIS (05-04-96) the commission for the "Informatisation of Railway Transport" was founded and the tasks, functions, and rights of the specialists were laid down.

The main tasks are as follows:

- elaboration of recommendations for the council as regards the strategy to be followed in the scientifically-oriented technical development, and the technological policy in the fields: automation of technological processes, railway management, and preparation of target programmes;
- co-ordination of the requirements by administrations, companies, and organisations as to computer services and means;
- problems of wagon lease accounting as they occur in daily operation;
- elaboration and development of automatic systems for controlling international goods and passenger transport;
- co-ordination of transport means;
- creation of joint project teams;
- preparation of expert opinions on hard- and software projects;
- co-ordination of the international co-operation with third countries (OSShD, UIC).

According to information given by the heads of the computer centres, work in the projects is financed from a joint fund fed by the railway administrations. Software development is aiming at producing a compatible software and is being done on a contractual basis by two organisations: the PKTB-ASUZT planning office (goods traffic) and the VNIZT research institute (passenger traffic). Difficulties, however, result from the different requirements to be met which are due to the different sizes. Also, despite the general willingness to co-operate there is opposition against Russian patronage.

Annex 1.2-12 gives a survey of the actual state / target state of computer applications in the three railway administrations.

1.2.2 Armenian Railway

The signalling installations of the Armenian Railway were examined placing the main emphasis on the Yerevan - Ayrum main line. However, the other lines were inspected, too:

- Yerevan - Ijevan
- Razdan - Sotk
- Masis - Yersakh

Over the past few years, the Armenian Railway have suffered from two severe setbacks which were, on the one hand, the 1988 earthquake and the disintegration of the Soviet Union starting in 1989, on the other hand.

The earthquake completely destroyed the buildings housing the signalling and telecommunication equipment in the section around Spitak.

Goods wagons without bogies were used as a temporary solution at the time. However, they were not heated. Thus, in winter the relay equipment failed repeatedly. This condition has prevailed up to the present day.

1.2.2.1 Signalling installations

Annexes 1.2-1 and 1.2-2 contain a survey of the condition of the switch mechanisms and the position of the repair bases for signalling and telecommunication installations in the line network of ARM.

Tab. 1.2-2: Installation units of the ARM

no.	equipment	total of equipment
1	switches	1,250
2	light signals	1,790 comprising 750 pole signals 1,040 dwarf signals
3	track circuits	1,601
4	interlocking cabins	72
5	level crossings	84

In the Gyumri - Ayrum section and especially in the area near Spitak the buildings housing the signalling and telecommunication installations were completely destroyed by the earthquake in 1988.

As an emergency solution, goods wagons without bogies were used as relay containers for four stations. However, they were not heated and thus the relay equipment failed repeatedly in winter. The aforementioned condition has prevailed up to this day. Further three stations are housed in other or damaged buildings. The following survey contains all stations affected:

Tab. 1.2.-3: Signalling and telecommunications installations in the earthquake area

no.	name of the station	km	switches	signals	track circuits	remarks
1	Archut	2,662	4	19	6	goods wagon
2	Spitak	2,673	15	22	18	goods wagon
3	Nalband	2,683	6	17	12	goods wagon
4	Kaltakhtshi	2,693	7	16	11	goods wagon
5	Dshadshur	2,702	11	19	13	damaged building
6	Maisyan	2,712	5	16	10	damaged building
7	Gyumri	2,723	67	80	62	damaged building
	total		**115**	**189**	**132**	

1.2.2.2 Telecommunication installation

The MKPAB type cable laid along the main lines is in a very bad condition. The necessary connections of the stations among one another, which forms the basis for a safe train operation, display a high rate of failure. A large amount of the non-ferrous metal components fell victim to vandals. The unstable supply of electric power affects the operability of the still existing installations considerably.

1.2.2.3 Data processing - State of affairs in the ARM administration

Unlike Tbilisi and Baku, Yerevan (seat of ARM) does not possess an information and computer centre. (Mr Sergey Saratnikyan, Tel.: 28 27 57, 38 39 95 was charged on 01-01-1997 to set up an ICC).

It is planned to equip the computer centre with a PC network and a server with admission to the Internet for international data communication. On the basis of standard software a team of 4 to 5 programmers is to make available user software.

In the Karmir Blur terminal exists a PC which can be used for certain tasks of container transport handling.

1.2.3 Azerbaijan State Railways

The signalling installations of the Azerbaijan State Railways were examined placing main emphasis on the main line Baku - Beyuk-Kyassik. However, the other lines and sections Baladshary - Yalama, Baladshary - Astara and Ali Bairamly -Sadarak were also recorded including the necessary measures.

- Baladshary - Yalama
- Baladshary - Astara
- Ali Bairamly - Sadarak.

1.2.3.1 Signalling installations

It emerged as a result of the analysis that the bulk of the failing installations is to be found in the track-release installations of the railways. Track circuits of some 2,400 kilometres in length are installed in the line network of the Azerbaijan State Railways.

An analysis of the irregularities occurring shows the following percentage share of the various divisions of Azerbaijan State Railways:

- 60% - 70% track division
- 15% - 20% signalling
- 5% power supply
- 5% others

Tab 1.2-4: Selected installations on the Baku - Beyuk-Kyassik line

no	installations	number of installations
1	switches	1,475 (124 of them hand-operated)
2	light signals	1,393 (36 of them floodlight signals)
3	track circuits	752
4	interlocking cabins	45
5	level crossings	8 automatic installations 11 electrically driven installations 11 mechanical installations

The following tables detail the stations which have been fitted with other signalling technology, differing from the technical standard of the Azerbaijan State Railways.

Tab. 1.2-5: Stations with floodlight signals

no	station	number of floodlight signals	number of switches
1	Puta	5	12
2	Atbulak	11	14
3	Navagi	8	16
4	Pirsagat	12	15

Tab. 1.2-6: Stations with hand-operated switches

no.	station	number of hand-operated switches
1	Kyrdamir	30
2	Alabashli	28
3	Shamkir	21
4	Dollyar	21
5	Dsegam	13
6	Kovlyar	11

There are some 600 level crossings between railway and road traffic. 135 level crossings feature technical protection. 138 level crossings are supervised by personnel and 316 level crossing are not supervised.

For the safety at crossings in the Baku - Beyuk-Kyassik sections the following installations feature technical protection:

- 8 automatic signalling dependent barriers
- 11 barriers with electric drive
- 11 mechanical barriers.

On the remaining lines, the following technical installations are used:

- 42 automatic, dependent on signals, barriers
- 50 barriers with electric drive
- 13 mechanical barriers

1.2.3.2 Telecommunication installation

The structure of the channels for the Azerbaijan State Railways is detailed in Annex 1.2-8. Two cables of the MKPAB 7 x 4 x 1,05 + 5 x 2 x 0,7 + 1 x 0,7 type were laid on the Baku - Aliat section through the Baladshary junction. On this section, 2 K-60 systems (120 channels) are used. The 5 x 2 x 0,7 (signal wires) contained in the cable are used exclusively for signal transmission. The signal wires are fed through branch sleeves in every location of a relay box along the line.

Overhead lines are used as transmission lines exclusively in the Aliat - Beyuk-Kyassik section. The technical condition of the overhead lines is not satisfactory. Problems are brought about by defective or lacking insulators, by corrosion of damaged stretchers and worn-out conductor material. 90 % of the complete line poles are worn-out.

The following number of channels is used in the individual sections:

- Aliat - Gyandsha 15 channels
- Gyandsha - Akstafa 12 channels
- Akstafa - Beyuk-Kyassik 3 channels

Two cables of the MKPAB 7 x 4 x 1,05 + 5 x 2 x 0,7 + 1 x 0,7 type were laid between the stations of Baladshary - Shirvan and Divitshi - Yalama in the Baladshary - Yalama sections . There is an overhead line comprising 12 channels between the stations of Shirvan - Divitshi.

1.2.3.3 Data processing - State of affairs in the AGZD administration

Applications at present are as follows:

a) SOSWAG - wagon lease accounting
Based on message no. 4610 the system processes 30,000 messages, nos. 5 to 7,000 of which concern AGZD. The processing is done by a PC program; a data set on wagons is constantly being updated.

b) Exchange of guard's journal telegrams with the Rostov (Russia) ICC. Messages are sent by the following stations: Baku-Tovarnaya, Port Baku, Kishli, Gyandsha, Sumgait, Baladshary, Shirvan, Giuzdek.

c) SOSKONT
The project for the follow-up of containers, co-ordinated within the CIS, is scheduled for a trial run in September 1997. It is planned to transmit message no. 4710 (container number; owner, weight, etc). Containers from abroad cannot be captured. It is planned to set up a container data bank on basis of this project.

At present 36 persons are working in the ICC. Computer equipment: 2 EC 1035 (1985 production); 30 PC's, 3 of which pentium.

1.2.4 Georgian Railways

The signalling installations of the Georgian Railways were examined placing emphasis on the Gardabani - Tbilisi - Poti/Batumi main line. However, the other lines and sections were also recorded.

- Tbilisi - Sadakhlo (direction Armenia)
- Zkhakaia - Gantiadi
- Kutaisi link line
- Borshomi link line .

1.2.4.1 Signalling installations

Tab. 1.2-7: Selected installations along the Tbilisi - Poti/Batumi line

no	installations	installations altogether
1	switches	1,397
2	light signals	2,044 (1,100 signals out of which are not operational)
3	track circuits	2,682 on the line 2,226 on the stations
4	interlocking cabins	69
5	level crossings	302 automatic installations 4 mechanical installations 24 installations are not operational

The technical condition and the operability of railway station and line equipment still existing is unsatisfactory. There is a semi-automatic section block on the line sections between Gardabani - Tbilisi-Uslovaya and Kaspi - Samtredia, i.e. train traffic is only possible between adjacent stations. There is an operational automatic section block between the Tbilisi-Uslovaya - Kaspi stations. The signalling equipment on the Samtredia - Poti and Samtredia - Batumi sections is no longer operational. Switch mechanisms and choke transformers are to be regarded as the priority of the equipment used. An emergency unit is available on the Gardabani - Zestafoni section to ensure a trouble-free power supply of the signalling equipment. Yet, the unstable supply of power is a problem in the period between November and May.

There are 2,226 track circuits at stations and 2,682 along line sections of the Tbilisi - Poti/Batumi line. 1,911 of the track circuits at stations and 2,256 along line sections are no longer operational due to various components having been stolen. The proper condition of the tracks is the basis for a trouble-free functioning of the track circuits. Due to the bad resistance displayed by the insulation of the tracks and switches, the track circuits still existing break down permanently. The chokes used

and the ropes and connectors required for connection to the track are in a bad condition.

There are 30 level crossings along the Tbilisi - Poti/Batumi line for safety reasons. Yet, only two automatic gate installations are still operational, four installations are mechanical gate installations. The safety facilities of the other installations have been dismounted due to vandalism.

1.2.4.2 Telecommunication installation

On the Tbilisi - Batumi/Poti section, there is a telecommunication system comprising 60 channels of the K-60 type and a system comprising 30 channels. There is a 12-channel system between Gardabani and Tbilisi. The channels are provided in cables. In most cases they are cables of the MKPAB-7*4*1,2+5*0,9+1*0,7 type. Cable of the MAVM-K-7*4*1,2+5*0,9+1*0,7 type was used in the Batumi - Lantshkhuti - Samtredia sections. The connections are made by automatic and manual exchanges.

The whole telecommunication line of the Tbilisi - Batumi/Poti section consisted of cables. The installations were built in 1984 between Tbilisi - Gardabani, in 1982 between Tbilisi - Khashuri, in 1979 between Khashuri - Zestafoni and in 1980 between Zestafoni - Samtredia. The cables required for establishing the connection in the various sections have been destroyed by vandalism. This condition has remarkable effects on the operability of the telecommunication installations.

Cables do no longer exist in the following sections.

Tab. 1.2-8: Survey of the cable installation of the Georgian Railways

no.	from	to	km	type
1	Senaki	Abasha	13,4	MKPAB-7*4*1,2+5*0,9+1*0,7
2	Gardabani	border AGZD	9,1	MKPAB-7*4*1,2+5*0,9+1*0,7
3	Marneuli	Sadakhlo	29,2	MKPAB-7*4*1,2+5*0,9+1*0,7
4	Batumi	Lantshkhuti	73,5	MAVM-K-7*4*1,2+5*0,9+1*0,7[1)] Type
5	Lantshkhuti	Samtredia	30,5	MAVM-K-7*4*1,2+5*0,9+1*0,7[1)] Type
6	Senaki	Poti	38,3	MAVM-K-7*4*1,2+5*0,9+1*0,7[1)] Type

[1)] The railways already laid optical fibre cables consisting of 4 fibres in these sections.

The structure of the cable installation is detailed in Annex 1.2-9 for the main line Gardabani - Tbilisi - Poti/Batumi.

1.2.4.3 Data processing - State of affairs in the GRZD administration

Applications at present are as follows:

a) SOSWAG - wagon lease accounting
Collecting by numbers of all wagons handed over to or received by ARM. Accounting is done by the large computer centre in Moscow, after the data which were collected in the Sadakhlo border station have been processed in the Tbilisi ICC and were then transmitted to the large computer centre via the network of computers.

b) Statistics of daily activities
Based on telephone reports on the fulfilment of operational requirements these data are prepared to be eventually presented to the management.

c) Preparation of running schedules (loco).

d) Integrated processing of the bill of loading data with output of the result lists by machine. Determination of revenues with invoices being made out without machines.

A project for modelling the movements of goods wagons in the network (centralised control of goods traffic) is under preparation.

The Consultants consider it to be especially important to establish data banks on infrastructure and rolling stock.

At present 125 persons are working in the ICC, 26 of whom are software developers. Computer basis: 1 ES 1036 (1995), 1 EC 1046 (1984), 8 PC.

1.3 Power supply

The present chapter describes the technical conditions of Power supply systems as:

- Traction power supply system
- Normal power supply system
- OCS (Overheadline catenary system).

1.3.1 Main components of power supply system for the Caucasian railways

1.3.1.1. General

The power supply networks of the three Caucasian railways in general are designed adequately. Differences were only found in the installed equipment, which results in different operational requirements. Each railway uses a DC power supply for the catenary system. The electrified networks of the Caucasian railways are supplied by a 3,000 V DC system. The nominal output voltage level of the substations is 3,300 V DC. The voltages on the overhead line contact system are limited to:

- Minimal 2,700 V
- Nominal 3,000 V and
- Maximal 4,000 V.

The main high voltage (HV) power supply of the railways is provided by the local energy supplier companies, organised in Arm-Energo (Armenia), Az-Energo (Azerbaijan) and Sak-Energo (Georgia).

Feeding voltages are normally AC 110 kV, 35 kV and 6 kV, 50 Hz. Each line is supplied by substations every 10 to 20 km. Technically they are normally equipped with 2 transformer sets for the traction power supply, including the rectifier units, and transformers for additional power supply (auxiliary railway supply, signalling supply and some times non-railway supply).

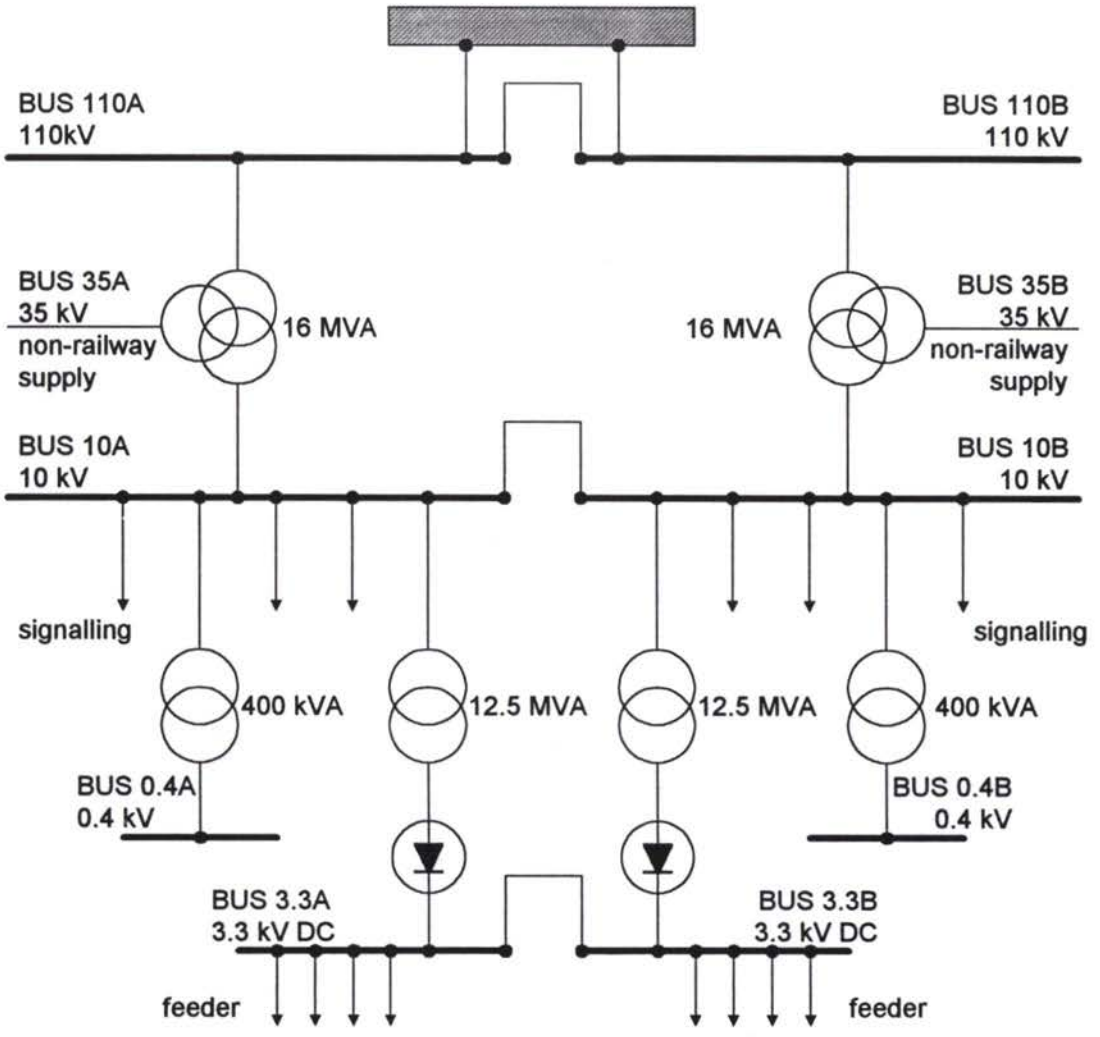
The substations are equipped with:

Tab. 1.3-1: List of main equipment for power supply substations

• 110 kV (or 35 kV, 6 kV) switchgear	– circuit breakers – isolator switches – earthing switches current transformer – voltage transformer – cable terminations – surge arrestors – control cubicles
• Main transformer	– with protection and monitoring equipment
• 10 kV switchgear	– circuit breaker – current transformer – potential transformer – earthing switches – switch disconnectors
• Rectifier transformer	
• DC switchgear	– high-speed circuit breakers – negative return cubicle
• Battery/ charger unit	
• Auxiliary switchgear	– LV distribution panel 220/380 V – circuit breaker – measurement equipment
AC cables	
DC cables	

The following figure shows the principle single line diagram of a 110 kV power supply substation.

Fig. 1.3-1: Single line diagram of power supply substations



1.3.1.2 Rectifier system / Regeneration of energy

Since 1956, silicon rectifiers have been used for DC traction power supply all over the world. Over the years, this type of solid-state equipment has given excellent service.

The naturally ventilated rectifiers operate without any moving parts. This feature is a safeguard against outage, moreover, it reduces maintenance. This type of rectifier units (12 pulse) is recommended for use in the Caucasian railways, instead of old oil cooled 6 pulse or ventilated 6 and 12 pulse rectifiers.

The relatively slow circulation of the cooling air reduces ingress of dust into the rectifier units and thus minimises the formation of unwanted surface contamination.

Based on the existing power supply system for the traction power supply, rectifier systems with conventional diodes or thyristors for energy feed back into the local energy company can be used.

Regeneration of energy

A comparison between a diode rectifier and thyristor rectifier is conducted below. We recommend the application of diode rectifiers without any energy feed- back options for the following reasons:

- Only in case of in long mountain regions with double track systems (in accordance with operations programme) or headway of trains among 1.5 to 3 minutes, the regenerative energy can be consumed economically usefully by adjacent trains. Computer simulation programs show that in this case, the regenerative energy can be used up to 85% and more by other trains.
- Regenerative energy to be fed back in the medium voltage (MV) system is not a continuous one. Local, public power utility companies (like Arm-Energo, Az-Energo or Sak-Energo) normally do not except this kind of short-time peak energy.
- Energy fed back to the MV system is considered to be one of the most costly energies. Separate thyristor rectifier units with all related equipment is necessary to feed back energy from the DC-side to the MV AC-side. The additional equipment needed causes extra investment costs.
- Additionally, each locomotive has to be equipped with energy feed back equipment, which will also increase the investment costs.
- Thyristor rectifiers are due to the more complicated control part, compared with the diode rectifier, more prone to failures. This will reduce the rectifier substation availability. Diode rectifiers are very easy to maintain, e.g. long-term saving due to the smaller work-force required.
- The control angle of diodes of the diode rectifier is $\alpha = 0°$. The ignition angle of the thyristors can be $\alpha = 0°$ to $\alpha = 90°$. For thyristor rectifiers, this will result in a much higher harmonic content transferred to the medium voltage system. The rectifier transformer will have higher extra losses.
- The prices for thyristor rectifier are approximately four to five times higher than the price of traditional diode rectifiers.
- Due to higher harmonic content caused by thyristor rectifiers additional filter equipment may be required, in accordance to the requirements of the local power company (additional costs).
- Additional thyristor rectifiers and filter equipment need additional space in substation buildings and incur higher maintenance costs.

Due to the limited competition, all project components will be higher in price than when using diode rectifiers for which there are more manufacturers available. We will recommend the use of conventional 12-pulse rectifiers. This solution will be applied in all new system, due to its reliability and cost effectiveness.

To meet the specific problems of traction power supply, there are the so-called power blocks, which are equipped with disc diodes cooled on both sides. Their thermal capacity has to be dimensioned for operational load peaks, caused by trains starting at the same time (vs. operations calculation, based on traffic forecasts and demand) and the transient short circuit currents.

The diodes have to be protected against overvoltages and overloads.

1.3.1.3 SCADA and protection system

Supervisory, Control and Data Acquisition Systems (SCADA), Dispatcher Line Communication Systems and Protection Systems are to be found in the Caucasian railways. Due to different reasons, mostly telecommunication failures, these systems are not operational or in use. For rehabilitation or future modernisation, it is first necessary to rebuild them.

In case of modernisation programmes for the line protection and the traction control, we could recommend a system with digital line fault detectors. The system protects the contact line system for DC railways against short circuit current that are not detected by the overcurrent trip of the high-speed circuit breaker. The protection limits are set by a PC for the line section control and protection in a single unit. The types of protection are di/dt - protection, thermal protection and static protection. This unit also has analysing options, such as error memory, fault pattern diagnostics and ongoing-value display, additional automation and communication.

In addition, there are other systems which can and have to be installed:

- Contact wire thermal overload protection,
- Automatic test facility,
- Line tester,
- Feeder panel control,
- Substation control,
- Catenary wire protection,
- Frame fault protection,
- Section feeder control,
- Substations control and
- All together a coupling to remote control.

At the Caucasian railways' power supply substations, the automatic line tester, including the auto-reclosing system, does not work due to the unsafe operation of this equipment and the lack of any communication system (for example line communication to the energy-dispatcher).

1.3.1.4 Earthing

The problem of an earthing system is a serious one. At the moment, taking into consideration the other main problems of the power supply systems in the three Caucasian railways, it is understood that not enough attention has been paid to the earthing problem. An operational earthing system has to be required for future operations, especially for new layout planning. At the moment, they have several systems.

The floating system for track layout planning is recommended as the earthing method for main lines and depots of the Caucasian railways. This method allows to specify requirements for protective provisions against the effects of stray currents, which result from the operation of a DC railway system. It applies to all fixed metallic installations that form part of a railway, and also to any other unrelated metallic components located in any position in the ground, which may carry stray currents resulting from the operation.

The major effects of stray currents can be:

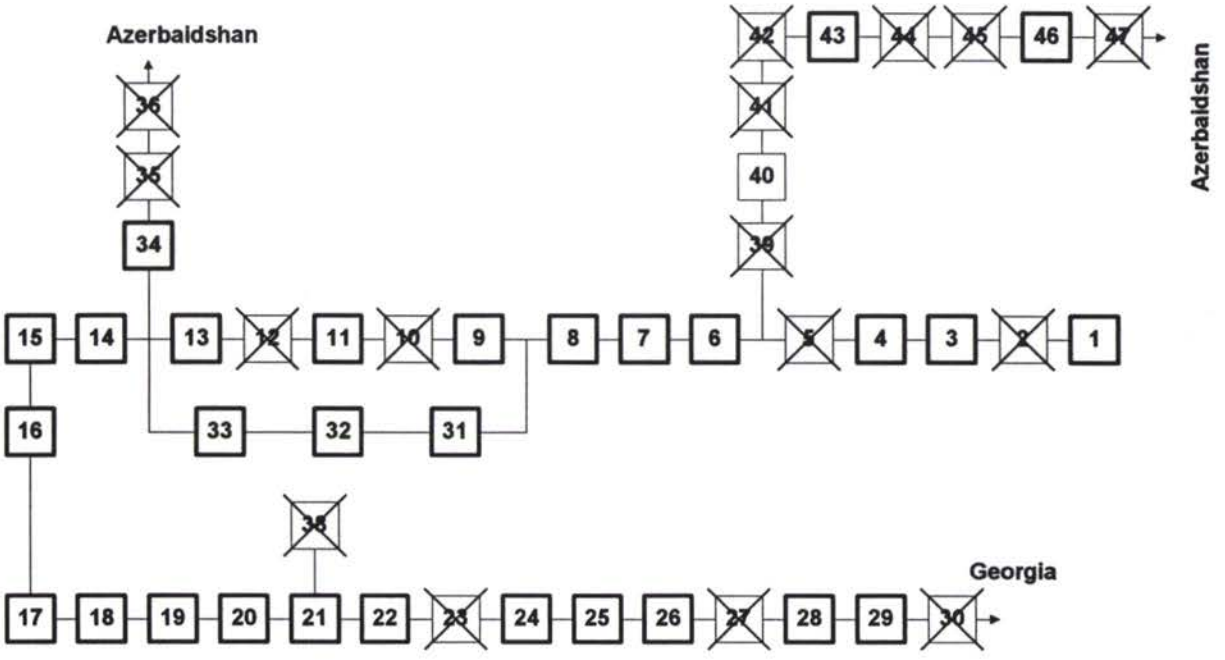
- corrosion and subsequent damage of metallic structure where stray currents leave the metallic structures
- the risk of overheating, arcing and fire and subsequent danger to equipment and persons not necessarily within the railway authority's area of responsibility
- influence on non-immunised signalling and communication systems
- influence on unrelated cathodic protection installations
- influence on unrelated AC and DC power supply

1.3.2 Armenian Railway

1.3.2.1 Inventory of the power supply system network

The main line traction power supply is normally organised with the help of 46 power substations, as follows:

Fig. 1.3-2: System overview of ARM substations



where: 1 Power Supply Substation (working) 2 Power Supply Substation (not working)

where:

No.	Location	No.	Location	No.	Location	No.	Location
1	Vardenis	13	9th km	25	Kirovakan	38	
2	Arek	14		26	Tshagali	39	Megrazor
3	Shorsha	15	Sovietakan	27	Tumanian	40	
4	Zovagyukh	16	Araks	28	Sanain	41	
5	Sevan	17	Karakert	29	Akhtala	42	Frapanovo
6	Razdan	18	Aragatz	30	Ayrum	43	Dilijan
7	Charentsavan	19	Ani	31	Abovian	44	Kuibishev
8	Nurnus	20	Agin	32	Kirza	45	Goshavank
9	Nor - Hadshn	21	Gyumri	33	Yerevan	46	Lusabaz
10	Yegvard	22	Dshadshur	34	Artashat	47	Ijevan
11	Proshyan	23	Kaltakhshi	35	Ararat		
12	Spandarian	24	Spitak	36	Yeraskh		

A detailed list of the main technical data concerning the ARM power supply substations is contained in Annex 1.3-1.

1.3.2.2 Main weak points of the power supply system

After the study of the existing power supply system, including visits to power supply substations and catenary maintenance shops (i.e. Yerevan, Masis), it can be stated that the whole system is still operational, but in very poor condition. Most of the power supply system is older than 20 years. Over the past years (since about 1988), no additional rehabilitation and/or modernisation work has been carried out, except light maintenance, serving and possible repair works. In many cases, maintenance work could only be carried out by looting spare parts from other stations or buying them from the "black market".

A planned and organised spare part supply is not in place anymore. It is easy to understand that as a result of such "maintenance", a lack of additional refurbishment work could be established. This refurbishment work has to be carried out immediately to bring the system back to an equivalent safe working level. Modernisation of the power supply system is not recommended for the moment.

First of all it is necessary to bring back the system into a continuously safe working position. Often, the substations only operate with one working transformer set. At the present stage of a relative small working operations programme, it looks sufficient. On the other hand, with such an operating profile, the substations are not able to react in hazardous or future situations. Under normal conditions the neighbourhood substation will take over the supply, but without any communication to the dispatcher (SCADA, dispatcher line, etc.) this is not realisable. Installed auto-reclosing systems are out of order or not in use, as many other installed systems are, too.

Rules and regulations for maintenance works exist but there were other reasons for a relatively poor level of in-time maintenance and repair.

After the disintegration of the former Soviet Union, many electrical factories are now located outside Armenia. This fact as well as the financial situation of the railways did not allow to maintain the system in time. One reason for working with only one transformer set is the deficit of transformer oil. Another cause of non-continuous work is the not operational protection equipment of substations. One has to consider that the substations were built many years ago, when the traffic volume was higher than now, the protection equipment was then selected in accordance with the old (then higher) requirements (high speed circuit breaker VAB 43/ 6,300A). Now, with smaller traffic and in case of lower traction currents on the lines, the installed protection high speed circuit breaker is unable to handle smaller currents, because of the construction limits and trip with delay! They have to change without any delay for safe operation of the railways.

This short-circuit protection units checks for the occurrence of any fault currents (current-protection) and dangerous touch voltages (voltage protection) in DC substations. But if the fault current or touch voltage exceeds the set overpowered limits, the frame's short-circuit protection trips with delay, with the result that the high speed circuit breaker is damaged (it burns out).

Another maintenance lack is to be found in the outdated rectifier and/or resistor units and battery sets, which could not be maintained, repaired or changed in time. At the moment there is no need for feeding back the energy and for maintaining the resistor units.

Additional spare parts, like cables (4 to 185 mm^2), switches, lamps, signalling lamps, protection relays, current or voltage transformers, measurement equipment and many other electrical parts are not available because of the problems mentioned. The railway electricians only get by thanks to their improvisation talent. For example, they are able to wrap windings for transformers, to rebuild (!) lamps, and carry out some other refurbishment work. This talent is not recognised by the railway administration, and thus, the power supply system looks sufficient, without any "big" problems.

The catenary system is in a poor condition too. The average wears of the contact wires is about 20% to 40%. The catenary system requires not only changing of the contact wires, but also spools, insulators, carrying cable, hangers, feeding cables, breakers, etc.

It has to be said that such a power supply system requires a high level of investments for refurbishment only, and at the moment people even expect a modernisation. It is necessary to restore the system first of all, to bring it back to an equivalent working level, and only as a result of such work it will be possible to think about modernisation.

The main weak points identified have to be rectified without any delay.

Summary of main deficiencies:

1. Transformer oil
2. Battery sets (110 V)
3. High and low voltage cables
4. Communication between substations and the dispatchers
5. SCADA system
6. Transformer (60 to 1,000 kVA)
7. Diodes/ rectifier units
8. Protection equipment
9. Lamps (every kind)
10. Catenary wires
11. Insulators (mostly for 10 kV)
12. Current and voltage transformer set (mostly 35, 10, 6 kV)
13. Measurement equipment
14. Instruments and personal safety equipment
15. Motor drives for breakers (mostly operated by hand)
16. Fuses (25 - 600 A)
17. Spare parts (every kind)

This list is only a short one and can not fully reflect the existing situation.

1.3.3 Azerbaijan State Railways

1.3.3.1 Inventory of the power supply system network

In general one can say that the electric network of the Azerbaijan State Railways is in a better condition than the Armenian one. The whole network is operational and meets the operational requirements at the moment. It also has to be said that the Azerbaijan State Railways in Nakhichevan is still operational, too.

An inventory of selected line traction power supply substations, found in Annex 1.3-2, serves as an example for the technical state.

1.3.3.2 Main weak points of the power supply system

After the study of the existing power supply system and several visits to power supply substations and catenary maintenance shops (e.g. Baku, Baladshary, Duvanni) it can be said that the whole system is operational up to a capacity of about 40 - 50 pairs of trains per day. Most of the power supply system is older than 15 years. About 93 non-railway plants and other facilities are supplied additionally by the railway network.

A planned and organised spare part supply is available but there are also financial problems. The AGZD had made contracts with the Russian Railway spare part supplier organisation, called Sheldorsnab, which is in charge of the former electrical factories and plants for railway supply. The Russian Railways will reconstruct the DC railways into AC operated. Because of this, many (also old) parts of the DC railway power supply are available in addition, at the moment. The AGZD has made agreements with the Russian side to build up the DC power supply substations with here own staff, to get the built-in equipment for their requirements (nearly free of charge). This will have financial consequences for both sides.

Rules and regulations for maintenance works exist. They are the same "old ones" adapted from the former USSR Ministry of Railway Transport (MPS).

After the disintegration of the former Soviet Union, many electrical factories are now located outside Azerbaijan. This and the financial situation of the railway did not allow to maintain the complete system in time.

Reconstruction of power supply substations and catenary workshops is ongoing. Only three substations are working without reserve (this means with only one transformer set). The biggest problems for the power supply system found in the climatic conditions along the coast. Because of the higher wind speeds and the higher humidity and soil, corrosion (especially on catenary supports) and catenary regulation problems prevail. An earthing problem was also identified at this stage.

As a result of the last reconstruction, 10 - 12 substations are working with 12 pulse rectifier units, the others with 6-pulse technology. All substations are equipped with operational high speed circuit breaker.

One catenary inspection train is being run for better maintenance, but it is a very old one with outdated equipment. It seems necessary to invest here and to buy a newer one, in order to inspect and maintain the catenary system in time. The railway plans to reconstruct about 100 km catenary line per year and to exchange the catenary supports continuously.

The built-in SCADA system is not operational at the moment. The bottleneck is to be found in the telecommunications system.

The following traction power substations are only working with one transformer set at the moment:

- Sagiri (No. 17), Transformer type TDN-10.000/110/10, 11,000 kVA,
- Geran (No. 23), Transformer type TFTP-10.000/110/35/10, 10,000 kVA and
- Dyugarlu (No. 29), Transformer type TDG-10.000/110, 10,000 kVA.

The HV input has to be reconstructed at the substation Gadshievo (No. 16).
Taking into account the outdated structure of the transformer sets, the railway has to change about 5 additional transformers over the next two years. High voltage switchgears VAB 43 (4000 A) are to be exchanged in 5 energy sections, per 8 switchgears, per year.

An other lack could found in the 1-phase auxiliary transformers for signalling/telecommunications supply. There will be a need of about 46 transformers (OM - 1.25 kVA, 6/0.23 kV) and 232 (OM - 1.25 kVA, 10/ 0.23 kV).

This OM- transformer need splits into the following sections:

Energy section	Transformers for Signalling (SZB)		Transformers for Telecommunications (HV line)	
Baku	21	OM- 1.25/ 6	31	OM- 1.25/ 10
Baladshary	9	OM- 1.25/ 10	14	OM- 1.25/ 10
Kasi-Magomed	25	OM- 1.25/ 6	14	OM- 1.25/ 10
Gyandsha	-		7	OM- 1.25/ 10
Nakhichevan	-		55	OM- 1.25/ 10

Summary of main deficiencies:

1. Battery sets (110 V)
2. High and low voltage cables
3. SCADA system
4. Transformer
5. Diodes/ rectifier units for 12-pulse equipment changing
6. Protection equipment VAB 43
7. Catenary wires
8. Supports
9. Voltage transformer
10. Electric motor drives for circuit breaker
11. Measurement equipment and tools
12. Instruments, tools and personal safety equipment
13. Motor drive for breakers
14. Additional spare parts
15. Catenary inspection vehicle

About 15 traction power substations are of the open type one. They are to be reconstructed. The staff common rooms also have to be refurbished.

1.3.4 Georgian Railways

1.3.4.1 Inventory of the power supply system network

In general it can be said that the electric network of the Georgian Railways is also in a better condition than the Armenian one. The network is increasingly operational and meets the operational requirements at the moment, except for the non-continuous power supply from the national power supply company.

All difficulties of the Sak-Energo power supply system, concerning the normal and steady supply of electricity, especially during the winter months, have a direct influence on the normal function of the railway traction power supply. Power cuts, non-continuous and non-powerful supplies are still regular. A priority railway supply provided by Sak-Energo is not yet available. On the other hand, the state police has come to the traction power supply substations to investigate the high power consumption of the railway! Such energy supply problems are to be found in the whole network, especially in the Batumi region.

The power consumption has dropped over the past years, because of the loss of operational requirements. The traction power supply network meets the operational requirement of about 15 - 20 pairs of trains per day at the moment. The former requirement was about 40 train pairs per day in the Azerbaijani direction and about 16 train pairs per day into the Armenian direction.

Additional problems will arise because of the outdated equipment. The spare part supply is also a financial problem in Georgia.

List of overheadline catenary systems of the Georgian Railways, which require modernisation (changing of contact wire MF- 100). The average height of the OCS system is about 8.24 mm. There are 35 line sections with a wear of more than 30%.

1.3.4.2 Main weak points of the power supply system

After the study of the existing power supply system and several visits to power supply substations and catenary maintenance shops (i.e. Tbilisi-Uslovaya), it can be said that the whole system is operational up to a capacity of about 15 - 20 pairs of trains per day. Most of the power supply system is older than 20 years.

A planned and organised spare part supply is not yet full available, also financial problems are existing. The GRZD had also made contracts with the Russian Railway spare part supplier organisation, so called Sheldorsnab, who organise the former electrical factories and plants for railway supply.

Rules and regulations for maintenance works exist, they are the same "old ones" adapted from the former USSR Ministry of Soviet Railways (MPS).

After the disintegration of the former Soviet Union, many electrical factories are now located outside Georgia. This and the financial situation of the railway did not allow to maintain the complete system in time.

Reconstruction of power supply substations and catenary workshops is ongoing. The biggest problems for the power supply system is to be found in the non-continuous supply by Sak-Energo and the climatic conditions. Because of the higher humidity and soil, corrosion (especially on catenary supports) and catenary regulation problems prevail. An earthing problem could also be identified at this stage.

Another maintenance lack is to be found in the outdated rectifier / resistor units and battery sets, witch could not be maintained, repaired or changed in time.
At the moment, there is no need for feeding back energy and thus for maintaining the resistor units.

Additional spare parts, like cables, switches, protection relays, current or voltage transformers, measurement equipment and many other electrical parts are not available because of the problems mentioned above.

The catenary system is in a poor condition, too. The average wear of the contact wires is about 20% to 40%. The catenary system requires not only changing of the contact wires, but also of supports, insulators, carrying cable, hangers, feeding cables, breakers, etc.

Short summary of main deficiencies:

1. Transformer oil
2. Battery sets (110 V)
3. High and low voltage cables
4. Communication between substations and the dispatchers
5. SCADA system
6. Transformer (60 to 1,000 kVA)
7. Diodes/ rectifier units
8. Protection equipment
9. Catenary wires
10. Insulators (mostly for 10 kV)
11. Current and voltage transformer sets (mostly 35, 10, 6 kV)
12. Measurement equipment
13. Instruments and personal safety equipment
14. Motor drive for breakers (mostly operated by hand).

1.4 Freight and passenger stations

In line with the objective of the project, the analysis has been concentrated on the facts and figures required for the preparation of joint ventures. The analysis deals with the main stations classified in the categories "Extra, 1 and 2". The selection of the stations was made in co-operation with representatives of the three Caucasian railways. The terminals for combined transport have been analysed in more detail (see section 1.5).

1.4.1 Armenian Railway

According to the analysis provided by ARM, there are 69 stations on the railway's 798 km network. Three of them are presently out of operation (Akhurian, Goyavan and Ijevan). Due to land slippage and rock slides, the section from Dilijan to Ijevan with the intermediate station Goyavan has been closed for some years. The border to Turkey with the border station Akhurian is also closed for the time being. The only working border crossing is with Georgia (Ayrum). The section between Arabkir and Yerevan cannot be used for scheduled trains due to the limited loading gauge.

Some stations are referred to in Russian as "Razjezd". They are for passenger boarding and alighting only; no overtaking, crossing or loading and unloading of freight wagons takes place.

Twenty stations have been analysed in more detail including the border stations Ayrum (border station to Georgia) and Akhurian (border station to Turkey) and the marshalling yard at Masis near Yerevan. The detailed analysis including tracks, facilities for freight loading and unloading, condition of tracks and structures, volume of passenger and freight traffic is presented in Annex 1.4-1.

Taking into account the current passenger and freight traffic as well as the projected traffic levels, all stations are generally characterised by overdesign and inefficiency.

The condition of most stations is poor due to age and maintenance backlog attributed to the general problems of the Armenian economy. The operation of trains is not hindered by the limitation of facilities, but rather by their condition.

The number and length of the tracks more than satisfy present and future requirements. The condition of the permanent way can be assessed as poor to satisfactory.

Due to the fact that, for some years, only a small number of freight trains has been running and some trains are formed at the loading yards, for instance Ararat, Karmir Blur, Yerevan, Charentsavan, Razdan and Sotk (gold mine; currently no mining), the capacity of Masis marshalling yard has only been used to a very limited extent.

Therefore, not all of the existing 20 operational tracks are needed. Although most of the sorting lines are in poor condition and allow only low speed, the present requirements can be met. A decision on the number of sorting lines and secondary tracks to be renewed or repaired should be made depending on the future requirements.
The number of the existing loading and unloading facilities and their distribution within the network is satisfactory. In addition, there are several branch lines or private sidings connecting major factories to the railway. However, the present condition of the facilities at the main freight stations (Vanadzor, Gyumri, Masis, Ararat, Karmir Blur, Yerevan, Charentsavan and Razdan) must be considered as ranging from poor to satisfactory.

The main passenger stations Yerevan, Vanadzor and Gyumri are in satisfactory condition. The existing passenger facilities are adequate for smooth operation of the train service. There are sufficient ticket offices and platforms. The number and length of the platforms more than satisfy the requirements. Due to the lack of demand, ticket reservation offices are not open at the present time. However, it will be necessary to perform maintenance on all passenger stations (station buildings, platforms, ticket offices). For instance, the station building at Yerevan is in urgent need of repairs to the roof. The station buildings at Sanain, Artik, Dalarik, Armavir, Etshmiadzin, Masis, Ararat, Karmir Blur, Abovian, Charentsavan and Razdan are in need of general repairs. The station buildings at Artshut, Spitak, Nalband, Kaltakhtshi, Dshadshur and Maisyan were destroyed by the latest earthquake.

1.4.2 Azerbaijan State Railways

There are 175 stations including the so-called "Razjezd" (see section 1.4.1) on the 2,123 km network. The analysis has been concentrated on the main line Baku - Beyuk-Kyassik - (Georgia) and the line (Russia) - Yalama - Baku - Goradis - (Dshulfa). The section from Goradis to Dshulfa has been closed for some years; entire portions are destroyed . Due to the situation in Chechenya, there are only a very small number of trains to Russia. Furthermore, the stations Salyany and Astara situated on the line Ali-Bairamly - Astara have been included in this analysis.

In agreement with AGZD management, 18 stations have been analysed in more detail including the border stations Beyuk-Kyassik (border station to Georgia) and Yalama (border station to Russia) and the marshalling yards at Shirvan, formerly the most important marshalling yard in the Caucasian region, and Baladshary. The detailed analysis including tracks, facilities for freight loading and unloading, condition of tracks and structures, volume of freight traffic is presented in Annex 1.4-2.

The condition of many stations is poor due to age and maintenance backlog. Since 1990, maintenance expenditures have been drastically reduced due to the lack of funds. The operation of trains is not hindered by the extent of facilities, but rather by their poor condition. Taking into account the current passenger and freight traffic as

well as the projected traffic levels, all stations of AGZD are also generally characterised by overdesign and lack of efficiency.

The permanent way is generally in poor condition, and average commercial speeds on the main lines is down to 36 km/h. The track condition of some important stations, for instance Kishli-Baku, Baladshary, Baku-Pass., Kasi-Magomed, Yevlakh, Beyuk-Kyassik, Ali-Bairamly, Imishli and Astara, is also poor and hampers train operations and operating safety. The number and length of the tracks more than satisfy present and future requirements. It can be assumed that Azerbaijan will probably never recover transport volumes as high as those during the Soviet era (compare chapter 3). Therefore, the number of tracks for operational purposes can be reduced especially at the marshalling yards. Depending on future requirements, a decision needs to be made on the number of sorting lines and secondary tracks to be renewed or repaired.

The number of the existing loading and unloading facilities and their distribution within the network can be assessed as satisfactory. In addition, there are several branch lines or private sidings connecting the major factories to the railways. According to the number of forwarded wagons in 1995, the main freight stations are Baku-Tov., Karadag, Kyrdamir, Mingetshaur Main Station, Gyandsha, Shamkor, Dollyar, Kiliasi, Sumgait, Gyuzdek and Vatagi. Taking into account the high level of traffic up to the beginning of the 1990's, it can be assumed that the number of facilities for freight loading and unloading meets the requirements. The present condition can be considered as being poor to satisfactory.

Most of the passenger stations, including Baku, Gyandsha, Yalama require repairs to the roofs and platforms. At the other stations the existing facilities for passenger traffic do not hinder train operations and passenger service.

1.4.3 Georgian Railways

Georgia's network (1,801 km broad gauge and 38 km narrow gauge) is characterised by a rapidly eroding asset base. After the break down of the Soviet Union, the Black Sea ports at Batumi and Poti as well as their rail connections have gained considerable importance. There are 154 stations on the railway network including 21 stations in Abkhasia. Thirteen stations were selected by the Consultant and the railway representatives concerned for detailed analysis including the two large marshalling yards (Samtredia and Tbilisi-Sort.) and the border stations at Gardabani (border to Azerbaijan) and Sadakhlo (border to Armenia). The average distance between operational points is 9.8 km. The detailed analysis including tracks, facilities for freight loading and unloading, condition of tracks and structures, volume of passenger and freight traffic is presented in Annex 1.4-3.

Rail infrastructure is generally characterised by overdesign and lack of efficiency. The condition is in most cases poor due to the age, maintenance backlog, obsolete

technology and damage through civil strife. Station lay-outs are characterised by a large number of parallel lines which can, however, only be passed at low speeds.

Taking into account the current passenger and freight traffic as well as the projected traffic levels, operations are not hindered by the extent of facilities, but rather by their condition.

The number and length of the tracks more than satisfy the requirements. The condition of the permanent way of most stations analysed can be assessed as poor to satisfactory. According to the information provided by GRZD, the tracks of the port stations Poti and Batumi are very poor to poor. The tracks at Khashuri, Tbilisi-Usl. and Gardabani are in satisfactory to good condition.

Most of the freight trains are presently formed at the loading yards (mainly at Poti and Batumi), the two marshalling yards being presently only partially used. Therefore, not all of the existing tracks for operational purposes (16 at Samtredia, 23 at Tbilisi-Sort) are needed. Although most of the sorting lines are in poor condition and allow only low speed, the present requirements can be met. Depending on the future requirements, a decision should be taken on the number of sorting lines and secondary tracks to be renewed or repaired.

At present, significant amounts of cargo are loaded only at the ports of Poti and Batumi. There are no capacity constraints at the loading yards. On the contrary, the load capacity cannot be fully used because the railway is neither in a position to supply a sufficient number of wagons in good time nor to form the outgoing trains accordingly. The present condition of the facilities for freight loading and unloading must be considered as poor to satisfactory.

The main passenger stations Samtredia, Zestafoni, Khashuri, Gori and Tbilisi are in good to satisfactory condition; the existing facilities for passenger traffic do not hamper passenger service. There are sufficient ticket offices and platforms. The number and length of the platforms more than satisfy the requirements. Due to the lack of demand, ticket reservation offices are not open at the present time. However, it will be necessary to perform maintenance on all passenger stations. The rehabilitation of the Tbilisi-Pass. station building and the platforms started in 1987, but has not yet been finished. At Batumi, new buildings and facilities have been under construction since 1996.

1.5 Container Terminals

Based on existing reports, together with additional facts and figures provided by the railways or obtained in field surveys, the following analysis and the overall assessment have been prepared. Apart from Gyandsha, all the container terminals mentioned below were visited.

1.5.1 Analysis

The railways of the Former Soviet Union operated approximately 240 container terminals. However, only ten of them were located in the Caucasian region (Armenia, Azerbaijan and Georgia):

Armenia
- Abovian (near Yerevan)
- Gyumri
- Karmir Blur (Yerevan)
- Vanadzor

Azerbaijan
- Kishli-Baku
- Gyandsha
- Khirdalan (near Baku)

Georgia
- Gori
- Samtredia
- Tbilisi-Tovarnaya (freight station)

Taking into account the existing size of the railway system, the network of container terminals in these countries is sufficient to meet the demand (including the facilities in the seaports). There is an adequate number of container terminals within the countries and the catchment area of each terminal is sufficiently widespread as to ensure complete coverage of the territory by the multi-modal system. Existing terminals are located adjacent to each of the capitals of the countries concerned, which themselves represent the most heavily industrialised regions.

On the other hand, the physical condition of the container terminals and the poor equipment are weak points which must be mentioned in connection with the multi-modal transport system in these countries:

The terminals at

- Abovian, Gyumri and Vanadzor (Armenia)
- Khirdalan (Azerbaijan)
- Gori and Samtredia (Georgia)

have not been in use for many years (at Gyumri and Vanadzor a very small number of containers were handled by truck crane in 1996). The terminal at Khirdalan has been out of operation since August 1995.

Only four railway container terminals are in working order

- Karmir Blur (Armenia)
- Kishli-Baku and Gyandsha (Azerbaijan)
- Tbilisi-Tovarnaya (Georgia).

The small terminals at Gyandsha and Gori are poorly equipped with cranes of 10 to 12 tonnes lifting capacity only. Two cranes have to work synchronically to lift together one 20' container.

Taking into account the limitation mentioned, there are only three container terminals that are able to handle 20' containers; one in each country. At Kishli-Baku, there is only one 20 t Valmet mobile container crane and in addition various other cranes with a lifting capacity up to 5 tonnes.

40' containers can only be handled at the sea ports (Baku, Poti and Batumi). At Karmir Blur 40' containers are lifted by railway revolving crane. 40' containers are handled at Baku sea port based on an agreement concluded between AGZD and the Port Authority.

At present, about two third of the 20 tonnes gantry cranes are not in working order (seven out of ten). The main reason is a lack of spare parts; many having been cannibalised. On the other hand, there has not been any necessity to maintain them because of considerably decreased volume of traffic.

The maximal possible train length under the crane is 20 container carrying wagons; on most terminals only 10 to 12 wagons. Therefore, the trains must be split up and shunting movements are necessary.

The present condition of the tracks is mostly very poor; some tracks should be renewed.

Most of the storage areas and the connecting roads to the terminals are in a very poor condition (not paved or damaged with large potholes). Damaged pavements (concrete, asphalt, concrete panels or simply compressed earth with gravel) obstruct

the use of reach stackers. Although the possibilities for future development are restricted at some terminals, e. g. Tbilisi-Tovarnaya (freight station), it can be assumed that the storage areas meet the future demand.

There are only one or two tracks under the crane and normally only one loading lane for the container trucks beside the storage area/craneway. In most cases, the location in the railway network is acceptable. Except for Khirdalan; the distance to trunk roads and the main destinations is short. Communication and data processing technology is not available; there is only a telephone connection at some terminals.

Some terminals are not fenced. The fences of the other terminals are in need of repair to prevent the entrance of non-authorised persons and larceny of goods. The illumination of most of the terminals is not possible due to missing or damaged light installations.

The main figures are compiled in Annexes 1.5-1 to 1.5-10 (Analysis of existing terminals for combined traffic). Furthermore, the main deficiencies are described and an overall assessment is made.

1.5.2 Conclusions and recommendations

In summary, it must be stated that only the terminals at Karmir Blur, Kishli-Baku and Tbilisi meet the present demand to some extent. Principally these terminals are able to handle 20' containers.

The proposal included in the TRACECA Port Project to establish a new container terminal at Baku Sea Port where also 40' containers can be handled is supported by the Consultant.

The envisaged inclusion of the terminal at Samtredia in the Trans-Caucasian-Logistic-Express would require the rehabilitation of the 20 t gantry crane or the use of a mobile container crane (taking into account the condition of the storage area/pavement). At Gyandsha, where this train has a stop from April 1997, 20' containers can only be handled by working two cranes together synchronically. The decision on the installation of a 20 t crane depends on future traffic development.

The present condition of the terminal at Vanadzor permits the handling of a small number of containers only. The decision on rehabilitation of the terminals at Vanadzor, Gyumri and Gori depends on the projected traffic level.

Based on the present condition and taking into account the other container terminals existing in the region, it is considered unwise to make any proposal to complete and/or to rehabilitate the terminals at Abovian and Khirdalan.

1.6 Rolling Stock

The Caucasian railways should now, after all the general political changes in the region, use and maintain their rolling stock in accordance with the own economic targets, as other comparable technical and constructional equipment too. Therefore, all kinds of rolling stock were here included as topics of studies.
For starting the investigations first a condensed overview about the rolling stock in the region and its technical condition as well as about the capabilities for its regular maintenance and their conditions had to be worked out. Doing that there were partly used the given results of proceeding projects and activities had been co-ordinated with the parallel TRACECA project "Rolling stock maintenance". Nevertheless in order to create a general overview it was necessary to add some additional investigations concerning the rolling stock of the ARM.

1.6.1 Technical condition of the rolling stock

1.6.1.1 Parameters of locomotives

The three Caucasian railways are performing the traction of passenger and freight trains by using the electric line locomotives VL-8, VL-10 and VL-11, all working with DC of 3kV. All these line locomotives consist of 2 short-coupled sections each with 4 axles.
The designed speed is 100 km per hour. The designed solutions of these locomotives are characterised by a high age of the systems for controlling as well as by the lack of modern components and elements. A short reflection about the main technical data of the concerned locomotives is given in Annex 1.6-1. The installed power per tons weight is comparable low as shown in the following overview.

Tab. 1.6-1: Specific locomotive power-weight

	locomotive type	power per tons weight
1	**VL-8**	22.83 kW
2	**VL-10**	28.26 kW
3	**VL-11**	29.78 kW

These locomotives are able to develop tracting power up to 38 - 39 tons and can haul heavy trains up to 3,000 tons. For tracting lighter trains, i.e. using the locomotives in the range of lower power, as usually today in Western Europe, these locomotives can be work only very inefficiently. Modern electric locomotives of Western European railways with comparable power can develop tracting power only up to 21 tons, allowing trains weight up to about 2000 tons. These locomotives posses a weight of about 120 tons coming to an installed power of about 40 kW per tons weight. These locomotives are better adapted to the demand of tracting lighter freight trains. As an example it is only refereed here to the locomotive BR 156 of the Deutsche Bahn AG (German Railways). The locomotive posses an installed power

of 5.880 kW and a weight of 120 tons coming to 49 kW per tons weight. A second main point of difference in technical parameters is the higher springless (unsuspensioned) load of locomotive axles which is here stated with 5 tons. For this parameter the limit in Europe is determined with 2.5 tons. The higher unsuspensioned load of locomotive axles here in the region causes more influence to the tracks and will lead at least to quicker track damaging.

1.6.1.2 Locomotive stock

In general the three Caucasian railways posses 547.5 electric line locomotives[1] at the end of 1996 as follows in the next table.

Tab. 1.6-2: Existing locomotive stock

no.	locomotive types	VL-8	VL-10	VL-11	subtotal
1	**ARM**	47	44	-	91
2	**AGZD**	183	-	43	226
3	**GRZD**	85	103	42.5	230.5
	total	**315**	**147**	**85.5**	**547.5**

The mentioned line locomotives are all overaged except the younger VL-11. 92% of the VL-8 type is older than 30 years, 58% of the VL-10 type is older than 21 up to 29 years and the VL-11 type is almost younger than 16 years. The next table gives a short overview of the age split of these three locomotive types.

Tab. 1.6-3: Locomotive age

Types	age (years)	locomotives	%
VL-8	30 and more	291	92
	26 - 29	24	8
VL-10	21 - 29	85	58
	13 - 20	62	42
VL-11	11 - 16	12	14
	1 - 10	73.5	86
total		**547.5**	

The complete age structure of the locomotives is given in Annex 1.6-2.

Coming from the age structure a main drawback is recognisable above due to the timely irregular procurement of new locomotives and their age. 400 locomotives (73.1%) are 21 years and older; among these 36 (6.6%) are 35 years and older.

[1] One electric line locomotive consists of two tracting sections.

1.6.1.3 Wagon parameters

The wagon stock includes only wagons with bogies, each bogie in majority with 2 axles. The weight is about 22 tons and the load about 65 - 70 tons. Furthermore there exists a small amount of special wagons with 8 axles, mainly tanks. Their weight is 44 tons and the load is 105 tons.

All wagons are designed corresponding to the technical standards of the former Soviet State Railway and they can operate within the whole railway net of all CIS railways. The wagons are equipped with automatic central buffer couplings. The bogies are equipped with a one-level spring system. Their speed is limited to 90 km/h with the exeption of the refrigerators. The bogies of the latter one have a two-level suspension system and therefore their speed limitation is 120 km/h. The average age of the wagons is more than 20 years with the exception of some special wagons for bulk freight and container transport. Wooden material is extensively used as constructional material for wagon details like doors, walls, floors and roofs. A small amount of bogies is still equipped with sliding axle boxes.

1.6.1.4 Wagon stock

The stock of wagons of the three Caucasian railways amounts to 55,816 wagons. The existing stock in different types is given in Annex 1.6-3. In the following table the wagon stock of the different railways is shown:

Tab. 1.6-4: Wagon stock

Railways	ARM	AGZD	GRZD	total
wagons	5,236	29,118	21,095	**55,449**

1.6.1.5 Coaches parameters

The coaches stock of the Caucasian railways contents only cars with bogies with 4 axles each and all with automatic central buffer couplings. In the opposite to the wagons the coaches are additionally equipped with side buffers in order to stabilise laterally the longitudinal movements within the passenger trains during operation. The speed limitation is 120 km/h. The coaches types are given in the following overview as a table.

Tab. 1.6-5: Types of coaches

ZMO	coach with middle corridor (open type), seats: 81/54
ZMK	coach with compartments (9), seats: 36
ZMKR	coach with compartments (9) and radio comp., seats: 36
ZMR	restaurant car
SW	sleeping car (weak car) with comp.(9), seats: 18
MIKST	coach with comp. (9), only a half of weak seats
ZMB	luggage car

The coaches are designed in the majority corresponding to the valid maximum clearance of the CIS standard. Only the SW coaches are constructed exceptionally corresponding to the RIC standard. The ZMK, ZMKR, ZMR and SW coaches were constructed in the GDR whereas the other coaches were constructed in Russia. Comparing the coaches with Western standards the ZMO, ZMK and ZMKR cars can be considered as couchettes. Only the SW is to count as a sleeping car. The bogies of the coaches have a two-level suspension system.

1.6.1.6 Coaches stock

The overall stock of the three Caucasian railways amounts to 2,173 coaches. A more detailed overview is given in the following table:

Tab. 1.6-6: Coach stock

coaches	ARM	AGZD	GRZD	total	total(%)
ZMO	119	416	529	**945**	**48.8**
ZMK	66	287	404	**691**	**35.7**
ZMKR	10	43	33	**76**	**3.9**
ZMR	14	30	35	**65**	**3.4**
SW	19	34	46	**80**	**4.1**
ZMB	8	39	33	**72**	**3.7**
MIKST	0	4	5	**9**	**0.5**
total	**236**	**853**	**1,085**	**1,938**	**100**

The given figures base on the assumption that 53 ARM coaches now allocated in Abkhasia should be considered as unusable for operation in future.
The complete structure of the overall coaches stock combined with the age structure can be found under Annexes 1.6-4 (ARM), 1.6-5 (AGZD) and 1.6-6 (GRZD).

The main categories ZMO, ZMK and ZMKR (for carrying passengers) amount to 87,8%. This is a good part of the stock. Only less than 15% of the whole coach stock are younger than 10 years. Even more important is the fact that more than 30% of the main coach categories ZMO, ZMK and ZMKR are older than 25 years. The summary of these facts is given in the table below.

Tab. 1.6-7: Age structure of coaches

age	>30/30	25/29	20/24	15/19	10/14	5/9
ARM	4%	27%	29%	20%	6%	14%
AGZD	6%	12%	16%	15%	38%	13%
GRZD	12%	13%	28%	19%	18%	10%

The volume of restaurant coaches (ZMR) is limiting the passenger train formation in order to compose comfortable train sets. In former times a train here was formed by 20 coaches. A possible composition of 1 Post-car, 1 ZMR, 1 ZMKR, 7 ZMK and 10 ZMO could carry then 828 passengers. This volume is rather low. In Western Europe such volumes of passengers are carried by trains of 12 coaches. But we should consider the long distances with more than 1,000 km for the trains were used in the past.

1.6.1.7 Parameters of Electric Multiple Units (EMU)

The mainly used EMU type QP-2 was designed before 1962 and delivered to the railways in the former Soviet Union starting from 1962. The QP-2 is designed for a speed of 130 km per hour. The train set is formatted by different car compositions depending on the railways need. The composition includes normally 2 head cars (G) and different motor cars (M) (a half amount of the unit car numbers) and so called passenger cars (P). Only the latter bear a toilette. The composition variety for the involved railways is to be found under the table below. In addition to QP-2 there are 2 trains CP-3 used by the AGZD, designed in 1951 and delivered in 1958.

Tab. 1.6-8: EMU compositions

Railway	train formula	seats	power (kW)	weight (t)	lenght (m)
ARM (QP-2)	2 G+3M+1P	614	1,600	284	120
AGZD (QP-2)	2 G+5M+3P	1,050	4,000	306	201
AGZD (CP-3)	P+M+P	380	782	139	60
GRZD (QP-2)	2 G+5M+3P	1,050	4,000	306	201

The acceleration is noted with 0.6 m per sec^2 (QP-2) and 0.45 m per sec^2 (CP-3).

1.6.1.8 EMU stock

The stock of train sets amounts to 119 units of which 100 are under operation. The table below shows the inventory volume of units in the Caucasian region.

Tab. 1.6-9: EMU stock

EMU sets	AGZD (QP-2)	AGZD (CP-3)	GRZD (QP-2)	ARM (QP-2)	Total
inventory	74	2	32	11	**119**
under operation	66	2	28	4	**100**

The EMU are used for both the domestic short-distance traffic in the area of the capitals (or of major regional centres) and for the domestic long-distance traffic between regional centres as well as between the capitals and the regional centres. As this kind of rolling stock for passenger traffic is mainly used by workers around the centres and the rural inhabitants along the lines the internal comfort of all cars is very low.

1.6.2 Maintenance of the rolling stock

1.6.2.1 Locomotive maintenance system

The maintenance system of the Caucasian railways includes inspections (TO-1, TO-2, TO-3), overhauls (TR-1, TR-2, TR-3) and main repairs (KR-1, KR-2). The periods of these different repair levels depend on the running kilometres. The different maintenance types are shown in the following table.

Tab. 1.6-10: Locomotive maintenance scheme

abbr.	running kilometres	after approximate time of operation	type
TO-1		daily	daily service
TO-2		weekly	weekly inspection
TO-3	11,000 km	monthly	monthly inspection
TR-1	22,000 km	after 2 months	first overhaul
TR-2	150,000 km	after 1.5 years	second overhaul
TR-3	300,000 km	after 3 years	overhaul with lifting
KR-1	600,000 km	after 6 years	first main repair in plants
KR-2	1,200,000 km	after 12 years	general repair in plants

Resulting from the maintenance scheme of the existing locomotive stock the regularly needed volume of the different maintenance types can be found. At least 3,229 TO-3, 2,555 TR-1, 183 TR-2, 91 TR-3, 46 KR-1 and 46 KR-2 should be done per annum as shown in the following table.

Table 1.6-11: Volume of yearly locomotive maintenance

type	Total	TO-3	TR-1	TR-2	TR-3	KR-1	KR-2
VL-8	315	1,864	1,470	105	53	26	26
VL-10	147	870	686	49	25	12	12
VL-11	85.5	506	399	29	14	7	7
total	**547.5**	**3,239**	**2,555**	**183**	**91**	**46**	**46**

1.6.2.2 Performances in locomotive maintenance

For carrying out the maintenance of the locomotives the railways in the region posses 11 locomotive depots and 2 repair factories namely the **Tbilisi Electro-locomotive Construction Plant** (TECF) and the **Tbilisi Electro-Wagon Repair Plant** (TEWRS) as shown in the table below.

Tab. 1.6-12: Locomotive repair plants

locomotive plants	repair tracks for locomotives		remarks	Overview given in Annex
	number	repair places		
ARM				
Depot Yerevan	2	6	electrolocomot. (el)	**1.6-7**
Depot Gyumri	3	6	el	**1.6-8**
AGZD				
Depot Baladshary	9/3	12/3	el, dl (sh.)	**1.6-9**
Depot Beyuk-Shtshor	2	6	el	**1.6-10**
Depot Gyandsha	3/3	3/3	el, dl	**1.6-11**
Depot Imishli	3	3	line diesellocomot.	**1.6-12**
Depot Dshulfa	3	3	diesel-locomot. (dl)	**1.6-13**
GRZD				
Depot Tbilisi-Pass.	2	3	el, dl (sh.)	**1.6-14**
Depot Tbilisi-Sortir.	6	11	el	**1.6-15**
Depot Khashuri	4	6	el, dl	**1.6-16**
Depot Samtredia	6	12	el, dl (sh.)	**1.6-17**
TECF	3	10	constructing electric locomot.	**1.6-18**
TEWRS	-	-	EMU repair	see chapter EMU

1.6.2.3 Wagon maintenance system

The maintenance system for wagons includes inspections (TO, OR, TR), overhauls (DR) and main repairs (KR). For special wagons with unloading or other special equipment the periodic inspection (TR) is again divided in TR-1 and TR-2. The TR-2, DR and KR maintenance services are carried out at regular intervals. The maintenance types are shown in the table below.

Tab. 1.6-13: Wagon maintenance scheme

TO	daily inspection in trains
OR	daily inspection and accidental repair outcoupled from trains
TR, TR-1	heavy damages, repair in depots
TR-2	after 3 month, regularly inspection
DR	after 2 years overhaul in depots
KR	main repair after 10 or 12 years in plants

Resulting from the maintenance scheme of the existing wagon stock the regularly needed volume of the different maintenance types can be found. At least 40,856 TR-2, 50,708 DR and 4,741 KR should be done per annum. The particular amounts for the different wagon types are shown in the following table.

Tab. 1.6-14: Volume of wagon maintenance

no.	wagons	Total	TR-2	DR	KR
1	**covered, open, flats**	35,417	0	14,757	2,951
2	**tanks**	7,238	21,714	6,514	724
3	**refrigerators**	2,848	8,544	2,611	237
4	**others**	9,946	10,598	9,117	829
	total	**55,449**	**40,856**	**32,999**	**4,741**

1.6.2.4 Performances in wagon maintenance

There exist 12 wagon depots for repairs, inspections and overhauls of wagons (TO to DR), 6 of them at the AGZD, 4 of them at the GRZD and 2 at the ARM. Furthermore in the region there exists the **Baku Wagon Repair Plant** (BWRS) specialised for main repairs of tanks (KR). The **Tbilisi Electro-Wagon Repair Plant** (TEWRS) is actually carrying out main overhauls of wagons. The following table shows the wagon repair plants of the Caucasus region.

Tab. 1.6-15: Wagon repair plants

wagon plants	repair tracks for wagons		remarks	Overview given in Annex
	number	repair places		
ARM				
Depot Yerevan	2	10	TR, DR, (+coaches)	**1.6-19**
Depot Gyumri	2	6	TR, DR	**1.6-20**
AGZD				
Depot Baladshary	2	16	TR, DR	**1.6-21**
Depot Kishli	-	-	Containers	
Depot Gyandsha	4	16	TR, DR	**1.6-22**
Depot Kasi-Magomed	2	8	TR, DR	**1.6-23**
Depot Aliat	4	5	DR of refriges KR of wagons	**1.6-24**
BWRS	5	15	KR of tanks	**1.6-25**
Depot Shirvan	2	8		**1.6-26**
GRZD				
Depot Tbilisi-Grus.	2	6	TR, DR	**1.6-27**
Depot Khashuri	3	12	TR, DR	**1.6-28**
Depot Samtredia	3	9	TR, DR	**1.6-29**
Depot Batumi	2	5	TR, DR	**1.6-30**
TEWRS	1	6	KR	see chapter EMU

The performances of wagon repair services for the first 5 months of 1996 are shown in the summary in the next table.

Tab. 1.6-16: Repaired wagons

wagons	TR	DR	KR
01 - 05 /1996	1,969	1,245	208

1.6.2.5 Coach maintenance system

The maintenance system for coaches includes inspections (TO, OR, TR-1, TR-2), overhauls (DR) and main repairs (KR-1 and KR-2). The TR-2, DR, KR-1 and KR-2 maintenance services are carried out at regular intervals. The following table shows the scheme for coach maintenance.

Tab. 1.6-17: Coach maintenance scheme

TO	daily inspection in trains
OR	daily inspection and accidental repair outcoupled from trains
TR-1	heavy damages, repair in depots
TR-2	after 3 month, regularly inspection
DR	yearly overhaul after 1 year in depots
KR-1	main repair after 6 years in plants
KR-2	capital repair after 12 years in plants

Resulting from the maintenance scheme of the existing coaches stock the regularly needed volume of the different maintenance types can be found. At least 6,632 TR-2, 1,787 DR, 179 KR-1 and 179 KR-2 of the main categories should be done per annum. A summary of the particular amounts for the different coach types is shown in the following table.

Tab. 1.6-18: Volume of yearly coach maintenance

ZMO	1,046	3,138	872	87	87
ZMK+ZMKR	843	2,529	703	70	70
ZMR	76	228	63	6	6
SW	99	297	83	8	8
ZMB	80	240	67	7	7
total	**2,144**	**6,432**	**1,787**	**179**	**179**

1.6.2.6 Performances in coach maintenance

There exist three coaches depots for the repair of coaches (TO to DR), one of them at each railway. Furthermore there exists only the **Tbilissi Electro- Wagon Repair Plant** (TEWRS) in the region specialised for repairing EMU (KR-1 and KR-2). The following table shows the coach repair plants of the Caucasus region.

Tab. 1.6-19: Coach repair plants

coach plants	repair tracks for coaches		repair type	overview given in Annex
	number	repair places		
ARM				
Depot Yerevan	2	2	DR	**1.6-31**
AGZD				
Depot Baku-Pass.	2	3	DR	**1.6-32**
GRZD				
Depot Tbilisi-Pass.	2	4	DR	**1.6-33**
TEWRS	1	6	KR	see chapter EMU

Actually there were carried out only TR-2 and DR in the passenger depots of AGZD for ensuring the limited passenger train service on the relation Baku - Tbilisi.

1.6.2.7 EMU maintenance system and performances

The EMU maintenance scheme is to be found under the following table.

Tab. 1.6-20: EMU maintenance scheme

TO-2	2-daily inspection
TO-3	5-daily inspection
TR-1	50-days inspection
TR-2	after 150,000 km or 1 year
TR-3	after 300,000 km or 2 years
KR-1	after 600,000 km or 4 years in plants (main repair)
KR-2	after 1,200,000 km or 8 years in plants (capital repair)

Resulting from the maintenance scheme of the existing EMU stock the regularly needed volume of the different maintenance types can be found. At least 29 TR-3, 15 KR-1 and 15 KR-2 of the main categories should be done per annum. The certain amounts for all different EMU types are shown in the following table.

Tab. 1.6-21: Volume of yearly EMU maintenance

EMU	Total	TO-3	TR-1	TR-2	TR-3	KR-1	KR-2
QP-2	117	4,680	585	59	29	15	15
CP-3	2	80	10	1	1	0	0
Total	**119**	**4,760**	**595**	**60**	**30**	**15**	**15**

There were carried out mainly TO-3, TR-1, TR-2 and TR-3 in some locomotive depots for ensuring the domestic passenger traffic service in different regions. Furthermore there exists the Tbilisi Electro-Wagon Repair Plant (TEWRS) in the region specialised in repairing EMU (KR-1 and KR-2). The following table shows the EMU repair plants and capabilities in the Caucasus region.

Tab. 1.6-22: EMU repair capabilities and plants

EMU plants	repair tracks for EMU		repair type	Overview given in Annex
	number	repair places		
ARM				
Loco-Depot Yerevan	3	3 sets		**1.6-34**
Loco-Depot Gyumri	2	2 sets	under construction	**1.6-35**
AGZD				
Loco-Depot Beyuk -Shtshor	4	4 sets	TO, TR	**1.6-36**
Loco-Depot Gyandsha	3	3 sets	To, TR	**1.6-37**
GRZD				
Loco-Depot Tbilisi-Pass.	1	1 set	TO, TR	**1.6-38**
Loco-Depot Khashuri	1	1 set	TO, TR	**1.6-39**
Loco-Depot Kutaisi	1	1 set	TO, TR	
EMU depot Batumi	1	1 set	TO, TR	
EMU depot Sukhumi	1	1 set	TO, TR	
TEWRS	2	2 sets	KR-1, KR-2	**1.6-40**

1.7 Deficiency analysis and rehabilitation plan

As a result of the analysis of the present technical condition of railways in Armenia, Azerbaijan and Georgia, it is possible to draw up a qualitative and quantitative analysis of the deficiencies of the railway infrastructure and rolling stock. As follows rehabilitation plans were developed for the respective sector.

The definition of investment needs was carried out using so called "different priorities". That means:

1st priority - urgent needed repair work in the next 2 - 3 years,
2nd priority - medium-term measures (up to the year 2005),
3rd priority - long-term measures (up to the year 2015).

As a general rule, a certain amount for planning effort and contingencies has been added to the total amount (costs per phase for each railway).

The planning of infrastructure and for particular projects must be prepared based on cost-benefit analyses. Therefore, the most important pre-condition for any further investment (other than in an emergency) must be to set up a central planning unit.

The individual cost estimates include the following services:

- planning and design
- producing the supporting structure
- setting up the building site with power station, accommodation for building and construction workers, cranes, excavators, crawler vehicles, concrete mixers and material stores
- installation of temporary bridges, diversion of running tracks with connection to the temporary bridges to ensure rail traffic during the construction period
- renewal or reinforcement of the foundations, abutments and columns
- erection of the supporting structure and diversion of the running tracks to the new bridge
- dismantling of the temporary bridge
- dismantling of the building site facilities and restoration of the former state, and
- acceptance and clearance of the new bridge for rail traffic.

1.7.1 Rehabilitation plan for track and bridges

1.7.1.1 Armenian Railway

1.7.1.1.1 Yerevan - Masis - Gyumri - Ayrum line

The line is 298 km long. There is a huge backlog of renewal work required for tracks and switches. The average speed is 38 km/h. The permitted speed for this section is currently 70 km/h for passenger and goods trains. The permanent speed restrictions are indicated in the following table.

Tab. 1.7-1: List of ARM network permanent way speed restriction

no.	station	from km	to km	speed restricted km/h	length km	remarks
1	Ayrum - Ashtabula	2583	2593	50	10.00	
2	Sanain - Kober	2615+07	2615+08	15	0.20	earth slip
3	Kober - Tumanian	2625+01	2625+10	40	1.00	
4	Tumanian - Shag.	2631+01	2631+10	40	1.00	
5	Block post	2673+06		25	0.10	block sig.
6	Block post	2677+02		25	0.10	damaged
7	Kaltakhtshi	2698+01	2698+10	40	1.00	
	Dshadshur	2699+01	2699+10	40	1.00	tunnel
8	Bajandur - Angim	2739+06	2739+08	50	0.20	bridge
		2743+08	2743+10	50	0.20	bridge
9	Agin - Bagravan	2759+01	2750+10	60	1.00	
10	Ani - Getap	2773+01	2773+10	50	1.00	
11	Aragatz - Arteni	2791+01	2795+10	40	5.00	bad track
12	Abovian - Arabkir	9+01	24+10	25	16.00	bad track
13	Araks - Armavir	2820+01	2828+10	50	9.00	bad track
14	Sovietakan -	2841+08	2841+10			
	Etshmiadzin	2842+01	2842+02	50	0.50	
15	Station Etshmiadzi.			25	0.90	track 2
16	Masis - Noragaw.	2864+01	2864+10	40	1.00	
17	Noraga. - Yerevan	2875+09	2875+10			passenger
18	Noraga. - Yerevan	.02	.02	15	0.10	mar. yard.
19	Masis - Mkhtshyan	594+02	594+03	25	0.20	
20	Charentsavan	40+01	40+10	40	1.00	
21	Sevan - Zovagyukh	87+01 94+01	87+10 94+10	35	2.00	
22	Sevan - Shorska	90+06	90+07	25	0.20	
		106+02	106+06	25	0.50	
23	Sevan sidings	23+04		25	0.10	
		95+02		25	0.10	
		87+07		25	0.10	
24	block post	2700+08		25	0.10	signals
		2721+02		25	0.10	damaged
		2818+01		25	0.10	

Annex 1.7-1 contains a diagram of the line's slow sections. The majority of the slow sections in the ARM network are on the line indicated above. The slow sections are supplemented by daily instructions given to the engine drivers. These supplements are the result of line section checks by the permanent-way districts, which are frequently incapable of eliminating operating hazards because of a lack of suitable materials. 40% of this line section has to be renewed. The wooden sleepers in this section have to be replaced by prestressed concrete sleepers because of the poor quality of the wood concerned. The following rehabilitation measures are therefore necessary for this section of the line:

- 120 km track renewal with full ballast bed replacement and partial subsoil renewal, new superstructure R 65 rails with prestressed concrete sleepers and W-bracket fastening
- 30 km replacement of wooden sleepers with prestressed concrete sleepers and W-bracket fastening (55,200 sleepers)
- 30 km suitable deep drainage in the vicinity of the cuttings
- 85 switches for R 65 rails and an incline of 1:11 are to be replaced as a direct link from and to the main through track.
- 170 switch sleeper sets for R 65 rails resp. R 50 rails and incline of 1:11, 1:9 are to be renewed.

1.7.1.1.2 Masis - Yeraskh border station to Nakhichevan line

This single-track line runs in a south-easterly direction from Masis km 595 to Yeraskh km 542, and is 53 km long. The limited train traffic for both passenger and freight trains means that the load limit of the R 65 has not been reached yet so that renewal is not necessary. On the other hand, the sleepers of the whole line and the ballast bed have to be completely renewed, with subsoil restoration in some places, too. The standard cross sections with side paths, as prescribed in the standard manuals, have to be reproduced. The following rehabilitation measures are therefore required for this section of the line:

- 20 km track renewal with complete ballast bed replacement and partial subsoil restoration, R 65-rails on prestressed concrete sleepers with W-bracket fastening
- 30 km sleeper replacement with concrete sleepers and W-bracket fastening
- 10 km subsoil head to be produced on standard ballast bed cross section with edge paths
- 10 km subsoil restoration and deep drainage including integration of a subsoil protection layer with suitable filter material.
- 15 switches for R 65 rails and an incline of 1:11 are to be renewed as direct link from and to the main through track.
- 30 switch sleeper sets for R 65 rails are to be renewed, resp. R 50 rails and inclines of 1:11, 1:9.

1.7.1.1.3 Masis - Razdan - Ijevan - border station to AGZD line

This single-track line runs in a north-easterly direction from Masis km 595 via Yerevan, Abovian, Razdan and Ijevan to the border with Azerbaijan and is 162 km long. The superstructure on this line consists mainly of R50 rails. Ijevan is also the headquarters of the permanent-way district responsible for this section of the track. The condition of this section of the line is the same as on the other lines. The lack of funds and the resulting backlog of regular track renewal work means that the following renewal work is necessary:

- 100 km track renewal with complete ballast bed replacement and partial subsoil restoration, R 65 tracks on prestressed concrete sleepers with W-bracket fastening
- 20 km sleeper replacement with prestressed concrete sleepers and W-bracket fastening
- 25 km subsoil head to be produced on standard ballast bed cross section with edge paths
  15 km rock securing measures and securing of the cutting embankments.
- 25 km subsoil restoration and deep drainage including integration of a subsoil protection layer with suitable filter material.
- 52 switches with R 65 rails, incline 1:11 to be replaced as direct link from and to the through main track.
- 110 switch sleeper sets for R 65 rails to be renewed, respectively R 50 rails, incline 1:11 or. 1:9.

1.7.1.1.4 Bridge and tunnel maintenance

The bridges are important links in the ARM track network, and their maintenance and renewal is of decisive importance to railway operation. Annex 1.7-2 lists the bridge data of the most important bridges. This list contains 12 bridges whose age, span and design make them the most important bridges. The bridges have an average age of 100 years and have passed the end of their service life. Material fatigue in the steel structures makes it necessary to replace some of the bridges. The following support structures are to be renewed:

- Bridge No. 2 span 32 m built in 1898
- Bridge No. 4 span 58 m built in 1898, only the middle section to be renewed
- Bridge No. 5 span 43 m built in 1899,
- Bridge No. 6 span 147 m, date of construction unknown
- Bridge No. 7 span 32 m built in 1898
- Bridge No. 8 span 24 m built in 1898

Neither project orders nor project documents exist. The lack of funds means that the bridge construction department is not in a position to award project or construction contracts. The bridge construction department is directly subordinated to the Minster for Transport. The lack of documents means that the costs for bridge rehabilitation can only be estimated.

1.7.1.1.5 Permanent-way districts

The lack of equipment and machinery available to the permanent-way districts means that they are not in a position to perform their tasks for scheduled track maintenance. Therefore, they have to be provided with complete basic equipment, including tools and small track machines. This complete basic equipment will make the heavy work easier for the track workers and increase their performance. Priority in equipping the permanent-way districts is to be coupled to renewal work on the corresponding sections of track.
The tools and equipment required in the ARM permanent-way districts are documented in Annex 1.7-4. The quantities stated refer to the basic requirements of a track section related to total requirements.

1.7.1.1.6 Permanent-way workshops

The current situation in the permanent-way workshop clearly shows that it cannot become an efficiently working unit with the current equipment. The machinery is in a desolate condition. The workshop has to be thoroughly re-equipped with heavy-duty track construction machines and equipment, with a comprehensive re-motorisation programme. This programme should restore the existing UK track construction systems in order to bring about the necessary operating condition. The objective is to equip the permanent-way workshop in such a way that ARM becomes independent of foreign services (contractors) for the pending track renewal work.

1.7.1.2 Azerbaijan State Railways

1.7.1.2.1 Baladshary - Beyuk-Kyassik - border station to Georgia line

Starting from Baladshary the line is 487 km long. The necessary renewal work along this line is:

- 366 km track renewal
- 200 switch renewal for R 65 rails and incline 1 : 11
- 140 switch sleeper sets for R 65 rails and incline 1 : 11

The Final Report of the project TNREG 9307 "Pre-Investment Study and Pilot Train Baku - Tbilisi - Batumi/Poti" contains a detailed plan of rehabilitation measures for this line.

1.7.1.2.2 Baladshary - Yalama line

The Baladshary - Yalama line is the railway link between Azerbaijan and Russia. The two-track electrified line leads to the border station of Yalama over a distance of 206 km. The superstructure consists of R 65 rails on concrete sleepers. The condition of this line is inadequate on account of lacking track maintenance and its minor significance following the decline in freight, as a result of the interrupted link to Russia. The load limit of 500 million gross ton-kilometres is exceeded over a length of

169 km. Vertical rail wear amounts to 9-12 mm for a distance of 174 km, and is greater than 12 mm for a length of 13 km. This means that the load reserves and the tolerable wear of the rails have been exceeded for around 82% of the monitored line. The effects of wear also cause permanent slow sections along the line.

Permanent slow sections reduce the permitted speed from 80 km/h to 40 km/h on average. The following two tables contain the frequency of speed restrictions for both directions. The restrictions are located between Baladshary and Siasan in both directions. This corresponds with the section which is still being used regularly.

Tab 1.7-2: Listed speed restriction for the Baladshary - Yalama line

no.	station	from km	to km	speed restricted to km/h	length km
1	Baladshary - Gyusdek	2646	2632	60	14
2	Sumgait	2620	2619	15	1
3		2563	2562	40	1
4	Siasan	2558	2556	60	2
5	-"-			15	1
6	-"-	2555	2550	60	5
	total				**24**

Annex 1.7-5 contains a diagram of the slow sections of this line.

Tab. 1.7-3: Listed speed restriction for the Yalama - Baladshary line

no.	station	from km	to km	speed restricted to km/h	length km
1	Ledshet	2464	2465	40	1
2	Kisil-Burun	2548	2559	50	11
3	Sorat	2568	2569	40	1
4		2605	2606	40	1
5	Shirvan	2609	2610	15	1
6	Sumgait	2620	2521	15	1
7		2624	2625	40	1
8	Gyusdek -Baladshary	2632	2646	50	14
	total				**31**

Annex 1.7-6 contains a diagram of the slow sections of this line.

Time lost in the direction of Baladshary - Yalama passing the 24 km of slow sections to Siasan amounts to 18 minutes compared to the permitted speed of 80 km/h. In the other direction, through 31 km of slow sections, the time lost compared to the permitted speed is already 24 minutes. The following renewal work is therefore necessary to restore the permitted speed:

- 55 km track renewal with complete ballast bed replacement and subsoil restoration on prestressed concrete sleepers with W-bracket fastening.
- 147 switch renewal for R 65 rails and incline 1:11 with ballast bed replacement.
- 100 switch renewal for R 50 rails on R 65 rails and incline 1:11 with ballast bed replacement.

1.7.1.2.3 Aliat - Sadarak line

The total length of the line is 541 km and consists of two tracks from Aliat to Batadga. The superstructure consists of R 65 rails on concrete sleepers for 362 km and R 50 rails on wooden sleepers for 179 km. The condition of this line is inadequate on account of the neglect of scheduled maintenance following the decline in freight and the interrupted link to Nakhichevan. The load limit of 500 million gross ton-kilometres is exceeded over a distance of 176 km. Vertical rail wear amounts to 9 - 12 mm for a distance of 146 km and exceeds 12 mm for a distance of 44 km. This means that the load reserves and tolerable wear limits are exceeded for around 62% of the monitored line. These effects of wear also cause permanent slow sections of the line. Permanent slow sections reduce the permitted speed from 80 km/h to 40 km/h on average. The following table contains the frequency of speed restrictions for both directions.

Tab. 1.7-4: Listed speed restriction for the Aliat - Osmanly - Sadarak line

no.	station	from km	to km	speed restricted to km/h	length km
even track					
1	Aliat - Osmanly	0	5	60	5
2	Osmanly - Batagi	60	139	40	79
3	Mindshevan - km 385	283	385	60	102
4		385	386	50	1
5		386	426	60	40
6		426	442	40	16
7		442	445	60	3
8		445	510	40	65
9	km 510 via Sadarak to border ARM	510	541	60	31
uneven track					
1	line 2 - 11 Mindshevan	275	273	40	2
2	to Osmanly	263	262	40	1
3		253	252	40	1
4		250	248	40	2
5		246	245	40	1
6		242	210	40	32
7		139	127	40	12
8		127	126	25	1
9		126	125	40	1
10		97	96	40	1
11	Aliat Nov. - Aliat	5	0	60	5

Annexes 1.7-7 and 1.7-8 contain diagrams of the slow sections of this line.

The average speed restriction for even track between Aliat - Osmanly and Batadga is 40 km/h for 84 km. In the uneven track section, the slow sections are spread out over 59 km altogether. Here, the average speed is 40 km/h once again. The time losses in this case are:

- 60 minutes for even track and
- 44 minutes in the other direction.

The speed restrictions are all located along the section Aliat - Goradis. This section is still being used regularly. The line section between Goradis and Salamalik had been destroyed totally during the armed conflict between Armenia and Azerbaijan. An investigation of the present state has not been possible. It is safe to assume that this section has to be rebuilt completely.

The switch connections to and from the main track consist of:

- 52 switches for R 65, incline 1:11
- 7 switches for R 65, incline 1: 9
- 119 switches for R 50, incline 1:11
- 102 switches on the Mindshevan - Sadarak line
- 136 switches for R 50, incline 1:9
- 5 switches for R 43, incline 1:11
- 5 switches for R 43, incline 1:9

The following measures are necessary to restore the permitted speed:

- 143 km track renewal with R 65 rails on prestressed concrete sleepers, complete ballast bed replacement and partial subsoil restoration
- 258 km track renewal, Mindshevan - Sadarak line
  102 switches R 65 1 : 11
- 266 switches to be consistently renewed as part of regular upkeep to replace the switches of the R50 and R 43 rails with the heavy-duty R 65 rail structures. This achieves a uniform switch structure, avoids weaknesses in the track links and reduces the wide range of different spare parts required.

1.7.1.2.4 Osmanly - Astara line

The line runs in a southerly direction from Osmanly to Astara. It is 183 km long and only single track from Osmanly to Astara. The superstructure consists of R 65 rails on concrete sleepers for 112 km and of R 50 rails on wooden sleepers for 71 km. This line is in a desolate condition on account of the failure to carry out regular maintenance and the decline in freight traffic. In addition, investment has been omitted because there has only been insignificant an traffic volume on this line. The load limit of 500 million gross-ton kilometres is exceeded over a length of 71 km. Vertical rail wear amounts to 9 - 12 mm for a length of 84 mm. This means that the load reserves and tolerable wear of the rails have been exceeded on around 46% of the line, resulting in permanent slow sections. The following table contains the current speed restrictions.

Tab. 1.7-5: Listed speed restriction for the Osmanly - Astara line

no.	station	from km	to km	speed restricted to km/h	length km
1	Dyalilabad	93	97	70	4
2		97	99	50	2
3		99	101	70	2
4		101	105	60	4
5		105	107	40	2
6		111	113	40	2
7		115	119	15	4
8		119	121	25	2
9		121	123	15	2
10		123	125	50	2
11		131	137	15	6
12		137	148	25	11
13		148	151	15	3
14		151	152	25	1
15	Lenkoran	153	155	25	2
16		155	177	15	22
17	Astara	177	185	25	8
	total				**79**

Annex 1.7-9 contains a diagram of the slow sections of this line.

The slow sections follow on one after the other almost without interruption between km 93 and km 185. The average speed on this section of the line is 34 km/h, resulting in time losses of 2 hours and 19 minutes compared to the target speed.

The line is equipped with switches as follows:

- 7 switches for R 65, incline 1:11
- 14 switches for R 50, incline 1:11
- 32 switches for R 50, incline 1:9 and
- 30 switches for R 43, incline 1:9.

The drops in speed occur in the section of the line close to the shore of the Caspian Sea. This section is flooded repeatedly at certain intervals, resulting in changes to the geometric position of the track. In conjunction with the poor quality of the superstructure, changes to track stability have to be expected also due to submergence there. It is worth considering whether to move the layout of the line out of the flood-risk area, or whether extra ballast could raise the embankment out of harm's way. The following measures are necessary to refurbish this line:

- 80 km track renewal with complete ballast bed replacement and partial subsoil restoration with R 65 rails on prestressed concrete sleepers and W-bracket fastenings.
- 80 km raised embankment for a new layout of the line and flood-protection measures
- 84 switches with R 65 rails, incline 1: 11

1.7.1.2.5 Bridge rehabilitation

Most of the bridges on the main line Baku - Aliat - Beyuk-Kyassik - border to GRZD are generally in good condition because of methodical maintenance measures although there are some bridges which have to be rehabilitated by major repair or renewal. The list below shows in order of urgency the bridges which require urgent repair or renewal:

Bridge construction at km 541 + 500
Bridge number 56 in km 541+500, entrance and exit of Baku main station had been damaged seriously and pulled down. The former bridge had been constructed as prestressed concrete slabs and was destroyed by road traffic. All trains going to and coming from Baku at present pass the temporary single - line working over the still well operating separate bridge of the old track line. The detention of trains (passenger and goods) in junction stations has to be planned and a careful traffic control has to be arranged. The project for renewing this bridge is in hand. A cost estimation has not been available.

Bridge construction at km 157 + 700
The bridge construction number 19 and 20 of the bridge list at km 157+700 is jeopardised by the washing away of the foundations of the abutments and piers. River training and security measures have to be undertaken. Project documents are already prepared. The cost estimation is figured with 866,000 $US.

Bridge construction at km 111 + 200
The bridge construction number 10 and 11 of the bridge list at km 111+200 is partially in need of replacement. The work on the renovation are in hand. Project documents exist and the cost estimation is figured at 954,000 $US.

Bridge construction at km 234 + 600
The bridge number 31 of the bridge list at km 234+600 has to be completely renewed. The bridge openings of 4 x 3,60 m are to small for the mass of water coming from the catchment area. The bridge is endangered of been washed away. Project documents do not exist. Cost estimation: 100,000 $US.

Bridge construction at km 252 + 800
The bridge construction number 33 and 34 of the bridge list at km 252+800 needs a complete renovation. This bridge was constructed in 1927 as a riveted steel construction. The physical deterioration and heavy corrosion demand the total renewal of the bridge. Project documents are already prepared. The cost estimation is figured out at 2,950,000 $US.

Bridge construction at km 360 + 200
The bridge number 41 and 42 of the bridge list at km 360+200 demands a continuation of the safety and protection measures. The construction is in good condition but is endangered to be undermined by water (foundations of abutments and piers). The project documents show an estimated cost of 200,000 $US.

Bridge construction at km 72 + 300
The bridge number 5 of the bridge list at km 72+300 was renewed in 1996 and is located in a single track-line section. This single track could be in the future a bottleneck when the line is carrying dense traffic. In the case of such improved traffic, a second track in this section would be needed. As a result, a second bridge will have to be constructed. The project documents are prepared and the cost estimation is figured at 4,545,000 $US.

No information is available about bridges, tunnels and other structures on the lines of Baku - Yalama and Osmanly - Astara, which present an impediment to rail traffic. 193 building structures are reported on the Goradis - Sadarak line under the responsibility of the AGZD's Nakhichevan department, including:

- 174 bridges,
- 15 tunnels,
- 3 galleries and one foot bridge

Renewal is necessary for 105 of the building structures, of which 80 are located in the occupied area, including 70 bridges and 10 tunnels. No information is available about the kind and scope of renewal measures.

1.7.1.2.6 Permanent-way districts

The permanent-way districts of AGZD are not suitably equipped to fulfil their tasks of scheduled track maintenance. Therefore, they have to be provided with complete basic equipment, including tools and small track building machines. This complete basic equipment will make the heavy work easier for the track workers and increase their performance. AGZD has allocated 15 different permanent-way districts to ensure operating safety. The tools and equipment required for carrying out the work properly are listed in Annex 1.7-10.

1.7.1.2.7 Permanent-way workshops

The permanent-way workshops of AGZD are handicapped with ancient track building machines and equipment so that they are not capable of carrying out modern track construction according to valid technical rules. Comprehensive renewal of the machinery is therefore necessary. The estimated costs for equipping a permanent-way workshop are indicated in the pre-feasibility study. However, this equipment is only required for two permanent-way workshops. The large machines should be shared out among the various sections of the line according to a machine schedule to prevent them being needed in two places at the same time.

1.7.1.3 Georgian Railways

1.7.1.3.1 Poti - Senaki - Tbilisi - border station to AGZD line

This line is 358 km long. The rehabilitation measures have been described in detail and listed in the Final report of the TRACECA project TNREG 9307 "Trans-Caucasian Railway Infrastructure: Pre-investment Study and Pilot Train ...". The principal measures are summarised here as follows:

- 564 km track renewal with complete ballast bed replacement and partial subsoil restoration, with 261 km to be renewed with first priority. The tracks are to be renewed on prestressed concrete sleepers with W-bracket fastening.
- 400 switches renewal with R 65 rails, incline 1:11 with complete ballast bed replacement.
- 150 switch sleeper sets for R 65 rails, incline 1:11.

1.7.1.3.2 Tbilisi - Sadakhlo - border station to Armenia line

This line is 68 km long. The line has to be renewed as a whole, as the permitted speeds have had to be reduced to 25 km/h because of the poor superstructure. The following has to be renewed:

- 24 km track renewal with complete ballast bed replacement and partial subsoil restoration
- 44 km sleeper renewal, including ballast bed replacement.
- 70 switches renewal R 65, 1:11 with ballast bed replacement.
- 35 switches sleeper sets R 65, 1:11 respectively. R 50, 1:11.

1.7.1.3.3 Batumi - Samtredia line

The line from Batumi to Samtredia is 106 km long. Renewal work on this line will be concentrated on converting the section of track from R 50 to the heavy-duty R 65 rails. This will be necessary in any case in order to transport heavy freight traffic to the Black Sea along this line. 40% of the total line has to be renewed. The following renewal work will be necessary:

- 45 km track renewal with complete ballast bed replacement and partial subsoil restoration.
- 1,000 bridge sleepers to be replaced on the bridges.

1.7.1.3.4 Veseloe - Ingiri - Senaki line

This line is 234 km long, but can be used by GRZD at present only between Senaki and Ingiri. The section between Senaki and Ingiri has to be renewed completely. Therefore, the following renewal measures will be necessary:

- 39 km track renewal with complete ballast bed replacement and partial subsoil restoration with R 65 on prestressed concrete sleepers with W-bracket fastening.
- 25 switches renewal R 65, 1:11 with complete ballast bed replacement.

1.7.1.3.5 Bridges

On the main line Poti - Senaki - Tbilisi - border to AGZD the following has to be renewed (see also Annex 1.7-3):

- Bridge No. 18 length 185 m built in 1896
- Bridge No. 27 length 93 m built in 1907
- Bridge No. 56 length 169 m built in 1896
- Bridge No. 65 length 123 m built in 1896
- Bridge No. 79 length 81 m built in 1896
- Bridge No. 1 -4, 10, 11, and 13 upkeep work

1.7.1.3.6 Permanent-way districts

As already indicated, the permanent-way districts of GRZD are not suitably equipped to perform their tasks for scheduled track maintenance either. Therefore, they have to be provided with complete basic equipment, including tools and small track machines. This complete basic equipment will make the heavy work easier for the track workers and increase their performance. GRZD has established 11 permanent-way districts to monitor track systems over the whole track network. The tools and equipment required for proper operation of a permanent-way district are listed in Annex 1.7-11.

1.7.1.3.7 Permanent-way workshops

GRZD's permanent-way workshops are handicapped with ancient track building machines and equipment so that they are not capable of carrying out modern track construction according to valid technical rules. Comprehensive renewal of the machinery is therefore necessary. A re-motorisation programme for the existing UK machines and accessories has also been drawn up by GRZD, similar to that for ARM. The estimated costs refer to the equipment for two permanent-way workshops. However, the equipment will be used for both workshops. Machine schedules should be drawn up for swapping the large machines to avoid them being required in two places at the same time. Exact job planning and co-ordinated timing of machine use in the workshops can result in high machine operating times and high economic efficiency rates. It is possible for the necessary machines and equipment to be procured in two phases; this also applies to the re-motorisation programme.

1.7.1.4 Summary of the track and bridges rehabilitation plan

The following table provides an overview of the rehabilitation plan for the Caucasian railways.

Tab. 1.7-6: Rehabilitation plan for track and bridges

	Measures	
	Track renewal	Switch renewal
ARM		
Yerevan-Ayrum line	• 120 km track renewal • 30 km sleeper replacement • 30 km deep drainage suitable to required functions	• 85 switches for R 65 rails, incline 1:11 • 170 switch sleeper sets with R 65- resp. R 50 rails and incline 1:11, resp. 1:9
Masis - Yeraskh line	• 20 km track renewal • 30 km sleeper replacement • 10 km subsoil head • 10 km subsoil restoration and deep drainage	• 15 switches for R 65 rails, incline 1:11 • 30 switch sleeper sets for R 65- resp. R 50 rails, incline 1:11, resp. 1:9
Masis - Razdan - Ijevan line	• 100 km track renewal • 20 km sleeper replacement • 25 km subsoil head 15 km rock securing measures • 25 km subsoil restoration and deep drainage	• 52 switch sleeper sets for R 65 rails, incline 1:11 • Switch sleeper sets for R 65- resp.. R 50 rails, incline 1:11 resp.. 1:9
AGZD		
Baladshary - Beyuk-Kyassik line	• 200 km first priority track renewal • 166 km second priority track re-newal	• 200 switches for R 65 rails, in-cline 1 : 11 • 140 switch sleeper sets for R 65 rails, incline 1:11
Baladshary - Yalama line	• 55 km track renewal	• 147 switches for R 65 rails, in-cline 1:11 • 100 switches from R 50 to R 65 rails, incline 1:11
Aliat - Sadarak line	• 143 km track renewal • 258 km track renewal	• 266 switches for R-65 rails
Osmanly - Astara line	• 80 km track renewal • 80 km raised embankment	• 84 switches with R 65 rails, in-cline 1: 11
GRZD	•	•
Poti - Senaki - Tbilisi line	• 564 km track renewal, with first priority for 261 km	• 400 switches with R 65-rails, in-cline 1:11 • 150 switch sleeper sets for R 65 rails, incline 1:11
Tbilisi - Sadakhlo line	• 24 km track renewal 44 km sleeper renewal	• 70 switch renewal for R 65 rails, incline 1:11 • 35 switch sleeper sets for R 65 rails, incline 1:11 resp. R 50 rails, incline 1:11
Batumi - Samtredia line	• 45 km track renewal	• 1000 Bridge sleepers
Veseloe - Ingiri - Senaki line	• 39 km track renewal	• 25 switch renewal with R 65-rails, incline 1:11

1.7.2 Rehabilitation plan for signalling, telecommunication and data processing

1.7.2.1 Caucasian railways in general

1.7.2.1.1 Signalling installation

The reliability and operability of the signalling installations have to be improved. It is necessary to effect short-term and medium-term renewals of the signalling equipment. Short-term measures relate to the renewal of important components of the existing installations in order to increase their reliability. For the necessary renewal of signalling equipment it is recommended to use Russian equipment also in future. It has proved its reliability and robustness over the past few years. Furthermore, the demands made on the operating and maintenance staff would not change. The investigations confirmed that a supply of spare parts from other countries of the former Soviet Union would be possible, given the respective financial funds.

1.7.2.1.2 Telecommunication installations

We base the measures to be carried out on the objective of bringing about a speedy improvement in the condition of the installations. Furthermore, it is necessary to use new and modern installations to meet the requirements arising from the increased transport volume. An important fact in handling the transport volume and achieving safety in passenger and goods traffic is a stable communication connection for all participants in the transport process. The cost of other equipment contains necessary items such as public address systems, alarm equipment and telephone systems for the technical service.

1.7.2.1.3 Aims of the information technology

Customers and senders in rail freight traffic require

- reliability,
- punctuality,
- ability to give information upon request,
- competitiveness as to prices.

The Railways must work out offers or products which meet the above mentioned general requirements. Information technology is an indispensable component for working out such offers and partly is a component of the offers themselves. Information technology methods are to improve freight savings in a way that they cover the investment expenses. Precise knowledge of the quantity, kind and place of usage of the freight wagons and containers permits to optimise the volume and the composition of the material transports.

Apart from competitive prices, senders and forwarders demand information concerning the exact time of the required loading volumes, of wagons and containers deliver-

ing, the delivery times of goods delivering and, at any given moment, the location of goods. To supply the Caucasian Railways with the methods meeting these requirements is the aim of the information technology.

Information systems on the basis of computer networks and communication networks distributed strategically will give information about the locations of freight wagons and containers and the pertinent statistics. This information forms the basis for the economical functioning of the railways since the deregulation of transport markets caused a loss of value of classical tariffs, and the share of individual freight standards will increase. It will be necessary to differentiate - as far as possible - between the requirements of the Operation System and the demands of the transport customer.

- FREIGHT TRANSPORT OPERATION SYSTEM
- PROCESSING and FREIGHT COST CALCULATION SYSTEM
- DECISION SUPPORT SYSTEM

Since central and regional interests will be concerned, a two-level conception for electronic data processing on the basis of a modern client-server architecture is called for.

1.7.2.1.3.1 Freight Transport Operation System (FTOS)

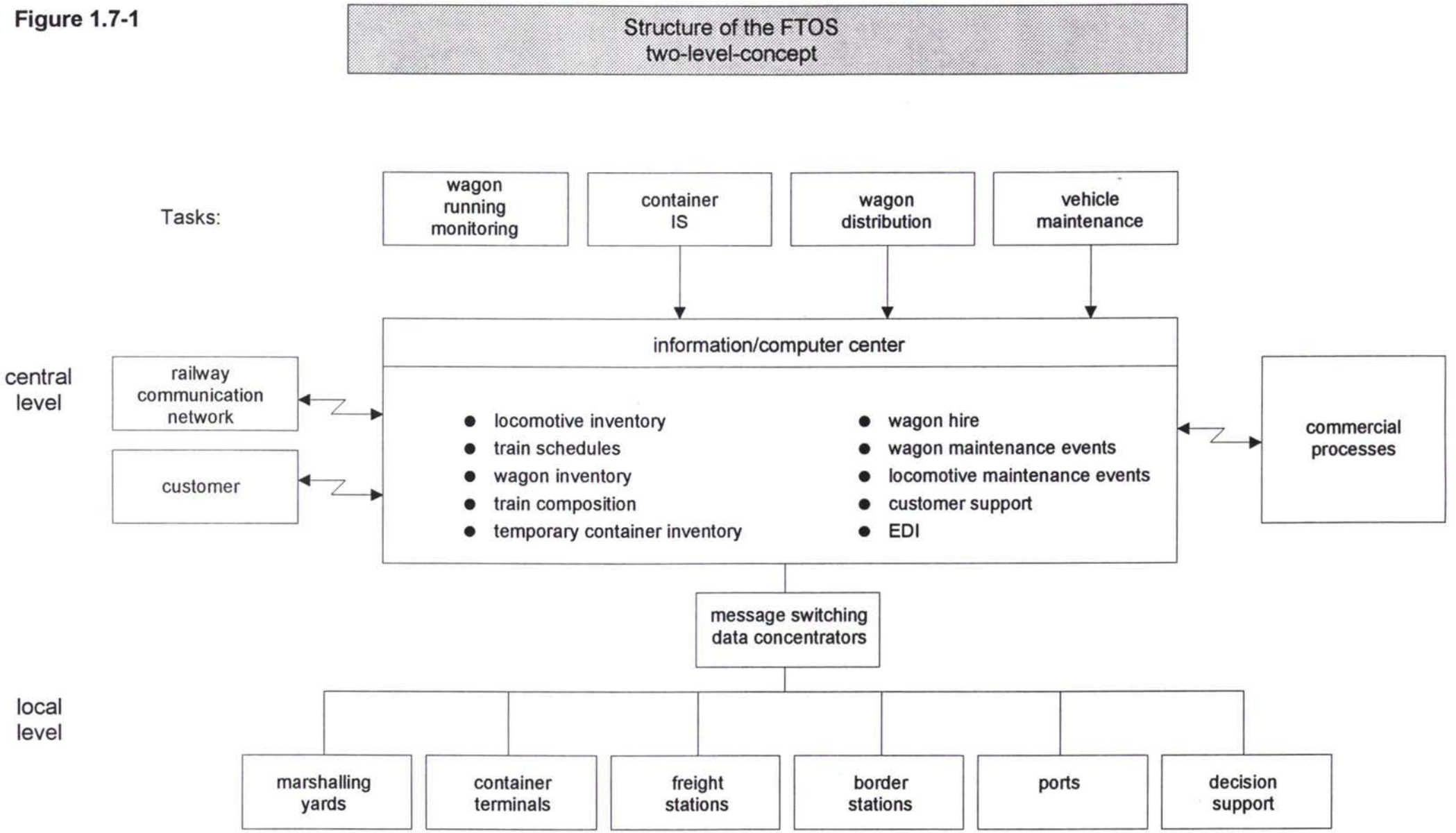
The FTOS is the basic system. In this system information is stored on wagons, containers, goods, and locations which is continuously being updated by incoming data about rolling stock, wagon locations and other statistics.

All application software take information from this basic system.
By means of data bases on rolling stock and containers, it is possible to provide to customers

- a continuous monitoring of wagon and container movements;
- information on train formation and splitting up of trains;
- information on the composition of trains;
- information on the exchange of rolling stock and containers with the shipping company, neighbouring railways, customers, and trucking companies.

The structure of the FTOS is described in the following picture.

Figure 1.7-1


Structure of the FTOS
two-level-concept
Tasks:
wagon running monitoring
container IS
wagon distribution
vehicle maintenance
central level
railway communication network
customer
information/computer center
locomotive inventory
train schedules
wagon inventory
train composition
temporary container inventory
wagon hire
wagon maintenance events
locomotive maintenance events
customer support
EDI
commercial processes
message switching data concentrators
local level
marshalling yards
container terminals
freight stations
border stations
ports
decision support

1.7.2.1.3.2 Processing and Freight Cost Calculation System (PFCCS)

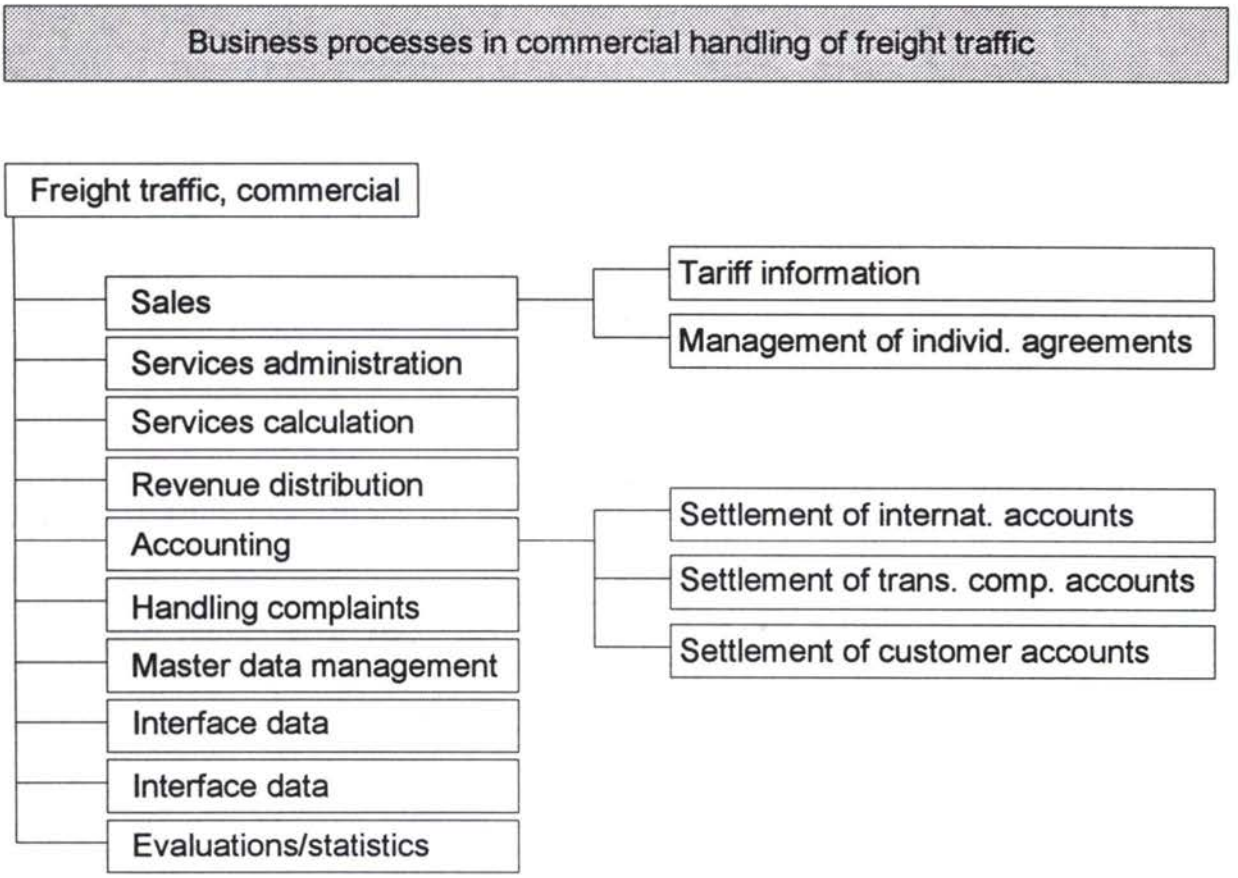
This system helps to calculate services rendered an to render accounts for customers. The main task of this application is to supply quick information upon the customer's request. The calculation system supports sales and gives necessary information about customers, market and competitors. The calculation system possesses the basic information to check both the honesty of the partners and the own service quality.

The main components of the system have to be

- preparation and storage of the operational daily, monthly and yearly statistic reports of the Caucasian railways;
- statistical analyses;
- calculation of payments to customers and other railway administrations;
- tariff information;
- distributing of revenues to partners (transport companies, ports, agents);
- calculation of accounts;
- communication with the accounting department.

The following system diagram shows the main components.

Figure 1.7-2



The function of the marketing module

- Provide information on tariffs
- Register tariff changes
- Store the codes of stations, goods, distances, transhipment and store rates, etc.
- Prepare inquiries about distances, tariffs, codes, etc.
- Download changes in the codes, tariffs, etc.
- Freight transport marketing
- Tariff modelling
- Keep statistics on transport and receipts in domestic and international freight transport

1.7.2.1.3.3 Decision Support System (DSS)

DSS are based on the above mentioned data base and serve to supply decision-supporting information to executive departments or directly to the managers. By using the corresponding software tools (access, business objects, etc.) management information about the following fields is provided:

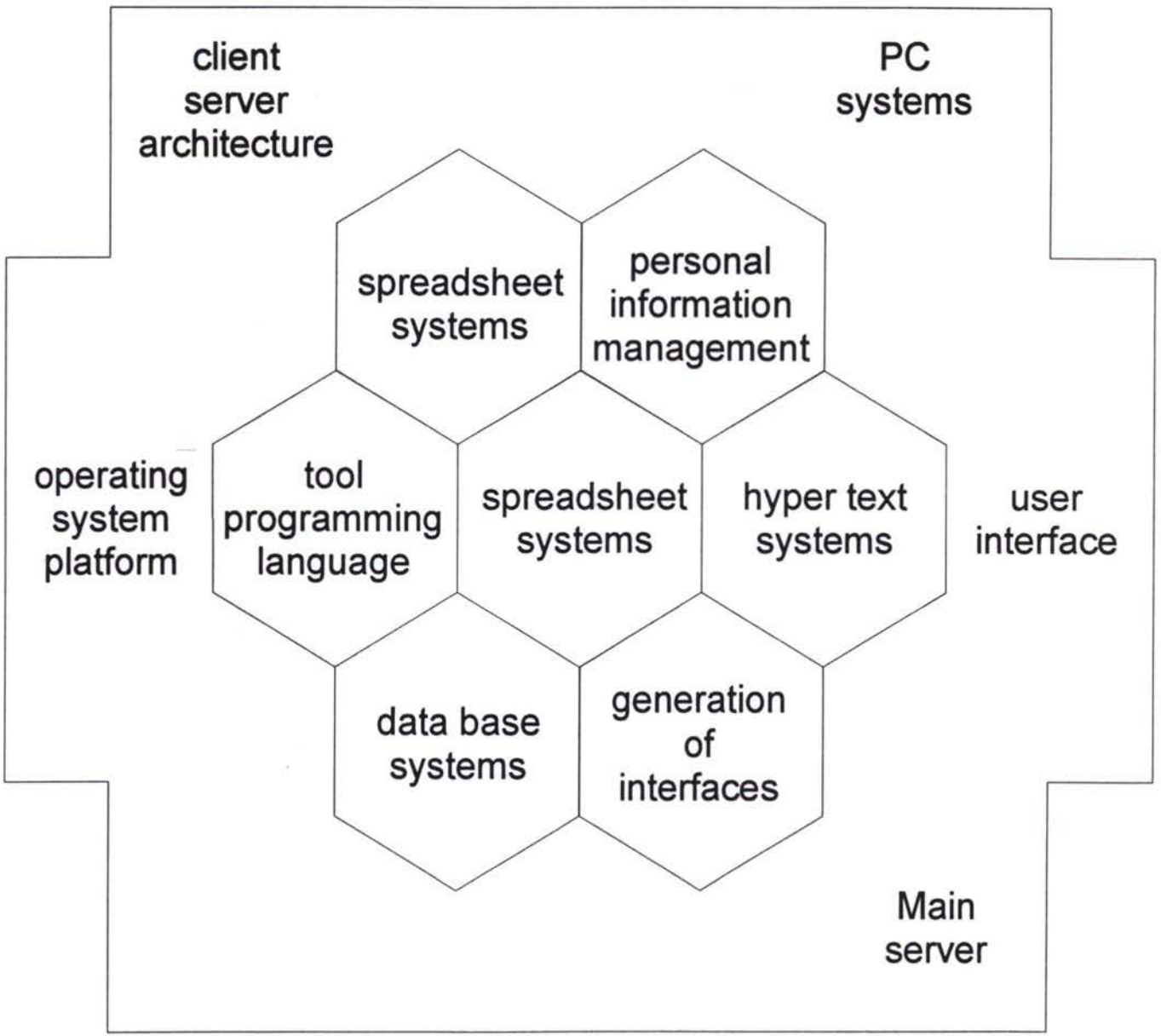
- Sales
  - name of customer (sender)
  - location of customer
  - sale proceeds
  - product name
- Production (transport)
  - operation
  - maintenance, rolling stock, track
  - maintenance, truck
  - power supply
- Finances
  - working capital
  - loans
  - receipts
  - profits
  - product-related costs
  - cost calculation models
- Personnel
  - wages/salaries
  - employee benefit costs
  - staff
  - ex gratia payments.

For routine inquiries non-varying pictures are made available; parameter-driven inquiries cause interactive data exchange.
DSS are parts of the Management Information System (MIS) which are to meet the following functions:

- optimisation of the electronic reporting;
- forecast calculations;
- weighting and compacting of information;
- provision of controlling data;
- early warning system in case of deviating sequences, code digits;
- reception of external data and information;
- numbers and graphics-oriented provision of reports.

The following figure shows the modules of a development environment for MIS.

Figure 1.7-3


client
server
architecture
PC
systems
spreadsheet
systems
personal
information
management
operating
system
platform
tool
programming
language
spreadsheet
systems
hyper text
systems
user
interface
data base
systems
generation
of
interfaces
Main
server

1.7.2.1.3.4 Technical solutions

A system featuring the following elements is proposed:

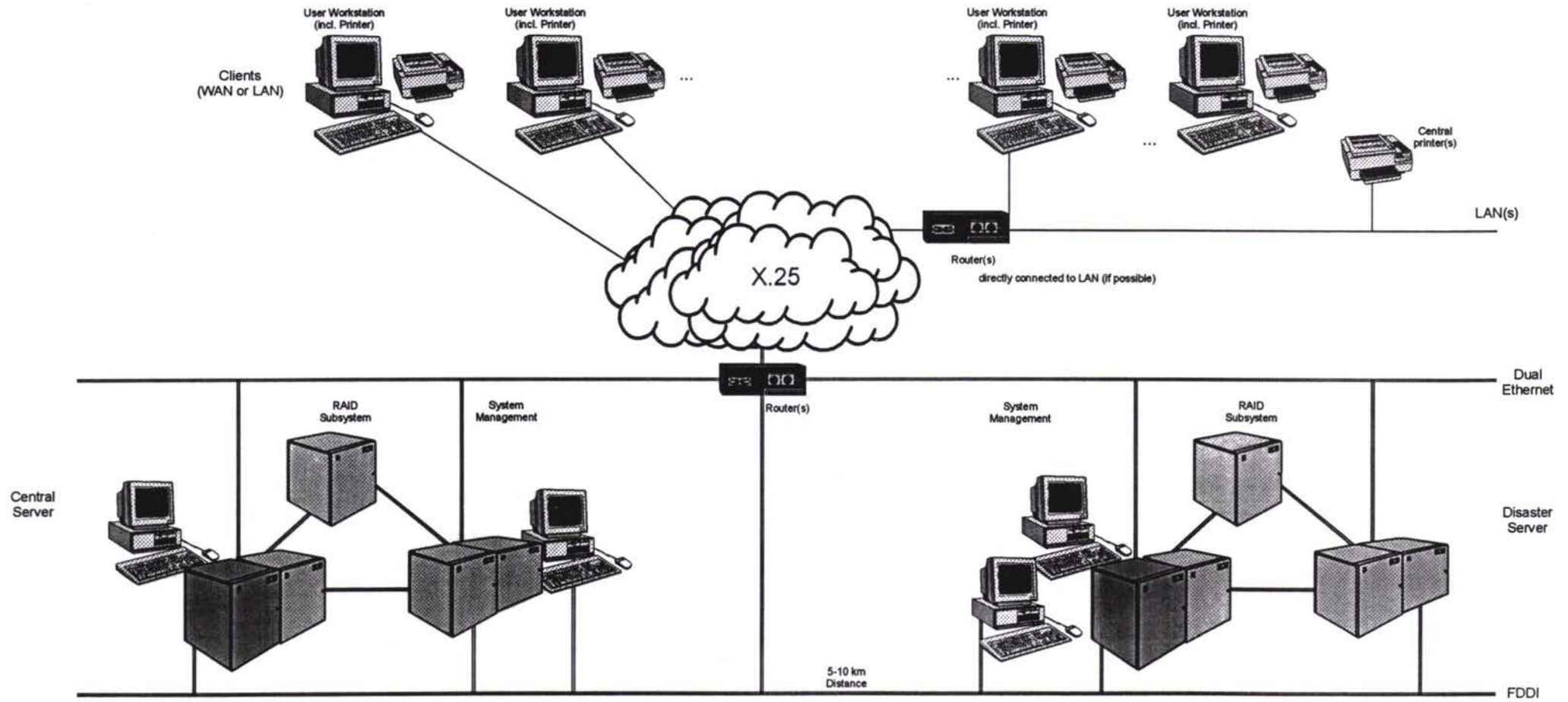
- Train management and marshalling yard management system (transport management information and control system for all operational processes with interfaces to the ASU OP of the Russian Railways);
- Invoicing and statistics system;
- marketing;
- container terminal system;
- operating company IS.

All customers (border stations, marshalling yards, container terminals and departments of the railway headquarters) are Windows-based workstations. Stand alone workstations are directly connected to WAN (optical fibre communication network). Two more workstations are connected to an LAN. The LAN WAN connection is established by one ore more router workstation(s) which communicate over the WAN with the central server.

The following figure shows the system architecture.

Figure 1.7-4

System architecture for the freight operation system



1.7.2.1.3.5 Computer application in passenger service

The development of international passenger traffic is a very slow one and the number of persons transported and the transport performance have decreased considerable. The passenger transport connections between Georgia and Armenia and Aserbaijan/Russia/Ukraine were not established until 1997.

Possible computer applications in passenger service are:

- ticket sale for long-distance and international traffic
- seat reservation for international trains
- information on passenger tariffs and train schedule

An application of computers can only be recommended for the ticket sale and seat reservation in international traffic. Therefore an LAN is needed each in Baku and Tbilisi and a counter-PC with interface to the Express Reservation System of the Russian Railways. The standard software RAILVISION seems to be a good solution for special conditions.

1.7.2.2 Armenian Railway

1.7.2.2.1 Signalling installations

Measures of 1st priority

During this period, the signalling installations will be repaired for the main track and a siding at the stations. The resulting demand for equipment is detailed in Annex 1.7-12. Furthermore, it will be necessary to take the following measures to improve the facilities of level crossings:

- replacement of 50 gate motors
- light signal lenses for road signals
- alarm installations

Measures of 2nd priority

During this period, all signalling installations of the stations will be fitted. The resulting demand for equipment is detailed in Annex 1.7-13. Furthermore, the existing track circuits are to be replaced gradually by axle counters. The necessary equipment was estimated roughly on the basis of the km of route and the existing track circuits.

Measures of 3rd priority

The existing provisional installations are to be replaced completely in this period, in order covers to meet the requirements for signalling installations arising from the expected increase in transport volume demand. The signalling installations fitted at this stage will consist of electronic signal boxes.

The construction of stations will be implemented in a few stages. The following table contains the demand for equipment required for stations. In addition, it will be necessary to replace some existing installations at level crossings completely by new installations.

Tab. 1.7-7: List of installations for the renewal of ARM stations

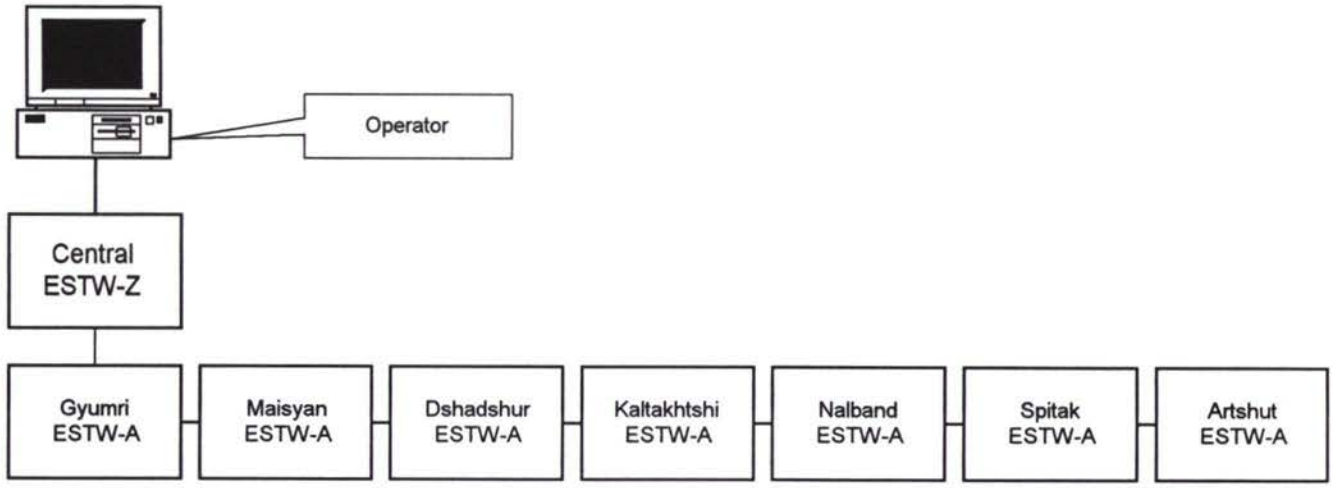
station name	km	switches	signals	presence of trains indicating equipment
		piece		
Artshut	2,662	4	19	6
Spitak	2,673	15	22	18
Nalband	2,683	6	17	12
Kaltakhtshi	2,693	7	18	11
Dshadshur	2,702	11	19	13
Maisyan	2,712	5	18	10
Gyumri	2,723	67	80	62
total		**115**	**193**	**132**

The following configuration is suggested for the construction of stations at the actual sites:

Gyumri	electronic signal box as centre
Artshut	electronic signal box as remote computer
Spitak	electronic signal box as remote computer
Nalband	electronic signal box as remote computer
Kaltakhtshi	electronic signal box as remote computer
Dshadshur	electronic signal box as remote computer
Maisyan	electronic signal box as remote computer

The remote computers may be controlled from the location of the electronic signal box centre.

Block diagram of the electronic signal boxes on the Gyumri - Artshut section



The sum of the signal box units of the electronic signal box centre is based on the existing stock of switches, signals and presence-of-trains indicating equipment of the individual stations. However, a change may arise with a view to the future transport volume.

1.7.2.2.2 Telecommunication installations

The use of optical wave-guide cables is envisaged for the Yerevan - Ayrum, Yerevan - Sotk, Masis - Yeraskh and Razdan - Ijevan sections for the reconstruction of the communication channel. To ensure full availability of the cable installation, two cables will be installed along the line. One glass fibre-cable with 12 fibres and a second cable with 6 fibres will be laid. The dimension of these cable already caters for the demand for communication channels in the future. One cable will be fixed to the poles of the catenary system along the line. The second cable will be laid underground. The suggestion for the type of laying is based on a cost estimate. Thus, laying the first cable along the poles of the catenary system will be more cost-efficient and reduce the period of assembly. The decision to lay the second cable underground is based on the fact that there is only a single-track line network in Armenia. It is furthermore necessary to choose separate cable channels for the two cables to increase their availability. Only one optical wave-guide cable with 12 fibres will be laid in the first six stages to achieve a faster availability of the channel. The second cable required for a ring structure will be laid when implementing longer-term measures. The optical wave-guide cable will be laid in several stages:

1st stage	Ayrum - Vanadzor section	71 km
2nd stage	Vanadzor - Gyumri section	70 km
3rd stage	Gyumri - Yerevan section	154 km
4th stage	Masis - Yeraskh section	60 km
5th stage	Yerevan - Sotk section	205 km
6th stage	Razdan - Ijevan section	125 km

The measures to be implemented during stages 1 - 3 on the Yerevan - Ayrum main line will be initiated in the next two years and laying the cable during the stages 4 - 6 will be considered in the measures to be implemented within the next 5 years.

Measures of 1st priority

During this period, stages 1 - 3 will be implemented.

1st section Ayrum - Vanadzor

- laying 71 km of optical wave-guide cable
- equipment of 10 stations with line terminal facilities
- equipment of 10 stations with PCM facilities

2nd section Vanadzor - Gyumri

- laying 70 km of optical wave-guide cable
- equipment of 7 stations with line terminal facilities
- equipment of 7 stations PCM facilities

3rd section Gyumri - Yerevan

- laying 154 km of optical wave-guide cable
- equipment of 16 stations with line terminal facilities
- equipment of 16 stations with PCM facilities

Measures of 2nd priority

In this period, stages 4 - 6 will be implemented.

4th section Masis - Yeraskh

- laying 60 km of optical wave-guide cable
- equipment of 5 stations with line terminal facilities
- equipment of 5 stations PCM facilities

5th section Yerevan - Sotk

- laying 205 km of optical wave-guide cable
- equipment of 15 stations with line terminal facilities
- equipment of 15 stations with PCM facilities

6th section Razdan - Ijevan

- laying 125 km of optical wave-guide cable
- equipment of 8 stations with line terminal facilities
- equipment of 8 stations with PCM facilities

Measures of 3rd priority

In this period, the second cable will be laid to establish a ring structure aimed at increasing the availability. The following measures will have to be carried out:

- laying 300 km of optical wave-guide cable in various sections on the main line Yerevan - Ayrum
- equipment of 9 junctions with the required facilities
- laying 390 km of optical wave-guide cable in the various sections on the other lines
- equipment of 6 junctions with the required facilities on the other lines

Train radio installations

To satisfy the increased demands on radio connections between the individual stations and the locomotive staff, new installations will be required for individual line sections.
In this case, the Train Radio 2002 system is suggested. The Train Radio 2002 system is a microcomputer-controlled radio system of a modular structure for the transmission of voice and data in accordance with West European standards.

The system provides for permanent line-side radio installations (FESA). They consist of radio stations and directional radio aerials fixed to concrete poles. When connecting operators of stations, so-called FADA installations (traffic controller installations) will be fitted.
ZÜV 2002 (supervision of train running) is an important part. It involves the installations for the responsible traffic controller, thus facilitating the transmission of information to the future control centre.
Traction units will have to be equipped with the MESA mobile railway radio installations. The shunting staff will use portable radio sets.

Tab. 1.7-8: Facilities of the ARM train radio stations

no.	facilities	unit	number
1	FESA	piece	34
2	FADA	piece	74
3	aerials	piece	34
4	poles	piece	34
5	switching buildings	piece	34
6	equipment of locomotives	piece	92
total			**302**

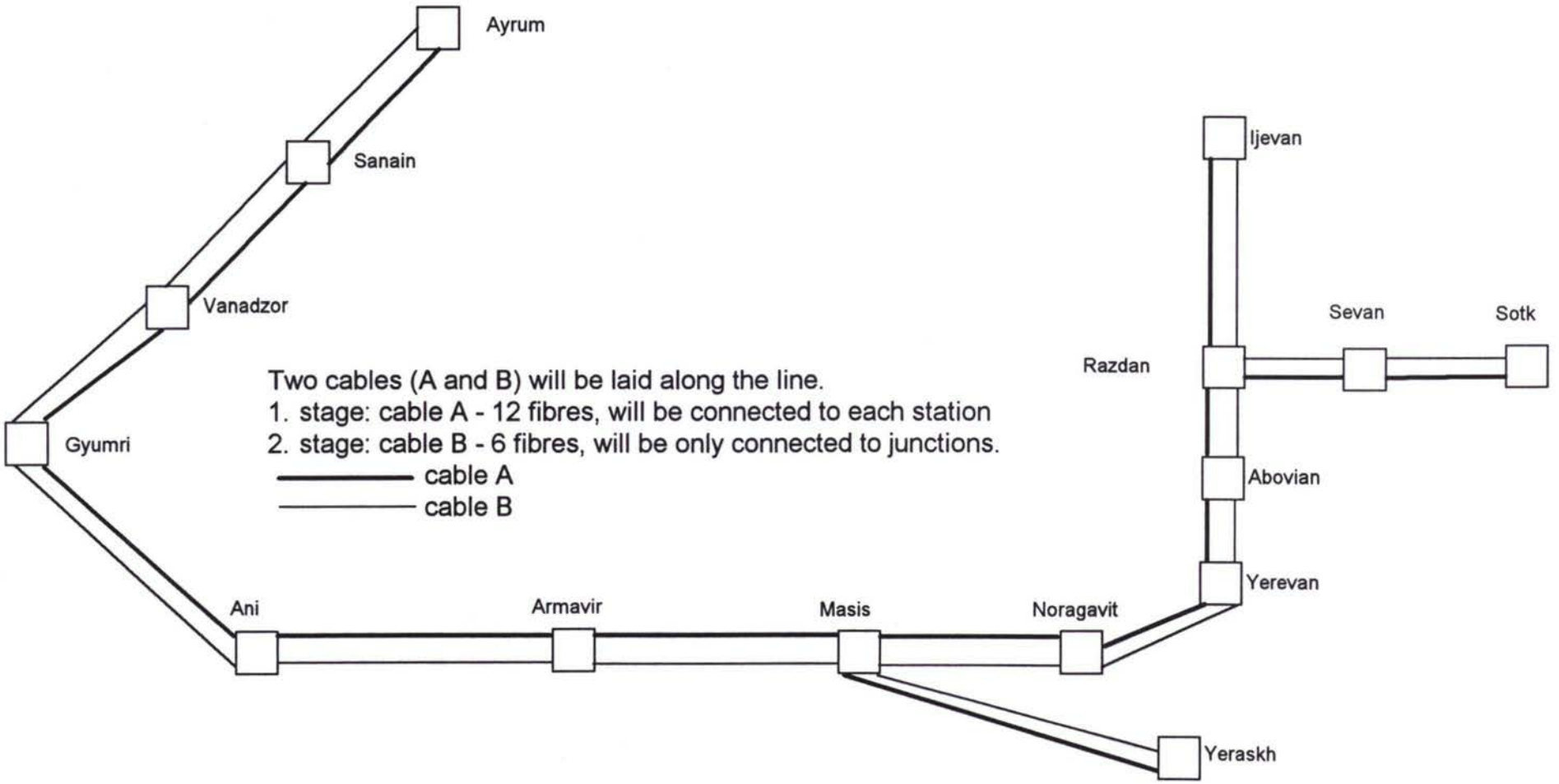
Exchanges

To satisfy the increased demands for telephone exchanges, the existing manual exchanges and automatic exchanges with analogue equipment will have to be replaced gradually by digital equipment. The extension of an exchange may be carried out in several stages, from a few subscribers up to 100,000 subscribers. The following demand for subscriber lines was determined for the size of individual exchanges:

Tab. 1.7-9: Connections for ARM exchanges

name of the station	subscriber (connections)
Yerevan	2,000
Gyumri	2,000
Sanain	400
Vanadzor	500
Ayrum	100
Masis	500
Razdan	200
Sevan	200
Charentsavan	200
total	**6,100**

Fig. 1.7-5: Structure of the transmission system including optical fibre cables of ARM



The necessary technical equipment and rolling stock for the railway sector are listed in the following tables:

Tab. 1.7-10: List of equipment for maintenance

no.	item	unit	number
1	measuring instruments for signalling installations	piece	70
2	measuring instruments for exchanges	piece	5
3	measuring instruments for telecommunication installations	piece	30
4	ohmmeter	piece	22
5	cable measuring instruments	piece	4
6	cable detectors	piece	4
7	equipment for cable assembly work	piece	10
8	pole climbers	pair	32
9	safety belts	piece	32
10	tool box, complete	piece	20
11	truckster	piece	12
12	truck with lifting gear	piece	3
13	small excavator	piece	2
14	cable trailer for cable laying	piece	2

1.7.2.3 Azerbaijan State Railways

1.7.2.3.1 Signalling installations

Measures of 1st, 2nd and 3rd priority

The complexity of the necessary measures for the rehabilitation of the full operability of the signalling installations requires their implementation over the entire period of investment.

Signals

- replacement of 113 complete light signals
- replacement of 180 complete ground signals
- replacement of 1,500 light signal systems of different design
- replacement of connection cable with 100 signals
- replacement of signal lamps with 500 signals
- replacement of 200 light signal panels
- new painting of all signals

Switches

- replacement of the electric motors with approximately 1,000 switch drives
- replacement of approximately 490 complete switch drives
- replacement of the internal wiring of approximately 500 switch drives
- replacement of the closing devices with 700 switch drives
- new painting of all switch drives

Track circuits

The connectors, connection ropes and the impedance bonds with secondary winding of the track circuit installations are to be replaced.
Replacement of 656 impedance bonds with secondary winding of different types.
Replacement of approximately 800 sets of connection ropes.

Level crossings

Regarding the barrier installations at the level crossings, the following parts have to be renewed:

- replacement of 150 barrier motors
- light signal systems for street signals
- bell installations

During the stages of 2nd and 3rd priority, 30 automatic barrier installations are planned to replace the existing installations. Furthermore, maintenance work on the installations for the power supply of the automatic blocks is necessary, such as renewal of the electric cables, replacement of the transformers and renewal of the poles for the power supply of the line. The installations at the stations listed in the following table are to be completely replaced by new ones during the stages of the 2nd and 3rd priorities.

Tab. 1.7-11: List of stations of AGZD to be renewed

station	km	year of construction	number of switches
Kasi-Magomed	417	1961	69
Mugan	405	1967	12
Gadshievo	391	1967	11
Kyrdamir	342	1968	30
Yevlakh	250	1966	53
Geran	225	1969	12
Kyurok-Tshai	214	1966	14
Beyuk-Kyassik	45	1975	47

Furthermore, due to the increase of the traffic density on the Baku - Beyuk-Kyassik line, it is necessary to replace the following signal boxes with manually operated switches by new ones. However, this measure will be decisively influenced by freight transport on the line from Baku to Georgia.

Tab. 1.7-12: Modernisation of the existing stations

station	km	year of construction	number of switches
Kyrdamir	342	1968	30
Alabashli	170	1963	30
Shamkir	159	1962	16
Dollyar	149	1962	21
Dsegam	136	1961	13
Kovlyar	122	1961	17

1.7.2.3.2 Telecommunication installations

The use of optical wave-guide cables is envisaged on the Baku - Beyuk-Kyassik, Baladshary - Yalama, Baladshary - Astara and Ali Bairamly - Sadarak sections for the reconstruction of the communication channel. To ensure full availability of the cable installation of Ali Bairamly - Imishli - Sadarak, two cables are envisaged for the line. One optical wave-guide cable with 12 fibres and a second cable with 6 fibres will be laid. On the Baku - Baladshary section, two cables with 24 fibres will be laid. Baladshary is a junction for the telecommunication region of the railway. The future demand for communication channels is already considered in this cable dimension. The cable between Baladshary and Beyuk-Kyassik will be fixed to the poles along the line of the catenary system. Laying the cable in the existing tube train tunnel is planned between Baku and Baladshary. This decision is based on the lower costs of fitting the cable to the poles of the catenary. It also takes into consideration the fact that suspending the cable will not affect the stability of the pole, which was confirmed by the competent department of the railway. Specific data relating to the condition of the catenary poles and a necessary replacement of individual poles are not available. In the cost estimate, it was assumed that the second cable should be laid underground. However, on double-track lines, it is possible to fix the cable on the opposite side of the catenary poles. Thus, the costs would be reduced. For the existing single-track sections, it was generally envisaged to lay the second cable underground. Only one optical wave-guide cable with 12 fibres or 24 fibres will be laid during the first six stages to achieve a faster availability of the channel. The second cable required for a ring structure will be included in the implementation of longer-term measures. The optical wave-guide cable will be laid in several stages:

1st stage	Akstafa - Beyuk-Kyassik section	46 km
2nd stage	Gyandsha - Akstafa section	95 km
3rd stage	Kasi-Magomed - Gyandsha section	235 km
4th stage	Baladshary - Kasi-Magomed section	102 km
5th stage	Baku - Baladshary section	25 km
6th stage	Baladshary - Yalama section	200 km
7th stage	Baladshary - Astara section	180 km
8th stage	Ali Bairamly - Imishli section	80 km
9th stage	Imishli - Sadarak section	410 km

The measures to be implemented during stages 1-5 on the Baku - Beyuk-Kyassik main line will be undertaken in the next two years and laying the cable during stages 6-9 will be considered in the measures to be implemented in the next 5 years.

Measures of 1st priority

Stages 1 - 5 will be implemented during this period.

1st section Akstafa - Beyuk-Kyassik

- laying 46 km of optical wave-guide cable
- equipment of 5 stations with line terminal facilities
- equipment of 5 stations with PCM facilities

2nd section Gyandsha - Akstafa

- laying 95 km of optical wave-guide cable
- equipment of 9 stations with line terminal facilities
- equipment of 9 stations with PCM facilities

3rd section Kasi-Magomed - Gyandsha

- laying 235 km of optical wave-guide cable
- equipment of 20 stations with line terminal facilities
- equipment of 20 stations with PCM facilities

4th section Baladshary - Kasi-Magomed

- laying 102 km of optical wave-guide cable
- equipment of 10 stations with line terminal facilities
- equipment of 10 stations with PCM facilities

5th section Baku - Baladshary

- laying 25 km of optical wave-guide cable
- equipment of 4 stations with line terminal facilities
- equipment of 4 stations with PCM facilities

Measures of 2nd priority

Stages 6 - 9 will be implemented in this period.

6th section Baladshary - Yalama

- laying 200 km of optical wave-guide cable
- equipment of 20 stations with line terminal facilities
- equipment of 20 stations with PCM facilities

7th section Baladshary - Astara

- laying 180 km of optical wave-guide cable
- equipment of 18 stations with line terminal facilities
- equipment of 18 stations with PCM facilities

8th section Ali Bairamly - Imishli

- laying 80 km of optical wave-guide cable
- equipment of 6 stations with line terminal facilities
- equipment of 6 stations with PCM facilities

9th section Imishli - Sadarak

- laying 410 km of optical wave-guide cable
- equipment of 41 stations with line terminal facilities
- equipment of 41 stations with PCM facilities

Measures of 3rd priority

In this period, the second cable will be laid to establish a ring structure increasing the availability. The following measures are necessary:

- laying 870 km of optical wave-guide cable in various sections on the Baku - Beyuk-Kyassik main line
- equipment of 8 junctions with the required facilities
- laying 460 km of optical wave-guide cable in the various section on the other lines
- equipment of 7 junctions with the required facilities on the other lines.

Train radio installations

To satisfy the increased demands on radio connections between the individual stations and the locomotive staff, new installations will be required for individual line sections. In this case, the Train Radio 2002 system is suggested. The Train Radio 2002 system is a microcomputer-controlled radio system of a modular structure for the transmission of voice and data in accordance with West European standards.

The system provides for permanent line-side radio installations (FESA). They consist of radio stations and directional radio aerials fixed to concrete poles. When connecting operators of stations, so-called FADA installations (traffic controller installations) will be fitted. ZÜV 2002 (supervision of train running) is an important part. It involves the installations for the responsible traffic controller, thus facilitating the transmission of information to the future control centre. Traction units will have to be equipped with the MESA mobile railway radio installations. The shunting staff will use portable radio sets.

Tab. 1.7-13: Facilities of AGZD train radio stations

no.	facilities	unit	number
1	FESA	piece	37
2	FADA	piece	77
3	aerials	piece	37
4	poles	piece	37
5	switching buildings	piece	37
6	equipment of locomotives	piece	100

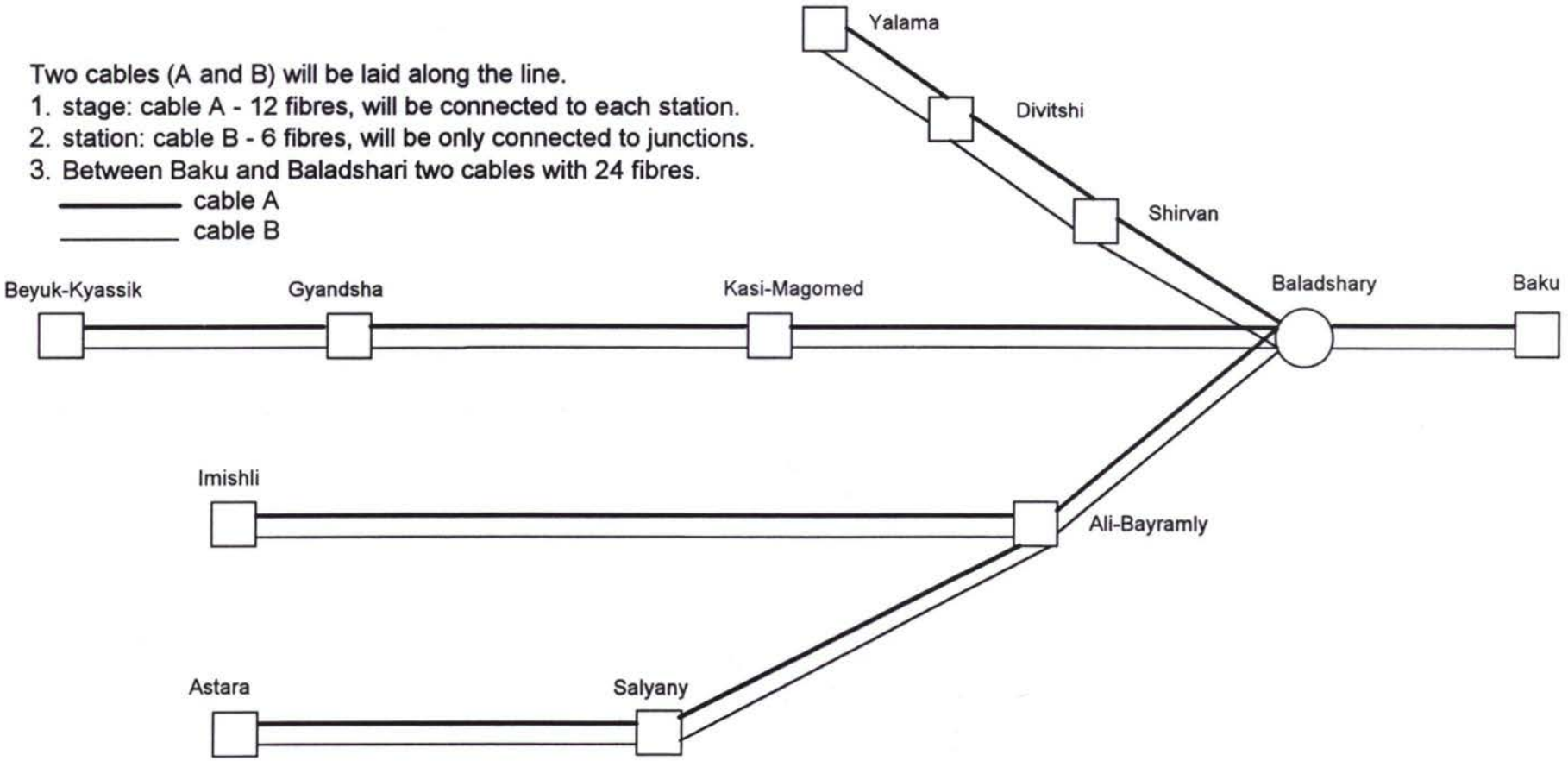
Exchanges

In order to satisfy the grown demands on telephone exchanges, it has become necessary to gradually replace the existing manual exchanges and automatic exchanges with analogue equipment by digital exchanges. An exchange may be extended in several stages, from a few subscribers up to 10,000 subscribers. The following demand for subscriber connections has been determined for the sizes of individual exchanges:

Tab. 1.7-14: Connections of AGZD exchanges

name of the station	subscriber (connections)
Baku administration	3,000
Baladshary	2,000
Baladshary settlement	1,500
Eybat	30
Puta	30
Karadag	100
Sangatshali	100
Duvanni	30
Aliat main station	500
Navagi	30
Kasi-Magomed	1,000
Padar	30
Sagiri	100
Kyrdamir	500
Udshari	300
Lyaki	100
Yevlakh	1,000
Geran	30
Dalimamedly	30
Gyandsha	3,000
Gyandsha settlement	400
Alabashli	30
Dollyar	50
Taus	50
Akstafa	500
Beyuk-Kyassik	300
line to Yalama	1,300
line to Astara	800
line to Sadarak	3,850
total	**20,690**

Fig. 1.7-6: Structure of the transmission system with optical fibre cables of AGZD



1.7.2.4 Georgian Railways

1.7.2.4.1 Signalling installations

Measures of 1st, 2nd and 3rd priority

The complexity of the necessary measures for the rehabilitation of the full operability of the signalling installations requires them to be implemented over the entire period of investment.

The replacement of the existing track circuits by axle-counter installations and their adaptation to the existing installations is planned as a medium-term measure.

Further measures are required for increasing the transparency of the line, such as the installation of the automatic block and the resulting necessary completion of the equipment.

The Georgian Railways have already commissioned the existing engineering office with the planning of projects on the Samtredia - Poti and Samtredia - Batumi sections. That means that the stations in these sections shall be put back into restricted operation again. semi-automated blocks will be installed between the stations. Existing exterior installations, destroyed by vandalism, will be decommissioned or repaired with available spare parts. In the Samtredia - Poti and Samtredia - Batumi sections, optical wave-guide cables provided by the EU were already installed by the signalling and telecommunication department. Adaptation sets were developed for the transmission of necessary information. However, there are no financial means available at the moment for implementing this measure. The respective demand is included in the cost estimate.

The following short-term measures on the individually listed parts are necessary for the rehabilitation of the full operability and the replacement of the dismantled signalling installations:

Signals

- replacement of 375 complete light signals
- replacement of 152 complete ground signals
- replacement of 1,700 light signal systems
- replacement of connection cable with 200 signals
- replacement of signal lamps with 700 signals
- new painting of all signals

Switches

- replacement of the electric motors on approximately 500 switch drives
- replacement of approximately 800 switch drives
- replacement of the internal wiring of approximately 1,200 switch drives
- replacement of the closing devices with 700 switch drives
- replacement of 400 complete switch drives
- new painting of all switch drives

Track circuits

1,750 impedance bonds with secondary winding and 1,600 connection ropes are to be replaced in the installations of the existing and functional track circuits . Complete equipment is required for 1,911 track circuits of the stations and for 2,226 track circuits of the sections.

Level crossings

The following parts are to be renewed on existing barrier installations at the level crossings:

- barrier motors
- light signal systems for street signals
- bell installations

It is necessary to completely renew the signalling installation of 42 former automatic barrier installations of the Georgian Railways, which are not operational due to the dismantling of various parts. Furthermore, maintenance work is necessary on the installations for the power supply of the automatic blocks, such as the renewal of the electric cables, replacement of the transformers and renewal of the poles for the power supply of the line. These costs are included in the required means for further repair measures. A second line in the Samtredia - Poti and Samtredia - Batumi section has to be built for the reserve provision of power supply.

1.7.2.4.2 Telecommunication installations

The use of optical wave-guide cables is envisaged on the Gardabani - Tbilisi - Poti/Batumi, Tbilisi - Sadakhlo sections as well as for the connections of the stations Kutaisi, Borshomi and the equipment of the Zkhakaia - Ingri section and further to Gatshiani for the reconstruction of the communication channel. Two cables are envisaged along the line in order to ensure full availability of the cable installation. One optical wave-guide cable with 12 fibres and a second cable with 6 fibres will be laid. The future demand for communication channels is already considered in this cable dimension. The cable will be fixed to the poles along the line of the catenary system. This decision is based on the lower cost in assembling the cable to the poles of the catenary. It also takes into consideration the fact that suspending the cable will not affect the stability of the pole, which was confirmed by the competent department of the railway. Specific data relating to the condition of the catenary poles and a nec-

essary replacement of individual poles resulting from it are not available. It was assumed in the cost estimate that the second cable should be laid underground. Only one optical wave-guide cable with 12 fibres will be laid during the first six stages in order to achieve a faster availability of the channel. The second cable required for a ring structure will be included in the implementation of longer-term measures. The optical wave-guide cable will be laid in several stages:

1st stage	Gardabani - Tbilisi section	35 km
2nd stage	Tbilisi - Khashuri section	126 km
3rd stage	Khashuri - Samtredia section	121 km
4th stage	Samtredia - Poti section	80 km
5th stage	Samtredia - Batumi section	120 km
6th stage	Rioni - Kutaisi section	10 km
7th stage	Khashuri - Borshomi section	30 km
8th stage	Tbilisi - Sadakhlo section	60 km
9th stage	Zkhakaia - Ingiri section	40 km
10th stage	Ingiri - Gatshiani section	200 km

The measures to be undertaken on the Gardabani - Tbilisi - Poti/Batumi main line in stages 1 - 5 will be initiated in the next two years and laying the cable during the 6th - 9th stages will be considered in the measures to be implemented in the next 5 years. In view of the political situation in the region, stage 10 will be included in the implementation of longer-term measures.

The optical wave-guide cables (4 fibres) already laid on the sections Samtredia - Batumi/Poti will be replaced by new cables in the framework of our project, after consulting experts of the Georgian Railways. The facilities used to fix the optical wave-guide cables do not correspond with the technical standards and the ideas of the railways. The optical wave-guide cables with 4 fibres removed may be laid on sidings not contained in the project.

Measures of 1st priority

During this period, stages 1 - 5 will be implemented.

1st section Gardabani - Tbilisi

- laying 36 km of optical wave-guide cable
- equipment of 8 stations with line terminal facilities
- equipment of 8 stations with PCM facilities

2nd section Tbilisi - Khashuri

- laying 126 km of optical wave-guide cable
- equipment of 17 stations with line terminal facilities
- equipment of 17 stations with PCM facilities

3rd section Khashuri - Samtredia

- laying 121 km of optical wave-guide cable
- equipment of 16 stations with line terminal facilities
- equipment of 16 stations with PCM facilities

4th section Samtredia - Poti

- laying 80 km of optical wave-guide cable
- equipment of 8 stations with line terminal facilities
- equipment of 8 stations with PCM facilities

5th section Samtredia - Batumi

- laying 120 km of optical wave-guide cable
- equipment of 14 stations with line terminal facilities
- equipment of 14 stations with PCM facilities

Measures of 2nd priority

In this period, stages 6 - 9 will be implemented.

6th section Rioni - Kutaisi

- laying 10 km of optical wave-guide cable
- equipment of 1 station with line terminal facilities
- equipment of 1 station with PCM facilities

7th section Khashuri - Borshomi

- laying 30 km of optical wave-guide cable
- equipment of 2 stations with line terminal facilities
- equipment of 2 stations with PCM facilities

8th section Tbilisi - Sadakhlo

- laying 60 km of optical wave-guide cable
- equipment of 5 stations with line terminal facilities
- equipment of 5 stations with PCM facilities

9th section Zkhakaia - Ingiri

- laying 40 km of optical wave-guide cable
- equipment of 4 stations with line terminal facilities
- equipment of 4 stations with PCM facilities

Measures of 3rd priority

In this period, the second cable will be laid to establish a ring structure in order to increase availability. The following measures are necessary:

10th section Ingiri - Gatshiani

- laying 200 km of optical wave-guide cable
- equipment of 19 stations with line terminal facilities
- equipment of 19 stations with PCM facilities

Laying of the second optical wave-guide cable

- laying 482 km of optical wave-guide cable in various sections on the Gardabani - Tbilisi - Poti/Batumi main line
- equipment of 11 junctions with the required facilities
- laying 340 km of optical wave-guide cable in the various section on the other lines
- equipment of 10 junctions with the required facilities on the other lines

Train radio installations:

To satisfy the increased demands on radio connections between the individual stations and the locomotive staff, new installations will be required for individual line sections. In this case, the Train Radio 2002 system is suggested. The Train Radio 2002 system is a microcomputer-controlled radio system of a modular structure for the transmission of voice and data in accordance with West European standards.

The system provides for permanent line-side radio installations (FESA). They consist of radio stations and directional radio aerials fixed to concrete poles. When connecting operators of stations, so-called FADA installations (traffic controller installations) will be fitted. ZÜV 2002 (supervision of train running) is an important part. It involves the installations for the responsible traffic controller, thus facilitating the transmission of information to the future control centre. Traction units will have to be equipped with the MESA mobile railway radio installations. The shunting staff will use portable radio sets.

Tab. 1.7-15: Equipment of GRZD train radio stations

no.	equipment	unit	number
1	FESA	piece	22
2	FADA	piece	79
3	aerials	piece	22
4	poles	piece	22
5	switching buildings	piece	22
6	equipment of locomotives	piece	100

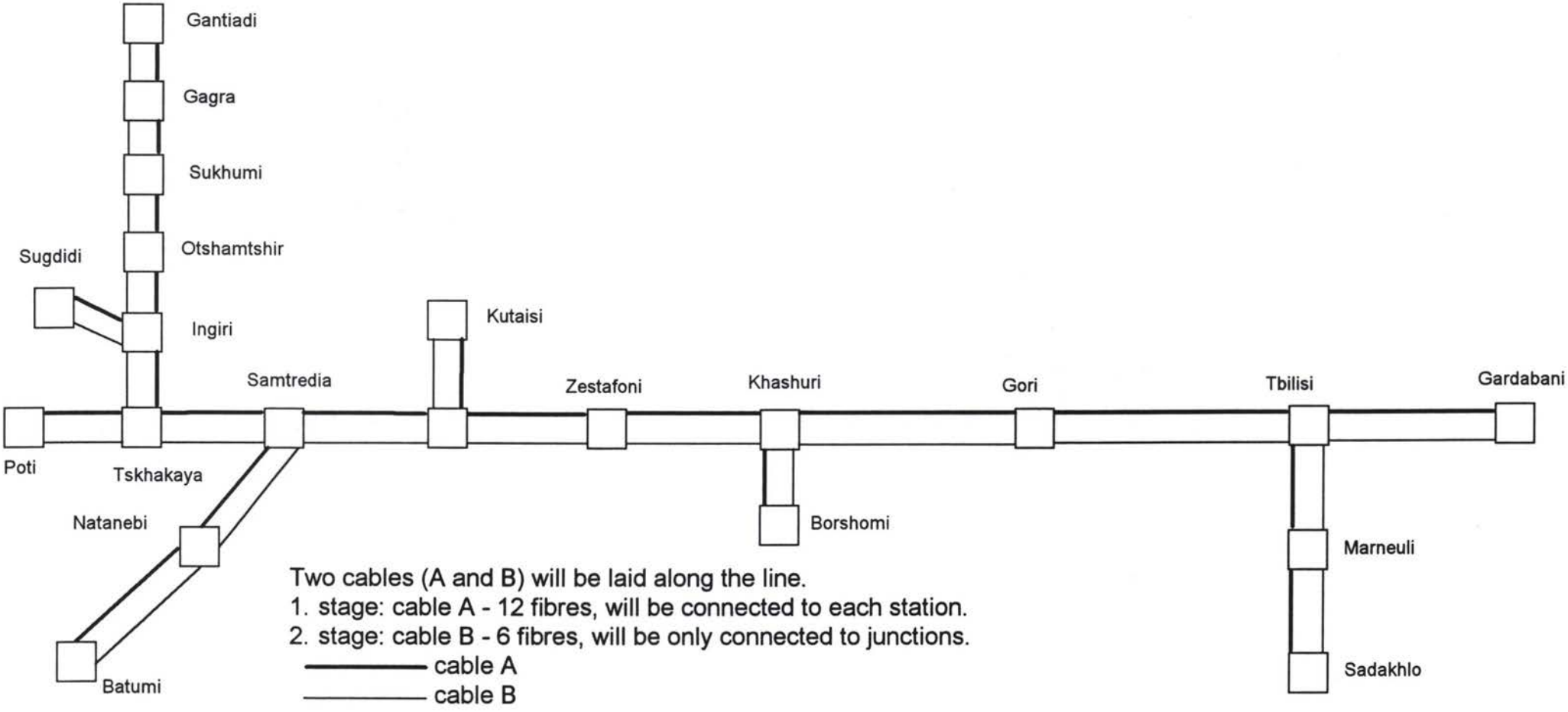
Exchanges:

In order to satisfy the grown demands on telephone exchanges, it has become necessary to gradually replace the existing manual exchanges and automatic exchanges with analogue equipment by digital exchanges. An exchange may be extended in several stages, from a few subscribers up to 10,000 subscribers. The following demands for subscriber connections has been determined for the sizes of individual exchanges:

Tab. 1.7-16: Connections for GRZD exchanges

name of the station	subscribers (connections)
Batumi	1,000
Poti	1,000
Senaki	400
Samtredia	3,000
Kutaisi	1,000
Zestafoni	500
Khashuri	3,000
Gori	500
Tbilisi	7,000
Rustavi	200
Gurdshaani	500
Marneuli	200
Borshomi	200
total	**18,500**

Fig. 1.7-7: Structure of the transmission system with optical fibre cable of GRZD



1.7.2.5 Supply of spare parts

Before political changes took place in the former Soviet Union, signalling equipment was produced in other Soviet republics. Signalling equipment was supplied to Caucasian countries and applied there. That is why the provision of spare parts and complete installations required for the signalling equipment is only possible from republics of the former Soviet Union.

There is no production in the field of signalling equipment in the Caucasian countries. Attempts have been made to contact existing factories and to negotiate on the production of spare parts. Components were handed over to factories as samples and their production was considered, e.g. the copper windings in the impedance bonds with secondary windings were replaced by aluminium windings and some impedance bonds with secondary windings were built for test purposes. However, the production of impedance bonds with secondary windings and further spare parts never started owing to a lack of financial funds.

As a result of the financial squeeze, spare parts have not been purchased in the last few years and the structural elements required for repair and maintenance have not been complemented. The required spare parts were taken from waste material and regenerated.

It is planned for Georgia that the TEWS company will produce spare parts for the signalling installations as for instance parts of the electric switch drive, signal panels and impedance bonds. Samples of the parts to be produced were handed to TEWS for that purpose. At present it is being examined which of the available machines can be used and where the production has to be reorganised according to the new requirements. After having carried out this measure and in accordance with contractual agreements, TEWS will be able to take on the production of spare parts for the Azerbaijan and Armenian Railways, too.

1.7.2.6 The rehabilitation plan for signalling and telecommunication

The following two tables contain a survey of the rehabilitation plan for signalling and telecommunication for the Caucasian railways.

Tab. 1.7-17: Rehabilitation plan signalling

signalling installations		measures		
		1st priority	2nd priority	3rd priority
ARM				
spare parts for DC circuits	piece	858	574	
switch mechanisms	piece	955	782	
constructional elements for switch mechanisms	piece	113	46	
spare parts for signals	piece	503	2,613	
assembly accessories for signals and switch mechanisms in m	piece	13,200	7,000	
spare parts for power supply	piece	14,688	1,016	
signalling cable	m	3,510	7,300	
electronic signal box	piece			7
AGZD				
light signals	piece	40	39	34
ground signals	piece	70	60	50
light signal lenses	piece	600	500	400
light signal panels	piece	100	50	50
electric motors for switch motors	piece	400	300	300
switch mechanisms	piece	200	150	140
impedance bonds with secondary winding	piece	300	200	156
sets for connection drops and connectors	piece	400	250	150
signalling cable	m	5,000	15,000	10,000
axle-counter equipment	piece	167	500	703
barrier motors	piece	60	50	40
GRZD				
light signals	piece	170	125	80
ground signals	piece	70	50	32
light signal lenses	piece	700	600	400
light signal panels	piece	150	125	75
electric motors for switch motors	piece	200	150	150
switch mechanisms	piece	200	100	100
impedance bonds with secondary winding	piece	800	700	250
sets for connection drops and connectors	piece	800	550	250
signalling cable	m	5,000	15,000	15,000
axle-counter equipment	piece	400	600	860
barrier motors	piece	30	20	10

Tab. 1.7-18: Rehabilitation plan telecommunication

telecommunication installations		measures		
		1st priority	2nd priority	3rd priority
ARM				
channel				
• optical wave-guide cable	km	295	390	1,080
• line terminal facilities	piece	33	28	15
• PCM facilities	piece	33	28	15
train radio installations				
• FESA	piece			34
• FADA	piece			74
• aerials	piece			34
• poles	piece			34
• switching buildings	piece			34
• equipment of locomotives	piece			92
exchanges	connections			6,100
AGZD				
channel				
• optical wave-guide cable	km	503	1,373	1,330
• line terminal facilities	piece	48	85	15
• PCM facilities	piece	48	85	15
train radio installations				
• FESA	piece			37
• FADA	piece			77
• aerials	piece			37
• poles	piece			37
• switching buildings	piece			37
• equipment of locomotives	piece			100
exchanges	connections			20,690
GRZD				
channel				
• optical wave-guide cable	km	482	140	1,085
• line terminal facilities	piece	63	12	40
• PCM facilities	piece	63	12	40
train radio installations				
• FESA	piece			22
• FADA	piece			79
• aerials	piece			22
• poles	piece			22
• switching buildings	piece			22
• equipment of locomotives	piece			100
exchanges	connections			18,500

1.7.3 Rehabilitation plan power supply

Generally, for the rehabilitation of power supply system the following approach was used:

- Organise a continuously spare part supply
- Organise a supply with measurement equipment, instruments and personnel safety equipment
- Organise a dispatching system
- Organise the replacement of main equipment for substations
- Organise the replacement of overhead lines
- Develop rules and regulations for maintenance and inspections
- Develop training programmes for staff and supervision personnel
- Organise reconstruction of workshops
- Reconstruction of the OCS system
- Reconstruction of autoblocking system
- Reconstruction of the dispatching lines (SCADA)
- Reconstruction of communications
- Reconstruction of power supply substations
- Reconstruction of feeding lines
- Develop maintenance philosophies, based on new requirements

1.7.3.1 Armenian Railway

The future of ARM as an electrified railway is undecided. Basic decisions not have been taken by the respective state authorities. Therefore urgent measures for safe-guarding the present operational situation have been included to the rehabilitation plan for the ARM power supply only.

Requirement of main deficit equipment and material

The following table shows the main deficiency of equipment and spare parts for the Armenian Railway. This will be the necessary requirement for a short term rehabilitation. Without investigations for the restoration of the power supply system, the found system may be workable as maximum for the next year. From technical point of view many substations does not fulfil the requirements of safety work, because of the above mentioned (see also: Main weak points of the power supply system).

Tab. 1.7-19: List and requirement of main deficit equipment and material

no	equipment	type	demand
1	Transformer oil		400 t
2	Battery sets (160 Ah)		30
3	LV cables [mm^2]	3 x 16 + 1 x12	1 km
		3 x 25 + 1 x16	1 km
		3 x 35 + 1 x16	1 km
		3 x 50 + 1 x25	1 km
		3 x 95 + 1 x35	1 km
		3 x 70 + 1 x35	1 km
		3 x 120 +1x70	1 km
4	HV cables [mm^2]	AAB 3 x 50	1 km
		AAB 3 x 70	1 km
5	Diodes VL 200		400
6	Relays	RT- 40/10	200
		RT- 40/ 6	200
		RT- 40/ 2	200
7	Signal Lamps	200/ 20, 8W	1,200
8	Transit insulators	pin-type	100
	Transit insulators	post-type	100
9	Current transformer	400/ 5	40
		300/ 5	40
		200/ 5	40
		100/ 5	40
10	Voltage transformer	6 kV	60
		10 kV	60
		35 kV	45
11	Overhead contact wire	MF- 100	20 t
12	Carrying cable	M-120	20 t
13	Steel-cored aluminium cable	AS- 70	15 t
14	High speed circuit breaker	VAB- 43	60
15	Motor drive		40
16	Isolating switch	RLND 10 kV	120
17	OCS circuit breaker	A 4000	100
18	Diesel engine	U1B6- 250 TK-S4	7
19	Lorry diesel engine	MAS	1
20	Lorry diesel engine	KAMAS	1
21	OCS pools		80
22	Transformer sets	OM 1.25 kVA	25
		25 kVA	8
		40 kVA	3
		63 kVA	3
		100 kVA	3
		160 kVA	3
		250 kVA	3
		400 kVA	5
		630 kVA	3

23	Time relay	RV 220	40
24	OCS maintenance vehicle		1
25	Multi tester (U,I,R)		100
26	Measurement equipment (U,I)		150
27	1 phase electricity meter		20
	3 phase electricity meter		50
28	Auxiliary transformer		30
29	Regeneration equipment for transformer oil		1
30	HV automatic blockage cable for LEP 10kV		150 km
31	Maintenance/ incidents cars	LADA	3

1.7.3.2 Azerbaijan State Railways

In accordance with the requirements for the Azerbaijan State Railways a detailed investigation plan for the next 10 years was developed. This plan was established in direct co-operation with the counterparts. The situation of the railway allows to fulfil the operational requirements, but because of the advanced average age of the equipment and system components a replacement of spare parts and equipment must be organised for the next years.

Required rehabilitation of main equipment and material

A list of demand for equipment and materials has been prepared.

The following table describes the demand of components for the overhead contact system. Main components are the concrete support with bracket system with isolators for fixation of the contact wire and carrying cables. Additional switching equipment, motor drives, earthing diodes, etc. are components of the catenary system. The table gives the demand according to the different priorities.

Tab. 1.7-20: List of demand for main equipment and materials for OCS System

no.	equipment/material	unit	demand			
			1. priority	2. priority	3. priority	total
1	Reinforced concrete supports SO-136,6	pcs.	500	1,500	2,500	4,500
2	Contact wire MF-100	t/ km	20	100	320	320
3	Carrying cable M-120	t/ km	20	100	320	320
4	Copper cable MGG- 95 (95 mm^2)	t/ km	10	20	80	80
5	Copper cable MGG- 120 (120 mm^2)	t/ km	10	20	80	80
6	OCS insulators IKSU- 27,5 kV	pcs.	1,000	5,000	16,000	16,000
7	Section isolators SI-2	pcs.	100	200	500	500
8	Isolators					
–	Type 1500/PF60-B , disk isolator	pcs.	2,000	5,000	17,000	17,000
–	Type PTF 70	pcs.	2,000	5,000	17,000	17,000

9	Safety shield equipment	pcs.	100	100	300	300
10	Circuit insulators RKS- 3,3/400	pcs.	50	100	350	350
11	Steel-cored cable AS- 70	t/ km	50	200	750	750
12	Earthing diodes DS	pcs.	100	200	600	600
13	Arc horn IMP-62	pcs.	500	500	2,000	2,000
14	Post bracket non-isolated	pcs.	500	1,000	3,500	3,500
15	Post bracket galvanised	pcs.	500	1,000	3,500	3,500
16	Additional bracket	pcs.	1,000	2,000	3,000	6,000
17	Motor drive UMP-P	pcs.	50	50	100	200
	OCS Insulators	pcs.	100	100	100	300
	Details for catenary system					
–	KS- 008-76	pcs.	500	1,000	3,000	4,500
–	KS- 009- 76	pcs.	500	1,000	3,000	4,500
–	KS- 011- 76	pcs.	500	1,000	3,000	4,500
–	KS- 013- 76	pcs.	500	1,000	3,000	4,500
–	KS- 040- 76	pcs.	500	1,000	3,000	4,500
–	KS- 041- 76	pcs.	500	1,000	3,000	4,500
–	KS- 043- 76	pcs.	500	1,000	3,000	4,500
–	KS- 046- 76	pcs.	500	1,000	3,000	4,500
–	KS- 049- 76	pcs.	500	1,000	3,000	4,500
–	KS- 053- 76	pcs.	500	1,000	3,000	4,500
–	KS- 054- 76	pcs.	500	1,000	3,000	4,500
–	KS- 055- 76	pcs.	500	1,000	3,000	4,500
–	KS- 059- 76	pcs.	500	1,000	3,000	4,500
–	KS- 061- 76	pcs.	500	1,000	3,000	4,500
–	KS- 063- 76	pcs.	500	1,000	3,000	4,500
–	KS- 066- 76	pcs.	500	1,000	3,000	4,500
–	KS- 069- 76	pcs.	500	1,000	3,000	4,500
–	KS- 075- 76	pcs.	500	1,000	3,000	4,500
–	KS- 0106- 76	pcs.	500	1,000	3,000	4,500
–	KS- 109- 76	pcs.	500	1,000	3,000	4,500
–	KS- 108- 76	pcs.	500	1,000	3,000	4,500
–	KS- 124- 76	pcs.	500	1,000	3,000	4,500
–	KS- 126- 76	pcs.	500	1,000	3,000	4,500
–	KS- 161- 76	pcs.	500	1,000	3,000	4,500
20	OCS moving iron	pcs.	50	100	200	350
21	Employee tool pack	unit	50	100	200	350

The demand of the autoblocking power supply system, used by signalling/telecommunication department of the Railway, is given in the next table. It consists of supports with brackets, one phasing transformer sets, cables and switches. The power supply for the autoblocking system will be organised by transformer sets, which will transform the feeding voltages (6 or 10 kV AC) to 230 V AC. The table is subdivided into the different periods of priority.

Tab. 1.7-21: List of demand for main equipment and materials for autoblocking systems

no.	equipment/material	unit	demand			
			1. priority	2. priority	3. priority	total
1	Supports for autoblocking system 10.2	pcs.	500	1,500	2,500	4,500
2	Porcelain isolator ShF- 20	pcs.	1,000	2,000	5,000	8,000
3	Steel-cored cable AS-35	t/ km	100	200	400	500
4	Insulating switch 3-pol. RLND	pcs.	50	100	300	450
5	Auxiliary transformer					
6	OM-1.25- 10/0.23 kV	pcs.	200	300	300	800
7	OM-1.25- 6.0/0.23 kV	pcs.	200	300	300	800
8	Wooden bracket (2 step)	pcs.	100	200	400	700
9	Wooden bracket (4 step)	pcs.	100	200	400	700
	Wooden pole 8.5 m	pcs.	200	500	1,000	1,700
	Armoured cable 10 kV					
–	ASB-3 x 70	km	10	20	50	80
–	ASB 3 x 95	km	10	20	50	80
–	ASB 3 x 50	km	10	20	50	80
10	Combined isolating switch PKN- 10	pcs.	200	500	1,000	1,700
11	LV cable 3 x 70 + 1 x 25	t/ km	10	20	50	80

The following table contains the demand of equipment components for the traction power substations.

Tab. 1.7-22: List of demand for main equipment and materials for traction power substation

no.	equipment/material	unit	demand			
			1. priority	2. priority	3. priority	total
1	Rectifier unit 12-pulse TPED or TPDP	unit	10	20	50	80
2	Traction power transformer TDN-10,000/110/10	pcs.	10	20	30	60
3	High speed circuit breaker VAB 43	pcs.	40	80	80	200
4	Circuit breaker 10 kV, VMP- 10	pcs.	10	20	50	80
5	Circuit breaker 35 kV, MKP- 35	pcs.	10	20	20	50
6	Oil circuit breaker VMT- 110	pcs.	2	3	5	10
7	Voltage transformer NTMI- 10	pcs.	50	50	100	200
8	Short circuit device KS- 110	pcs.	20	20	40	80
9	Disconnecting switch OD- 110	pcs.	20	20	60	100

The demand for the energy section consists of cables and wooden poles. The following table contains the demand for the next years.

Tab. 1.7-23: List of demand for main equipment and materials for energy section

no.	equipment/material	unit	demand			
			1. priority	2. priority	3. priority	total
1	Wooden poles 8.5 m	pcs.	200	500	1,000	1,700
2	Steel- cored cable					
–	AS- 35	t/ km	100	100	200	400
–	AS- 50	t/ km	100	100	200	400
–	AS- 70	t/ km	50	100	200	350
3	Isolators					
–	Sh- 20	pcs.	500	2,000	2,000	4,500
–	TF- 20	pcs.	2,000	2,000	2,000	6,000
4	HV cable 10 kV					
–	AAB 3 x 50	km	10	20	50	80
–	AAB 3 x 95	km	10	20	50	80
–	ABB 3 x 120	km	10	20	50	80

The demand for the energy section consists of motor inspection vehicles and cranes. The following table contains the demand for the next years.

Tab. 1.7-24: List of demand for main equipment and materials for transport section

no.	equipment/material	unit	demand			
			1. priority	2. priority	3. priority	total
1	Motor inspection vehicle ADM	pcs.	5	5	5	15
2	Motor inspection vehicle AGV	pcs.	5	5	5	15
3	Motor vehicle on base GAS 66	pcs.	5	5	10	20
4	Driller for foundations	pcs.	2	2	2	6
5	Motor driving crane	pcs.	5	5	5	15
6	Support installation crane	pcs.	1	2	5	8
7	Railway driving crane	pcs.	1	1	1	3

1.7.3.3 Georgian Railways

In accordance with the requirements for the Georgian Railways a detailed investment plan for the next 10 years was developed. This plan was established in direct co-operation with the counterparts. The situation of the railway allows to fulfil the operational requirements, but because of the average age of the equipment and system components must be organised a replacement of spare parts and equipment for the next years.

Required rehabilitation for main equipment

The following table contains the demand of components for the overhead contact system as well as for the power supply substations of the Georgian Railways.

Tab. 1.7-25: List of requirements of main deficit equipment and material

no	equipment	type	unit	demand
1	Contact wire	MF- 100	t/km	60.0
2	Carrying cable	M-120	t/km	5.0
3	Carrying cable (bimetal.)	PBSM- 70	t/km	20.0
4	Steel-cored cable 70 mm^2	AS- 70	t/km	30.0
5	Steel-cored cable 50 mm^2	AS- 50	t/km	30.0
6	Aluminium cable 185 mm^2	A- 185	t/km	20.0
7	Copper cable	MGG -95	t/km	5.0
8	Control cable	AKPSVT	t/km	10.0
9	Auxiliary transformer 6 and 10 kV	OM- 1.25 to 2,5 kVA	pcs.	60
10	Auxiliary transformer 6 and 10 kV	OM- 4.0 to 10.0 kVA	pcs.	20
11	OCS disconnecting switch	PS- 3000	pcs.	30
12	Motor drives for 11.	UMP-II	pcs.	30
13	OCS Isolators	PF- 70-A	pcs.	4,000
14	OCS Isolators	SF- 70-A	pcs.	2,000
15	Isolators for 10 kV	ShF- 20	pcs.	4,000
16	Disconnecting switch	RLND-10	pcs.	30
17	Transformer 6 and 10 kV	KTP 25 to 100 kVA	pcs.	30
18	OCS inspection car	Murot	pcs.	6
19	Motor cars	GAS 66	pcs.	6

The following table give the demand of equipment components for the traction power substations as well as for the catenary system.

Tab. 1.7-26: List of requirements for traction power substations

No.	Equipment	Type	Demand	Required			
				urgent	1. priority	2. priority	3. priority
1	Traction power transformer	TDN-10,000/ 100	13	3	2	2	6
2	Auxiliary transformer	TM- 250-35/0.23	2	2			
3	Auxiliary transformer	TM-250-10/0.4	10	2	4	4	
4	Auxiliary transformer	TM-250-10/0.4	6	1	3	2	
5	Circuit breaker	MKP- 110 M	16	6	2	3	5
6	Circuit breaker	VMD- 35	1	1			
7	Circuit breaker	VMD- 10	36	13	10	10	
8	Disconnecting switch	RLND- 110	120	60	20	20	20
9	Disconnecting switch	RLN- 35	20	20			
10	Voltage transformer	NKF- 110	18	18			
11	Voltage transformer	SNOM- 35	5	5			
12	Voltage transformer	NTMI- 10	20	20			
13	Voltage transformer	NTMI- 6	15	15			
14	Disconnectors	RVS- 110	4	4			
15	Circuit breaker RU- 10 kV	VMG -133	20	20			
16	Circuit breaker RU- 10 kV	VMP- 10	30	30			
17	Circuit breaker RU- 3.3 kV		40	20	10	10	
18	Rectifier units	UVKE, PVE-3.5 VIPE	22	4	4	4	10
19	High speed circuit breaker	VAB 28	30	30			
20	High speed circuit breaker	VAB 43- 4000	10	10			
21	Battery sets	SK 6-12	35	20	5	10	
22	Charger units	VU-24, VASP	20	10	5	5	
23	Filter units	FU	10	2	4	4	
24	Signalling lamps 110V, 8W	SZ-21	8000	2000	2000	2000	2000
25	Signalling lamps 220V, 15W	RNZ	3500	1000	500	1000	1000
26	Measurement equipment Kilo- Ammeter DC	M-1611/ 4 kV	300	100	50	50	100
27	Measurement equipment Kilo- Voltmeter DC	M1611/ 4 kV	300	100	50	50	100
28	Relay units	PT, RNT, RP, RU	600	200	100	100	100
29	HV cables	3 x 240 mm^2	1.5 km	1.5			
30	HV cables	AS- 120	10 km	10			

31	Diodes	VL-200-10B	10,000	2000	2000	2000	4000
32	Transformer oil		720 t	120	120	240	240
33	Transformer acid		25 t	5	5	5	10
34	OCS inspection vehicle	LIK 10 M	6	3	1	2	

1.7.3.4 Short summary of rehabilitation plan for power supply

The following table gives a short summary of the rehabilitation plan for the power supply system of the three Caucasian railways.

Tab. 1.7-27: Rehabilitation plan for power supply

rehabilitation work	demand			
	urgent	1. priority	2. priority	3. priority
ARM				
battery sets	30			
1 phase power transformer	56			
auxiliary transformer	30			
voltage transformer	165			
current transformer	160			
relays, insulators	240			
high speed circuit breaker	60			
cables [km]	160			
rectifier diodes	400			
OCS switches, breaker	220			
OCS cable and wire [t/km]	55			
transformer oil in t	400			
measurement equipment	320			
AGZD				
traction power transformer		10	20	30
auxiliary transformer		400	600	600
voltage transformer		50	50	100
high speed circuit breaker		40	80	80
circuit breaker		22	43	75
rectifier units		10	20	50
cables [km]		30	60	150
switches, breaker		40	40	100
OCS insulators; isolators		5100	15100	30100
OCS cable and wire [t/km]		60	240	800
OCS supports		500	1500	2500
earthing diodes		100	200	600

GRZD				
battery sets	20	5	10	
traction power transformer	3	2	2	6
auxiliary transformer	5	7	6	
voltage transformer	58			
high speed circuit breaker	40			
circuit breaker	20	12	13	5
circuit breaker RU	70	10	10	
cables [km]	10.5			
switches	80	20	20	20
relays	200	100	100	100
measurement equipment	200	100	100	200
rectifier units	4	4	4	10
rectifier diodes	2000	2000	2000	4000
transformer oil in t	120	120	240	240

1.7.4 Rehabilitation plan stations

The railway network and its facilities have to be adapted according to the projected traffic volume needs; the extensive track layouts at some stations; especially at the marshalling yards, should be rationalised. The viability of branch lines and wayside stations should be assessed.

Taking into account the urgent need for rationalisation and adaptation of the railway network and its facilities to the projected traffic volume needs, the investment measures and the repair work listed in Annexes 1.7-14 to 1.7-16 and summarised in the following sections do not reflect the overall requirements, because there is also a demand for repair work at other stations outside the main railway corridors selected.

1.7.4.1 Armenian Railway

Based on the detailed analysis of present conditions of freight and passenger stations and the volume of present and future freight and passenger traffic in section 1.4.1 repair work is required or planned for tracks, facilities for freight loading and unloading, station buildings, platforms and other facilities for passenger traffic as listed in Annex 1.7-14.

First priority should be given to the main line Ayrum - Gyumri - Masis - Yerevan.

1.7.4.2 Azerbaijan State Railways

Based on the detailed analysis of present conditions of freight and passenger stations in section 1.4.2 and the volume of present and future freight and passenger traffic repair work is required or planned for tracks, facilities for freight loading and unloading, station buildings, platforms and other facilities for passenger traffic as listed in Annex 1.7-15.

In accordance with the present number of trains per section, the priority has been determined: First priority is given to the transit line (Poti - Tbilisi) - Beyuk-Kyasik - Baku, especially to the section Yevlakh - Kasi Magomed - Aliat - Baladshary.

1.7.4.3 Georgian Railways

Based on the detailed analysis of present conditions of freight and passenger stations in section 1.4.3 and the volume of present and future freight and passenger traffic repair work is required or planned for tracks, facilities for freight loading and unloading, station buildings, platforms and other facilities for passenger traffic as listed in Annex 1.7-16.

In line with the priority determined for the Azerbaijan State Railways, priority is also given to the transit line Poti / Batumi - Tbilisi - Gardabani - (Baku). In the first phase, the stations Batumi (without track relaying work) Poti, Samtredia, Gori, Tbilisi Tov., Tbilisi Pass. (only station building, platforms and other facilities for passenger traffic)

and the border station Gardabani as well as the border station to Armenia, Sadakhlo, should be rehabilitated.

1.7.4.4 Summary of rehabilitation plan stations

The following table gives a survey over rehabilitation plan stations for the Caucasian Railways.

Tab. 1.7-28: Rehabilitation plan stations

rehabilitation work	measures		
	1. priority	2. priority	3. priority
ARM			
Tracks	35,6 km	5,3 km	11,8 km
Facilities for freight loading and unloading	4	4	5
Station building, platforms and other facilities for passenger traffic	7	5	5
AGZD			
Tracks	25,9 km	12,7 km	20,1 km
Facilities for freight loading and unloading)	4	1	2
Station building, platforms and other facilities for passenger traffic	7	5	5
GRZD			
Tracks	Rehabilitation	Rehabilitation	Rehabilitation
Facilities for freight loading and unloading)	3	n/a	2
Station building, platforms and other facilities for passenger traffic	8	2	3

1.7.5 Rehabilitation plan container terminals

1.7.5.1 Armenian Railway

In Armenia four railway container terminals exist. For three of them, Karmir Blur, Gyumri and Vanadzor, rehabilitation measures are included in the respective plan.

Karmir Blur:
General overhaul of the gantry crane; procurement of a 40 ft spreader; rehabilitation of lighting installation and electrical supply system (see also Annex 1.5-3).

Gyumri:
Repair of fencing and road access; general overhaul of the gantry crane (see also Annex 1.5-1).

Vanadzor:
General overhaul of the gantry crane; repair of storage area and fencing (see also Annex 1.5-4).

1.7.5.2 Azerbaijan State Railways

In Azerbaijan three railway container terminals exist. For two of them, Kishli-Baku and Gyandsha, rehabilitation measures are included in the respective plan.

Kishli-Baku:
Various repairs (see also Annex 1.5-5).

Gyandsha:
Purchase of one reach stacker for the container terminal (see also Annex 1.5-6).

1.7.5.3 Georgian Railways

In Georgia three railway container terminals exist. For all of them (Gori, Samtredia, Tbilisi-Tovarnaya) and for the port container terminals in Poti and Batumi rehabilitation measures are included in the respective plan.

Gori:
Repair of the warehouse (see also Annex 1.5-8).

Samtredia:
Repair of the craneway and the contact wire; purchase of 300 m wire for the crane (see also Annex 1.5-9).

Tbilisi-Tovarnaya:
Repair of three cranes; repair of craneways; repair and paint of the gantry crane (see also Annex 1.5-10).

Poti:
Construction of an area for the handling of 20 ft and 40 ft containers.

Batumi:
Repair of the warehouses roof; repair of the craneway, asphalt work; construction of a new area for the handling of 20 ft and 40 ft containers - a project already exists.

1.7.5.4 Summary of rehabilitation plan container terminals

Because of their urgency, all measures are attached to first priority.

1.7.6 Rehabilitation plan rolling stock

After the investigations concerning the technical condition in a second step the future needed rolling stock was estimated based on the traffic forecast optimistic and pessimistic scenarios worked out under the terms of this project. Than the found figures of the future stock of locomotives, wagons, coaches and EMU had been transformed to a framework of quantities concerning the different maintenance levels. In order to find out this framework the valid regulations of the railways regarding the maintenance periods had been used.

1.7.6.1 Future needed rolling stock

Wagons - future transport volume and needed fleet

The estimation of the future maintenance for all means of the rolling stock is based on the traffic forecast. In a first step the forecasted future freight transport volumes and passenger traffic figures for the horizons 2000/2005, 2010 and 2015 were used in order to determine the volume of needed transport cars by putting in the respective conditions of operation and corresponding factors of influence. In a second step the tractive stock has been estimated by using the accounted figures of the needed transport cars. Following this method the order of the rolling stock means in this chapter is wagons, coaches, locomotives and Electric Multiple Units (EMU). The future wagon fleet was estimated by assuming 312 working days per year, different tons per wagon load average and different rates of wagon turn-rounds (t-r). The used reserve factor is 0.2. The used different rates of wagon loads (tons) and wagon turn-round are shown in the table below.

Tab. 1.7-29: Wagon load and turn-round

railway		transit	import	export	domestic traffic
ARM	t-r-days	20/18/17[1]	7/5/4[1]	20/18/17[1]	7/5/4[1]
	tons	40	30	30	30
	remarks	100% wagons needed[2]	33% wagons needed[2]	90% wagons needed	100% wagons needed
AGZD	t-r-days	20/18/17[1]	8/7/6[1]	20/18/17[1]	8/7/6[1]
	tons	40	30	50	50
	remarks	10% wagons needed[2]	10% wagons needed[2]	90% wagons needed	100% wagons needed
GRZD	t-r-days	20/18/17[1]	8/7/6[1]	20/18/17[1]	8/7/6[1]
	tons	40	30	50	50
	remarks	33% wagons needed[2]	100% wagons needed	100% wagons needed	100% wagons needed

[1] for the periods 2000-2005/2010/2015

[2] needed for loading at border stations and ports

The founded results of the estimation carried out can be found under the Annexes 1.7-20 (ARM), 1.7-21 (AGZD), and 1.7-22 (GRZD). For the optimistic scenario there is an overall need of 24,024 wagons in 2000/2005, of 32,971 wagons in 2010 and of 34,455 wagons in 2015. For the pessimistic case the fleet is increasing from 12,784 to 19,874 wagons. The table below gives a complete overview about the railways split of the demand of wagon fleet development in future.

Tab. 1.7-30: Wagon fleet development in future

horizons / wagons		2000/2005	2010	2015
ARM	opt	2,559	3,080	3,620
	pess	1,492	1,987	2,436
AGZD	opt	15,068	20,873	21,234
	pess	8,068	12,087	12,206
GRZD	opt	6,397	9,018	9,601
	pess	3,224	4,704	5,232
total	**opt**	**24,024**	**32,971**	**34,455**
	pess	**12,784**	**18,778**	**19,874**

Coaches - future transport volume and needed stock

The future coach fleet was estimated by using 256 working days a year and a 36 seat capacity per coach as an average. Different rates of coach turn-rounds were used because there was put in a split of the international traffic of AGZD in regional distance and in long distance ones. The regional international traffic was accounted with 33% of the whole volume and 2 days turn-round. The long-distance international traffic with 67% and a 7 days turn-round. The international traffic of GRZD was estimated as long-distance traffic with a 8 days turn-round. The international traffic of ARM was accounted as a short-distance traffic with a 2 days turn-round. The used reserve factor is 0.4 in order to cover the seasonal traffic differences. For the optimistic case there is a overall need of 188 coaches in 2000/2005, of 473 coaches in 2010 and of 631 coaches in 2015. For the pessimistic case the fleet is increasing from 91 to 302 coaches. The table below gives an complete overview about the railways split of the demand of coaches fleet development in future.

Tab. 1.7-31: Coach fleet development in future

horizons / coaches		2000/2005	2010	2015
ARM	opt	20	42	46
	pess	9	22	25
AGZD	opt	70	229	329
	pess	38	92	117
GRZD	opt	98	202	256
	pess	44	123	139
total	**opt**	**188**	**473**	**631**
	pess	**91**	**257**	**302**

The complete results of the estimation are to be found under the Annexes 1.7-23 (ARM), 1.7-24 (AGZD), and 1.7-25 (GRZD).

Locomotives - future transport volume and needed stock

The future locomotive fleet was estimated by using 312 working days a year. For estimating the needed freight train figures there was used an average train weight of 2,000 tons for AGZD and GRZD, however, for ARM 1,500 tons. The used reserve factor is 0.3. The normally used reserve factor of 0.2 was increased by 0.1 in order to cover the need of railways service trains and the empty wagons trains. For the optimistic scenario, there is an overall need of 499 locomotives in 2000/2005, of 535 locomotives in 2010 and of 616 locomotives in 2015. For the pessimistic case the locomotive fleet is increasing from 261 to 361 units. The table below shows the railways split of the demand of locomotive fleet development in future.

Tab. 1.7-32: Locomotive fleet development in future

horizons / locomotives	2000/2005	2010	2015
ARM opt	45/3/**48**[3]	66/5/**71**	83/5/**88**
pess	28/2/**30**	42/3/**45**	53/3/**56**
AGZD opt	224/3/**227**	211/11/**222**	246/15/**261**
pess	131/3/**134**	139/6/**145**	160/6/**166**
GRZD opt	188/5/**193**	205/11/**216**	235/12/**247**
pess	88/3/**91**	104/7/**111**	125/7/**132**
total opt	**468**	**509**	**596**
pess	**255**	**301**	**354**

The complete results of the estimation can be found under the Annexes 1.7-20 up to 1.7-25.

EMU - future transport volume and needed stock

The future EMU fleet was estimated by using 256 working days a year and a 102 seat capacity per car as average. Different rates of EMU turn-rounds were put in with 3 rounds per day for short distance traffic and 2 days for the long-distance one. The used reserve factor is 0.4 in order to cover the daily and weekly traffic differences. For the optimistic scenario there is an overall need of 86 EMU in 2000/2005, of 145 EMU in 2010 and of 184 EMU in 2015. For the pessimistic case the EMU fleet is increasing from 53 to 83 units. The table below shows the railways` split of the demand of the future EMU fleet development.

[3] freight transport/passenger transport/**total**

Tab. 1.7-33: EMU fleet development in future

horizons / EMU	2000/2005	2010	2015
ARM opt	8	10	11
pess	7	8	8
AGZD opt	42	83	94
pess	29	43	45
GRZD opt	36	62	79
pess	17	27	30
Total opt	**86**	**155**	**184**
pess	**53**	**78**	**83**

The detailed results of the estimation can be found under the Annexes 1.7-23 to 1.7-25.

1.7.6.2 Future needed maintenance performances

Needed maintenance for wagons

The estimated number of wagons serves as basis for the determination of needed maintenance capabilities. Following the valid maintenance system the yearly maintenance performances are to account with 26,037 TR-2, 21,877 DR and 2,147 KR for the period 2000/2005 in the optimistic case. For the pessimistic traffic development the respective figures are 13,855, 11,642 and 1,142 wagons. The following table contains the complete overview.

Tab. 1.7-34: Volume of wagon maintenance per annum

wagons	total wagons	TR-2	DR	KR
optimistic scenario				
covered, open, flats	15,345	0	14,066	1,279
tanks, refriges and others	8,679	26,037	7,811	868
2000/2005	**24,024**	**26,037**	**21,877**	**2,147**
2010	**32,971**	**30,421**	**30,025**	**2,946**
2015	**34,455**	**31,791**	**31,376**	**3,079**
pessimistic scenario				
covered, open, flats	8,166	0	7,485	680
tanks, refriges and others	4,618	13,855	4,157	462
2000/2005	**12,784**	**13,855**	**11,642**	**1,142**
2010	**18,778**	**17,326**	**17,100**	**1,678**
2015	**19,874**	**18,337**	**18,098**	**1,776**

Needed maintenance for coaches

The estimated coach fleet is the basis for the determination of the needed maintenance capabilities. Following the valid maintenance system the yearly maintenance performances are to account with 564 TR-2, 157 DR , 16 KR-1 and 16 KR-2 for the optimistic case in the period 2000-2005 . For the pessimistic case of the passenger traffic development the respective figures are 273 TR-2, 76 DR, 8 KR-1 and 8 KR-2 in 2000/2005. The complete overview is to be found in the following table.

Tab. 1.7-35: Volume of coach maintenance per annum

horizons		coaches	TR-2	DR	KR-1	KR-2
2000/2005	**opt**	188	564	157	16	16
	pess	91	273	76	8	8
2010	**opt**	473	1,419	394	39	39
	pess	257	771	214	21	21
2015	**opt**	631	1,893	526	53	53
	pess	302	906	252	25	25

Needed maintenance for locomotives

The estimated locomotive fleet is the basis for the determination of the needed maintenance capabilities. Following the valid maintenance system the yearly maintenance performances are to account with 2,952 TO-3, 2,329 TR-1, 166 TR-2, 83 TR-3, 42 KR-1 and 42 KR-2 for the optimistic traffic development in the period 2000-2005. The complete overview is to be found in the following table.

Tab. 1.7-36: Volume of locomotive maintenance per annum

horizons	locomotives	TO-3	TR-1	TR-2	TR-3	KR-1	KR-2
optimistic case		2000/2005					
ARM	48	284	224	16	8	4	4
AGZD	227	1,343	1,059	76	38	19	19
GRZD	193	1,142	901	64	32	16	16
Total	468	2,769	2,184	156	78	39	39
		2010					
ARM	71	420	331	24	12	6	6
AGZD	222	1,314	1,036	74	37	19	19
GRZD	216	1,278	1,008	72	36	18	18
Total	509	3,012	2,375	170	85	42	42
		2015					
ARM	88	521	411	29	15	7	7
AGZD	261	1,544	1,218	87	44	22	22
GRZD	247	1,461	1,153	82	41	21	21
Total	596	3,526	2,781	199	99	50	50
pessimistic case		2000/2005					
ARM	30	178	140	10	5	3	3
AGZD	134	793	625	45	22	11	11
GRZD	91	538	425	30	15	8	8
Total	255	1,509	1,190	85	43	21	21
		2010					
ARM	45	266	210	15	8	4	4
AGZD	145	858	677	48	24	12	12
GRZD	111	657	518	37	19	9	9
Total	301	1,781	1,405	100	50	25	25
		2015					
ARM	56	331	261	19	9	5	5
AGZD	166	982	775	55	28	14	14
GRZD	132	781	616	44	22	11	11
Total	354	2,095	1,652	118	59	30	30

Needed maintenance for EMU

The estimated EMU fleet is the basis in order to come to the needed maintenance capabilities. Following the valid maintenance system the yearly maintenance performances are to account with 3,440 TO-3, 430 TR-1, 43 TR-2, 22 TR-3 , 11 KR-1 and 11 KR-2 for the optimistic case of traffic development in the period 2000-2005. The complete overview is to be found in the following table.

Tab. 1.7-37: Volume of EMU maintenance per annum

horizons	EMU	TO-3	TR-1	TR-2	TR-3	KR-1	KR-2
optimistic case			2000/2005				
ARM	8	320	40	4	2	1	1
AGZD	42	1,680	210	21	11	5	5
GRZD	36	1,440	180	18	9	5	5
Total	86	3,440	430	43	22	11	11
			2010				
ARM	10	400	50	5	3	1	1
AGZD	83	3,320	415	42	21	10	10
GRZD	62	2,480	310	31	16	8	8
Total	155	6,200	775	78	39	19	19
			2015				
ARM	11	440	55	6	3	1	1
AGZD	94	3,760	470	47	24	12	12
GRZD	79	3,160	395	40	20	10	10
Total	184	7,360	920	92	46	23	23
pessimistic case			2000/2005				
ARM	7	280	35	4	2	1	1
AGZD	29	1,160	145	15	7	4	4
GRZD	17	680	85	9	4	2	2
Total	53	2,120	265	27	13	7	7
			2010				
ARM	8	320	40	4	2	1	1
AGZD	43	1,720	215	22	11	5	5
GRZD	27	1,080	135	14	7	3	3
Total	78	3,120	390	39	20	10	10
			2015				
ARM	8	320	40	4	2	1	1
AGZD	45	1,800	225	23	11	6	6
GRZD	30	1,200	150	15	8	4	4
Total	83	3,320	415	42	21	10	10

1.7.6.3 Rolling stock actual maintenance deficiencies

Locomotive fleet deficiencies

Due to the lack of heavy cranes and lifting jacks in the depots there are existing drawbacks of TR-3 with 159 locomotives that means more than 174% of a yearly TR-3 volume. The maintenance types KR-1 and KR-2 were carried out in former times only abroad, excepted small capabilities in Tbilissi (1 place) and Gyumri (1 place). Thus, at all 223.5 locomotives require these maintenance types which is more 243% of the yearly repair referring to the inventory. The expense for catching up these drawbacks is to add to the regular planned maintenance types.

Wagon stock deficiencies

Besides to the needed regular maintenance types for the existing wagon stock is to consider that due to different reasons like war, earthquake, theft and so one 35,522 wagons are damaged and cannot operate. The expense for catching up these drawback is to add to the regular planned maintenance types.

Coach fleet deficiencies

Mainly there were carried out actually only TR-2 and DR in the passenger depots of AGZD for ensuring the limited passenger train service on the relation Baku - Tbilisi. KR-1 and KR-2 were not carried out. The drawback in KR-1 and KR-2 is estimated at all with about 1,800 coaches.

EMU fleet deficiencies

During the last few years there were carried out only TO-3, TR-1, TR-2 and TR-3 in some locomotive depots for ensuring the domestic passenger traffic service in different regions. KR-1 and KR-2 were not carried out. This fact is even more not for understanding as a repair plant for these capital repair categories does exists in Tbilisi. The drawback in KR-1 and KR-2 is estimated at all with about 100 EMU.

1.7.6.4 Rehabilitation of the rolling stock repair capabilities

Locomotive repair capabilities

The description in details of the 11 locomotive depots and 2 repair plants dealing with locomotive repair is to be found under the Annexes 1.6-7 to 1.6-18 and 1.6-40. The following table gives an overview concerning the certain depots and plants.

Tab. 1.7-38: Locomotive repair capabilities to be renewed

locomotive plants		objects to be renewed	Details given in Annex
ARM	Depot Yerevan	19 objects	1.6-7
	Depot Gyumri	18 objects	1.6-8
AGZD	Depot Baladshary	8 objects	1.6-9
	Depot Beyuk-Shtshor	7 objects	1.6-10
	Depot Gyandsha	4 objects	1.6-11
	Depot Imishli	-	1.6-12
	Depot Dshulfa	-	1.6-13
GRZD	Depot Tbilisi-Pass	3 objects	1.6-14
	Depot Tbilisi-Sortir	8 objects	1.6-15
	Depot Khashuri	4 objects	1.6-16
	Depot Samtredia	3 objects	1.6-17
	TECF[1]	62 objects	1.6-18
	TEWRS	31 objects	1.6-40

Wagon repair capabilities

The description in details of the 12 wagon depots and 2 repair plants dealing with wagon repair is to be found under the Annexes 1.6-19 to 1.6-30 and 1.6-40. The following table gives an overview concerning the certain depots and plants.

Tab. 1.7-39: Wagon repair capabilities to renew

wagon plants		objects to be renewed	Details given in Annex
ARM	Depot Yerevan	see chapter coaches	1.6-19
	Depot Gyumri	6	1.6-20
AGZD	Depot Baladshary	5 objects	1.6-21
	Depot Kishli	-	
	Depot Gyandsha	8	1.6-22
	Depot Kasi-Magomed	9	1.6-23
	Depot Aliat	4	1.6-24
	BWRS Baku	2	1.6-25
	Depot Shirvan	8	1.6-26
GRZD	Depot Tbilisi-Grus	17	1.6-27
	Depot Khashuri	10	1.6-28
	Depot Samtredia	23	1.6-29
	Depot Batumi	10	1.6-30
TEWRS		see chapter locomotives	1.6-40

[1] TECF should be treated as a Joint Venture

Coach repair capabilities

The description in details of the 3 coach depots and 1 repair plant dealing with coach repair is to be found under the Annexes 1.6-31 to 1.6-33 and 1.6-40. The following table gives an overview concerning the certain depots and plants.

Tab. 1.7-40: Coach repair capabilities to renew

coach plants		objects to be renewed	Details given in Annex
ARM	Depot Yerevan	8 objects	1.6-31
AGZD	Depot Baku-pass	16 objects	1.6-32
GRZD	Depot Tbilisi-pass	11 objects	1.6-33
	TEWRS	see chapter locomotives	1.6-40

EMU repair capabilities

The description in details of the locomotive depots and 1 repair plant dealing with EMU repair is to be found under the Annexes 1.6-34 to 1.6-40. The following table gives an overview concerning the certain depots and plants.

Tab. 1.7-41: EMU repair capabilities to renew

EMU plants		objects to be renewed	Details given in Annex
ARM	Loco-Depot Yerevan	19 objects	1.6-7 / 1.6-34
	Loco-Depot Gyumri	18 objects	1.6-8 / 1.6-35
AGZD	Loco-Depot Beyuk -Shtshor	7 objects	1.6-10 / 1.6-36
	Loco-Depot Gyandsha	4 objects	1.6-11 / 1.6-37
GRZD	Loco-Depot Tbilisi-Pass	3 objects	1.6-14 / 1.6-38
	Loco-Depot Khashuri	4 objects	1.6-16 / 1.6-39
	Loco-Depot Kutaisi	-	
	EMU depot Batumi	-	
	EMU depot Sukhumi	-	
	TEWRS	31 objects	1.6-40

1.7.6.5 Demand of urgently needed spare parts

Concerning the drawback in supplying the railways with spare parts, material and elements for rolling stock maintenance the consultant worked out a survey about their urgent demand. This demand is characterised by a high priority and should be covered therefore up to the year 2000. The respective financial cover is involved in the financial estimation for the rolling stock maintenance for the period 1998 - 2000. In details the survey is to be found under the Annexes 1.7-17 for ARM, 1.7-18 for AGZD and 1.7-19 for GRZD.