BULGARIA

BULGARIA

1. GENERAL INFORMATION

1.1. General Overview

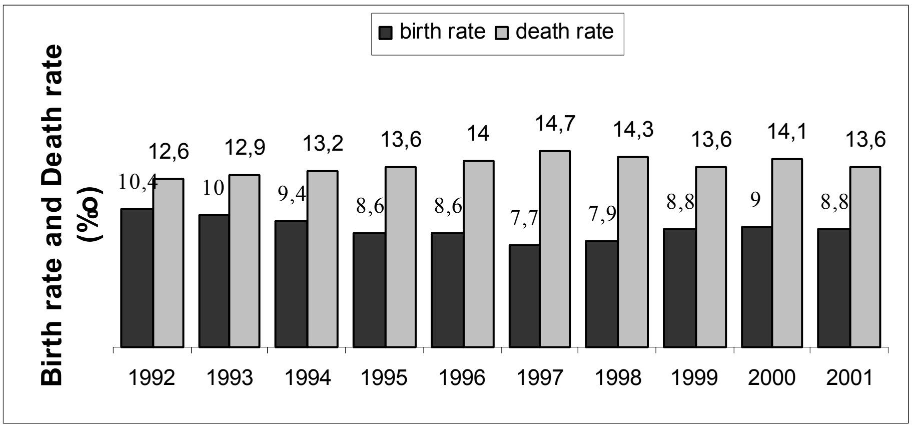
Bulgaria is a country situated in the south-eastern Europe and it occupies the biggest part of the Balkan peninsula. The northern border of Bulgaria continues for 470 km on the Danube River and later in south-eastern direction to the Black Sea for about 139 km on land. In eastern direction, Bulgaria borders the Black Sea while to the south there is a 752 km long border with Turkey and Greece. To the west, the country has a border with the Former Yugoslav Republic of Macedonia and Yugoslavia. Within these borders, Bulgaria has 110 975-km^2 surface, including an altitude correction.

The demographic situation in the country is characterised with a clear tendency of decrease in the population (Table 1). For the period between 1985 and 1998, the population has decreased by 719,509 people (8.0%). At the end of 1994, the population of the country numbered 8.43 million people and population density of 76 persons per square kilometre. There exists a negative trend in the change of the population, which was for 1990 -0.4%; for 1991 -1.7%; for 1992 -2.2%; and for 1993 -2.9%; see Figure 1, which shows the birth and death rates from 1992 to 2000. According to the National Institute of Statistics, the total number of the population is expected to decrease by another 320,000 (319,392) people around the year 2000, compared to 1993 (Table 2 and Figure 2).

TABLE 1. POPULATION INFORMATION

	1960	1965	1970	1975	1980	1985	1990	1999	2000	2001	2002
Population (millions)	7.9	8.2	8.5	8.7	8.9	8.9	8.7	8,19	8,15	7,93	n/a
Population density (inhabitants/km^2)	71	71	77	77	80	80	78	73,8	73,4	71,5	n/a
Urban population as percent of total	38	38	53	53	63	63	67	69	68	69,3	n/a
Area (1000 km^2)	111.0										

Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia.



Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia

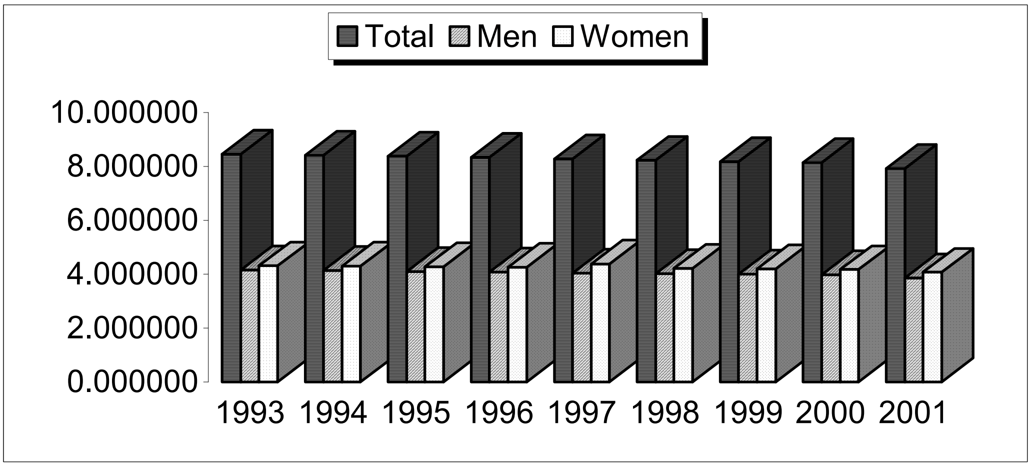
FIG. 1. Birth and Death Rate of the Bulgarian Population

Bulgaria has four distinct seasons, which create changes in the demand for energy and in particular for electricity. The annual fluctuation of Bulgarian's electric power demand has one peak period in winter, which has been identified to be the result from using electricity for space heating. The average temperature of 12^{o}C, below which space heating is necessary, lasts about 200 days. The average temperature in November is 5.1^{o}C, in December – 0.0^{o}C, in January –1.8^{o}C, in February – 0.3^{o}C, in March 4.6^{o}C.

TABLE 2. POPULATION OF BULGARIA (1993 - 2001)

Year	Inhabitants		
	Total	Men	Women
1993	8,459,763	4,151,638	4,308,125
1994	8,427,418	4,129,966	4,297,452
1995	8,384,715	4,103,368	4,281,347
1996	8,340,936	4,077,501	4,263,435
1997	8,283,200	4,044,965	4,238,235
1998	8,230,371	4,014,071	4,216,300
1999	8,190,900	3.964.042	4.226.857
2000	8,149,500	3.944.006	4.205.493
2001	7,929,483	3,863,420	4,066,063

Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia



Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia

FIG. 2. Population of Bulgaria (1993 - 2001)

1.2. Economic Indicators

Table 3 shows the historical Gross Domestic Product (GDP) data from the IAEA Energy and Economic Database (EEDB) in USD. GDP in 1998 was 21 577 billion levs at current prices, which amounts to 112 325 million levs at 1991 prices. The economic crisis of 1996 and 1997 led to a decline in real GDP, which dropped by -10.1% and -7.0% respectively. The economy picked up again in 1998, with real growth estimated at 3.5% and remained on that level. Figure 3 shows the real GDP index for 1990 through 2006, where 1990 was taken as the base year.

TABLE 3. GROSS DOMESTIC PRODUCT (GDP)

	1980	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
GDP(1)	19,993	20,726	7,625	8,603	10,833	9,708	13,106	9,831	10,141	11,390	11,536	11,156	11,992
GDP(2) per capita	2,256	2,377	887	1,014	1,279	1,150	1,558	1,198	1,251	1,543	1,577	1,542	1,705
GDP by sector (%):													
-Agriculture	14	18	15	12	10	12	13,4	13,1	23,4	18,8	16,3	13,9	13,6
-Industry	54	51	47	45	39	38	32,7	32,4	25,0	30,5	28,1	29,2	28,5
-Services	32	31	38	43	51	51	53,9	54,5	51,6	50,7	55,6	56,9	57,9

(1) Millions of current US$. (2) Current US$ per capita.

Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia.

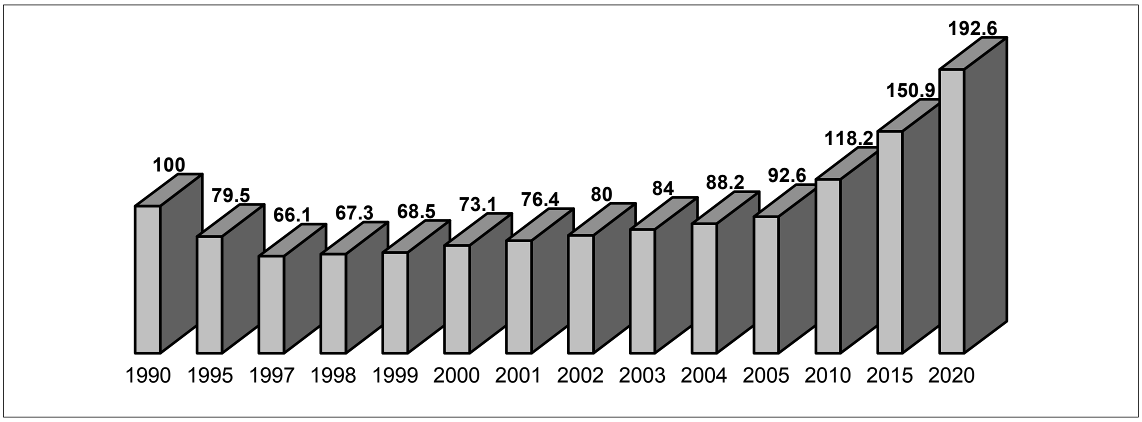


FIG. 3. Index of the Gross Domestic Product of Bulgaria

1.3. Energy Situation

1.3.1 Current status

Bulgaria has very few domestic energy resources. Data in Table 4 indicate the national provision with domestic primary energy source. Proven oil and gas reserves for the country have declined for a number or years and are only about 5 million tons of oil equivalents. In fact, it is less than six months normal hydrocarbon consumption for Bulgaria. Hydropower potential is also limited since most of Bulgaria's rivers are small and the only large river, the Danube, has a small drop in altitude where it forms Bulgaria's northern border with Romania. Largely because of this constraint, hydro capacity accounts for about 17,6% (HPP – 15.1% and PSHPP – 6.5%) of the country's total installed generating capacity and an even smaller percentage of generation. The thermal power is 50.0%, and nuclear power is 28.4% of the country's total installed generating capacity.

TABLE 4. ENERGY INDEPENDENCE OF THE COUNTRY

Per cent (%)

	1998	**1999**	**2000**
Total	51,13	50,18	53,50
Coal	69,26	66,69	67,21
Crude oil	0,58	0,76	0,84
Natural gas	0,74	0,82	0,41

Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia.

The country has significant but very low-grade coal reserves (Table 5). The mineable reserve amount to about 2.2 billion tons including lignite, of which 2.1 billion tons are situated in the Maritsa East deposit. The production in 2001 amounted to about 27.3 million ton per year (Table 6 and Figure 4). About 90% of these reserves have a heating value of about 1500-1600 kcal/kg, which is 20-25% of the heating value of internationally traded, steam coal. In addition, these lignite reserves have very high sulphur content. Consumption of coal in Bulgaria reached its historically highest level in 1987. In that year, 40.5 million tons of coals were consumed.

Bulgaria imports almost all of its petroleum since domestic production is negligible, for example in 1997 domestic production was 27.800 tons of oil and 35 million cubic meters of gas. Imported petroleum is in the form of crude oil and is being refined in Bulgaria or directly imported as products. Typically, about 90% of petroleum are imported as crude and most of the rest is imported as heavy fuel oil. Bulgaria has three refineries located respectively at Burgas, on the Black Sea Coast, and at Pleven and Ruse on the Danube plain in the northern part of the country. The Burgas refinery accounts for about 85% of the country refining capacity with the other two refineries being very small with insertion economics.

TABLE 5. BULGARIA COAL RESERVES

	Mineable Reserves (million tons)	Present Production (million tons/year)	Lifetime (years)
Lignite	2350	28	85
Sub-bituminous coal	210	5	40
Bituminous	10	<1	40
Anthracite	1	<1	20

Source: Country Information.

TABLE 6. STRUCTURE OF THE COAL PRODUCTION IN BULGARIA
(IN THOUSAND TONS)

	1999	2000	2001
Brown coal	3,342	2,758	2,245
Antracite	119	118	110
Lignite	22,586	23,707	24,293
Total	26,047	26,583	26,648

Source: Statistical guide, 2002, National Institute of Statistics, Sofia.

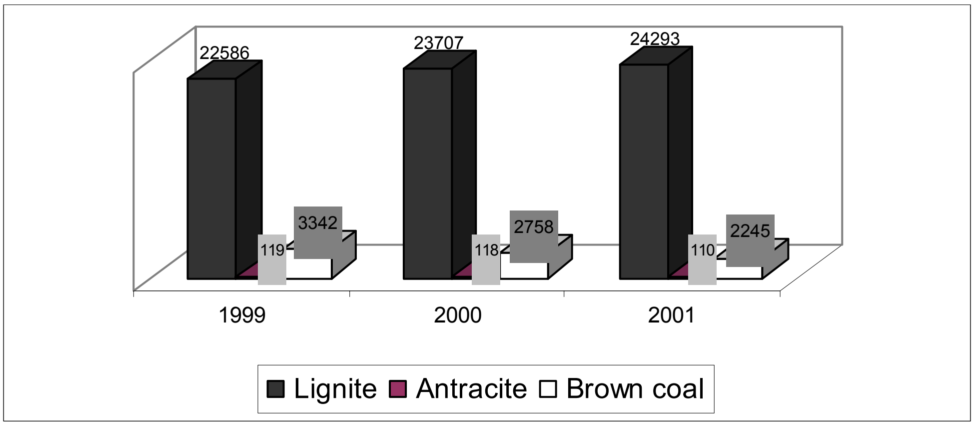


FIG. 4. Structure of the coal production in Bulgaria

The average annual consumption of natural gas for the past five years (1997-2001) was around 3.5 bcm, which represents a considerable decrease compared to the highest demand in the country in 1989 and 1990 (6.8 bcm). The reduction of the share of natural gas in the structure of primary energy demand, however, is far less (18.3% in 2000 compared to 23.4% in 1990). That is due to the registered total drop of demand for energy resources over the past 10 or 12 years.

In order to fulfil Decree No 162, August 20, 1992, and Decree No 56, March 29, 1994 of the Council of Ministers, the technical liquidation of the uranium mining sites have been completed. The liquidation of the processing plants has been finalised. By 2002, the projects of technical and biological re-cultivation of the uranium mining regions shall be completed, and by 2005 - sanitary treatment and safeguarding of the tailings ponds of the processing plants. Special attention is paid to the regions of Buhovo, Eleshnitza and Sliven, where the damages to the environment are most markedly pronounced, and where their effect on the population is the most direct. In parallel to performance of the re-cultivation and sanitary treatment projects, the required treatment facilities for purification of radionuclide polluted waters and monitoring networks will be built in the uranium mining regions. For performance of the projects in these regions, we depend on the co-operation and assistance of the European Union and the PHARE Programme, especially to avert the danger of cross-border water pollution. A project for engineering works for closing of uranium mines in Eleshnitza and Dospat under PHARE CBC 1999 Bulgaria-Greece programme is under implementation. Two other projects –regional monitoring network for radio-ecological monitoring in Mesta river valley and Smolian and feasibility study for the status of the uranium mines in Southern Bulgaria are going to be implemented under PHARE CBC Bulgaria-Greece programme 2001.

The energy intensity of Bulgarian Gross Domestic Product (GDP) does not appear to have decreased, with energy consumption and output roughly at the same rate. However, this pattern should start to change as the economic restructuring occurs and as relative energy prices continue to increase. Reduction of energy consumption and, therefore, of net energy imports is likely to be an important component of any improvement of Bulgaria's balance of trade. Table 7 shows the national primary energy data (production, primary energy balance and consumption) in their typical units and Table 8, Table 9 and Table 10 the Energy statistics.

TABLE 7. NATIONAL PRIMARY ENERGY DATA

		1998	1999	2000
Production of Primary energy				
Coal	M toe	5,079	4,341	4,520
Crude oil	M toe	0,033	0,044	0,046
Natural Gas	M toe	0,023	0,022	0,012
Other solid fuels	M toe	0,413	0,413	0,550
Nuclear and hydroenergy	M toe	4,993	4,591	5,154
Total	M toe	10,541	9,411	10,282
Primary energy				
Production	M toe	10,54	9,41	10,28
Import	M toe	11,82	11,02	11,47
Export	M toe	1,64	2,00	25,99
Bunkers	M toe	0,07	0,008	0,064
Stock Changes (+. -)	M toe	-0,04	0,329	0,118
Total	M toe	**20,62**	**18,76**	**19,22**

Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia.

TABLE 8. FINAL CONSUMPTION OF ENERGY SOURCES

		Total consumption			Energy			Non-energy		
		1998	1999	2000	1998	1999	2000	1998	1999	2000
Total	Mtoe	10,920	9,784	9,566	9,676	8,742	8,434	1,244	1,042	1,132
Hard Coal and Lignite	Mtoe	0,289	0,317	0,278	0,289	0,317	0,278	-	-	-
Fuels from coal and lignite	Mtoe	0,986	0,744	0,707	0,986	0,744	0,707	-	-	-
Natural gas	Mtoe	1,667	1,246	1,545	1,326	0,880	0,937	0,341	0,366	0,608
Petroleum products	Mtoe	4,282	4,067	3,529	3,379	3.391	3,005	0,903	0,676	0,524
Biomass and industrial waste	Mtoe	0,409	0,407	0,555	0,409	0,407	0,555	-	-	-
Electricity	Mtoe	2,224	2,049	2,075	2,224	2,049	2,075	-	-	-
Heat	Mtoe	1,063	0,954	0,877	1,063	0,954	0,877	-	-	-

Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia.

The pattern of energy use in Bulgaria is significantly different from the West. The main area of difference is in the direct use of gas. In most western industrial countries, households and the service sector use gas. In Bulgaria, gas is almost entirely used in the industrial sector and in power generation, including district heating plants (many plants being combined heat and power or CHP plants), with a negligible amount being used in services and households. Furthermore, this pattern of usage will not change rapidly since Bulgaria lacks a distribution network for gas so that it cannot currently be supplied to most households and commercial establishments. Indirectly, of course, the household and service sectors use some gas since a small part of the electricity they consume and most of the heat supplied by district heating plants, comes from gas. Even considering this indirect use, however, the use of natural gas in Bulgaria is still heavily skewed towards the industrial sector.

TABLE 9. FUEL STRUCTURE OF TRANFORMATION INPUT IN POWER PLANTS AND HEAT PLANTS

Percent %

			Electric power stations						District heating plants	
	Total		Public electric plants		Combine Heating Public plants		Autoproducers			
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Hard coal	9,4	8,9	5,7	4,4	22,9	26,4	18,2	21,2	-	-
Total lignite	35,4	35,0	40,3	38,5	23,2	27,5	3,0	-	0,3	0,3
Other solid fuels	2,1	2,0	-	-	10,8	10,7	4,7	3,6	-	-
Petroleum products	2,5	1,6	0,2	0,2	2,7	1,6	35,9	28,3	15,0	12,0
Natural gas	8,6	7,3	-	0,0	40,4	33,8	28,5	33,0	84,7	87,7
Other gas	0,5	0,6	-	-	-	-	9,7	13,8	-	-
Nuclear energy [1]	41,6	44,6	53,8	56,9	-	-	-	-	-	-

([1]) Excl. Hydro-power plants

Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia.

TABLE 10. FUEL USED FOR ELECTRICITY AND HEAT PRODUCTION IN POWER PALNTS

		1998	1999	2000
Coal	M toe	5,552	4,354	4,924
Petroleum products	M toe	0,283	0,263	0,176
Natural Gas	M toe	0,919	0,898	0,806
Other fuels	M toe	0,132	0,277	0,286
Nuclear energy	M toe	4,993	4,591	5,154
Total	**M toe**	**11,613**	**10,478**	**11,043**

Source: Statistical Yearbook, 2001, National Institute of Statistics, 2001, Sofia.

1.3.2. Bulgarian National Energy Development Strategy

The main objectives guiding the energy development are:

- Through competitive energy to competitive economy
- continuous and safe coverage of the national energy needs with minimum public cost;
- providing energy independence for the country;
- reduction in specific energy intensity per GDP unit in economy;
- ecologically oriented development;
- establishment of competitive internal energy market;
- integration of the Bulgarian energy system and energy market with that of the EC;
- maintaining the nuclear safety at the acceptable level;
- utilization of local renewable energy sources (RES).

However, the establishment of an up-to-date and market-oriented energy sector, calls for a series of prerequisites that have been missing up to this date, namely:

- Normalisation of energy prices in line with the justified full economic costs and phasing out of the subsidies for generators;
- Financial recovering and establishment of energy companies operating on a commercial basis
- Properly functioning regulatory authorities and mechanisms
- Market rules and structures
- Appropriate legal framework.

Concurrent actions should be undertaken, mainly in the following areas:

- financial restructuring: establishment of financially viable commercialised companies;
- institutional changes: enhancement of the role, autonomy and influence of the regulatory body

(SERC);

- commercial restructuring: transition from administration to regulation and introduction of clear regulatory rules for the market players;
- deregulation: introduction of clear and sustainable market rules and a clear schedule for the opening of the internal and external market to competition, including delegation to SERC of the powers to enforce market rules;
- legal changes: discussion and adoption of a new energy law which would ensure a legal framework for the successful implementation of the above areas of the reform;
- privatisation: transfer of ownership aiming to attract investments and to bring the management practice in line with up-to-date standards.

The government policy in the area of energy will be based on the following principles:

- Introduction of market relations, based on cost-reflective tariffs and free contracting;
- The active role of the state in the creation of a clear and stable legal and regulatory framework for investments, commercial activity and protection of public interests;
- Creation of a legal, regulatory and market environment prior to the implementation of new large-scale investment and privatisation projects;
- Pro-active energy efficiency policy as a means for improving the competitiveness of the economy, security of energy supply and environmental protection;
- Efficient social protection through shifting government subsidies from the producer to the consumer, through energy efficiency measures and introduction of socially-oriented tariffs;
- Positioning of Bulgaria as a reliable country for the provision of future transit of oil, natural gas and electric power and as a dispatching and market centre in the region.

The government policy in tender procedures will continue the good traditions and will rely on two main sources:

- Nuclear energy and
- Local lignite coal.

TABLE 11. EXPECTED ENERGY CONSUMPTION

(million kW-h)

	2000	2005	2010	2015	2020
Minimum scenario	36,307	37,510	40,180	44,370	49,000
Maximum scenario	36,307	37,540	40,640	46,980	54,200

Sources: NEK Information

TABLE 12. RATIO OF EXPECTED ENERGY CONSUMPTION AND GDP

Year	Dimension	Basic scenario	Minimum scenario
1996	tones of reference fuel/million $	1978	1978
2000	tones of reference fuel/million $	1825	1927
2001	tones of reference fuel/million $	1788	1857
2005	tones of reference fuel/million $	1607	1665
2010	tones of reference fuel/million $	1256	1332

Sources: NEK Information

1.4. Energy policy

The energy strategy of the Republic of Bulgaria is based on the national priorities and corresponds to the new lasting positive political and economic trends in the country as well as to the requirements of the European guidelines, the principles of market mechanisms and the Government's Programme. It is determined by the requirements for ensuring sustainable economic growth, and raising the living standard. The strategy has been developed in conformity with the natural and geographic factors determining the inherent role of the country in this region, and the optimal mix of energy resources used in accordance with the specific conditions.

The main goals of the Bulgarian energy industry are focused in energy efficiency improvement, integration of the national energy system and energy market into the European ones, guaranteed nuclear safety and establishment of a competitive domestic energy market.

The energy sector is a determinative section of the Bulgarian industry, especially taking into account that its structure and development are based predominantly on imported energy sources and Bulgarian Lignite Coal. Moreover, the development of the sector is highly dependent on our geopolitical location on the Balkan Peninsula and in Europe. In this complicated stage of its development, Bulgaria unambiguously proves the willing to conform to the priorities of European Union and make the needed steps for technical and political integration with these structures.

During the transition period and according to the stated intention of the country to be a Member of the European Union, Bulgarian Energy Industry fulfils its main goal satisfying the fuel and energy needs of the population and industry at affordable social price. At the same time, a structural reform will start in all energy subsections following the goals of the European Union to stimulate the competition, provide reliable power supply and protect environment. The main direction during the whole process of preparation for integration with the European Union is to harmonise the Bulgarian Energy Policy with the policy of the European Union and with the legislation and structural reforms as a way for closer relations and integration with the European structures.

As a country with limited energy resources, the basis of the energy sources of Bulgarian Energy Sector is too large - solid fuel, nuclear power, natural gas, hydro resources and utilisation of the new energy sources. This multiformity will be kept for the future and the specific priorities of the country will be determined as follows:

- introduction of market relations, based on cost-reflective tariffs and free contracting;
- creation of a clear and stable legal and regulatory framework;
- implementation of new large-scale investment and privatisation projects;
- improving the competitiveness of the economy, security of energy supply and environmental protection;
- efficient social protection and introduction of socially-oriented tariffs;
- positioning of Bulgaria as a reliable country for the provision of future transit of oil, natural gas and electric power and as a dispatching and market centre in the region.

2. ELECTRICITY SECTOR

2.1. Structure of the Electricity Sector

The structure of the energy sector is shown in Figure 5.

2.2. Decision Making Process

The energy policy of Bulgaria is developed and implemented by the Ministry of Energy and Energy Resources (MEER). The MEER has obligations to propose a strategy of energy development and efficient utilisation of energy and energy resources to be carried by the Council of Ministers and passed with a resolution of the National Assembly. The MEER manages the “Radioactive Waste” Fund and the “Nuclear Facility Decommissioning” Fund.

The State Energy Efficiency Agency is an executive agency to the MEER. It implements the state energy efficiency policy. The Agency participates in the development of a National Strategy of Energy and Energy Efficiency Development, for the improvement of energy efficiency, for promotion of the utilisation of renewable sources of energy.

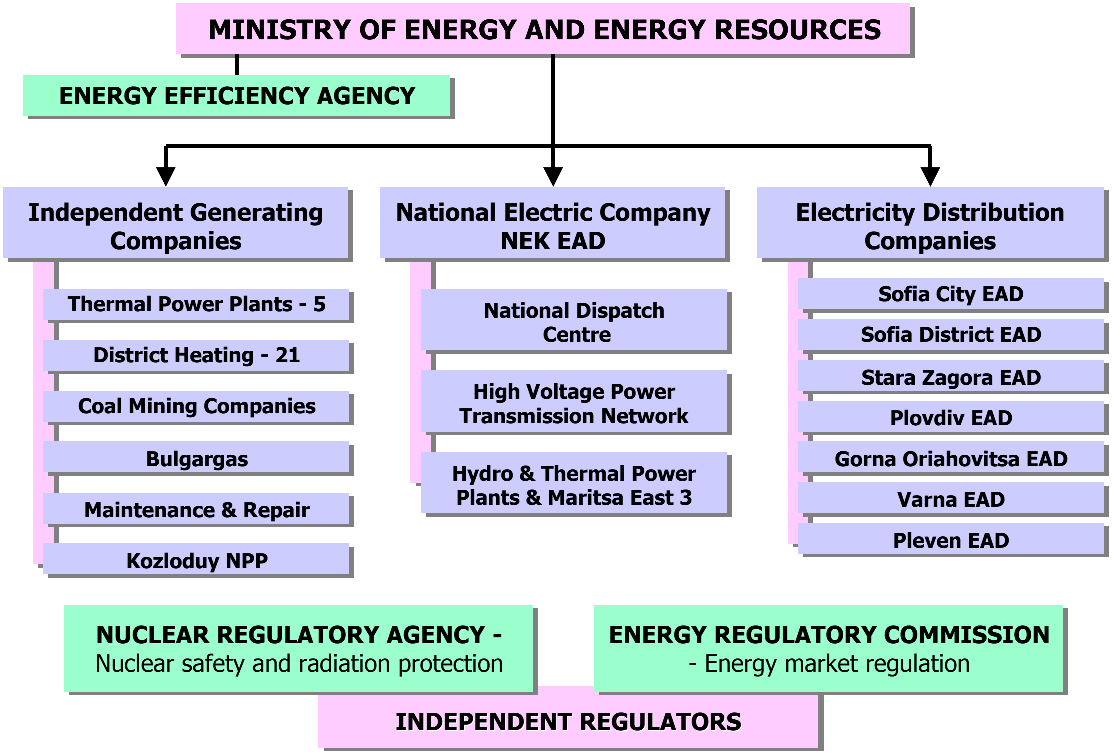


FIG. 5. Organisation of the Energy Sector

State regulation in the field of energy is carried out by the State Energy Regulatory Commission (SERC). The Commission has obligations for developing instruments and take the required steps to issue the permits and licenses provided by the Energy and Energy Efficiency Act. The SERC issues licenses for construction of generation capacities, heat transmission systems, gas transmission systems, natural gas storage facilities, direct power lines and gas pipelines, and for decommissioning of energy facilities. In the process of performing its regulatory functions under the Act, the Commission is guided by several basic principles, as achievement of energy efficiency, environmental protection, etc.

2.3. Main Indicators

The domestic electrical production amounted to 43.89 TW-h in 2001. The main producers of electricity are the TPPs – 22.2 TW-h and Kozloduy NPP plc – 19,55 TW-h, which is the operator of the six nuclear units at the Kozloduy site. The PSHPP and HPPs produced – 2.14 TW-h (Table 13 and Table 14 and Figure 6).

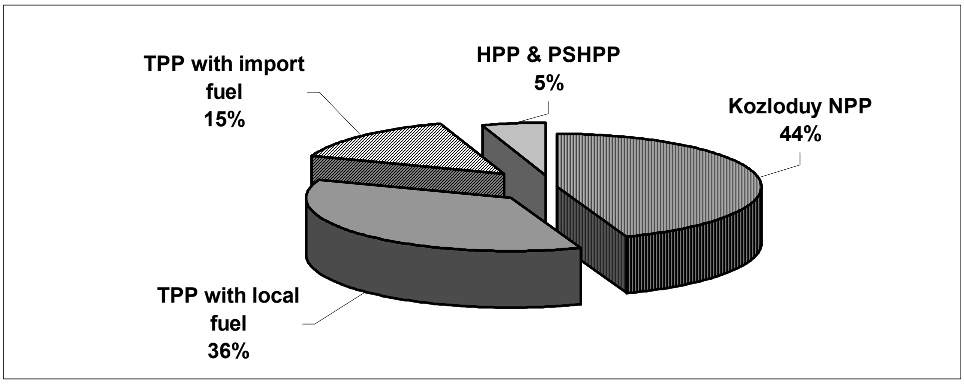
The total electrical installed capacity in 2001 amounts to 13, 245 MW of which 6, 628 MW are thermal, 3, 760 MW nuclear, 1, 993 MW hydro and 864 pumped storage.

The 87 hydropower plants, built between 1912 and 1984 have an installed capacity of around 2,000 MW but the available capacity in all hydropower plants is estimated at 1 600 MW. Since 1991 several small hydropower plants have been returned to their previous private owners. Most or the power plants (58) are of the run-of-river type with total capacity 177 MW. There are 12 power plants with total capacity 237 MW connected to seasonal, storage reservoirs and 17 power plants with total capacity 1,560 MW connected to multi-annual storage reservoirs. The majority of hydropower plants

TABLE 13. NATIONAL ELECTRICITY DATA

Electricity generation and demand in GW-h							
	1992 г	**1994 г**	**1996 г**	**1998 г**	**1999 г**	**2000 г.**	**2001 г.**
Generation incl.:	35 570	38 176	42 801	41 711	38 253	40 927	43 890
KNPP	11 552	15 335	18 082	16 899	15 814	18 178	19 553
TPP incl.:	21 954	21 333	21 736	21 496	19 472	19 791	22 200
Maritza East	10 862	11 509	12 251	11 747	10 534	11 582	12 403
HPP&PSHPP	2 063	1 509	2 984	3 315	2 967	2 958	2 137
Imports/Exports	2 705	-72	-449	-3 647	-1 957	-4 620	-6 926
Demand	38 275	38 104	42 352	38 064	36 296	36 307	36 965
own consumption	4 082	4 173	4 281	4 356	3 955	4 040	4 307
Transportation consumption	4 960	4 731	5 596	5 595	6 469	6 290	6 343
Electrical grid systems consumption	246	339	494	344	351	491	781
Country demand	28 987	28 861	31 981	27 769	25 521	25 486	25 534

Sources: NEK, Annual report, 2001



Sources: NEK, Annual report, 2001

FIG. 6. Electricity Production Structure in 2001

TABLE 14. ELECTRICITY PRODUCTION

Generation in GW-h	**1992 г**	**1995 г**	**1998 г**	**1999 г**	**2000 г**	**2001 г**
Generation by NEK	30 887	37 443	37 179	33 896	12 005	6 385
Generation by independent producers	4 683	4 560	4 532	4 357	28 922	37 505
Total generation	35 570	42 003	41 711	38 253	40 927	43 890

Sources: NEK, Annual report, 2001

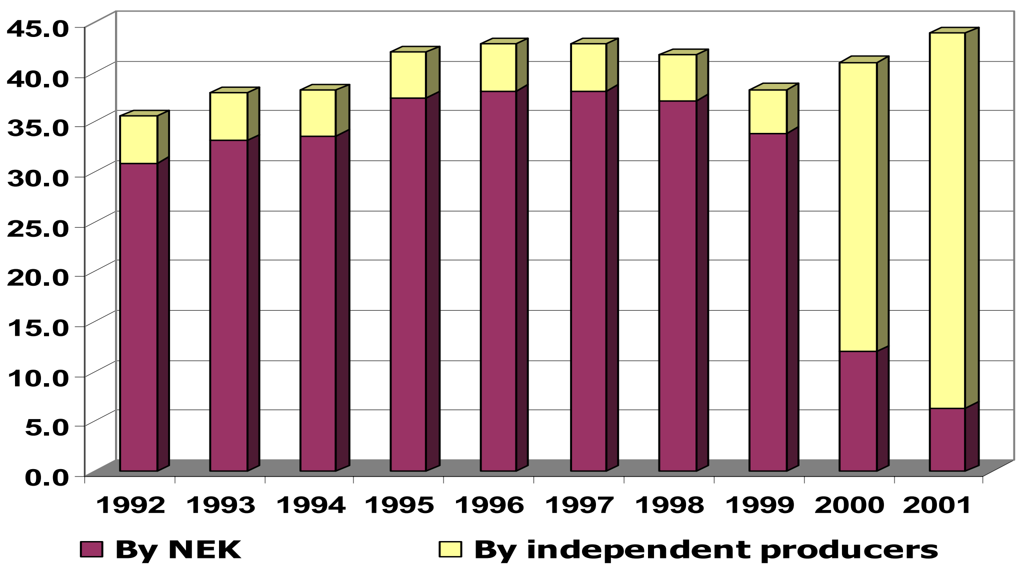


Figure 7. Electricity generation by NEK and independent power producers in TW-h

(89%) have been in operation for more than 30 years now. In 1994 was finishing the first stage of pump-storage hydro power plant Chaira, with 2 turbines having 432 MW generation capacity and 395 MW pump capacity.

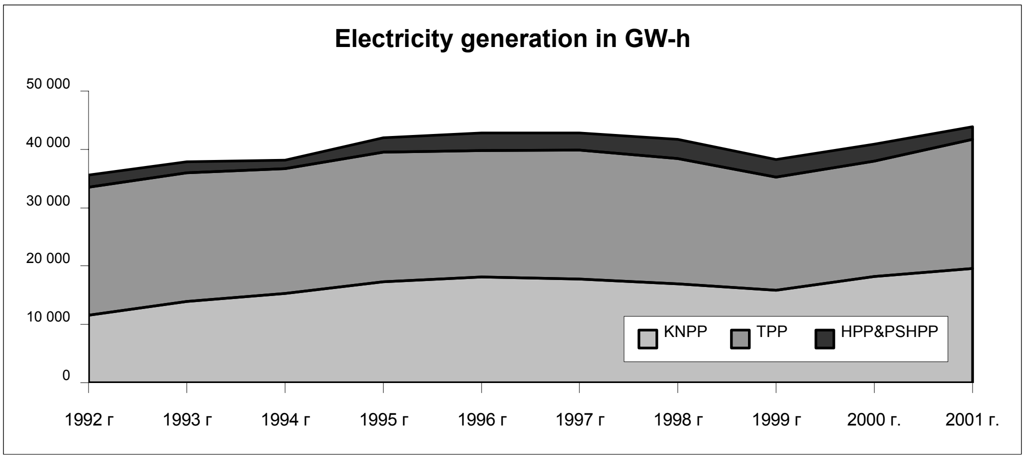


Figure 8. Electricity generation and demand in GW-h

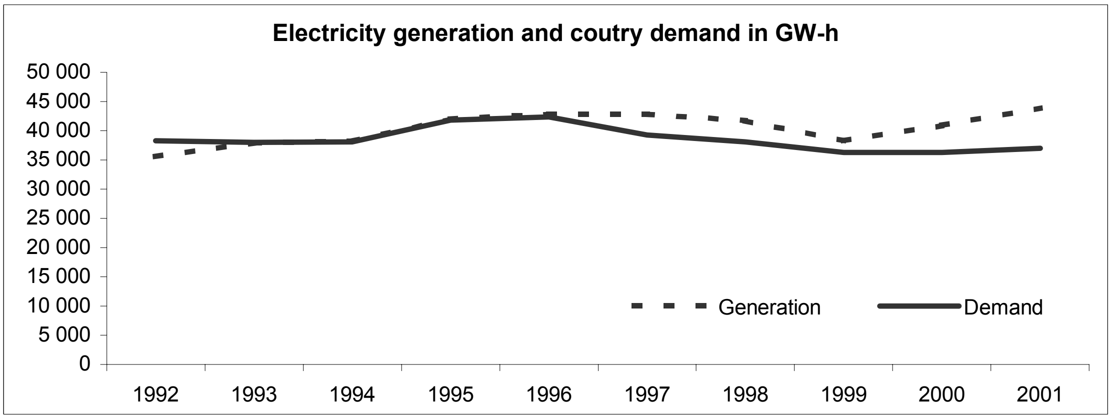


Figure 9. Generation and demand in GW-h

Prognoses

Since 1991, the energy consumption in the Republic of Bulgaria is characterised by large fluctuations determined by the unstable and dynamic social and economic conditions. The prognosis for development of the energy consumption is based on the policy for economical stabilisation and development. The forecast was elaborated according to two scenarios: maximum and minimum, which correspond to the maximum and minimum scenarios of GNP development and energy demand development. They define the area of most probable power demand development (see Figure 10).

2.4. Influence of open electricity market in the nuclear sector

The policy of joining the European Union conducted by the Government, as well as the need to attract foreign capital into the energy industry require radical organisational restructuring of the country's energy in conformity with the EU energy policy. That policy conforms to the EU policy of economic and social closing up based on market integration, limited Government intervention reduced to what is absolutely necessary in order to safeguard the public interest, consumer protection and welfare.

The main prerequisite and condition for the implementation of the structural reform and privatisation in the energy sector is the creation of new, modern energy law harmonised with the law of the European Union, as well as appropriate institutional base. In order to achieve the aims stated, it is necessary to institutionalise legally the governmental bodies responsible for the development and implementation of the government policy and regulation in energy.

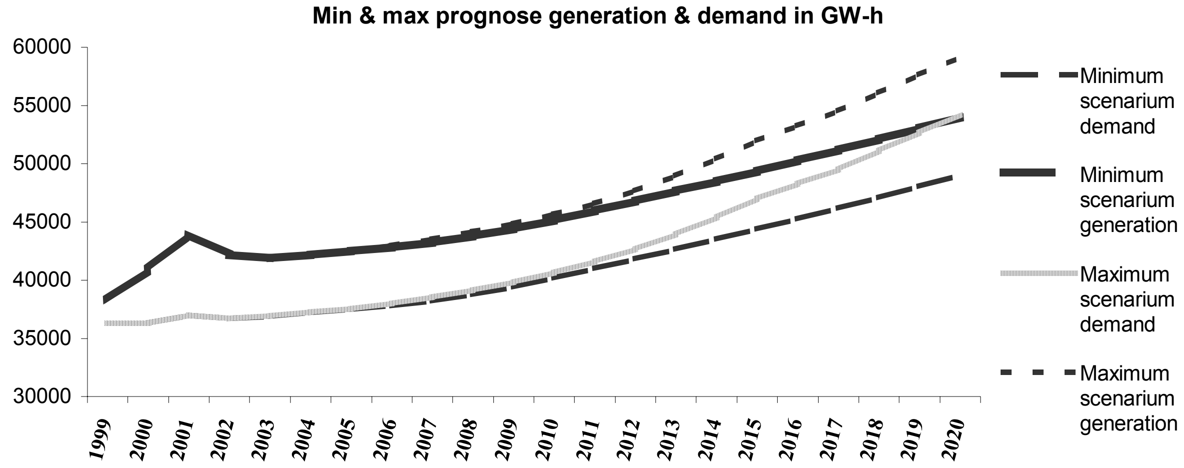


FIG. 10. Energy Consumption Prognoses

3. NUCLEAR POWER SITUATION

3.1. Historical development

The nuclear development of Bulgaria started after the Geneva conference "Atoms for peace" in 1956 and was the favoured strategy of the political leadership ever since. The first step was the construction and the start of operation of IRT-2000 research reactor and a large programme of isotope applications and scientific research. Later, in 1966, an agreement was signed with the Soviet Union to deliver commercial reactors for electricity production. This agreement laid down the foundations of the Bulgarian nuclear power programme. The main articles of this agreement described the role of the reactor manufacturer and designer as well as the participation of the Bulgarian organisations and industry.

The Soviet nuclear industry was designing and supplying the nuclear island as well as the conventional part of the plants, while the architect engineer of the conventional plant and the auxiliary systems was the Bulgarian Company "Energoproekt". The Soviet safety rules and norms were supposed to be used as long as there was no special Bulgarian legislation available. Unfortunately, there was no nuclear law adopted and no provisions for a regulatory authority. During the construction and start up period, the Russian representatives at the site adopted the role of supervisors, but later they have only taken the position of manufacturer and supplier representatives. A number of Russian organisations also carried out all of the important assembly operations.

The first two units, which are a typical WWER 440/230 model, were built and put into operation for a period of less than 5 years and, even if a parity of the rouble to the dollar is assumed the investment cost was less than 500 $ per kW installed. The second pair of reactors was completed and connected to the grid in 1980 and 1982 accordingly. By that time, the model 230 developed towards model 213, which is the reason why Units 3 and 4 incorporate many of the safety characteristics of the 213's. The further increase in the demand for electricity resulted in the construction of additional two units of 1000 MW each from the model known as WWER-1000/320. A second site was chosen in the early eighties near the city of Belene. The site was prepared with the entire necessary infrastructure to host six 1000 MW units. Completion of the first unit reached about 40% on view point construction, and 80% on delivery of equipment, in 1990, when due to lack of financial resources and some opposition from the near by communities the construction was frozen.

3.2. Status and Trends of Nuclear Power

Bulgaria has six nuclear power units in operation at Kozloduy of which operation started between 1974 and 1991 comprising four WWER-440 units, net capacity 408 MW(e) and two WWER-1000 units, net capacity of 953 MW(e), all imported from the former USSR (Table 15). The output of the Kozloduy Nuclear Power Plant was 19.553 TW-h in 2001 (net generation). For the last 10 years the electricity share of KNPP in Bulgaria has been 44-46 %.

TABLE 15. STATUS OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier
KOZLODUY-1	WWER	408	"Kozloduy NPP"-plc	Operational	AEE
KOZLODUY-2	WWER	408	"Kozloduy NPP"-plc	Operational	AEE
KOZLODUY-3	WWER	408	"Kozloduy NPP"-plc	Operational	AEE
KOZLODUY-4	WWER	408	"Kozloduy NPP"-plc	Operational	AEE
KOZLODUY-5	WWER	953	"Kozloduy NPP"-plc	Operational	AEE
KOZLODUY-6	WWER	953	"Kozloduy NPP"-plc	Operational	AEE

Station	Construction Date	Commissioning Date	Criticality Date	Commercial date
KOZLODUY-1	01-Apr-70	25-Oct-74	30-Jun-74	28-Oct-74
KOZLODUY-2	01-Apr-70	07-Nov-75	22-Aug-75	10-Nov-75
KOZLODUY-3	01-Oct-73	17-Jan-81	04-Dec-80	20-Jan-81
KOZLODUY-4	01-Oct-73	17-Jun-82	25-Apr-82	20-Jun-82
KOZLODUY-5	01-Jul-80	21-Jun-88	05-Nov-87	20-Sep-88
KOZLODUY-6	25-Dec-82	13-Aug-92	29-May-91	20-Dec-93

Source: IAEA Power Reactor Information System

During the 70's, a site for the construction of a second nuclear power plant was selected near the town of Belene. In 1980, the Ministry of Energy started its construction. Initially the construction of 4 units with WWER-1000/V320 reactors was envisaged with a possibility for exceeding this capacity with additional new facilities. The engineering works on the site and the construction of the infrastructure started at the end of the year 1980. The construction of unit 1 started in 1987. In the year 1991, the Belene NPP construction was halted mainly due to lack of funds. At that time the first unit was 40% complete. In recent years, certain investigations were carried out and are being carried out now concerning the possibilities for the construction to be continued. There is no decision taken regarding continuing the construction for the present moment.

3.3. Kozloduy Nuclear Power Plant

3.3.1. Units 1-4

The Kozloduy NPP units 1, 2 and 3, 4 (V230 and advanced V230 type respectively) have power reactors of the WWER-440. They are constructed in modules with 2 units each: 2 reactors are situated in one reactor building and they use jointly some systems for normal operation. The safety systems of each unit are separate and independent from the other one. Each unit has two 220 MW main generators. The main mechanical equipment can be considered as standard design and it is produced by standard procedures. The design of the units has been done by regular industrial standards, only the design and the manufacturing of the reactor equipment and the pipelines of the primary circuit comply with special requirements. However, they carry a number of inherent safety features of units, which are safe by their design. At the same time, some discrepancies with the current requirements for ensuring safe operation were identified. For this reason during the 80's, a number upgrading activities were carried out, based on the operational experience as well as on the recommendations of the Chief Designer. The characteristics of these reactors, their positive safety features and shortcoming, requiring safety upgrading are nowadays well evaluated and presented in several internationally available documents.

It is important to mention that while KNPP Units 1&2 were built as standard WWER-440/230 design, Units 3&4 are a new design solution that differs from the rest of 230 type reactors. Their safety systems design is based on three independent trains, each fully capable of performing 100% of safety functions. Low pressure ECCS is also provided to cope with large break LOCA. Each safety system train consists of DG, 6 kV, 0.4 kV and 220 V (DC) bus-bars and batteries, pumps and heat exchangers of ECCS (high and low pressure), SS, EFWS, SWS. In case of emergencies, each train is actuated by its ESFAS simultaneously with the other two trains' activation.

The general approach adopted by the plant, during the last decade, towards continuous safety improvement of the units and to meet current safety standards comprises several stages that have been implemented after 1991. The results were achieved in a close co-operation with the IAEA, WANO and other international organisations, and are summarised bellow:

- Significant extension of the list of postulated events, for which the units' safety systems can cope with, in line with the commonly accepted design approaches;
- Qualitative and quantitative improvements of the capability and reliability of the last protective barrier against spreading of radioactive products into environment in case of an accident;
- Significant reduction of the overall Core Damage Frequency (CDF), approaching the target value established for the reactors in operation world-wide;
- Extensive and thorough justification of a new safety case corresponding to good international practices;
- Steady and significant improvements in plant operational practices and safety culture, following the international community expectations; etc.

Design upgrade - Short Term Modernisation Program 1991-1997

The systematic analyses for compliance of the KNPP units 1-4 with the current safety requirements and the internationally adopted codes and practices began in 1990 and were initiated by the IAEA Safety Review and ASSET missions. The IAEA teams assessed the status of the Units and made recommendations for safety improvement. In response to those missions, the Council of Ministers of Bulgaria made a decision to ensure the implementation of a special program for safety improvement of Units 1 - 4. Through an open discussion with the BNSA, the NPP adopted the step-by-step approach for the implementation of the technical measures during extended outages for maintenance and refuelling.

The European Community Committee, with the agreement of the Bulgarian government, organised technical and financial aid for the Kozloduy NPP and support to BNSA establishing a Consortium of expert institutes and regulatory authorities from European Community member-countries.

The plant developed and presented to the BNSA a three-stage program for implementation of safety measures. The Program was based mainly on the assessment of the experts and covered the recommendations and suggestions made by IAEA, WANO and KNPP experts.

The implementation of the Three-Stage Program was commenced during the outage of the Units in 1991. More than 260 modifications from the First Stage were implemented during the outages of Units 1- 4 in 1992 and 1993. A total of over 650 modifications from the second and the third stage were implemented, beginning with the 1994 outage and ending with the 1997 outage. All modifications and installation of new systems have been carried out in compliance with the QA system requirements, developed and implemented at that time.

The process of safety improvement was subjected to special attention by the IAEA within the framework of the so-called IAEA Extra budgetary Program. A total of eight ASSET and SRM missions have been carried out on-site to support the NPP. The plant incorporated in a common program not only BNSA requirements and IAEA recommendations, but also all available results of international experience gained trough WANO involvement, plant staff and Bulgarian engineering institutes proposals, etc. As a result, good effectiveness of the Program was achieved. The Three-Stage Short Term Program was fully implemented by the end of 1997 and amounted to a total investment of 129.1 million ECU, 38% of which were Bulgarian funds.

Design upgrade - Complex Modernisation Program 1998-2002

After completion of the Short Term Program, the NPP presented to BNSA in March 1995 a Concept for Units 1-4 reconstruction. The goal of the study was to bring the Units into conformity with current safety standards and requirements. A group of targets and criteria for the improvement of the original design were established as follows:

- expanding the DBA criteria to enable management of LOCA accidents larger than those covered by the original design basis;
- implementation of measures to improve the primary circuit piping reliability to a level that allow classification of larger LOCA accidents as hypothetical;
- improvement of safety systems' reliability, to bring safety systems into conformity with the target value of core damage frequency;
- improvement of accident detection and localisation systems, thus improving accident management capability.

Safety targets to be reached through the implemented measures were defined by the BNSA in compliance with current international practices:

- A probability for reactor core damage frequency (CDF) of less than 10^{-4} per reactor-year.
- The measures for accident management and containment integrity improvement should allow a decrease in the probability for exceeding the allowed off site dose by one order of magnitude.

The basis for assessment of the current safety level was found in the IAEA methodology, developed for safety assessment of operational NPPs and described by INSAG-8. Based on that document, a decision was made for carrying out of Periodic Safety Reviews at Units 1-4 using the IAEA procedure as defined in Safety Series 50-SG-012. This includes deterministic safety analysis, probabilistic safety analysis - level 1, analysis of operating experience, etc. A joint team of leading Bulgarian and Russian design institutes and organisations was formed in 1996 to carry out the analyses according to the above-mentioned procedure. The work was completed within two-year period in accordance with specially developed QA Program, and after a specific license by BNSA. More than 450 man-months of highly qualified experts' efforts were dedicated to this assessment. All together, three different analyses were carried out namely - deterministic safety analysis, probabilistic safety analysis and operational experience analysis. As a result, a total of 86 Measures were identified and included in the Complex Modernisation Program for Units 1-4 (known also under the acronym PRG'97). The implementation schedule of the program envisaged investment of about 100 million USD between 1998 and 2001. Its final revision, together with the results from the analysis was presented to the Regulatory Authority at the end of 1997. After a detailed discussion with the BNSA and with the Russian organisations involved, in January 1998, all parties accepted the program.

The methodology was presented to IAEA experts in February 1998, together with a plan for Programme implementation. Assessment conclusions, safety categories developed by the NPP and progress assessment of each safety issue (defined by IAEA TECDOC-640) were added to the IAEA database. It was found that the methodology was very similar to the approach suggested by GRS for safety assessment of this reactor type and complies with the suggestions of the original designer. In 1998, two parallel expert assessments were made to evaluate the compatibility of the approach with the current requirements for safety assessment by Siemens and EdF independently. The two studies resulted in a comprehensive assessment of the developed methodology. Several suggestions for additional measures were made, based on the companies' own experience. In 1999, the Complex Modernisation Program was analysed also by an expert mission from the Western European Nuclear Regulators Association (WENRA), which basically approved the approach and the scope of reconstruction carried out by the Kozloduy NPP. The mission analysed not only the progress status of the measures that had already been implemented but also the plans for updating the program, which was developed by the NPP during that period.

Based on all received proposals in February 2000, a new updated revision of PRG'97 was developed. The scope of practically all on-going technical measures was revised. In addition, 16 new measures were included and a new implementation schedule was developed for the main activities to be performed through year 2002 (implementation of some of the measures will commence in the year 2003). The funds allocated to the program since 1998 was assessed at about $ 66 million, primarily for the modernisation of Units 3&4. The full implementation of some of the measures at Units 1-2 was considered as dependent on the duration of future operation of the units and has been postponed in the view of the current situation.

Responding to an invitation by the NPP, the IAEA organised an expert mission to review the updated revision of the program PRG'97A in 2000. The mission assessed the measures that had been planned but had not been implemented and made an assessment of the status of implementation of the recommendations for eliminating the Units' design problems in conformance with TECDOC-640. Out of a total of 60 technical issues, 56 were found completely resolved. The mission found that the plant program includes many measures and aspects of safety upgrading that went beyond the IAEA recommendations.

At the moment of the preparation of this information, the implementation of the technical measures from the initial scope of the program is practically in final phase. The implementation of a part of the additional measures introduced into the program scope at it's updating is ongoing. The activities, related to the extension of the list of DBA initiating events, have been completed, including assurance of the cooling during LOCA Dn 200 (conservative approach) for all four units and BDBA LOCA Dn 500 (realistic approach) for units 3&4. The necessary technical solutions for the modernisation of the Localisation System (LS) have been developed and justified. The implementation of the basic measure Jet Vortex Condenser (JVC) was successfully completed at Unit 3 and 4. The package of measures for the qualification of equipment is completed.

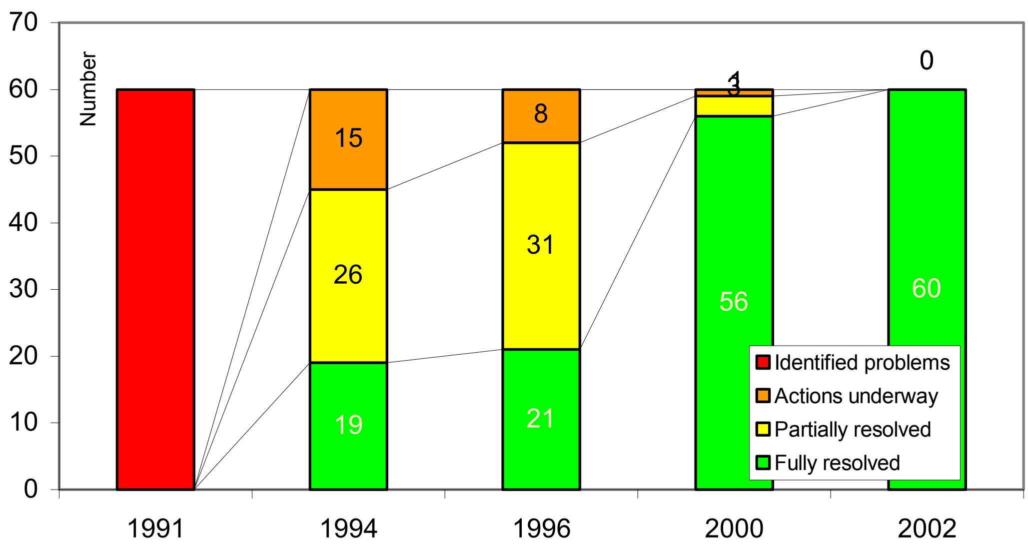


FIG. 11. TECDOC-640 Design Issues

Other important improvements, achieved in 2002 are the development of a total update of the Units SAR, on the basis of the current safety regulations and implementation of Symptom Based Emergency Operating Procedures. Thus, in 2002 practically all the recommendations from TECDOC-640 and the modernisation program goals were achieved. The following diagram presents the progress of the resolution of TECDOC0-640 recommendations during the years.

Operational safety improvements in the period 1998-2002

After the successful implementation of the Short Term program in 1998 the plant decided to perform an in-depth operational safety self-assessment based upon a well established, proven and internationally accepted approach. After evaluation of possible options it was decided to use the OSART evaluation methodology as described in the IAEA manual "OSART Guidelines" - 1994 edition - (IAEA TECDOC-744). A review of all eight areas according to the OSART guideline was foreseen in the Plant Self-Assessment Review (PSAR). The main goal of the PSAR was to review the current plant practices in each specific area according to national standards, international experience, and good practices in a systematic manner. In addition to the OSART guideline methodology, two specific tools were used - OSMIR database (compilation of recommendations made in other OSART missions) and TECDOC-640 database. An OSART mission was conducted in January 1999 and made an in-depth assessment of the plant operational safety level. Specific attention was paid to the assessment of the results of PSAR and on this basis, several recommendations were made to the plant but as a general conclusion, the self-assessment approach developed and applied was assessed very positively.

The results of the OSART mission in 1999 confirmed the achievements in the improvement of safety culture and placed in the priority list of the NPP 49, new recommendations and suggestions for further improvement, to reach good international practices. The follow-up OSART mission, conducted in January 2001, found that 98% of the recommendations and suggestions were either implemented completely or resolved to the expected degree It was also found that in many of the issues the actions implemented by the NPP exceeded the intend of the recommendation. At the same time, the follow-up mission team reviewed the degree of implementation of the TECDOC-640 recommendations concerning operational aspects. The assessment found a complete resolution of the issues addressed in 38 recommendations. The complete schedule for their implementation during the period 1991 to 2001 is presented in the following diagram.

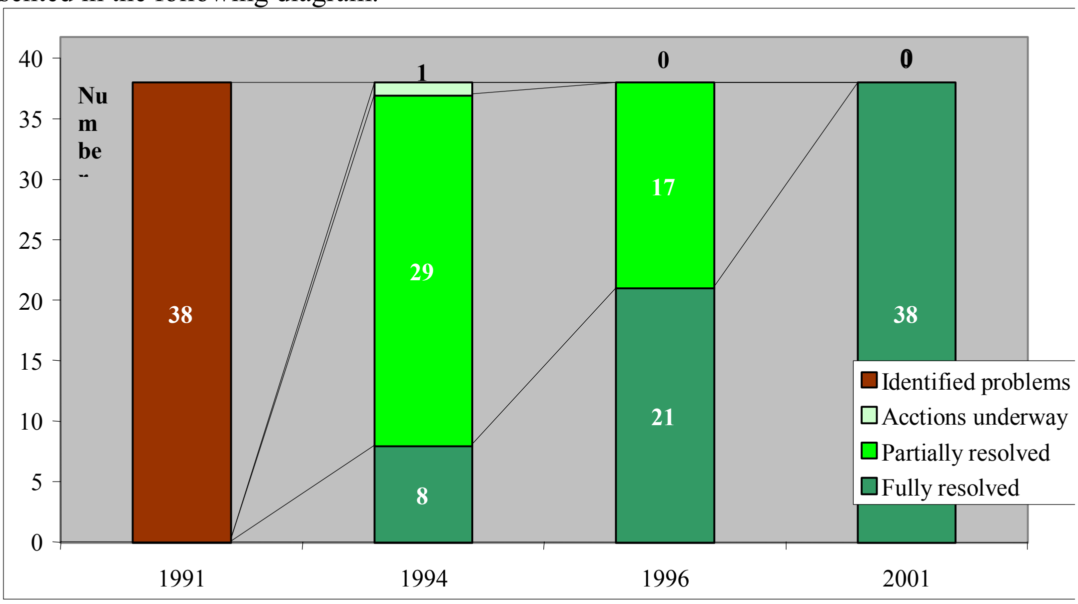


FIG. 12. Operational Issues

Currently, the NPP continue the implementation of its program of measures for improving operating conditions and culture. In this aspect, the separation of the KNPP from National Electric Company (NEK) in May 2000, subsequent structural changes and declaring of KNPP as the Utility had a major influence. As a result the plant received an extended capability in financing the activities related to safety from one hand and from another simplified the procedure for contracting the necessary services in accordance with the priorities of it’s own program. Both effects led to accelerating of the implementation of the modernisation programs on units 3 and 4 and of units 5 and 6. The plant investment program was growing during the last three years and nowadays represents more then 120 million EUR/year, which assures timely completion of the ongoing activities and further safety and reliability enhancements.

New safety case for units 3&4

Strategic safety targets were developed by the plant for upgrading of units 3&4 safety basis as a justification of their upgrading ability and in full conformance with the current safety requirements. Nowadays, the plant has accomplished all those safety goals.

A plan was developed for re-qualification of Units' design into a new design model, called WWER-440/B-209M. The aim of this plan is to re-evaluate the current design basis and carry out a comparative analysis with the current safety standards.

Ensuring reactor core cooling at all initiating events related to primary circuit rupture is included in the review of the safety analysis of the new B-209M design, including demonstration that the limits of radiation impact on the environment are not exceeded. The acceptance criteria and conditions for the respective analysis were defined for each case in compliance with the recommendations of the IAEA and WENRA experts.

Reliable fuel cooling (without reaching failure conditions for fuel assemblies) was demonstrated through the application of a deterministic approach for all initiating events, including LOCA Dn 200. The initiating event of main circulation piping rupture (diameter 500 mm) was analysed as DBDA with the application of a realistic approach. It was demonstrated that at this initiating event, no unacceptable changes are reached in the geometry of the fuel assemblies in the reactor core. The conditions for preserving the integrity of fuel assemblies are as follows:

- Fuel temperature, not higher than 1200 ^{o}C;
- Localised depth of surface oxidation in the fuel rods, not more than 18% of the initial wall thickness;
- Percentage of the reacted zirconium, less than 1% of the quantity contained in the reactor core.

In accordance to the BNSA requirements, the limits for DBA and BDBA specified below are met for all initiating events:

- <u>For design basis accidents</u> – effective dose of 50 mSv during the first year after the accident and ingested dose of 150 mGy for the thyroid of a human at the border of the 3-km monitored area.
- <u>For beyond design basis accidents</u> – effective dose of 5 mSv during the first year after the accident and ingested dose of 50 mGy for the thyroid of a man at the border and out of the protected area of Kozloduy NPP with a radius 30 km.

Preserving the integrity of the concrete confinement is demonstrated for all the initiating events, including dynamic loads during the accident. The confinement leak rate was decreased gradually to no more than 100% of its volume in 24 hours. The maximum allowed untightness of the confinement is defined based on the limits specified for acceptable radiation impact at accidents of different classes.

In case of a primary circuit piping rupture, reactor core cooling is ensured by two three-train systems for high and low pressure emergency core cooling. As regards to initiating events without LOCA, the application of the approach, to use the additionally installed complementary emergency feed-water system, is adopted.

To limit the pressure increase in case of an accident, a completely new passive system for pressure suppressing through condensing steam in water volume (Jet Vortex Condenser) is implemented. This solution is analogous to the solution for limiting the pressure, incorporated in project B-213. The overall ALS modernisation includes already scheduled installation of a passive hydrogen recombination system and forced filtering ventilation system, both aimed to cope with severe accidents.

The gradual replacement of the control systems of the Units with a new generation of digital devices, initiated within PRG'97A is carried out. This covers not only the systems for initiating the safety systems actions (which for these Units are three independent sets each with its own sensors) but also the control of the basic supporting systems (DG, Reversible Motor Generator, etc), diagnostic and information systems as well. Reliability of the Reactor Protection System is justified but in view of the expected long operation of the units its replacement with a digital one is planned too.

Based on the three-train safety system structure, a complex of measures for enhancing the functional reliability of the auxiliary systems is implemented, including replacement of equipment with units of higher capacity and reliability and adequate qualification (for example all accumulator batteries, all circuit breakers etc.) This leads to enhancing the reliability of the control systems, cooling systems capacity, etc.

The necessary activities are implementing based on the analysis of the real conditions, identifying high stress zones and potential degradation mechanisms and implementation of corrective measures when necessary. Many structural analyses have been performed for this purpose and necessary measures are taken to ensure the reliability of the main piping system. Important results were received trough the development of a complete Rest Lifetime Management Program based on modern assessment tools and diagnostic systems. This leads to identifying of all important degradation mechanisms for the safety related structures, systems and components and implementation of the corresponding corrective actions.

The approach was based on continuation of the risk analysis and completion of the Measures necessary for qualification of the equipment, enhanced safety related structure supports in order to bring them into conformity with the updated seismic assessment, additional fire protection Measures, etc.

In addition to the implementation of Symptom Based Emergency Operating Procedures the plant is implementing a large number of technical measures aimed in development of a complete strategy for management of severe accidents. These include measuring coolant level in the reactor vessel, filtered venting system in the containment, installing a system for hydrogen recombination, etc. The development of SAMG is already initiated in the framework of an international project.

The incorporation of the described changes in the Units design leads to a new design basis, which includes a complete set of technical means to cope with the updated list of initiating events. Based on that a new SAR was developed following the requirements for structure and content, established by the Western TSO experts, supporting BNSA.

IAEA Safety Review Mission to Units 3 and 4 in 2002 - summary results

The most recent evaluation of the safety status of Units 3 and 4 was performed by an IAEA expert mission, conducted between 24 – 28 June 2002 at a request of the Bulgarian Regulatory Authority. The purpose of the mission was to review the progress of the modernisation program for these two units with respect to the IAEA TECDOC 640, the Issue Book related to WWER-440/230 type nuclear power plants. The review mission was organised as a follow-up of three previous reviews both in the design and operational safety areas; OSART mission of January 1999, OSART follow-up mission of January 2001 and review of the modernisation program (for Units 1-4) of October 2000. One area, which is not covered in TECDOC 640 but was addressed specifically in the present review, is seismic safety. This area was a subject of significant activity for the IAEA in relation to the Kozloduy NPP and in a general sense the present review represents a follow-up of the past recommendations in this area. The review team comprised three IAEA staff members and five external experts with experience and expertise related to WWER 440/230 type of plants and more specifically to Kozloduy NPP Units 3 and 4. To describe the general conclusion of the IAEA team, a summary of the mission report is presented hereinafter.

General Comments

Kozloduy NPP (KNPP) began a systematic safety evaluation and improvement of Units 1-4 in 1991 with the assistance of the IAEA, which organised a series of missions to assess the status of the units and to support the efforts of the plant management. Since that time, with the support of international organisations, the plant has successfully implemented several modernisation programmes for safety upgrading in terms of design and operational safety. At present, the plant is implementing the final phase of the safety improvements for Units 3 and 4 within the framework of the overall modernisation programme.

The last review of the programme was performed by the IAEA during a specially organised mission for the evaluation of Units 3 and 4 in October 2000. In general, the mission assessed positively the overall modernisation programme of the plant, as well as the status of resolution of the design issues of TECDOC 640. Additional suggestions to improve the process were also provided by the IAEA review team at that time. In parallel, the operational practices of the plant were thoroughly evaluated by the IAEA OSART mission in 1999 and its follow-up in 2001. It was concluded that the plant operational safety is a priority for KNPP management and that in the process of its improvement the plant has reached a level that corresponds to the level of plants of the same vintage world-wide. The report presents, in a broad perspective, the overall plant safety upgrading approach, results of the activities implemented as of June 2002 and the assessment of the safety status of Units 3-4 by the IAEA SRM. The Government of Bulgaria requested the mission as a follow up of all the previous recommendations and suggestions made for Units 3-4 including design safety, seismic safety and operational safety. It is also important to indicate that the approach of KNPP technical staff and management to safety and quality has significantly evolved over the past decade. This approach will be the fundamental tool for maintaining plant safety in all aspects of KNPP operation in compliance with IAEA Safety Standards and current international practice.

Specific Comments

Regarding Units 3 and 4, in the course of the Modernisation Programme, the main safety functions were improved to the level, or in some cases beyond the level, which meets the IAEA initial recommendations of TECDOC-640. Controlling the power in all operational states and accident conditions has been realised to meet the safety objectives of the extended design basis for the KNPP Units 3 and 4. Cooling the core in all conditions is now based on successive layers of defence-in-depth going beyond initial expectations in some cases.

Since a jet vortex condenser has been installed in the confinement, the core cooling and confinement functions are now fulfilled for the whole spectrum of primary pipe breaks up to Dn 200 with conservative assumptions, and, for the largest one (Dn 500) using realistic assumptions. Leak tightness of the confinement was also largely improved, using the experience of other plants of this type. Concerning primary circuit integrity, all baseline information on material composition, mechanical properties and in-service inspection are of good quality. A comprehensive international project for a more precise assessment of RPV embrittlement after annealing (Unit 3) is under way. UT ISI qualification program for critical weld area is a high priority for the management. The results of investigations indicate that the RPV integrity maintained and that its remaining lifetime is at least equal to the design lifetime.

The LBB concept application on the primary piping including surge lines provides solution for the primary piping integrity. It also eliminates leading PTS scenario due to double-ended break of the pressurizer surge line. Significant improvements were also implemented in the safety function support systems such as I&C, Electrical Power, Service Water and Air-conditioning. Concerning the electrical systems as well as components important to safety, the plant has set up a programme for upgrading all electrical components and systems concerning reliability as well as quality in accordance with IAEA Safety Guide recommendations during the outage of 2002. Concerning the I&C systems important to safety the plant has also set up a modernisation programme as well as a qualification programme in accordance with IAEA Safety Guide recommendations. These programs are also to be finalised during the outage of 2002. Both modernisation and qualification programs will be accompanied by periodical PSA as well as reliability investigations. All electrical as well as I&C issues are assessed in accordance with IAEA TECDOC 640 as intent of recommendation met.

Due to the significant improvement in plant's defence-in-depth and protection against all sources of common cause failures (fire, flooding, etc.) the safety functions can now be performed with a high level of reliability in all plant conditions including shutdown states.

The KNPP (Units 3&4) has implemented an extensive programme of seismic re-evaluation and upgrading of structures, systems and components as a consequence of a change in the seismic design basis of the plant. The seismic hazard analysis was performed (between 1990 and 1992) following a recommendation of the IAEA and using IAEA standards and current international practice. The re-evaluation and upgrading was performed systematically to all items in the safe shutdown path, as well as those used for mitigation and confinement. Furthermore, new equipment procured and installed within the framework of the modernisation programme have been seismically qualified using well-defined procedures and following IAEA standards as well as current international practice. The plant has modern seismic instrumentation, which was recently reviewed by the IAEA and there are procedures in place on operator and plant actions following an earthquake. There is perceptible renewed awareness at the technical and management levels to issues related to seismic safety which provides assurance that the plant will keep up the positive attitude towards this area.

The new accident analyses have been performed for the full scope of the postulated initiating events and for a spectrum of selected beyond design basis accidents, applying qualified tools, methods and practices. Major progress was achieved by developing a new Safety Analysis Report for each of the units in 2002. Probabilistic Safety Analysis Level 1 was used in support of safety decisions. In particular, it contributed to justification of the safety measures implemented and to evaluation of their impact on overall plant safety. It showed that major risk contributors have been significantly reduced, and that the core damage frequency already achieved is significantly lower than the INSAG target - 1.E-04/reactor.year adopted by the plant for reconstruction. The SRM team encouraged KNPP to continue in its work for updating the Probabilistic Safety Analysis for shutdown operational modes, and for further development of a comprehensive Accident Management Programme for mitigation of severe accidents which would go beyond the initial IAEA recommendations, but represents recent trends in nuclear safety.

In the assessment of operational safety, the SRM team noted that management expectations are well understood at all level in the organisation, and high quality standards were observed in all areas dealing with assurance of operational safety. The SRM team made particular note of the improvements observed in the areas of training and qualification, implementation of symptom based emergency operating procedures, and in the quality of management processes in the technical support area. The team also noted significant improvements in the material condition and housekeeping of the plant. In several of the areas where these improvements were identified the issues were already rated as 'resolved' by a previous IAEA review team and OSART mission. The willingness of the plant to invite a second review to ensure that there was no decline in performance is an indication of the commitment by Kozloduy management and staff towards continuous improvement in operational safety. The team also recognised the efforts by KNPP to implement a strong self-assessment program. The team noted that significant improvements have been made to complete the maintenance training facilities and the second Emergency Control Centre, as well as upgrading associated training materials. The team supports further the plant activities to continue to explore methods to enhance team training for control room staff on the use of abnormal and symptom based emergency operating procedures. During the entire SRM the team noted the professionalism of the control room staff and their willingness to provide open and frank discussions with the team. In the majority of the operational issues the team recognised meaningful improvements, revealing the aim of Kozloduy management and the staff to continuously improve operational safety. Many examples of these relevant improvements are in the areas of quality and control of the plant documentation.

3.3.2. Units 5 and 6

The Kozloduy NPP units 5 and 6 are equipped power reactors of the WWER-1000/V320 type. The design of these reactors meets entirely the international requirements for nuclear safety. The main principle for NPP safety is applied: defence-in-depth with several physical barriers, including the redundancy, variety, independence, protection against failures, and passive elements. The active safety systems have 3x100% capacity, functional independence and they are physically separated. Their containment is designed for full pressure - (0.5 MPa).

Two OSART missions of the IAEA in 1990 and in 1991 were carried out for assessment of the operational safety. They established a good functional order concerning the analysis of the operational events, the management of operation, the programmes for control over the state of the equipment, and the control over radiation protection. The organisation of the operation needs improvement as well as the maintenance activities and the technical support. Additional recommendations were made concerning the interaction between the NRA and the NEC-PLC. The recommendations were implemented in accordance with an elaborated programme. The IAEA ASSET mission carried out during 14-25 November 1994 reviewed over 400 events.

Based on the analysis of the operational experience, the comparison with similar reactors of the PWR type and the enhanced international requirements for safety, a programme for modernisation was elaborated and its implementation has already started. Generally, the aims of the programme are to enhance both the safety and the availability of the units. The last IAEA mission (SRM) carried out from 26 June to 1 July 1995 reviewed the programme for modernisation of units 5 and 6 and defined 7 additional measures. The last version of the programme for modernisation was accepted with a positive evaluation by Riskaudit in 1997 and was approved by the NRA. It was established that the programme is elaborated in compliance with the existing assessments and analyses of the IAEA on the safety of the WWER-1000/V320 type reactors. In 1996, a tender was announced by the NEC-PLC for implementation of the programme. The implementation of the main part of the measures was consigned to the European Consortium "Kozloduy", including Atomenergoexport-Russia, Siemens-Germany and Framatom-France. Westinghouse (USA) undertook the implementation of a number of measures. In 1998-1999, the contracts were signed and the implementation started.

The phase preparing the development of the modernisation projects ended in 2000. The purpose of the basic engineering phase was to develop technical projects for the hardware measures and studies, which will be used as a basis for the decision to be made in the next phase beginning in 2001, when the implementation of the Modernisation programme itself is to start. The conditions of the contract with ECK and Westinghouse were updated. The technical scope of measures was optimised and on this basis started the implementation of the priority measures of both contractors. In order to provide the necessary financial support Loan agreements were signed with City Bank USA, Euratom and Rosseximbank. The overall financing of the project is complemented with the plant own funds.

The remaining part of the programme is carried out using company own resources. The replacement of boron-meters and super-heaters has been completed. The reliable power supply equipment of the safety systems is being replaced on schedule. The implementation was reviewed by two missions of the International Atomic Energy Agency. The IAEA experts expressed their high opinion of the current state and plans for future activities.

Probabilistic Safety Analysis – level 1 was performed for units 5 & 6. In 1996, an IAEA mission was held for methodology and analysis results' assessment - International Peer Review Service (IPERS). The implementation of units 5 & 6 Modernisation Programme second phase is to be executed for the period 2001÷2006.

Bulgaria maintains and will continue to maintain its open policy of inspection and phased safety improvement in conformity with the international practices. The findings of the missions registered the progress and closer approach to the up-to-date methods of safety assurance for nuclear power plants.

3.3.3. Data on the Nuclear Installations

3.3.3.1 Basic Data and Main Characteristics of Nuclear Facilities at the Kozloduy NPP site

Table 16 shows information about Kozloduy units.

3.3.3.2. Kozloduy Site Description

Location and Hydro-geological Characteristics

The Kozloduy NPP site is located 3.5-km south-east from the town of Kozloduy and 12 km north-west from Miziya town, region Montana. At about 3 km away from the NPP is the border with the Romania - the Danube River.

The Danube River lowland (20m absolute altitude) surrounds the site from north and by the water shed plateau slope (90m absolute altitude) from south. The NPP Kozloduy site can not be submerged, it has +35 m absolute altitude. The relief of the region represents a hilly plain with 100-200 m absolute altitude, segmented by the Tsibritsa, Ogosta and Skat rivers. Wide elongated and flat new soil elevations, the biggest of which is the Zlatia plateau, have been formed between them. The Danube riverbank is higher (up to 100-110 m) in the Oryahovo region and westward from Kozloduy, while the lowest point (25-30 m) is in the Kozloduy low land.

Concerning the geology, the site consists of Pliocene and Quaternary sediments. The over-layer has 14-15 m thickness and consists of loess and loess type clay. The surface layer has about 7-m thickness of sediment loess and Pliocene deposits (dense marl clays and sands) are observed at 18-20 m depth. There is a sand layer at about 35 m in depth, about 10 m thick. The overall thickness of the Pliocene deposits is about 100 m.

The underground water is connected with the water bearing alluvial gravel-sandy deposits and the Pliocene sands. The hyposometric level of the existing underground water is 29 m with a flow direction from south-west to north-east. The underground water is not "aggressive" towards concrete.

Seismic Characteristics

NPP site is located in a seismic region, but there are no active tectonic structures. The maximum design basis earthquake is evaluated to be 8 on the MSK-64 scale and the design basis earthquake according to the same scale is evaluated to be 7. In case of an earthquake, no residual deformations and other resulting phenomena are expected. The plant site is located on the so-called Miziya platform, which is classified as 7^{th} degree on the MSK-64 seismic scale.

TABLE 16. WWR-440 AND WWER-1000 GENERAL DESIGN FEATURERS AND PARAMETERS

Reactor type		WWER-440 Type V-230 Unit 1÷4	WWER-1000 Type V-320 Unit 5÷6
Parameter	Dimension		
Reactor power			
- Thermal	MW	1375	3000
- Electrical	MW	440	1000
Primary circuit pressure	MPa	12,3	15,7
Reactor inlet coolant temperature	ºC	265	288
Reactor outlet coolant temperature	ºC	292,7	318
Average coolant temperature difference of the reactor core	ºC	27,7	30
Fuel assemblies	number	349	163
Reactor control rod assemblies	number	37	61
Fuel rods in a fuel assembly	number	126	312
Average density of the thermal flow	W/cm^2	50, (44,8 - IV)	57,9
Average linear thermal flow	W/cm	142,9, (128,2 – IV)	165,7
Loops in primary circuit	number	6	4
Coolant flow rate	m^3/h	44 000	86 400
Maximum fuel enrichment in U-2335	%	3,6	4,4
Steam Generators			
Type		PGV-4E	PGV-1000
Quantity per unit	number	6	4
Steam capacity	t/h	425	1470±60
Thermal power	10^6kJ/h	825	2700
Steam pressure	MPa	4,6	6,3
Feed Water temperature	ºC	225	220
Turbines			
Type		K-220-44	K-1000-60/ 1500-2
Quantity per unit	number	2	1
Power	MW	220	1000
Main steam parameters			
- Pressure	MPa	4,3	5,9
- Temperature	ºC	256	274
Main Coolant Pumps			
Type		GCN-310	GCN-195M
Quantity per unit	number	6	4
Generators			
Type		TVV-220-2	TVV-1000-4
Rated Power	MW	220	1000
Generator voltage	kV	15,75	24
Grid voltage	kV	400/220	400

Source: Country Information.

Meteorological Data

The climate is "moderate continental" with cold winter and hot summer, which is representative of the north climatic region of the Danube lowland. The NPP Kozloduy surrounding landscape is such, that cold and strong winds especially from the West and North-West are possible during winters. For the period 1971-2001 the absolute maximum temperature measured for Kozloduy is +43.2 °C (August), the absolute minimum temperature measured is -26.6 °C (January) and the average annual air temperature is +11.5 °C.

Data about the air temperature, the relative humidity and the wind for the period 1997-2001 provided by the NPP Kozloduy automatic meteorological monitoring system is presented in Table 17 and Table 18. The strongest winds with speed up to 18.3 m/s are observed during April 1997. Measurements of the Danube River water temperature have been performed at the Oryahovo post for the period 1937-1967. The specific temperatures are presented in Table 19.

TABLE 17. AIR TEMPERATURE AND RELATIVE HUMIDITY AT NPP KOZLODUY

Month	Air temperature [°C]			Relative humidity [%]		
	Minimum	Average	Maximum	Minimum	Average	Maximum
January	-14.0	-1.3	16.0	36	84	99
February	-15.1	2.8	18.7	40	80	99
March	-5.0	6.1	21.8	27	68	99
April	-3.6	11.2	30.3	28	68	99
May	2.0	18.3	31.1	34	72	98
June	6.4	21.6	38.2	39	70	97
July	10.9	23.7	41.9	31	65	98
August	10.1	23.9	40.0	27	64	99
September	1.5	17.6	33.3	26	73	98
October	-2.6	11.4	28.9	25	73	99
November	-11.9	4.9	24.3	38	81	99
December	-17.2	-0.6	17.1	44	74	99
Year Average	-17.2	11.6	41.9	25	73	99

Source: NPP Kozloduy

TABLE 18. AVERAGE WIND SPEED WITH FREQUENCY AND DIRECTION

Direction	N	NE	E	SE	S	SW	W	NW
Frequency [%]	7.3	13.8	11.8	10.1	8.2	11.3	21.6	15.9
Average speed [m/s]	2.2	2.4	2.0	2.7	2.6	3.1	3.5	3.7

Source: NPP Kozloduy

TABLE 19. SPECIFIC DANUBE WATER TEMPERATURES (°C)

Month	Maximum	Average	Minimum
January	5.8	1.4	0
February	8.1	1.7	0
March	11.2	5.0	0
April	17.9	1 1.2	4.1
May	23.9	16.7	10.9
June	25.8	20.7	15.2
July	27.3	22.9	17.6
August	27.5	22.9	17.0
September	25.3	21.3	14.2
October	21.3	13.9	7.5
November	14.0	8.3	1.7
December	8.2	3.5	0
Year Average	27.5	12.2	2.0

Source: Country Information.

Demographic Data

The population density in the region is non-uniform. The towns with highest density are Oryahovo (100-120 persons per km^2). Kozloduy (80-100 persons per km^2) and Miziya (20-30 persons per km^2). The average population density for the area is 60-80 persons per km^2.

3.3.3.3. Belene site description

The Belene site is situated in the lowland of Svishtov and Belene on the bank of the Danube River, 571st km. The site is located 7.5 km from the border with the Republic of Romania, across from the largest island in Danube River - the Belene (Persin) island.

In 1987, experts from Atomenergoproekt - Kiev and Energoprojekt Sofia, developed an engineering design for construction of four units with WWER 1000N-320 type reactors. The construction activities started up in 1987. The all-out NPP construction was performed in the period 1988- 1990. In 1991 the construction activities were stopped.

In the period of 1-20 July 1990, IAEA experts, including observers from Romania and Cuba held a PREOSART mission on review of the construction. The conclusion of the mission was that the project organization is an integral and centralized formation, valid for the member states of the former Council of Mutual Economical Assistance. It functions on the basis of the accepted unified design of WWER-1000 aimed to achieve a high level of reliability and safety with minimum cost and optimal construction schedule. The mission gave a positive evaluation of the management, construction and preparation for operation. The main recommendation was for a Quality Assurance Programme to be developed.

In 1990, another IAEA mission took place to assess the safety aspects of the design. The duration of the mission was two months. A review of the reactor core design, safety systems design and safety analyses was performed. The conclusion of the mission was that in consideration of the topics reviewed, the design of Belene NPP is similar to the modern Pressurized Water Reactors. No significant safety deficiencies were recognized. The recommendations made by the experts related to possible future safety upgrading.

After stopping the construction activities of the Belene NPP, a programme was implemented with conservation measures for the main building constructions, and re-conservation of the main equipment stored at the site. A current control of the building construction conditions is performed and the deficiencies identified are removed. Recommendations by the manufacturers delivered the main equipment are used in the conservation process. So far, no final decision has been taken relating to the continuation of the Belene site construction.

3.4. Current Policy Issues

During the last decade, the Kozloduy NPP implemented tremendous amount of safety improvements in all design and operational areas. Hundreds of millions of Euro (dollars) have been spent to safety upgrading. As a result, currently units 3 and 4 meet all internal and international safety standards and there are no technical reasons for their early closure. This is also proved by the conclusions of the IRRT SRM mission, carried out in 2002, that units 3 and 4 has reached a safety level comparable with the international units from that generation.

The Kozloduy NPP intends to continue its safe and reliable operation in compliance with all country safety requirements and the recent development of science and technology. It should be noted that Kozloduy NPP significantly contributes to maintaining economical and political stability at the Balkan region by covering a large part of the energy deficiency in the region energy balance through supply of ecologically clean energy at reasonable price.

These objectives conform to the spirit and principles underlying the nine international agreements in the nuclear energy field, which were signed and ratified by the Republic of Bulgaria including the Nuclear Safety Convention.

4. NUCLEAR POWER INDUSTRY

Bulgaria has not developed its own nuclear industry, since it uses a "once through" fuel cycle and all fuel cycle services and the nuclear steam supply systems have been delivered from the Former Soviet Union (now Russia). The country has been a member of the co-operative effort of the former COMECON countries and the RADOMIR METAL company near Sofia has been selected to produce some equipment for the 1,000 MW reactors containment buildings (heavy isolation doors, penetrations, seals, etc.). A number of companies from Bulgaria, Russia and other countries participate in the regular maintenance of the different systems of the plants. Several smaller local companies specialised in different aspects of the plant operations deliver several services.

Some of the companies are:

i) ENERGOPROEKT - for design, engineering, safety assessment etc.;
ii) RISK ENGINEERING - for safety assessment, design, etc.;
iii) ENERGOREMONT - the largest maintenance company in the energy sector;
iv) ATOMENERGOREMONT - maintenance company specialised for the NPP.

Important Russian organisations are:

- GIDROPRESS;
- IZORA JSC;
- VNIIAES Institute;
- KURCHATOV NATIONAL RESEARCH CENTRE;
- PODOLSK METALLURGICAL WORKS.

International companies also participate in the maintenance and support of the NPP Kozloduy.

- INETEC-Zagreb is the main contractor for performing ISI of the SG, Pressure vessel and other important components;
- WESTINGHOUSE is supplying the radwaste reprocessing and packaging plant;
- FRAMATOME (SIEMENS) have been important suppliers of safety equipment.

The Ministry of Energy and Energy Resources is the organisation, responsible for the development of the power industry, including nuclear power. The State Nuclear Regulatory Body is the Nuclear Regulatory Agency (NRA). The operator of the nuclear power plant "Kozloduy" is the “Kozloduy NPP”-plc. In April 2000, was the NPP Kozloduy separated from the National Electric Company and became a shareholder entity with 100% state ownership. The main technical support organisations to the nuclear power are: Energoproekt PLC, EQE-Bulgaria, Risk Engineering, Enpro Consult, Institutes of the Bulgarian Academy of Sciences -Institute of nuclear research and nuclear energy (INRNE-BAS), Institute of metal science, Institutes of the earth, etc.

Description of the national system for monitoring the use of atomic energy

Under the Constitution of the Republic of Bulgaria, the Council of Ministers pursues the state internal and external policy in compliance with the Constitution and the laws. The Council of Ministers governs the implementation of the state budget, organises the management of the Governmental property, signs, approves and denounces the international contracts in cases envisaged by the law. In fulfilling its functions the Council of Ministers has the right to establish bodies such as commissions, agencies, councils, in order to pursue the state policy in a definite area. The Nuclear Regulatory Agency (NRA) is the main regulatory body in the field of nuclear safety and radiation protection. It exercises the state regulation over the use of nuclear energy and sources of ionising radiation, as well as the safe management of radwaste and spent fuel. The Ministry of Health, the Ministry of Internal Affairs, the Ministry of Environment and Waters and other state authorities, exercise control within the framework of their competence.

Ministry of Health

The Public Health Act and the Public Health Act Enforcement Regulations determine the Ministry of Health's and its control bodies' functions. The organisation of radiation safety control activities is determined by the Regulations on Radiation Safety Control Bodies' Structure. The Ministry of Health in co-operation with other state authorities permits and controls the labour conditions related to import, export, production, storage, use, transportation and making harmless of nuclear material and other sources of ionising radiation, within the framework of their legal competency. The Ministry of Health is the authority that controls the use of sources of ionising radiation for the purposes of medicine. In addition, the Minister of health determines the obligatory sanitary standards in all radiation protection areas. The National Centre on Radiology and Radiation Protection is the specialised sanitary control authority in the field of safe nuclear energy utilisation.

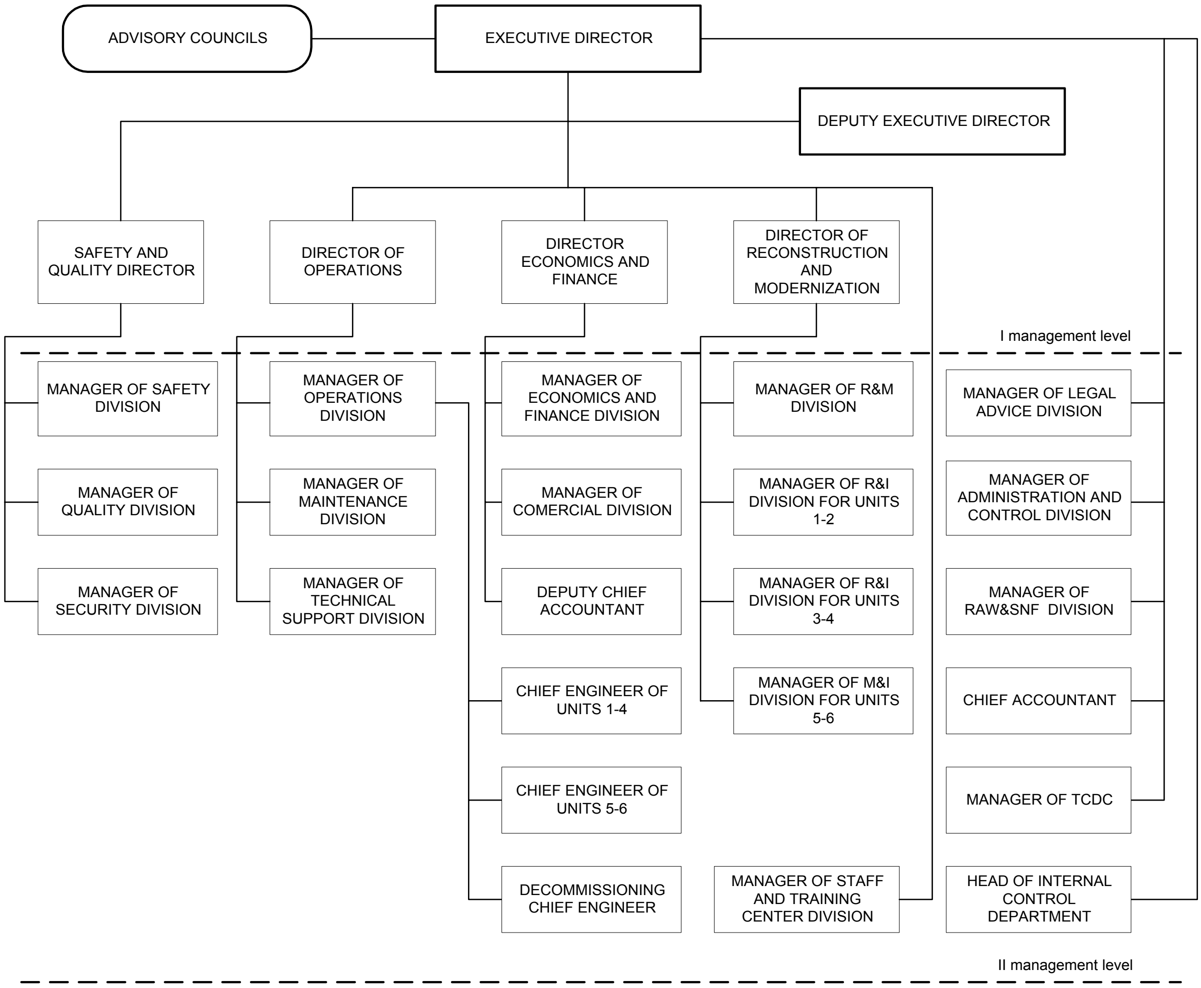


FIG. 13. Management Structure of Kozloduy NPP plc

Ministry of Internal Affairs

The structures of the Ministry of internal affairs are mainly responsible for the physical protection and the fire protection of the NPP. The Security Services of the Ministry of Internal Affairs performs the following activities:

- collection of information from different sources about intention of persons or groups of persons for planning and preparing for implementation of illegal actions or inaction, related to nuclear facilities and nuclear material;
- collection of information on deliberate activities or inaction, leading to violation of technological processes and instructions and causing premises for nuclear accidents and radiological emergencies;
- distribution of gained information among corresponding boards of the interested authorities, which are able to apply necessary measures for mitigation or prevention of injurious sequences;
- preliminary inspection of the reliability of candidates to pass to the security area or internal areas for work with secret materials or physical protection information, as well as external persons visiting the nuclear facility;
- preliminary inspection of accidents, for which malice aforethought is suggested, as well as other accidents with casualties (victims) or danger for the public health;
- control over the protection of state secret and physical protection information.

Security activities are carried out in close co-ordination with the NRA, licensees and corresponding national, central and territorial services of the Ministry of Internal Affairs.

Ministry of Environment and Waters

The Protection of Environment Act determines the control over environment states and over sources of contamination, as a basic function of the Ministry of Environment and Waters (MEW). All activities of physical persons and legal entities can be put under assessment of the impact on environment. For energy industry projects of national and regional importance, it is obligatory an impact assessment to be carried out. Among them are: nuclear power plants and other nuclear reactors, except research reactors with power less than 1 kW; facilities, exclusively aiming storage, final disposal and/or reprocessing of radioactive wastes and irradiated burning materials; facilities for nuclear fuel mining and enrichment.

MEW operates national automated system for monitoring of the gamma-background in the Republic of Bulgaria. The system comprises of 26 local monitoring stations, each of them contains a gamma-probe and a detector for rain. 9 are equipped with meteorological detectors. In addition there is a mobile monitoring station, which gives the possibility of monitor the radiological and meteorological parameters, and to perform on-site gamma-spectrometry sampling. The central station of the system is in MEW. Additional monitoring centres exist at the NRA and Civil Protection Directorate. In addition, the regional structures of the MEW operate 16 laboratories on radiological measurements.

Ministry of Defence-Civil Protection Department

The State Agency “Civil Protection” was established to the Council of Ministers in February 2001 as a successor of the Civil Protection Department to the Ministry of Defence. This act guaranteed the independence of this institution and approved its over-institutional character. The State Agency “Civil Protection” exercises the functions of the operative headquarters of the Public Protection in Cases of Calamities and Emergencies Permanent Commission within the Council of Ministers. The State Agency “Civil Protection” is responsible for the development of the National Emergency Plan. Stations for monitoring and notification of the Civil Protection authorities are established based on the on duty officers at regional and municipal authorities. Thirty of the total 335 stations are equipped with highly sensitive apparatus for gamma-background measurement. Based on the data obtained, a daily report is prepared on the status of the radiation situation. Additionally there are 5 stations in the emergency-planning zone of the Kozloduy NPP (30 km). The gamma-background is measured 3 times per day at the rest of the stations located in the country. The data are reported to the State Agency “Civil Protection” and then to the Emergency Response Centre of the NRA.

4.1. Supply of Nuclear Power Plants.

Bulgaria does not supply nuclear power plants and/or equipment for nuclear power plants. The equipment for the existing plants have been purchased from Russia, but some parts and systems have been supplied from western suppliers like Siemens, Westinghouse, Sempel, Sebim, Framatome and others.

4.2. Operation of Nuclear Power Plants

The Council of Ministers of Republic of Bulgaria adopted Resolution No.70 dated 20 February 2001, according to which all nuclear power plants and other equipment on “NPP Kozloduy” PLC are defined as one nuclear installation and “NPP Kozloduy” PLC is its operator according to the Vienna Convention on Civil Liability for Nuclear Damage.

“NPP Kozloduy” PLC as “nuclear installation operator” according to the Vienna Convention on Civil Liability for Nuclear Damage is the bearer of the corresponding civil responsibility. As “license holder” according to Nuclear Safety Convention, the company bears the responsibilities for nuclear safety. This is reflected in the NPP “Kozloduy” PLC Statute (art.2, para 2 and para 3) and in Corporate Structure and Activities Code (art. 5 and art. 6). In this respect, the company holds a license, given by the State Energy Regulation Committee on production of electrical and thermal energy (Verdict No. 049 dated 11.12.2000 of SERC).

As the operating organisation is responsible for ensuring fulfilment of safety requirements, “NPP Kozloduy” PLC rights and obligations are defined in the Statute, Corporate Structure and Activities Code, company structural subdivision and sections activity organisation regulations, as well as in the personnel job descriptions for the whole hierarchy managing chain.

“NPP Kozloduy” PLC responsibilities and obligations are summarised in art. 7 of Corporate Structure and Activities Code and are performed through “ implementation of activities for nuclear safety maintenance and enhancement, radiation protection, physical protection, emergency preparedness, technical safety, preserving the health of personnel and population and environment.”

In “NPP Kozloduy” PLC Corporate Structure and Activities Code” (art.8) the implementation of overall company activity, the following principle is of top priority: “Following the requirements for nuclear safety, radiation protection, as well as preserving the life and health of personnel, population and environment has priority over operational and other public needs.”

“NPP Kozloduy” PLC is a separate corporate body, registered according to Commercial Law, which has an independent balance and bank accounts. The Company is managed by General Meeting and Board of Directors. “NPP Kozloduy” PLC organises and manages its commercial activities in accordance with the Statute and “NPP Kozloduy” PLC Corporate Structure and Activities Code”.

For ensuring safe operation, the Kozloduy NPP management:

- develops and implements an administrative structure, assigns responsibilities and powers within the structure and exercises the overall management;
- develops, introduces and supervises the implementation of the programmes for administrative control (guiding documents for systematic implementation of planned works-schedules. procedures, inspections and revisions provided with adequate resources for their implementation);
- establishes a system for the accomplishment and control of the license conditions and terms of duration;
- establishes and maintains openness and correctness with the Regulatory Body, other state control bodies, organisations and the public, concerning the supervision, inspections and discussions on the fulfilment of the prescribed and universally accepted safety requirements;
- for exchange of experience and information, keeps in contact with the design, engineering, maintenance, mantling and construction organisations, and the manufacturers of equipment for nuclear power plants;
- ensuring the necessary resources and services for safe operation.

4.3. Fuel Cycle, Spent Fuel and Waste Management Service Supply

Bulgaria utilises a "once through" fuel cycle. Nuclear fuel is supplied from Russia. At present, the JSC TVEL company is the only foreign supplier of nuclear fuel, licensed by the NRA. Kozloduy NPP - plc has been given the authority to purchase, use and handle special nuclear material. According to an agreement between Bulgaria and Russia, the spent fuel shall be returned to the manufacturer for reprocessing.

4.3.1. Management of the Spent Fuel

The SF removed from the reactors is stored in pools situated near by the reactors. In 1990, the construction of a pool type spent fuel storage facility (SFSF) on the site of the Kozloduy NPP was accomplished. The SFSF is of a pool type. It is situated in a separate building on the territory of the Kozloduy NPP, nearby units 3 and 4. According to the design, the SFSF is to be filled in 10 years and the assemblies can be stored in it for a period of 30 years. After 3-5 years storage in the near reactor pools, the SF is transported to the SFSF. In 1991, a programme for enhancement of the SFSF safety was elaborated which is now being updated. In 1992, the new seismic characteristics of the Kozloduy NPP site were taken in account in the Programme.

Two independent ecological assessments of the SFSF were carried out: an expertise made by a team from the Risk-Engineering company as well as a complete report of the impact on the environment made by a group of specialists from the Sofia University "Kliment Ohridski". The results of these assessments do not show any considerable negative impact on the environment from the SFSF operation.

In 1998-2000, measures for the enhancement of the reliability of the systems and equipment were implemented as well as seismic stability of the SFSF as follow:

- upgrading the reliability of the SFSF systems' power supply;
- upgrading of the reliability of the SFSF supply with de-mineralised water;
- upgrading the reliability of the SFSF supply with service water;
- seismic, anchorage of the safety related equipment;
- seismic anchorage of the SFSF building.

In March 2001, the NRA has licensed the SFSF. Since 1988, the generated SF has been stored in the spent fuel pools at the reactors and SFSF. In 1998, 240 assemblies with SF from WWER-440 were shipped to Russia. On the basis of a bilateral agreement part of the spent fuel is returned to Russia for reprocessing.

The National Strategy on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management has been elaborated. In July 1999, the Government adopted the National Strategy.

Major measures include:

- Construction by stages of new dry storage facility for spent fuel of the VVER-440 and VVER-1000 reactors;
- Investigation of the possibilities for increasing the storage capacity of the storage pools at reactors 3 and 4 and the exist SFSF;
- Partial shipping back of spent fuel to Russia;
- Investigation of the possibilities for long term storage of spent fuel in regional storage facilities.

4.3.2. Management of Low and Intermediate Level RAW

The generated from the NPP operation RAW are stored in auxiliary buildings (AB), one for two units. In recent years, the NPP generates annually average of about 400 m^3 liquid RAW. 360 m^3 solid RAW and 20 m^3 low and intermediate ion exchange resins.

Extensive work on the completion of construction of the RAW Treatment and Storage Facility for LILW at the Kozloduy NPP site is carried out. Westinghouse and the equipment of the auxiliary systems delivered the main equipment and technology and construction works were ensured through a PHARE project. This treatment facility is extremely useful for the future operation of the NPP as the capacity for storage of RAW is nearly completed by using the treatment facility the stored RAW are expected to be treated, conditioned and stored on-site until a national RAW repository is constructed. The Treatment and Storage Facility is in the process of commissioning.

A fund for Safe Management of Radioactive Waste is established by the SUNEA. All waste generators shall pay a special fee to the fund: currently for NPP Kozloduy it is 3% of the average market price of energy sold to the National Electric Company. The Minister of Energy and Energy Resources through relevant Steering Committees manages the funds.

According to the National Strategy on RAW and SF Management, under preparation are:

- A programme on development of complete legislation on the safety of the RAW and SF management. This programme is part from the National Programme for Adoption of the Acquis (NPAA).

- A draft of the amended Basic Safety Standards is under preparation in compliance with the EC Directive 96/29.

The programme has to consider too:

- the development of regulations on the Safety of the RAW management and safe storage of SF;
- the ratified by Bulgaria Joint Convention;
- the established by the Act Radioactive Waste Management Organisation (in force from 1 Jan. 2004);
- Construction of a National RAW disposal facility;
- Partial shipping back of spent fuel to Russia; etc.

4.4. Research and Development Activities

Nuclear research and development activities in Bulgaria are carried out in several institutes, the most important of which are:

- The Institute of Nuclear Research and Nuclear Energy at the Bulgarian Academy of Sciences;
- The University of Sofia Department of Nuclear Physics, Dept of Nuclear Technology and Nuclear Power Engineering and the Radiochemical laboratory;
- Technical University of Sofia, Department of Power and Nuclear Engineering;
- Engineering companies: ENERGOPROEKT, EQE Bulgaria, ENPRO (Consult and Risk) Engineering;
- Institute of Radiation Protection, at the Ministry of Health;
- Plovdiv University, Department of Nuclear Physics; and
- other smaller Institutes and research organisations.

4.5. International Co-operation in Nuclear Power Development and Implementation

An important part of the Research and Development activities is being carried out through co-operation with international organisations like: the Joint Institute of Nuclear Research in Dubna, Russia; the Institute of Theoretical Physics, Trieste; CERN and other foreign institutes.

Scientific and Technical Co-operation of the NRA

After 1992, with the assistance of the European Community, the Consortium of Western Regulators, which included AEA-Technology (United Kingdom), AVN (Belgium), GRS (Germany) and IPSN (France), assisted the Bulgarian Regulatory Body. Assistance is received also by the operating organisation from the World Association of Nuclear Operators (WANO). In the process of development and licensing of the Programme for safety and operational reliability improvement of WWER-440 (V-230) units of the Kozloduy NPP, the so called “2+2” schedule was created in the documentation assessment process related to issuing of licenses for implementation of the modifications. Co-operation with the Consortium of Western Regulators is foreseen also during the licensing of the measures of the Complex Programme for Safety Reconstruction of the Kozloduy NPP units 1-4 and the Programme for Modernisation of the Kozloduy NPP units 5-6.

On a number of nuclear safety issues, the NRA receives technical support from Bulgarian engineering organisations and institutes. The NRA receives technical support from the IAEA, European Union, United States and Japan for getting acquainted with the methodologies and existing practices of the developed countries in the areas of control, licensing and inspection practices.

The NRA is in co-operation with:

- the Co-operation Forum of WWER Regulators;
- the Working Group of Nuclear Regulators to the European Union;
- the Working and Consultative Groups of the IAEA;
- the United States Nuclear Regulatory Commission (US NRC);
- the Regulatory Body of the Russian Federation;
- the Regulatory Body of Ukraine;
- the Regulatory Body of Slovak Republic, etc.

5. REGULATORY FRAMEWORK

5.1. Safety Authority and Licensing Process

The National Regulatory Authority in the field of safe use of nuclear energy is the Nuclear Regulatory Agency (NRA). The legal framework in respect of the NRA is provided for in the Safe Use of Nuclear Energy Act (SUNEA - in force from July 2002). According to Article 4 (1) of the Act, *"State regulation of the safe use of nuclear energy and ionising radiation, the safety of radioactive waste management and the safety of spent fuel management is implemented by the Chairman of the Nuclear Regulatory Agency"* and *"the Chairman is an independent specialised authority of the executive power"*. Article 4 (2) specifies: *"The NRA Chairman shall be designated by a decision of the Council of Ministers and shall be appointed by the Prime Minister for a mandate of five years and may be selected for one more term of office (mandate)"*. The functions of the NRA are effectively separated from those of the bodies and organisations involved in promotion or use of nuclear technology.

5.1.1. Safety Authority

Pursuant to Article 5 of the SUNEA, the Nuclear Regulatory Agency shall have the following powers:

- Grant, amend, supplement, renew, suspend and revoke licences and permits;
- Control the fulfilment of safety requirements and standards, as well as the conditions of licences and permits granted;
- Issue and withdraw individual licenses;
- Undertake enforcement measures and impose administrative penalties;
- Assign (contract) nuclear safety and radiation protection related external expertise, researches and studies;
- Implement the interactions with other competent authorities of the executive power vested with some regulatory and control functions and propose to the Council of Ministers measures for co-ordination of the activities;
- Implement the international co-operation of the Republic of Bulgaria in the field;
- Provide individuals, legal persons and state bodies with objective information referring to nuclear safety and radiation protection;
- Submit annually to the Council of Ministers a report on the status of nuclear safety and radiation protection, as well as on the operation of the Agency;
- Organise and co-ordinate the drafting process and submit to the Council of Ministers the reports for implementation of country obligations under the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management;
- Organise and co-ordinate implementation of the obligations of the Republic of Bulgaria arising from the Agreement Between the People's Republic of Bulgaria and the International Atomic Energy Agency for the Application of the Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons, as well as from the Additional Protocol to the Agreement;
- Perform the functions of a competent authority and a contact point for notification of an accident and for provision of assistance according to the Convention on Early Notification of a Nuclear

Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency;

- Develop and submit for adoption to the Council of Ministers regulations for the application of the SUNEA;
- Exercise other powers as may be entrusted thereto by the national legislation.

An administration helps the NRA in implementation of its authorities, assures technically its activity, and performs activities on administrative service provided to legal persons and citizens. In its activities, the NRA and its administration is guided by the adopted by the Council of Ministers Organisational Rules of Procedure. The administration is organised in a directorate general and 4 directorates, distributed into general and specialised administration.

5.1.2. Organizational Structure of the NRA

A Chairman supported by two Deputy Chairmen and an Executive Secretary governs the NRA. The permanent number of the NRA staff is 102 persons (4 – management team, 19 positions in the general administration and 79 experts and inspectors). Eight inspectors work permanently at the Kozloduy NPP site. 95% of inspectors have university education and more than 60% of them have over 15 years of experience in the nuclear field. Five NRA employees have Ph.D. degree, including the Chairman and one of the deputies. The organisational structure of the NRA is shown in Figure 14.

The NRA is forming its own budget within the overall state budget. The former Fund "Nuclear Research and Nuclear and Radiation Safety" was transformed into Activity "Nuclear Safety and Radiation Protection" and is currently included in the Agency budget.

5.1.3. Functions of the NRA Structural Units

The organisational structure and duties of the NRA structural units are described in the Statute of the NRA (Rules of Procedure), adopted by the Council of Ministers Decree No.199 dated 29 August 2002. The specialised administration is organised into four Directorates:

- Directorate General “Safety Regulation of Nuclear Facilities” with a residential department at the NPP Kozloduy site;
- Directorate “Safety Analyses, Assessments and R&D”;
- Directorate “Radiation Protection and Emergency Preparedness”;
- Directorate “International Co-operation and European Integration”.

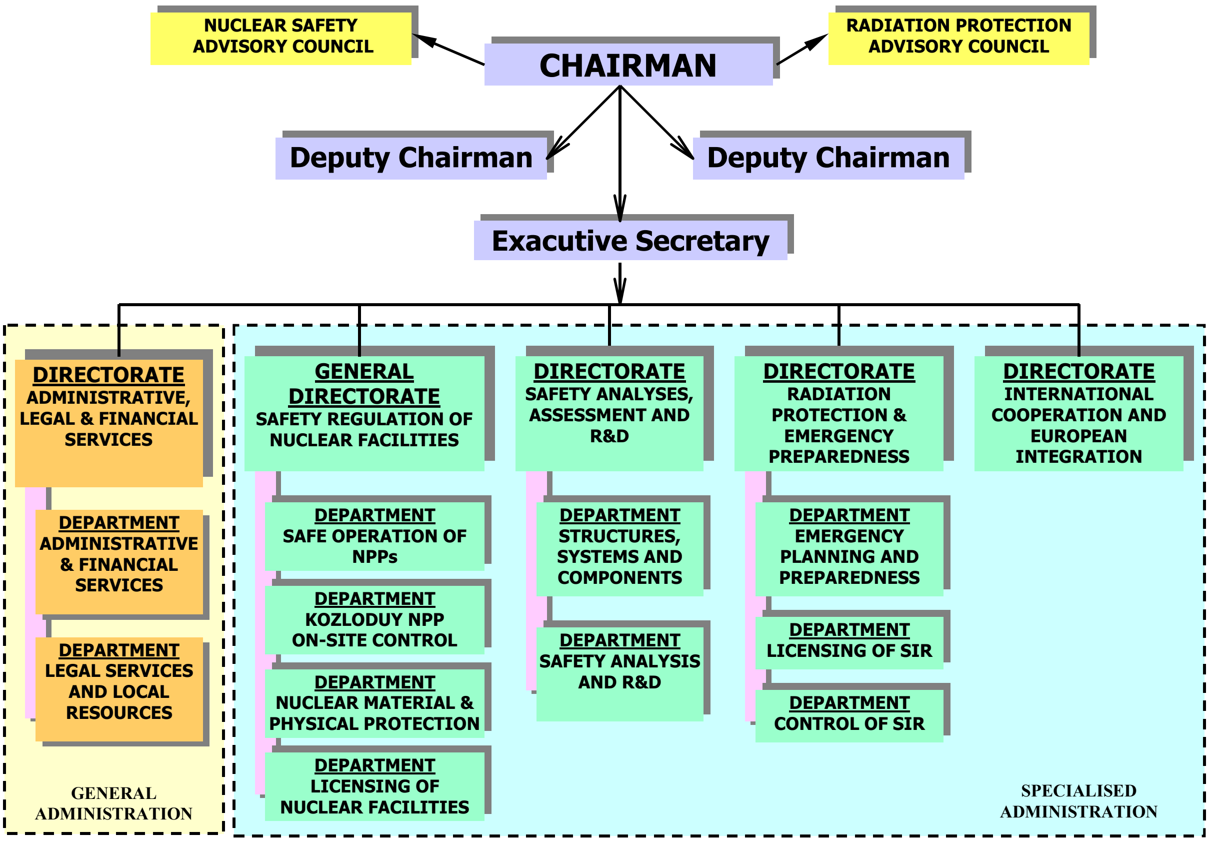


FIG. 14. Organisational Structure of the NRA

Directorate General "Safety Regulation of Nuclear Facilities"

This directorate regulates the safety of nuclear facilities in the following areas:

- commissioning;
- operation;
- decommissioning;
- quality assurance;
- maintenance and tests;
- modifications of structures and systems;
- physical protection of nuclear facilities and special nuclear material;
- procurement and services to the operating organisation;
- transportation, storage and accounting of special nuclear material.

Directorate "Safety Analyses, Assessments and R&D"

This directorate analyses and assesses the information submitted by the operating organisation or the applicant/licensee in the following areas:

- siting of nuclear facilities;
- nuclear facilities design;
- construction of nuclear facilities;
- commissioning of nuclear facilities;
- operation of nuclear facilities;
- modification of safety related structures and systems;
- qualification of nuclear facilities personnel and persons, exercising procurement or services to the Operator;
- co-ordination of research and development.

Directorate "Radiation Protection and Emergency Preparedness"

The directorate exercises control over meeting the established requirements on radiation protection, in the following areas:

- use, ownership and registration of Sources of Ionising Radiation (SIR);
- production, trade, import, export, storage, transportation and repository of radioactive substances and other SIR (devices, apparatus and installations), including initial nuclear material;
- siting facilities with SIR;
- design of facilities with SIR;
- construction of facilities with SIR;
- commissioning, operation and decommissioning of facilities with SIR;
- modification of radiation safety related designs, structures and technologies of facilities with SIR, including radioactive waste storage and conditioning facilities.

In the field of emergency planning and response, the directorate exercises the following functions:

- fulfils the duties of a National Contact Point with the IAEA in compliance with the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency;
- takes part in the activities of the NRA Emergency Response Teams, maintains and operates the communication and computer equipment;
- analyses, records and stores radiation monitoring data from the country;
- receives, processes and distributes within the NRA the operational data of the nuclear facilities;
- keeps in contact with the National Centre for Management in Crisis Situations and the Permanent Commission to the Council of Ministers for Protection of the Population in Case of Calamities and Accidents.

Directorate "International Co-operation and European Integration"

The Directorate "International Co-operation and European Integration" exercises the following activities:

- organises and co-ordinates the co-operation of the Republic of Bulgaria with international organisations and on bilateral basis with other states in the field of the safe use of atomic energy;
- participates in the elaboration of draft inter-governmental and inter-institutional agreements with other states in the field of safety in the use of atomic energy;
- organises the submission to the international organisations of projects for technical co-operation in the field of peaceful use of atomic energy;
- submits proposals for training of Bulgarian specialists, working in different fields of the peaceful use of atomic energy, to the international organisations as well as to the other states on the basis of bilateral agreements;
- organises the participation of Bulgarian specialists in international conferences, symposia and seminars in the field of the peaceful use of atomic energy;
- practical implementation of the integration of the Republic of Bulgaria to the European Union in the field of atomic energy utilisation;
- the support to the NRA through the PHARE programme;
- provides the participation of the Republic of Bulgaria in the IAEA International Nuclear Information System (INIS) through the local INIS Centre.

5.1.2. Licensing Process

The main legal provisions for the licensing of nuclear installations in Bulgaria are outlined in the SUNEA and Regulation No 5 of the CUAEPP. The Act specifies a two years period for development and adoption of new regulations. The Act specifies the conditions, the order, terms and time-limits for issuance of licences and permits. The NRA Chairman based on a written application by the applicant shall issue licences and permits for utilisation of nuclear energy. Until the adoption of a new licensing regulation, the applicant should follow the procedure established by the Act and

Regulation No 5 (when it is not in contradiction with the Act). Regulation No 5 specify the documentation required for the issuance of the requested licence/permit. All documentation submitted in respect of requested license issuance shall be in Bulgarian language. Submission of the original documents in a foreign language is permissible if a notarised translation into Bulgarian language is thereto attached.

Regulation No. 6 governs the criteria and requirements in respect of training, qualifications and capacities of human resources employed in the field of nuclear energy utilisation to the end of acquiring, sustaining and advancement of their professional qualifications and assurance of the requisite capacity.

5.2. Main National Laws and Regulations

The following fundamental acts of legislation are currently applicable in the matter of safe utilisation of nuclear energy and in respect of nuclear material procurement, accountability, storage and transport:

- Safe Use of Nuclear Energy Act (Promulgated in the State Gazette issue No. 63 of 28 June 2002);
- Regulation No. 2 on the Cases and Procedures for Notification of the Nuclear Regulatory Agency about Operational Changes, Events and Accidents relating to Nuclear and Radiation Safety (Promulgated SG No. 26 of 1988, amended SG No. 28 of 1988);
- Regulation No. 3 on Nuclear Power Plants Safety during Design, Construction and Operation (Promulgated SG No. 27 of 1988);
- Regulation No. 4 on Accounting, Storage and Transportation of Nuclear Material (Promulgated SG No. 66 of 1988; amended SG No. 83 of 1993, updated April 2001). The name of the updated Regulation is "Accounting, Storage and Transportation of Nuclear Material and Application of Safeguards in connection with the Treaty on the non-proliferation of Nuclear Weapons;
- Regulation No. 5 on the Licence Issuance Procedure for Utilisation of Atomic Energy (Promulgated SG No. 13 of 1989; amended and supplemented SG No. 37 of 1993);
- Regulation No. 6 on the Criteria and Requirements for Training, Qualifications and Certification of Personnel working in the field of Atomic Energy (Promulgated SG No. 47 of 1989; amended SG No. 43 of 1991);
- Regulation No. 7 on Collecting, Storage, Processing, Keeping, Transport and Disposal of Radioactive Waste on the Territory of the Republic of Bulgaria (Promulgated SG No. 8 of 1992);
- Regulation No. 8 on the Physical Protection of Nuclear Facilities and Nuclear Material (Promulgated SG No. 83 of 1993);
- Regulation No. 10 on Safety during Decommissioning of Nuclear Facilities (Promulgated SG No 12 of February 2001);
- Regulation No. 11 on Safety of Spent Fuel Storage Facilities (Promulgated March 2001);
- Regulation for Emergency Planning and Preparedness for Action in Case of Radiation Accident (Promulgated SG No. 33 of 1999);
- Regulation on Basic Standards for Radiation Protection – 2000 (Promulgated SG No. 5 of 2001)

The above-mentioned regulations shall be replaced in two years time, as from 2 July 2002.

5.3. International, Multilateral and Bilateral Agreements

AGREEMENTS WITH THE IAEA

• NPT related safeguards agreement INFCIRC/178	Entry into force:	29 February 1972
• Additional Protocol	Entry into force:	10 October 2000
• Improved procedures for designation of safeguards inspectors	Entry into force:	16 October 1988
• Supplementary agreement on provision of technical assistance by the IAEA	Entry into force:	18 August 1980
• Agreement on privileges and immunities	Entry into force:	17 June 1968

OTHER RELEVANT INTERNATIONAL TREATIES, etc.

• NPT	Entry into force:	5 September 1969
• Convention on physical protection of nuclear material	Entry into force:	8 February 1987
• Convention on early notification of a nuclear accident	Entry into force:	26 March 1988
• Convention on assistance in the case of a nuclear accident or radiological emergency	Entry into force:	26 March 1988
• Vienna convention on civil liability for nuclear damage and joint protocol	Entry into force:	24 November 1994
• Protocol to amend the Vienna convention on civil liability for nuclear damage	Not signed	
• Convention on supplementary compensation for nuclear damage	Not signed	
• Joint convention on the safety of spent fuel management and on the safety of radioactive waste management	Entry into force:	18 June 2001
• Convention on nuclear safety	Entry into force:	24 October 1996
• Convention on Black Sea contamination protection		
• ZANGGER Committee	Member	
• Nuclear Export Guidelines	Adopted	
• Acceptance of NUSS Codes	No reply	
• Nuclear Suppliers Group	Member	

BILATERAL AGREEMENTS

- Agreement between the Government of the Republic of Bulgaria and the Government of the United States of America on Co-operation in the Field of Peaceful Uses of Nuclear Energy.
  - By way of this Agreement the Contracting Parties reaffirmed their commitment that they would ensure international development in the peaceful utilisation of nuclear energy in compliance with all agreements which to the maximum possible extent contribute to the objectives of the Treaty on non-proliferation of Nuclear Weapons

- Agreement between the Government of the Republic of Bulgaria and the Government of the Russian Federation on Co-operation in the Field of Peaceful Uses of Atomic Energy.
  - The Agreement reaffirms the Republic of Bulgaria's membership to the United Institute of Nuclear Research in the city of Dubna, regulates the mutually advantageous co-operation of the Parties in the field of peaceful utilisation of atomic energy. The Parties guarantee their strict adherence to their obligations in respect of the Treaty on non-proliferation of Nuclear Weapons and the continued endeavours towards nuclear safety amelioration.
  - The Agreement covers a rather broad scope of possible joint research domains, such as nuclear physics, controlled thermonuclear fusion and plasma physics, condensed-matter physics (physics of the solids), radiochemistry, radiation chemistry, atomic energy engineering, inclusive of safe and reliable operation decommissioning of nuclear power plants, fuel cycle management, control and issuance of licences, betterment of nuclear fuel storage and transport technologies, prospective nuclear energy sources, nuclear safety and radiation protection, radiological protection from nuclear irradiation, normative and technical documentation, etc.

- Agreement between the Government of the People's Republic of Bulgaria and the Government of the Republic of Greece on Early Notification of a Nuclear Accident and Exchange of Information on Nuclear Facilities.
  - This Agreement governs the technical aspect of extended operational reporting and notification between the Contracting Parties in case of a nuclear accident after the Convention on Notification in Case of a Nuclear Accident, signed in Vienna on 26 September 1986.

- Financing Protocol between the Government of the Republic of Bulgaria and the Government of the French Republic.

- To the end of strengthening the friendly relations that have traditionally linked them, the Government of the Republic of Bulgaria and the Government of the French Republic have agreed to conclude this Protocol with the purpose to contribute to the economic development of Bulgaria. 21/2 million French francs shall be lent to assist financing of the purchase from France of full-scale nuclear power plant simulators and the installation thereof.

- Agreement between the Committee for the Use of Atomic Energy for Peaceful Purposes with the Council of Ministers of the Republic of Bulgaria and the Federal Ministry of the Environment, Protection of Nature and the Reactor Safety of Germany on Issues of Mutual Interest Relating to Nuclear and Technical Safety and Radiation Protection.
  - The Contracting Parties shall notify and inform each other forthwith and directly of accidents under Article 1 of the Convention on Notification in Case of a Nuclear Accident, signed in Vienna on 26 September 1986. The Agreement also provides for the exchange of information and experience in nuclear and technical safety and radiation protection, favourable co-operation between the Parties and also provides that the Federal Ministry of the Environment, Protection of Nature and the Reactor Safety of Germany shall, upon request, endeavour within the limits of possibilities available under the national law to provide assistance on technical aspects of safety by way of attracting German consulting and expert organisations.

- Agreement between the Government of the Republic of Bulgaria and the Government of Romania on Early Notification of a Nuclear Accident and Exchange of Information on Nuclear Facilities.
  - The Agreement governs the technical aspect of extended bilateral operational reporting and notification to the Parties in case of a nuclear accident following the Convention on Notification in Case of a Nuclear Accident, signed in Vienna on 26 September 1986.

- Agreement between the Government of the Republic of Bulgaria and the Government of the Argentine Republic on Co-operation in the Field of Peaceful Use of Nuclear Energy.
  - The Contracting Parties shall collaborate in the development of scientific research and practical utilisation of atomic energy for peaceful purposes. Specific fields of co-operation are listed. Co-operation shall be based on agreements between institutes, organisations and legal entities of the Parties in compliance with the national law.

- Agreement between the Government of the Republic of Bulgaria and the Government of the Republic of Turkey on Early Notification of a Nuclear Accident and Exchange of Information on Nuclear Facilities.
  - The Agreement shall apply in respect of activities on the subject of notification in case of a nuclear accident after Article 1 and Article 3 of the IAEA Convention.

- Agreement between the Nuclear Regulatory Agency of the Republic of Bulgaria and the Federal Nuclear and Radiation Safety Authority of the Russian Federation on Co-operation in Nuclear and Radiation Safety.
  - The Agreement provides for exchange of information on the organisation of activities of the regulatory authorities, exchange of regulatory documentation as well as experience in conducting nuclear and radiation safety inspections, training of inspectors, etc.

- Agreement between the Nuclear Regulatory Agency of the Republic of Bulgaria and the Ministry of Environmental Protection and Nuclear Safety of Ukraine on Co-operation in the Field of the State Regulation and Control of Safety in the Use of Atomic Energy for Peaceful Purposes.
  - The Agreement provides for exchange of information on the organisation of activities of the regulatory authorities, exchange of regulatory documentation as well as experience in conducting nuclear safety inspections, training of inspectors, etc. It also provides for exchange of information on control of the physical protection of nuclear material and facilities and of the system of accounting for and control of nuclear material.

- Agreement between the Committee on the Use of Atomic Energy for Peaceful Purposes of the Republic of Bulgaria and the Ministry of Economy of the Slovak Republic on Co-operation in the Field of the State Regulation and Control of Safety in the Use of Atomic Energy for Peaceful Purposes.
  - The Agreement provides for exchange of information on the organisation of activities of the regulatory authorities, exchange of regulatory documentation as well as experience in conducting nuclear safety inspections, training of inspectors, etc. It also provides for exchange of information on control of the physical protection of nuclear material and facilities and of the system of accounting for and control of nuclear material.

REFERENCES

[1] Committee on the Use of Atomic Energy for Peaceful Purposes, Annual Reports 1991, 1992, 1993, 1994 and 1995.

[2] National Electric Company Annual Reports 1993, 1994 and 1995.

[3] Report No.116110, Bulgaria - Power Demands and Supply Options, WB.

[4] Strategy for Development of the Energy Sector, Committee of Energy December, (1995).

[5] Tariffs for Electricity and Heat Energy Bechtel Int. Inc., prepared for USAID, (June 1996).

[6] European Bank for Reconstruction and Development, Annual Reports 1994, 1995.

[7] Collection of Bulgarian Nuclear Regulatory Documents, Balbok ltd. Sofia, (1994).

[8] Social and Economic Development of Bulgaria 1990 -1993, National Institute of Statistics, Sofia, (1994).

[9] Additional unpublished materials have also been used, like:
a) Reports of NEK prepared for the Commission for State Energy Regulation.
b) Materials prepared for the Council of Ministers concerning the Association procedure of Bulgaria in the European Union.

[10] Data & Statistics/The World Bank, www.worldbank.org/data.

[11] IAEA Energy and Economic Data Base (EEDB).

[12] IAEA Power Reactor Information System (PRIS).

Appendix

DIRECTORY OF THE MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL ATOMIC ENERGY AUTHORITIES

Nuclear Regulatory Agency 69 Shipchenski Prokhod Blvd. 1574 Sofia, Bulgaria	Tel: +359-2-9406800 Fax: +359-2-9406919 http://www.bnsa.bas.bg/
Ministry of Energy and Energy Resources 8 Triaditza str., 1040 Sofia, Bulgaria	Tel: +359-2-9885932 Fax: +359-2-9865703

OTHER NUCLEAR ORGANIZATIONS

Bulgarian Academy of Sciences (BAS) Institute of Nuclear Research and Nuclear Energy (INRNE) 72 Tzarigradsko shosse Blvd., 1784 Sofia, Bulgaria	Tel: +359-2-7144616 Fax: +359-2-9753619 http://www.inrne.bas.bg/
Bulgarian Academy of Sciences Institute of Metallurgy 53 Shipchenski Prokhod Blvd. 1574 Sofia, Bulgaria	Tel: +359-2-703485 Fax: +359-2-703207 http://www.bas.bg/
National Electric Company 5 Vesletz Str., 1040 Sofia, Bulgaria	Tel: +359-2-54901 Fax: 875826;
Kozloduy Nuclear Power Plant 3321 Kozloduy, Bulgaria	Tel: +359-973 7177 Fax: +359-973 80591;Telex: 33416 http://www.kznpp.org/index_e.htm
ENERGOPROEKT JSC 51 J. Bourchier Blvd., 1407 Sofia, Bulgaria	Tel: +359-2-6321 Fax: +359-2-668529
ATOMENERGOREMONT JSC 3321 Kozloduy, Bulgaria	Tel: +359-973 7177 Fax: +359-973 2591 Telex: 33416
Technical University of Sofia 8,Kliment Ohridski St. Sofia- 1000, Bulgaria	Tel: +359-2-623073 Fax: +359-2-685343 http://www.vmei.acad.bg/
University of Sofia Department of Nuclear Physics and Nuclear Energy 5 J. Bourchier Blvd., 1126 Sofia, Bulgaria	Tel: +359-2-62561 Fax: +359-2-622028 http://www.uni-sofia.bg/
University of Sofia - Radiochemical Laboratory 1 J. Bourchier Blvd., 1126 Sofia, Bulgaria	Tel: +359-2-62565 Fax: +359-2-622127

RISK ENGINEERING LTD. 34 Totleben str., 1660 Sofia, Bulgaria	Tel: +359-2-521217 Fax: +359-2-9549100
BALBOK ENGINEERING JSC 29-37 H. Smirnensky Blvd. Vh.B, Ap.13,1421 Sofia, Bulgaria	Tel/Fax: +359-2-9634413 Tel/Fax: +359-2-9630252
EQE Bulgaria Ltd. 1 Hristo Smirnensky Blvd. Et. 11. 1421 Sofia, Bulgaria	Tel/Fax: +359-2-660417 Tel/Fax: +359-2-9632049
ENPRO CONSULT Ltd. 16 G. M. Dimitrov Blvd, 1797 Sofia,	Tel: +359-2-9711416 Fax: (+359 2)971 14 21 http://enproco.hit.bg
Black Sea Regional Energy Centre (BSREC) 8,Triadiza Str. Sofia	Tel : +359-2-9806854 Fax: +359-2-9806855 http://www.bsrec.bg/