NUCLEAR POWER AND THE ENLARGEMENT OF THE EUROPEAN UNION.

ANTONY FROGGATT

DRAFT

10th July 1999

LIST OF CONTENTS:

LIST OF TABLES

ABBREVIATIONS:

CANDU	Canadian Designed Heavy Water Reactor.
CEE	Central and Eastern Europe.
EBRD	European Bank for Reconstruction and Development
ECCS	Emergency Core Cooling System
EIB	European Investment Bank
EU	European Union
GDP	Gross National Product
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IFI	International Financial Institution
LOCA	Loss of Coolant Accident.
NIS	Newly Independent States.
NPP	Nuclear Power Plant
Phare	EU's Grant Program for CEE countries
RMBK	Soviet Designed Gas cooled Reactor.
Tacis	EU's Grant Program for NIS countries
VVER	Soviet Design Pressurised Water Reactor.

EXECUTIVE SUMMARY:

The Enlargement of the European Union will, over the next decades, lead to a twenty six country Union, with a population of around half a billion citizens. This highly complex process will impact upon all sectors of the aspiring countries' societies. An area that will need to be addressed and one that has been identified as a priority is that of nuclear safety. Agenda 2000 stresses this point and calls for the issue to be urgently and efficiently addressed. However, unlike other areas nuclear safety does not fall under the Community Acquis, as nuclear safety standards are the competence of the national government and their appropriate authorities. Despite this, Agenda 2000 calls for an increase in nuclear safety to a standard dependent on the original reactor design. These reactor categories are: -

The first generation of reactors: the VVER 440-230 and RBMK designs. Agenda 2000 states that these cannot be economically upgraded to an acceptable safety standard and thus need to be closed. The reactors in question are already the subject of agreements that lay out closure dates and conditions. Agenda 2000 calls for these agreements to be abided by. The reactors in question are: Bohunice V-1 in Slovakia; Ignalina 1 and 2 in Lithuania; and Kozloduy 1-4 in Bulgaria.

The second generation of reactors: the VVER 440-213 and VVER 1000 designs. Agenda 2000 states that the reactors of these design which are in operation or under-construction can be economically upgraded to meet international safety standards. The Commission states that an upgrading program should be fully implemented over the next ten years. This applies to, Dukovany and Temelin in the Czech Republic; Bohunice V-2 and Mochovce in Slovakia; Paks in Hungary; and Kozloduy 5 and 6 in Bulgaria.

The final category put forward is for the Western design reactors in operation and under-construction in accession countries (Krsko in Slovenia and Cernavoda in Romania). In these cases monitoring and assessments need to be undertaken to ensure that the operation is in line with the appropriate safety standards.

A report prepared by the Western European Nuclear Regulators Association (WENRA) in 1999 largely agreed with the Commission categorisation. Of the ten CEE countries applying for accession, seven have nuclear reactors currently in operation.

Bulgaria has one nuclear power plant at Kozloduy, which has four VVER 440-230 reactors and two VVER 1000 reactors in operation. The power station contributes about 40% to the country's electricity. An agreement signed in 1993 with the Nuclear Safety Account (NSA) sought the closure of the first four units by mid 1998.

However, the closure dates proposed were dependent on the implementation of alternative energy projects, often referred to as trigger projects. These have not fully been implemented yet and therefore although the proposed closure dates have passed, the NSA agreement has not been technically broken. In fact one key trigger project, the upgrading of units 5 and 6, had not even begun by the middle of 1999.

The Czech Republic, has two nuclear power plants. At Dukovany there are four operating VVER 440-213 reactors and at Temelin two VVER 1000 reactors are under construction. The Dukovany reactors are the subject of an extensive retrofitting program, which is expected to be completed by 2005, costing around €750 million. This program is being undertaken in order to fulfil the yet to be defined safety criteria of enlargement and to increase the operational life of the reactors from thirty to forty years. The Temelin reactors were the first VVER 1000 reactors to have significant western involvement in their proposed completion. In 1992 Westinghouse was awarded the contract to supply their instrument and control technology. At that time it was expected that unit 1 would be operational by 1995. However, the project has been plagued with technical problems, especially the addition of western technology to a Russian designed plant at such a late stage of construction, and the reactors are still not operational today. The revised start-up date for unit 1 is now 2001. In 1999 the Government narrowly decided to continue construction at Temelin despite protests from the Czech President Vaclav Havel, the European Parliament and neighbouring Austria.

Hungary has four VVER 440-213 reactors operating at Paks. These reactors are being subjected to a €250 million upgrading program, which in addition to proposing to increase the safety is also expected to increase the power production by 10-15%. Although the operators of Paks have not yet applied yet, it is anticipated that the upgrading program will also allow the reactors lives to be extended by a further ten years. In 1999 a bid by Paks to build additional reactors, supplied by Westinghouse or Atomic Energy of Canada Limited (AECL) was rejected.

Lithuania has two RMBK 1500 reactors currently operational at Ignalina, which generate 80% of the total electricity produced annually. In 1994 the Lithuanian Government signed an agreement with the NSA which limited the life of the reactors, by disallowing the re-channelling of the reactors. After about ten to fifteen years operation the fuel channels of RMBK reactors have to be replaced. The exact date when re-channelling will be needed is not known, but many believe it will be 2002 if not sooner. The Ignalina reactors, which were built in the 1980s, were designed to supply electricity to the region and have always done so and continue to today. Proposals exist to construct an export link from Lithuania to Poland to allow the sale of electricity from Lithuania to the Western European Grid. This would significantly increase the potential revenue of the power station.

Romania has Europe's only operating CANDU reactor, which was design and project managed by AECL of Canada. The reactor's construction was begun in 1980 and was finally completed in 1996. Originally it was intended that four reactors would be built on site, but today plans exist for only the construction of a second unit. During the pre-accession process little attention has been given to the Cernavoda reactor as it is of Western design, but concerns have been raised over the financial problems of the power station which may impinge of the reactor's safety level.

Slovakia has two nuclear power plants, at Bohunice and Mochovce. Mochovce was originally intended to have four VVER 440-213 on site, but proposals for the third and four reactors have been abandoned. Unit 1 was completed in 1998 and unit 2 is scheduled for completion in late 1999. In 1994 it was proposed that the completion of Mochovce would be financed in part by the European Bank for Reconstruction and Development (EBRD) and Euratom, this would have been the first time that either body had been involved in the financing of a nuclear power plant in Eastern Europe. However, just prior to a decision by the Board of Directors of the EBRD, the Slovakian Government withdrew the project stating that the conditionalities required were unacceptable. One of these conditionalities was that the two VVER 440-230 reactors at Bohunice V-1 would have to be closed by 2000. Slovakian, Czech, Russian, German and French firms finally completed the Mochovce reactors with financing also coming from these countries. In April 1999 the Slovakian Government formerly overturned a previous Government resolution committing to close V-1 by 2000. The Bohunice V-1 reactor has over the last been subject to a € 120 million upgrading program and consequently it operators are planning to continue the units producing power until the end of their design life, until around 2010. However, the Slovakian Government is hoping to be included in the first wave of countries negotiating accession and a closure date for Bohunice V-1 will have to be agreed.

Slovenia is host to the Krsko reactor, which is jointly owned with Croatia. This Westinghouse reactor was built in the 1970s and 80s and is the subject of an ongoing ownership dispute with Croatia. The reactor is said to compare well with similar reactors currently being operated in EU Member States.

Fear of another Chernobyl scale accident lead to Western donors giving about €1.8 billion in grants for nuclear safety programs in Central and Eastern Europe (CEE) and the Newly Independent States (NIS) during the last decade. The European Union's Phare and Tacis programs are the largest contributors to the international efforts with a combined contribution of € 840 million. This massive program has been severely criticised by the Court of Auditor who stated: -

- That the strategy regarding the closure of the high-risk reactors and decommissioning reactors was confused.

- Almost a third of the value of the contracts was awarded without any invitation to tender, but without a consequential improvement in the speed of implementation.
- The contracts entered into the accounts were overestimated by 20% in relation to the actual contracts.

In addition to the Community funded programs since 1990 many G7 and EU countries have established bilateral assistance programs. In 1991 a body called the G24 Nuclear Safety Assistance Co-ordination (NUSAC) was established to promote efficient use of resources amongst the multilateral and bilateral program. However, no agency was given the role of co-ordinating Western efforts in this area. In 1993 the NSA was established to give small grants for the first generation of reactors, in return for accelerated closure. The NSA has given grants to Kozloduy, Ignalina, Chernobyl and reactors in Russia.

Despite the considerable funding that has been allocated one of the primary objectives of the G7 and EU, to seek the early closure of the first generation of reactors has not been achieved. This is in part due to the political and economic importance that the reactors play within the energy sector. During the early 1990s when there was significant decrease in electricity demand, due to the slow down in the economy, there was an increase dependency on nuclear power. This is because the nuclear power plants were kept in operation while fossil fuelled power plants were switched off, in order to reduce dependency on Russian gas.

However, it is not just in Eastern Europe that there is some reluctance to accelerate the closure of reactors. There is a genuine fear that another accident in Eastern Europe would make the chance of a reversal in the decline in the Western European nuclear industry virtually impossible. However, at the same time Western construction firms are all to aware that CEE is one of the few regions in the world with an active program for the construction of nuclear power plants, the last EU reactor will be completed in 1999. Therefore contracts for assisting with upgrading of reactors, waste management programs and completion of reactors in CEE are increasingly important to an industry with few contracts.

The nuclear power plants in CEE make substantial contributions to their domestic electricity supply and in some cases to the regional supply. The Trans-European electricity Network (TEN) programs are assisting with the creation of a pan-European electricity grid. Already, the countries in the former CENTRAL network (Czech Republic, Hungary, Poland and Slovakia) are fully integrated with the UCPTE (Western European) network. Further developments, in particular the finalisation of the Baltic ring will bring most of the accession countries into the Western European electricity network.

The full implementation of the Community Acquis – body of legislation that new members will have to conform to - will take a number of years and is not expected to be completed prior to accession. Calculations

undertaken for the European Commission anticipate that the full implementation of environmental Acquis will cost around € 120 billion, the power sector is expected to be the most expensive sector analysed. It is therefore unlikely that the power sector in all accession countries will have fully implemented the Acquis prior to membership of the EU. Consequently power stations will be operating at lower environmental standards than EU facilities; this is seen to be a distortion of the single market. The prices that are charged for electricity in CEE countries is lower than that in the EU, in some sectors, in particular the domestic, by a considerable margin. The entering into force of the EU's Electricity Directive in February 1999 makes it possible for electricity producers to sell electricity throughout the Union.

Although the Enlargement of the EU offers many possibilities for the nuclear power plants and their constructors it also increases the importance of a number of countries and industries previously formerly uninvolved. Most importantly, the Accession Treaties will have to be unanimously agreed by the existing Member States. Austria, which has been active for many years against nuclear power in Central Europe, is aware of this and passed a resolution that called for the closure of all first generation of reactors and the non-completion of part-built reactors. While in the proposed resolution the Austrian Council of Ministers falls short of calling for a veto of new Members if these conditions were not complied to. The Council make it clear that they would use every opportunity to ensure that higher safety standards were met and binding closure dates agreed too. Given the need for unanimity of support for new members into the EU the concerns of all existing Member States needs to be considered.

CHAPTER 1: INTRODUCTION TO ACCESSION.

PRE-ACCESSION STRATEGY

The political and economic changes in 1989 and 1991 in Central and Eastern Europe (CEE) and the former Soviet Union (now known as the Newly Independent States – NIS[1]) although momentous events may well become just a stepping stone to a much larger political occurrence. That of a unified political region with a population of nearly 500 million, with common rules, a joint defence strategy and eventually a single currency. Part of this trend is the enlargement the European Union (EU), with ten countries in CEE and Cyprus proposed for entry. Once complete this will have been the largest intake of new members the EU has seen and will significantly alter the cultural, political and economic histories and attitudes of its collective members. The countries in CEE that have applied for membership are listed below.

Table 1.1 Countries in Central and Eastern Europe that have Applied to Join the European Union

Country	**Application to join the EU**
Poland	05/04/94
Hungary	31/04/94
Lithuania	08/12/95
Romania	22/06/95
Slovakia	27/06/95
Latvia	27/10/95
Estonia	24/11/95
Bulgaria	14/12/95
Czech Republic	17/01/96
Slovenia	10/06/96

Source: European Commission.

The 1993 the Copenhagen Council meeting decided that the CEE countries that wished to join the EU could do so provided they met the necessary economic and political conditions, including: -

- The existence of a functioning market economy
- The implementation of EU legislation
- The stability of institutions that guaranteed democracy, rule of law and protection of minorities.

To help further define and implement these conditions a series of actions were proposed, including the establishment of a multilateral framework for discussing common areas of interest and the speeding up of the Community's initiatives for opening up its markets. In December 1994, at the Essen Council meeting these

[1] The former Soviet Union is also referred to as the Commonwealth of Independent States – CIS.

initiatives were developed further and the process of defining of the body of legislation – the Acquis – that each prospective member must conform to was begun. This included the development of a structured relationship between the community and accession countries in particular areas, especially those that had a trans-european impact, e.g. energy, transport and telecommunications.

From 1993 onwards the EU signed bilateral agreements with each prospective Member States known as the "European Agreements". These provide a framework for CEE countries to prepare for accession and cover co-operation in political, economic, trade, environment, culture and other areas. In addition they proposed a framework over ten years leading to free trade with the EU. In June 1995 the European Council endorsed the Commission's Single Market White Paper which sets out the key legislation that govern trade in goods and services within the EU's internal market and to which prospective new members must apply.

The European Council established the Phare program (Poland and Hungary Assistance for the Restructuring of the Economy) in 1989 to provide economic support for the emerging Polish and Hungarian economies. However, Phare has grown to become the Union's main financial instrument for accession for all CEE countries. Its aim is to assist CEE countries achieve market economies based on free enterprise and private initiatives.

The structured relationship, the European Agreements, the Single Market White Paper and the Phare program are the foundations of the pre-accession strategy.

AGENDA 2000

The Commission is responsible for assessing the viability of the applications to join the EU and make its recommendation to the Council of Ministers. The Commission put forward its initial opinion in July 1997 in Agenda 2000. In this the Commission calls for the establishment to two groups or "waves". The first contains Czech Republic, Estonia, Hungary, Poland and Slovenia; the second, Bulgaria, Latvia, Lithuania, Romania and Slovakia. The decision to create different streams of applicants and the choices of the countries in each was not without controversy. As a compromise EU Foreign Ministers stressed that all the applicants would have the same opportunities, and that it would even be possible for a second-wave country to overtake a first wavers during the negotiation period. There are strenuous efforts being made by countries in the second wave to be "re-categorised" for inclusion in the first wave and thus speed up their entry into the EU.

The Luxembourg Summit declaration in December 1997 stated that "the Commission's opinion of the applicant States constitute a sound overall analysis of each Applicant State's situation in the light of membership criteria

set out by the Copenhagen European Council". Following this endorsement the accession process was launched on 30th March 1998 at a meeting of the Ministers for Foreign Affairs of the fifteen Member States of the EU, the ten CEE applicant States and Cyprus (Turkey was also invited but declined to attend). This meeting became known as the European Conference and is held annually and chaired by the current Head of State of the country holding the Presidency of the EU.

The Council requested from the end of 1998 that the Commission make annual reports reviewing the progress of each applicant country towards accession in the light of the Copenhagen criteria. The first of these reports were published in November 1998. These are the key publications for assessing the progress made by each accession country and will be used to determine the time when countries can join the EU.

THE REINFORCED PRE-ACCESSION STRATEGY:

As part of Agenda 2000 the Commission put forward a proposal for reinforcing the pre-accession strategy being applied to applicant countries, which was adopted at the Luxembourg Council meeting. The strategy is designed to provide support in introducing reforms required by accession. The revised strategy has two main components.

- The development of a framework, the Accession Partnership Agreements, which draws together all the resources and assistance available for facilitating each countries adoption of the Community Acquis.
- Extending the participation of applicant countries to the Communities programmes and mechanisms to assist in applying the Acquis.

The implementation of this strategy has two main elements, legal and financial.

Legal Instruments for the Reinforced Pre-Accession Strategy:

There are three main legal tools open to the Union; the most important of which is the Accession Partnership Agreement. These are said to be "the linchpin of the reinforced pre-accession strategy, bringing together all the initiatives for assisting the applicant states of Central and Eastern Europe in a single framework, with the aim of launching national programmes to prepare for their accession to the Union"[2]. The Agreements require each applicant prepare timetables of commitments for adopting the Community Acquis. While the EU will make available its resources for facilitating the accession process. This includes the Phare program and new forms of financial assistance (agricultural aid, Euratom loans and balance of payment loans). In March 1998 following the adoption by the Council of the framework for the pre-accession strategy, the Commission

[2] Pre-Accession Strategy for Enlargement of the European Union, European Parliament Briefing, No 24, Luxembourg, 17th June 1998.

submitted the drafts of the accession partnerships for each of the ten CEE applicants. Each Accession Partnership includes a conditionality clause, which stipulates that pre-accession aid will depend on compliance with the European Agreements.

The second tool is the bilateral European Agreements with the Union. These Agreements cover most of the fields associated with the Acquis and are used to facilitate its adoption nationally. The bodies set up under these Agreements (councils, associations committees and Parliamentary Committees) are said by the Commission to be the preferred bodies for consulting with applicant countries. Although the work carried out under the Agreements is designed to reinforce the pre-accession strategy, the Agreements are not necessarily a precursor to accession and can exist as a set of formally structured trade relations in their own right.

The final legal instrument is the increased participation of applicant countries in the existing Community programs. This includes: -

- Extending the briefing of the Technical Assistance Information Exchange Office (TAIEX) to provide information on the entire Acquis (in particular on the environment and transport).
- The progressive opening up of the Community programs, such as research, education and single market etc.
- The participation in certain machinery for administrative co-operation and application of the Acquis.

Financial Instruments for the Reinforced Pre-Accession Strategy:

The entry of the CEE countries into the Union will increase the total population by 100 million, from the present day level of about 400 million. However, this additional 25% of the population will add only 4% to the Union's existing Gross Domestic Product (GDP). Furthermore, with the average per capita GDP in the CEE-10 at only one third of the EU average there is some concerns on the budgetary constraints that enlargement will impose. Importantly it has been agreed that the current budget ceiling for the Union of an average of 1.27% of the total GDP will not be increased even to allow for enlargement.

The Commission, assuming an increase in GDP across the Union and in accession countries has forecast a budget of ECU 745.5 billion for 2000-6. Of this CEE countries will receive, assuming entry by 2002 for the first wave countries into the Union, just over 10% or ECU 74.8 billion.

For the period of 2000-6 ECU 275 billion has been earmarked for structural funds throughout the Union. Of this, the current members will expected to receive ECU 230 billion and the first wave countries just ECU 45 billion (which includes ECU 7 billion for pre-accession aid). Furthermore, in total the first wave countries will receive ECU 57.4 billion prior to 2006 and the second wave ECU 17.4 billion. Therefore those countries in the second wave will receive three times less than those in the first. This disparity compounds the problems of the

second waver countries, that by the nature of their grouping are further away from EU standards in many areas and thus will require more financial assistance. The table below shows the funding allocation for accession countries, based on the entry of the first wave countries by 2002. This date is extremely optimistic and many would say unrealistic. Clearly, should first wave countries not begin entry into the EU in 2002, the structural funds will not be made available.

Table: 1.2 The European Commission's Budget Proposals for Accession Countries

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total**
First Wave Countries								
Pre-accession aid								
Agriculture	0.3	0.3	-	-	-	-	-	0.6
PHARE	0.9	0.9	-	-	-	-	-	1.8
Structural Operations	0.6	0.6	-	-	-	-	-	1.2
Transfer after accession								
Structural Funds	-	-	3.6	5.6	7.6	9.6	11.6	38.0
Agriculture	-	-	1.5	1.9	2.4	2.9	3.3	12.0
Other internal policies	-	-	0.7	0.7	0.8	0.8	0.8	3.8
Total first wave	1.8	1.8	5.8	8.2	10.8	13.3	15.7	57.4
Second Wave Countries								
Pre-accession aid								
Agriculture	0.2	0.2	0.5	0.5	0.5	0.5	0.5	2.9
PHARE	0.6	0.6	1.5	1.5	1.5	1.5	1.5	8.7
Structural operations	0.4	0.4	1.0	1.0	1.0	1.0	1.0	5.8
Total second wave	1.2	1.2	3.0	2.0	3.0	3.0	3.0	17.4
Total CEE	3.0	3.0	8.8	11.2	13.8	16.3	18.7	74.8

Source: European Commission 1997

The costs of the full implementation of the Community's Acquis are enormous and the funds available from the community will only go part way to finance what is needed. The Commission therefore stresses that the funds that are allocated must be used to maximum effect by co-ordinating closely with other potential contributors, such as Member States, the European Investment Bank (EIB) and other International Financial Institutions (IFIs).

The Phare Program:

The Phare program has been re-orientated to focus solely on preparing countries for EU membership within two priorities: -

- Investment Support, to help CEE companies carry out the necessary restructuring to apply EU legislation and assist CEE authorities with improvement in infrastructure, such as transport and energy.

- Institution Building, to help the strengthening of democratic institutions and public administration to ensue public services are ready and able to apply the Acquis.

The Phare program is the largest source of donor financing for know-how transfer to countries in CEE and will have an annual budget of € 1.5 billion. The budget is managed by the Commission but under the joint budgetary authority of the European Parliament and Council.

The Commission has proposed two additional accession-funding programs: -

- The Instrument for Structural Policies for Pre-Accession Aid (ISPA) is similar in scope to the Cohesion Fund and can provide 50% of the cost of transport and environmental projects. €7.3 billion has been allocated to this instrument over the next seven years.
- The Special Action for Pre-Accession measures for Agriculture and Rural Development (SAPARD) addresses the agriculture and rural development sectors. It covers support for improving the efficiency of farms, promoting quality products, vocational training, etc. € 3.6 billion are available from this line item.

RESOURCES:

Institutions and Governments:

Task Force for the Accession Negotiations (TFAN): This website provides information on the issues and procedures involved in the negotiations. It explains briefly what enlargement is all about and provides links to related information available elsewhere through the Europa server. http://europa.eu.int/comm/tfan/index_en.html.

European Commission: Agenda 2000: 1. For A Stronger and Wider Union: 2. The Challenge of Enlargement: 3. The Opinions of the European Commission on the Applications for Accession, Summaries and Conclusions. 15th July 1997. http://europa.eu.int/comm/dg1a/enlarge/agenda2000_en/agenda.htm

European Commission: Briefings on Enlargement, http://europa.eu.int/comm/dg1a/enlarge/checkpoint.htm

European Parliament: Accession Briefing Papers. http://www.europarl.eu.int/enlargement.

UK Department of Trade and Industry: EU Enlargement and 'Agenda 2000' – A Consultation Document – March 1998. http://www.dti.gov.uk

Individuals:

Grabbe, Heather and Hughes, Kirsty (1998) Enlarging the EU Eastwards. The Royal Institute for International Affairs. Pinter.

CHAPTER 2: ACCESSION AND NUCLEAR POWER.

The enlargement of the EU was always going to create difficulties for accession countries as they rapidly try to conform to the Community Acquis. The nuclear industry is no exception and its importance was emphasised early on by the Commission: -

"The problem of nuclear safety in some candidate counties causes serious concern to the EU, even independent of enlargement, and should be urgently and effectively addressed… Public opinion is likely to be increasingly sensitive to nuclear safety as a consequence of some nuclear power plant problems in acceding countries, and this could affect major Community policy developments in the field"[3].

Therefore, even though it is more than ten years since the Chernobyl disaster in Ukraine in 1986, there is still the fear that a similar accident will destroy the chances of a revival the EU's nuclear power program, which is current in the doldrums. Furthermore, the ever-increasing links between the Eastern and Western European nuclear power programmes make the likely political repercussions of an accident in an accession country much greater for Western firms than in 1986.

The operation of Soviet designed reactors within the European Union is not new, as consideration has been given to this question on two previous occasions.

Firstly, Finland which joined the European Union in 1995 has two VVER 440-213 reactors currently operational at Loviisa, 100 km to the West of Helsinki. According to the Finnish Nuclear Society the original design of the plant was adopted to a western safety philosophy by adding several safety features, including a containment building of the ice condenser type. This was undertaken during the design stage and implemented from the start of construction. Furthermore, the plant has been backfitted –the addition of new safety equipment- to meet the latest safety standards as they have been developed internationally. This has resulted in the increase generating capacity of each of the reactors being increased from 445 MW to 488 MW at a cost of 200 FIM million (€33.64 million).

Secondly, in former Eastern Germany there were a number of Soviet designed reactors in operation or under-construction. The re-unification of Germany resulted in the closure of all operating Soviet designed reactors, the five VVER 440s at Greifswald (four, 230 and one, 213 designs) and the non-completion of the partially built VVER 440-213s and VVER 1000 reactors at Greifswald and Stendal respectively. The VVER 440-230

[3] Agenda 2000 2. The Challenge of Enlargement, July 15th 1997, page 46.

reactors were closed soon after unification, but no decision was taken immediately on the VVER 440-213 and VVER 1000 reactors. Rather the German Safety Agency – the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) made detailed assessments. These assessments suggested the redesign and backfitting work that would be needed prior to the project being awarded an operating licence in Germany. Following this technical assessment calculations were made as to the expected costs and the projects were subsequently abandoned. At Greifswald the upgrading of the VVER 440-213 reactor, which had just become operational was expected to cost to between 500 million and 2 billion DM ($277-1 100 million). While at Stendal, for the completion of one reactor it was estimated that it would cost $2.3-2.9 billion. Their closure is seen as a benchmark for the safety standard of the VVER reactors as detailed technical and economic assessments were undertaken to review the feasibility of the reactors receiving an operating license within Germany and hence the European Union.

In the field of nuclear safety Agenda 2000 calls for the implementation of safety programs throughout the region, the scale and objectives of which are based on the original design of the reactors in question. The three categories defined by the Commission are outlined below:

- These reactors are often referred to as the first generation reactors and are the VVER 440-230 and RBMK reactor designs. The time-tables agreed by the Governments concerned, subject to certain conditions, for the closure of non-upgradable units must be respected (This applies to units 1-4 at Kozloduy in Bulgaria, Ignalina in Lithuania and Bohunice V-1 in Slovakia).

- Where the safety of Soviet-designed nuclear stations which are in operation or under construction, can be upgraded to meet international safety standards (VVER 440-213s and VVER 1000-320s), modernisation programs should be fully implemented over a period of 7-10 years. (This applies to Dukovany and Temelin in the Czech Republic, Paks in Hungary, Bohunice V2 in Slovakia, Kozloduy 5 and 6 in Bulgaria, as well as Mochovce in Slovakia). These are commonly knows as second generation reactors.

- Where western-designed nuclear power plants are in use, at Cernavoda in Romania and Krsko in Slovenia, developments should be monitored to ensure that operations comply with the appropriate safety standard.

Agenda 2000 looks in detail at the readiness of each country to fulfil the requirements of the community Acquis. The sections related to nuclear power programs in each country can be found in Appendix 1. The most pertinent parts on the nuclear power program are found in the table below.

Table 2.1: Summary of Agenda 2000's Country Assessments of Nuclear Power Programmes.	
Bulgaria	The design and construction standards of the VVER 440-230 reactors are considered not to meet the safety objectives generally acceptable in the EU. The VVER 1000-320 are of more recent upgradable type
Czech Republic	At Dukovany (modernisation program is ongoing) the safety of which is considered to be close to safety objectives generally accepted in the EU once upgrading programs are implemented. There are two VVER 1000 under construction at Temelin (with integration of US technology).
Hungary	The Paks nuclear power station of Russian design produces 40% of the country's electricity and the four reactors of the VVER 440-213 type will be close to objectives generally accepted in the EU once the already planned upgrading programs (300 MECU) will be implemented of which two-thirds relates to safety upgrades.
Lithuania	Lithuania operates two large RBMK nuclear reactors (Chernobyl type) at Ignalina... Improvements are ongoing at the plants mainly through the assistance of the Nuclear Safety Account of the EBRD. The assistance is linked to an extensive Safety Report made with support of Western experts. This report provides many recommendations to be implemented by the plant to get the safety Authority license for further operation. The intention is to operate the plant until the limit for channel re-tubing is reached. Re-tubing is precluded by the Nuclear Safety Account Agreement, but the position of the government needs clarification.
Romania	Nuclear safety standards, especially those related to plant operation, should be handled appropriately and long-term solutions found for waste.
Slovakia	Slovakia operates at Jaslovske Bohunice two VVER 440-230 (first generation) and two VVER 440-213 (second generation) nuclear reactors representing nearly half of the electricity production. For Units 1 and 2 after a short-term improvement program, they are currently further upgraded (1996-1999) and should then increase the safety level towards EC safety standards. At Mochovce, two VVER 440-213 reactors are under construction with some participation of Western firms and they should be on stream within the next two years... Nevertheless the problem of nuclear safety has to be dealt with and realistic programs, including effective closure when necessary, have to be agreed upon and implemented.
Slovenia	Nuclear safety standards should be handled appropriately and long term solutions for nuclear waste will have to be found.
Source: European Commission 1997.	

INSERT MAP.

FIRST GENERATION REACTORS:

The first generation reactors are the RBMK (The RBMK is a Russian acronym for "Channelized Large Power Reactor") and the VVER 440-230 reactors (the first commercial design of the Soviet Pressurised Water Reactors). The reactors are also known as the "high risk reactors". Appendix 2 contains a detailed critique of the safety standard of RBMK and VVER reactors undertaken by the Western European Nuclear Regulators Association (WENRA) published in March 1999.

The majority of the international community has on a number of occasions in the last decade declared that they believe these reactors have inherent deficiencies and they cannot economically be brought up to a standard that is acceptable for long-term operation. International statements of concern, coming largely from the G7 and the European Union, have resulted in a variety of international programmes – see Chapter 5. This included the establishment of specific agency, the Nuclear Safety Account (NSA) administered by the European Bank for Reconstruction and Development (EBRD), to provide small grants for short-term operational improvements in the first generation of reactors, in return for accelerated closure agreements.

Agenda 2000 and subsequent documents from the Commission, Council and Parliament refer to the closure of the first generation of reactors within the terms laid down by existing agreements. The agreements that are referred to are: -

Kozloduy, Bulgaria: On June 16th 1993, the first NSA agreement was signed, which granted ECU 24 million to units 1-4 of the NPP Kozloduy. This agreement sought the closure of units 1-4 when named investments in the electricity sectors had been implemented. These were: -

- Units 1 and 2 would be closed when the Chaira Pumping station was operational and the upgrading of either Unit 5 and 6 of Kozloduy or the Varna Power station was completed. This was expected to happen by April 1997.
- Units 3 and 4 would be closed when the upgrading of both Units 5 and 6 at Kozloduy was complete and the conversion of Sofia, Kostov and Republika district heating plants to combined cycle co-generation of heat and power plants. This was expected to occur during 1998.

Ignalina, Lithuania: In February 1994 the NSA awarded Ignalina a ECU 35 million grant which limited the operating lives of both units. The agreement made the following life limiting demands of the operator: -

- That neither of the reactors is to be re-channelled. This involves the replacing of the fuel channels and the re-aligning of the graphite moderator and has been shown to be necessary after about 10-20 years operation.
- That unit 1 should stop operation by the 30th June 1998, unless all the safety upgrades recommended by an expert panel have been implemented to the satisfaction of the state regulator (VATESI). This deadline was later extended to 17th May 1999 due to the delay in preparing the technical review of the reactor.

Bohunice V-1, Slovakia: On the 14th May 1994, the then Slovak Prime Minister, Vladimir Meciar, signed a resolution that committed Slovakia to closing the two Bohunice V-1 units as soon as Mochovce entered commercial operation or by 2000 at the latest.

SECOND GENERATION:

The VVER 440-213s and VVER 1000 models are often referred to as the second generation of Soviet designed reactors. As has been stated the Commission and other national and international bodies believe that these reactors can economically be made acceptably safe and thus provided the necessary upgrading work is undertaken they will continue to operate when the countries join the EU. See Appendix 2 for a more detailed view of the reactor designs. No detailed calculation have been recently produced as to how much these upgrades will cost, but the Agenda 2000 states that the modernisation program and assistance outlined will cost about 4-5 billion ECU's over a ten year period. The bulk of this suggested expenditure would be for the upgrades of the second generation of reactors. However, the question of the required standard for the backfitting programmes is a vexing problem for the politicians, regulators and engineers. This is because Agenda 2000 only refers to the need for reactors to conform to international safety standard. However, there are no definite and enforceable standards that reactors must conform to either within the European Union or the international community.

International Safety Standards:

The International Atomic Energy Agency (IAEA) has been responsible for assisting the development of common safety concepts and setting safety principles, but not enforcing standards. In 1988, the IAEA's International Nuclear Safety Advisory Group (INSAG) published a report, "Basic Safety Principles for Nuclear Power Plants", which set safety targets for nuclear reactors to achieve. The report differentiated between operating reactors and those currently under construction and recommends higher standards for the newer reactors. The IAEA uses a methodology called Probabilistic Safety Assessment (PSA) which assesses the statistical probability of accidents involving the melting of the reactor core. In the case of an operating reactor an accident involving the melting in a core should not occur more than once every ten thousand years, in new

reactors or those under-construction once every hundred thousand years. Assessments undertaken by the IAEA show that the VVER 440-213 and VVER 1000 reactors do not conform to these guidelines, as can be seen in the table below.

Table 2.2: Probabilistic Safety Assessment for Second Generation VVER Reactors in Accession Countries.		
Reactor Type	**Reactor**	**PSA Result**
VVER 440-213	Dukovany, 1	1.8×10^{-4}
	Paks, 3	5.0×10^{-4}
VVER 1000-320	Kozloduy, 5,6	3.7×10^{-4}
	Temelin, 1	7.6×10^{-5}
Source: IAEA 1996		

In addition to INSAG the IAEA has been involved in the establishment of the Vienna Nuclear Safety Convention which entered into force on 24th October 1996. As of 21 September 1998, 47 States had deposited an instrument of ratification, acceptance or approval, 29 of, which have at least one nuclear installation that has achieved criticality in a reactor core. The convention is part of an international package of reforms proposed following the Chernobyl accident in 1986. At its outset many felt that the Convention would require legally binding commitments which would need to be backed by mandatory verification and the threat of sanctions. However, the final Convention had a different operational mandate and now acts by "encouragement and peer review". As part of this process each country that is a member of the convention produces an annual safety report. The IAEA in turn publishes them on its web site (http://www.iaea.org/ns/nusafe/safeconv.htm). All accession countries with nuclear power plants have signed, ratified or adopted the convention[4]. However, despite this the international community still cannot enforce a required safety standard.

European Union Nuclear Safety Standard:

Within the European Union there is no universal or even staggered safety requirement, as the setting of specific nuclear safety standards is the competence of the individual Member States and their regulatory bodies. In 1957 when the European Atomic Energy Community (Euratom) was founded any references to the need for universal nuclear safety standards was conspicuous by their absence. The 1995 White Paper on Energy Policy makes this much clear as it states: -

[4] Bulgaria (ratified November 1995); Czech Republic (approved September 1995); Hungary (ratified, March 1996); Lithuania (ratified June 1996); Romania (ratified June 1995); Slovakia (ratified March 1995); Slovenia (ratified November 1996). Convention on Nuclear Safety, International Atomic Agency, Web Site, June 1999.

"The European institutions have responsibilities under the Euratom Treaty, which permit the development of nuclear energy in **conformity with the rules and policies at a national level**[5] "– (emphasis added).

It has been said that 'Seveso' Directive – 'On the Major Accident Hazards of Certain Industrial Activities'- is the section of the EU Acquis that nuclear safety standards would most comfortably sit. However, Article 2 of the 1982 Directive states that the Directive does not apply to "nuclear installations and plant for the reprocessing of radioactive substances and materials" [6]. Later revisions of the Directive have left in place this exclusion for nuclear installations. However, in 1975 the Council of Ministers did adopt a resolution "The technological problems of nuclear safety"[7] which is said to remain important for promotion of co-operation in the field of nuclear safety, as the resolution calls for: -

"The progressive harmonisation of safety requirements and criteria in order to provide for an equivalent and satisfactory degree of protection of the population and of the environment against the risk of radiation resulting from nuclear activities and to assist the development of trade".

The lack of definitive safety standard for accession countries has been noted by a number of EU institutions and reports. The Court of Auditors report (see Chapter 3 for more details), in its February 1999 report comments by saying: -

"At the end of 1997, owing to the absence of a binding legal basis, there was still no formal consensus at [the] European level concerning technical standards in the area of design and operational safety of nuclear installation. The 25 basic nuclear-safety principles published by the IAEA are still implemented in accordance with each Member State's own technical standards and regulations, which has not facilitated the action the EU has been taking with regard to the safety authorities in the CEECs and the NIS".[8]

Furthermore, the Panel of Experts appointed by Commissioner Hans Van Den Broeke, in their final report – the so-called Contzen Report (see Chapter 3 for more details)– concluded: -

"For the Applicant countries there is a need to provide a definition of "Western Standards". The Panel recommends that the Applicant countries are advised to choose from the Member States those regulatory practices which most closely meet their needs".

[5] An Energy Policy for the European Union, White Paper, Com (95) 682.
[6] Council Directive 82/501/EEC of June 24 1982 'On the Major Accident Hazards of Certain Industrial Activities', Official Journal L 230, 5/8/82, pp 1-18
[7] Council Resolution of 22nd July 1975 (OJ C185 of 14th August 1975)
[8] Court of Auditors Special Report 25/98, 9th February 1999, page 10, paragraph 3.1

The European Parliament also noted the lacking in safety standard and made the following as statement in their resolution of March 1999.

"Calls on the Commission to seek an accord on nuclear safety standards and regulations for the construction and operation of nuclear power stations, the fuel cycle and transport conditions with the CEEC and NIS, within the framework of the International Convention on Nuclear Safety and with EURATOM, if and when EURATOM guidelines are established"[9]

The Current Proposals:

The lack of a definitive safety standard, International or Western European, has impacted on the wording of the Commission and Council of Ministers positioning on the required safety standard and has resulted in a number of different pronouncements.

- Agenda 2000(July 1997): "Where the safety of Soviet-designed nuclear power stations, which are in operation or under construction, can be upgraded to meet International Safety Standards, modernisation program should be fully implemented over a 7-10 year period"[10].
- Commission's Document (March 1998): "to bring the general standard of nuclear safety [including the management of radioactive waste] up to a level that is comparable to that which prevails in the EU"[11].
- Council of Ministers (September 1998): nuclear safety must be enhanced "so it reaches a level corresponding to the technological, regulatory and operational state-of-the-art in the Union"[12].
- Council of Ministers (December 1998): to co-operate to help improve nuclear safety in the candidate States with the aim that they ensure that the technological and operational safety levels are aligned with current prevailing safety practice in the Union.[13]

The Commission is currently preparing technical guidelines for the upgrading of second generation of reactors to facilitate the countries in setting the appropriate safety standard for their upgrading programs. To date the variation of standard that has been suggested will be required is enormous, from "state of the art" to "current prevailing safety practice". While the experience in Germany suggests that it is not economic to attempt the upgrade when a definite EU standard is required.

[9] European Parliament Resolution, Nuclear Sector related Activities for Third Countries, 11th March 1999
[10] Agenda 2000, 1. For a Stronger and Wider Union, European Commission, July 1997, page 67
[11] Com 134, page 9
[12] European Council - Justice and Home Affairs, Press Release Information: Brussels (24-09-1998) - Document 11282/98 (Presse 302).
[13] General Affairs Council: Reaffirming its commitment to assist applicant countries to improve nuclear safety and to develop medium and long term energy strategies for the replacement of the less safe nuclear power reactors: 6th December 1998.

NUCLEAR ACQUIS:

As with all other aspects of enlargement the nuclear industries and their infrastructures must conform to the EU Environmental Acquis. This is about 70 Directives - some of which, however, have been amended several times and supplemented with "daughter" Directives - and 21 regulations. Specifically relating to the nuclear sector the new members must conform to the Euratom Treaty, 5 Directives and 3 regulations, which are listed below.

Nuclear safety and Radiation Protection

0. Treaty establishing the European Atomic Energy Community (EAEC-Euratom).

- Title two, provision for the encouragement of progress in the field of nuclear energy, chapter III: Health and safety, articles 33,35 and 37.

1. Non-White Paper legislation

Directives

- Radiation protection related to medical exposures, 97/43/EURATOM
- Information of the public, 89/6I8/EURATOM
- Radiation protection of outside workers, 9O/64I/EURATOM

Regulations
none

2. White Paper legislation

Directives

- Shipments of radioactive waste, 92/3/EURATOM
- supplemented by decision 93/552 EURATOM
- Basic Safety Standards, 96/29/EURATOM
- related decision on easy exchange of information in case of a radiological emergency, 87/6OO/EURATOM

Regulations

- Maximum permitted levels of radioactive contamination of foodstuff following a radiological emergency, 87/3954/EURAT0M
  amended by 2218/89/EURATOM
  related regulations:
  770/90/EURATOM,
  2219/89/EURATOM,
  944/89/EURATOM
- Imports of agricultural products following the Chernobyl Accident, 90/737/EEC amended by 95/686/EC and 97/727/EC
- Shipments of radioactive substances, 93/1493/EURAT0M

Prior to the process of adopting the Acquis, the Commission with the individual prospective members reviews the current legislation and practises and assesses their compatibility with the Community Acquis, a process known as screening. This is undertaken sector by sector (or Chapters) of which there are 29. Nuclear falls under two Chapters: Energy, regarding nuclear safety; and Environment, regarding the Acquis. For first wave countries the screening process has been completed for all 29 chapters, energy occurred in November 1998 and for environment in January/February 1999. A more precise identification of any problems that the screening has raised occurred during bilateral screening meeting in March and July 1999. For second wave countries the process begun in mid 1999. The screening process identified problem areas or bottlenecks for which further attention and assistance may be necessary for full implementation of the Acquis.

Following screening, the Commission has identified a three-stage process for countries when adopting the environmental Acquis.

i) Transposition: The adoption or changing of national laws and rules so that the requirements of EU law are fully incorporated into the national legal order.
ii) Implementation: Ensuring that the necessary budgets and institutions are provided to carry out the laws and regulations.
iii) Enforcement: To ensure that the necessary controls and penalties are in place to guarantee full compliance with the laws.

The adoption and implementation of the Acquis relating to nuclear issues is not felt, within the Commission, to pose major investment or technical problems, especially in relation to nuclear safety standards. Consequently, bilateral discussions and negotiations with accession countries have to date focused on nuclear safety.

RESOURCES:

Nuclear Safety Convention: http://www.iaea.org/ns/nusafe/safeconv.htm
Guide to the Approximation of European Union Environmental Legislation, 1999 update: http://europa.eu.int/comm/dg11/guide/contents.htm

CHAPTER 3: THE EUROPEAN UNION INSTITUTIONS.

THE EUROPEAN COMMISSION

The European Commission is the leading international institution involved in nuclear safety in CEE and the NIS. Due to the historical complexity of the development of nuclear power within the European Union and the international nature of accession a large number of different colleges and departments are involved in nuclear safety and accession. These are: -

DG1A - External Relations: Europe and New Independent States.
DG II - Economic and Financial Affairs.
DG XI – Environment, Nuclear Safety and Civil Protection.
DG XII – Science, Research and Development.
DG XVII – Energy.
TFAN - Task Force for Accession Negotiations.

The lead agency for nuclear issues within the European Commission is DG1A, which are responsible for the Phare and Tacis program, the largest multilateral nuclear safety program for CEE and NIS. In early 1999, reorganisations took place within the Commission. Virtually all of the Tacis and Phare planning and program implementation functions have been removed from DG1 and placed in a new entity called the Join Relex Service, which is responsible for all operational functions of external relations in light of Enlargement. A specific nuclear safety division within the Join Relex Service will handle nuclear safety programs.

Since the Commission began its nuclear safety programs in CEE and the NIS many different position papers, audits and expert panels have been appointed and prepared, which both indicates the complexity of the problems and the scale of co-ordination that is required. Some of these documents and reports are outlined below.

Commission Communications.

On two occasions the Commission has produced communication papers that were sent to the Parliament and Council of Ministers for comment, these papers are: -

1. *Communication from the Commission to the Council and the European Parliament: Nuclear Safety in the Context of the Electricity Sector in Central and Eastern Europe and in the CIS*[14].

[14] Com (93) 635 Final, 9th December 1993.

2. *Communication from the Commission to the Council and the European Parliament on Nuclear Sector related Activities for the applicant countries of Central and Eastern Europe and the New Independent States*[15].

The 1993 paper raises many of the same points of later Commission publication, including that: -

- "Nuclear energy production in the CEEC/CIS is of great importance, as it is essential for many of these countries and represents for some of them a substantial part of their total electricity production, and at the same time is of great concern, as Soviet-designed nuclear installations do not generally meet Western safety standards".
- VVER 440-230 and RBMK reactors show fundamental design deficiencies, which cannot be overcome fully.
- VVER 440-213 and VVER 1000 reactors can be substantially upgraded.

The paper states that the European Union's assistance is driven by certain concerns.

- The safety of citizens, both of the CEEC/CIS and the EU, in the event of further nuclear accidents;
- The recognition that a further major incident involving a nuclear power plant in an Eastern country would undermine the nuclear power sector in EU Member States, which produce a large percentage of electricity;
- The need to protect the process of economic development in the CEEC/CIS;
- The weakness of the regulatory environment in the CEEC/CIS, whereas a strong environment is needed to encourage inward investment to these countries;
- The need to ensure security of energy supply to the EU (in particular gas).

The Commission notes a number of actions, which need to be taken to reinforce the coherence and effectiveness of their actions: -

- Guidelines to be agreed with each recipient country, in order to secure an environment more conducive to investment, to analyse and prioritise projects and to ensure rationality and therefore cost effectiveness.
- Conditionalities of Union financing in order to ensure that safety objectives are properly met and that assistance and investments lead to the shutdown of less safe reactors as early as is feasible.

The 1998 paper reiterates that Nuclear Safety is a priority of Agenda 2000 and repeats its main objectives namely: -

[15] Com (1998) 134 Final, 31st March 1998.

- That the Western designed reactors must remain at a high safety level over the long run.

- That for the "upgradable reactors" – VVER 440-213 and VVER 1000, the program must ensure that the upgrading undertaken by the countries is rapid and effectively implemented and lead to a satisfactory result.

- That a definite closure must be secured on the basis of a realistic and agreed timetable for the high-risk reactors.

The Commission notes that it is necessary to work with the countries to enable them to give them the right priority to nuclear safety and to develop solutions to their energy problems. The Commission proposed the establishment of road maps for the reform of the energy sector in conjunction with.

- The International Financial Institutions

- Subcommittees established by the Europe Agreements

The Commission further calls for the road maps to be compatible with the implementation of the "Accession Partnerships" and in the framework of the "National Plans for Adoption of the Acquis".

The Commission envisages an increase in funds available for nuclear safety in Phare countries, with 50 MECU proposed for 1998 and 1999 (and increase from 6 and 12 MECU in 1996 and 1997). It is also noted that an extension of the Euratom loan facility may be needed and that the use of ISPA (Instruments for Structural Policies for Pre-accession (ISPA) cannot be excluded. However, many within the Commission do not believe that ISPA is a suitable instrument for nuclear projects as its total financial capabilities are €1 billion per year and thus not large enough to consider nuclear within its funding remit.

An Illustrative Nuclear Programme (PINC):

The Euratom Treaty, (article 40 of chapter IV from Title two) requires that the Commission publish periodically an Illustrative Nuclear Programme describing the major trends of future nuclear power generation developments and proposing guidelines concerning the investments to be made. The Commission is further required to obtain the opinion of the Economic and Social Committee on such programmes. The latest PINC paper was published in 1997, the fourth such publication. The introduction of the 1997 PINC paper noted a number of reasons for a revision: -

- An increased understanding of the seriousness of climate change and the need for a global reduction in greenhouse gases emissions.

- The growing awareness of the crucial nuclear safety issues related to nuclear power in CEE and the NIS.

- The significant political changes in the CEE and NIS have lead to a reinforced policy of disarmament.

Although the PINC paper is largely concerned with developments of the EU's nuclear industry, due to accession and the close geographical proximity the paper notes the importance of nuclear safety in CEE and the NIS.

"A high degree of nuclear safety within the Community alone is not sufficient. Nuclear safety improvements in Central and Eastern Europe and in the New Independent States are also needed, and to achieve this, the combined efforts of the Member States, the European Community, the partner countries and the wider international community are essential".[16]

The paper notes that assistance, through the Phare and Tacis programs, was targeted in the following areas: -

- Support to safety authorities
- Design and operational assistance
- Spare parts
- Waste treatment and fuel cycle
- Early warning systems
- Chernobyl

The PINC paper further defines the priority of programs in CEE/NIS as: -

Short term: to remedy the most urgent deficiencies as regards the less safe reactors, and to transfer the EU safety culture.

Long term: to bring the reactors, either existing or under construction, as well as other nuclear installations to an internationally accepted safety level.

What is interesting and important to note is that the PINC paper does not re-iterate the calls for closure of the first generation of reactors in the CEE and NIS regions, put forward by the Commission and the G7. This is despite the recognition that changes in Eastern Europe are one of the major events to effect the EU's nuclear industry in the past decade. Rather it gives the impression that all reactors in CEE and NIS are capable of reaching international safety levels.

[16] An Illustrative Nuclear Programme (PINC), September 1997, page 31.

Panel of Experts:

In late 1998 the Commission released a review of the Nuclear Programs in Eastern Europe, produced by a so-called High Level Panel of Experts, under the chairmanship of Mr Jean-Pierre Contzen. The Panel was convened to "advise Commissioner van den Broek on the orientation and implementation of the EU's support activities for the coming years related to nuclear safety in the Applicant Countries and in the NIS". However it has also been said that the Panel was appointed to deflect some of the criticism expected by the imminent release of the Court of Auditors Report – see below.

The Panel's main conclusions are: -

- Progress has been achieved in reaching the goal of improving the safety level of nuclear power plants; this level is depending on both the motivation and the resources of the country. Safety culture is no longer unknown in the East.
- Nuclear energy is and will remain a substantial component of the energy policy of those countries already using it.
- In most applicant countries, the safety of nuclear power plants has been reinforced through upgrading and modernisation programmes, and the strengthening of their nuclear regulatory authorities. The panel does not foresee major difficulties for Applicant Countries in reaching, at the time of Accession, a level of nuclear safety comparable to that of current EU Member States. To ensure the fulfilment of this goal, a more precise definition of the level of nuclear safety to be reached needs to be formulated.
- Problems in three countries require, nevertheless, special attention at this stage: they relate to the early closure of Kozloduy units 1 and 2 in Bulgaria, of Bohunice V1 units in Slovakia and of Ignalina Unit 1 in Lithuania.
- In the New Independent States, the nuclear safety situation has also improved but more slowly and with more contrasted results.

Other general recommendations related to:

- The need to move away from unilateral assistance to effective co-operation and partnership, with a much greater involvement, at all stages of the process, of the beneficiaries of the EU support; this is an integral part of the strategy for the eventual return to self help. Assistance programmes cannot continue indefinitely.
- The desirability for extending the scope of the EU action beyond nuclear power plant safety not only in Russia but in all countries i.e. to the safety of the fuel cycle, radioactive waste management site decontamination, safeguards, safety of research reactors.

- The opportunity for promoting collaborative R&D between East and West; R&D could be a cornerstone of future contacts with Eastern countries, enlarging the co-operation upstream of technical and industrial support.

It is interesting and important that the Panel only highlights the closure of unit 1 at Ignalina. This is because the Panel differentiates between the first and the second/third generations of RBMK reactors and support their design capability to deal with fuel melting accidents. The Panel goes on to say "If these reactors are continuously updated and well maintained, they could be treated, in terms of their capacity to cope with design base accident, in the same way as the later designs of VVER reactors." This is a significant departure from the NSA agreement and therefore Agenda 2000.

COURT OF AUDITORS

The Court of Auditors was created by the Treaty of Brussels on July 22nd 1975 and took up its duties in October 1977. The Court was created with two particular events in mind, the extension of the power of the European Parliament into the area of budgetary control and the use of own resources to finance the whole of the European Union budget. The Court was "promoted" to the rank of an Institution on 1st November 1993 with the entry into force of the Maastricht Treaty

Under the terms of the Treaty on European Union, the Court is required to provide the Council and the Parliament with a Statement of Assurance as to the reliability of the accounts, which is in addition to the annual report, produced each November and presented to the Parliament.

As well as the annual report, the Court exercises the right to submit observations through the production of special reports. One such report was a review of the EU's nuclear safety[17]. This was the second report undertaken by the Court of Auditors that touched on nuclear safety in Eastern Europe, but the first to focus exclusively on the issue.

The first, published in June 1997, was a special report on TACIS program in Ukraine[18]. Their assessment looked at four areas that receive TACIS assistance, one of which was the nuclear sector. The Inspection "gave cause for concern" and in particular pointed to the fact that one person was responsible for monitoring

[17] Special Report No 25/98 of the European Court of Auditors on the Operations Undertaken by the European Union in the field of Nuclear Safety in Central and Eastern Europe (CEECs) and in the Newly Independent States (NIS).
[18] Special Report No 6/97 concerning Tacis Subsidies allocated to Ukraine.

over 100 nuclear safety projects, which is impossible for one person to carry out. The report goes on to highlight many inadequacies in the TACIS program and the Ukrainian nuclear industry.

The Commission and other institutions concerned have the initial findings of the reports made known to them and given the opportunity to "justify their management and formulate such counter-arguments as they feel to be necessary". These are taken into account by the Court and published with the report.

Ultimately, the Court has no jurisdictional powers and cannot directly impose sanctions. However, the Court does believe that its comments often lead to voluntary corrective measures, but ultimately the reports are sent to the budgetary authorities for them to draw their own conclusions and take action.

The Court's main findings:

The research for the special report on nuclear safety was undertaken at the end of 1997 and early 1998. The on-the-spot audit, which was conducted by the Court in four Eastern European countries and also at several specialised organisations, highlighted shortcomings and delays in the implementation of the operations. The Court further stated that although progress has been achieved in a field of intervention in which there had previously been little opportunity for international co-operation, the programmes' short-term objectives had not been achieved by the end of 1997. This was owing to both ambiguities at the strategic level and procedures that were not really appropriate to this specialised and very complex environment (6.2 - refers to the section of the Court's report). The other major conclusions of the Court were: -

- The Commission's intervention strategy with regard to the older-design reactors, to decommissioning, dismantling and waste processing is still confused (3.2-3.7).
- As regards co-ordination, and in the context of the mandate entrusted to it by the G24, the Commission was not able to go beyond exchanges of information (3.12-3.20).
- The heterogeneous and rapidly changing human resources of the unit in charge of the programmes, the inadequate tools for project management and for monitoring the accounts and the laxness of the management all mean that it is not possible for operations to be monitored satisfactorily, problems to be solved swiftly and the quality of the services rendered by contractors to be checked (4.12-4.16, 5.14).
- The Commission has made extensive use of external bodies to help it in its work. Over-delegation of its programming responsibilities has undermined its authority and its independence (4.3, 5.4-5.5).
- Almost a third of the value of the contracts (192 Mio ECU) was awarded without any invitation to tender procedure but there was no consequent improvement in the speed of implementation (4.1-4.2).

- Once the projects had been decided, they then sometimes underwent modifications over which the Commission had little control. Projects were discontinued after large sums had been expended, whilst useful projects were cut back because of lack of budgetary funds, even though there were appropriations that were still unused (5.1-5.3).
- Because of delays in communicating the results, planned studies involving about 40 Mio ECU under the 1991 program are of doubtful use to the recipients (5.18).
- The implementation mechanism adopted by the Commission has proved to be particularly slow. The urgent needs justifying the supplying of equipment could not always be satisfied, and the other measures to develop a safety culture were insufficiently developed and supervised (3.8-3.10).
- Lastly, the contracts entered in the accounts were overestimated at the end of 1997 by 20% in relation to the actual contracts, and the lack of transparency of the management and the accounting deprives the administrators and the budgetary authority of the means to ensure that resources are allocated - and continue to be allocated - in the best possible way (5.21-5.23).

The Court's main recommendations

- In order to be able to produce an objective report on the progress that has been achieved, priority attention should be paid to establishing indicators, in conjunction with the IAEA, that will enable the effectiveness of the programmes and the safety developments at each power plant to be measured (6.2).
- The strategic and contractual frameworks need to be clarified by taking better account of the economic circumstances prevailing in the recipient countries, especially as regards the future of older-design power plants (6.3).
- The Commission departments responsible for executing the programmes should be reorganised and equipped with managerial and staff resources that are equal to the complexity and scale of the task, without excessive reliance on intermediaries (6.4).
- The budget and the accounts drawn up by the Commission should better enable the budgetary authority to monitor the progress that has been made. The allocation of the 294 Mio ECU of appropriations that have not been mobilised via contracts should be examined and updated (6.7, 6.10).
- Owing to the difficulties experienced in applying tendering procedures, the rules concerning the use of the derogation system in respect of the tendering procedures and the rules for using subcontractors should be further defined (6.8-6.9).

The Commission’s Response to the Report.

While the Commission accepted some of the criticisms of the Court of Auditors Report, "in a number of cases identified", it rejected the Courts conclusions. Most significantly, the Commission rejected the reasoning of the report, in that the court claims that the objective of the safety program was to bring the reactors up to a level in line with international standards. The Commission claim that this was not the case and rather that the objective was confined to helping the recipients meet their own responsibility in the field of nuclear safety. Furthermore, the Commission point out that they were never going to be able to provide the ECU 50-60 billion required to close down or modernise the reactors. The Commission accepts that there were shortcomings in the manner in which its strategy has been translated into concrete projects. However, the Commission claims that these shortcomings can be attributed to the urgency in which the initial programs were launched; the differences of perception between Eastern and Western experts; and the inadequate staff resources.

The Commission notes a number of changes that have been made to redress the delays and management deficiencies that the programs have suffered.

- A reduction in the number of projects selected for financing
- Cancellation of projects whose launch is unduly delayed
- Establishment of better lines of communications, for example through the Moscow-based Joint Management Unit.

One of the most obvious results of the Court of Auditors report was the final cancellation of the contracts between the Commission and the Twinning Program Engineering Group (TPEG). TPEG was established in 1992 to provide technical assistance to EC staff preparing specifications for the Tacis and Phare programs. TPEG is made up of nine utilities or utility groups from the EU (DTN of Spain, EdF of France, Enel of Italy, Fortum of Finland, EPZ of the Netherlands, Magnox Electric of the UK, Tractebel of Belgium, Vattenfall of Sweden and VGB of Germany). TPEG finally closed down its technical operations in January 1999.

For a number of years critiques have pointed to the conflict of interest that could occur with representative of TPEG drafting project specifications which might later be bid on by their companies. As a result in 1996 the Tacis rules were revised to bar TPEG from drafting specifications for projects which they might later bid on. However, the Court of Auditors report highlighted the problems of lack of competitive bidding and this resulted in the Commission cancelling the TPEG contract.

COUNCIL OF MINISTERS

In June 1992 the Council of Ministers consolidated the basis for co-operation between Member States and the Commission on the technological problems of nuclear safety by adopting a resolution "On the technological problems of nuclear safety"[19]. The resolution provides guidance on ways of seeking consensus throughout the Union on key safety requirements and also to ensure a coherence between the best uses practises within the EU and the transfer of know-how to the CEE and NIS via the Community's technical co-operation and assistance programmes. The specific requirements of the resolution are: -

4 Requests the Member States to continue – with an active contribution from the Commission – to ensure greater concerted effort between the national safety authorities in the Community on safety criteria and requirements and on the incorporation of the conclusions reached into the practice followed in the Member States, in order to arrive at a system of safety criteria and requirements recognised throughout the Community.

5 Emphasizes the particular importance it attaches to nuclear safety in Europe and therefore requests the Member States and the Commission to adopt as the fundamental and priority objective of Community cooperation in the nuclear field, in particular with the other European countries, especially those of Central and Eastern Europe and the Republics of the former Soviet Union that of bringing their nuclear installations up to safety levels equivalent to those in practise in the Community and to facilitate the implementation of the safety criteria and requirements already recognized throughout the Community.

Although nuclear safety in CEE/NIS is said to be of importance the over-riding interest of the Council of Ministers appears to be for reactors in Ukraine and Russia. Since 1993 the final statements of the EU bi-annual Summits have mentioned the need for closure of reactors, largely Chernobyl on six separate occasions, but only mentioned accession and countries in CEE twice (Copenhagen, June 1993; Vienna, December 1998). By far the most explicit, the Vienna Communiqué, states the follow: -

"It invites the Council to further develop this work in other Community policies, particularly in the Development, Internal Market and Industry Councils. The Council should also put emphasis on cross-sectoral issues such as climate change and the environmental dimension of employment and enlargement. In this context, the European Council welcomes the Council Conclusions on accession strategies for the environment, and on nuclear safety in the context of enlargement of the European Union".

The Austrian presidency in the second half of 1998 was one of the most active on nuclear issues and accession, in part because of the then status of the political process but largely due to the high level of political and public interest in the issue. As a result two Council resolutions were past in the second half of 1998.

i) The Justice and Home Affairs Council Meeting, 24th September 1998.

[19] Official Journal of the European Communities, Council Resolution of 18th June 1993 on the technological problems of nuclear safety, C172 Volume 35, 8th July 1992

The Council recalls that its evaluation of the Commission opinions on the accession applications of the Central and Eastern European States reveals that considerable efforts will be required by these States to enable them to meet the environmental "Acquis" and implement it effectively, including through the establishment of the necessary administrative capacity. It also recalls the need to enhance nuclear safety in the candidate States so that it reaches a level corresponding to the technological, regulatory and operational state-of-the-art in the Union. The Council also recalls the need for the candidate States to respect all existing commitments in this area".

ii) The General Affairs Council: 6th December 1998.

"The Council, reaffirming its commitment to assist applicant countries to improve nuclear safety and to develop medium and long term energy strategies for the replacement of the less safe nuclear power reactors:

1. recalls the Council resolution of 18 June 1992 and the Council conclusions of 7 December 1992, of 25 June 1993, of 25 May 1994 and of 24 September 1998;

2. recalls the Union's general negotiating framework for the enlargement process and the objective of a high level of nuclear safety therein;

3. recalls that competence and responsibility for the safe design, construction and operation of a nuclear installation rests with the Member State having jurisdiction over such an installation;

4. recalls the complementary Acquis communataire in the field of nuclear safety based on the EAEC Treaty, in particular Chapter III (health and safety);

5. notes the initiative of the heads of nuclear regulatory bodies of Member States of the Union to assess the situation of nuclear safety in the candidate States operating nuclear power reactors;

6. asks the Commission, in the framework of the dialogue with the candidate States under the Europe Agreements, with a view to fostering their readiness for accession in line with paragraph 2:

- to ensure that a high level of nuclear safety continues to be given priority in the Accession Partnership process;

- to continue, for example within the context of the Phare programme and, where relevant, the SURE programme:

* To cooperate to help improve nuclear safety in the candidate States with the aim that they ensure that the technological and operational safety levels are aligned with current prevailing safety practice in the Union;

* to promote, through co-operation, the development of technically competent, adequately resourced and fully independent nuclear safety authorities capable of reaching effective decisions on the safety of the installations within their jurisdiction corresponding to current prevailing regulatory practice in the Union;

7. Notes that, further to its communication "Agenda 2000", the Commission has forwarded to the Council and the European Parliament, on 2 April 1998, a communication entitled "Nuclear sector related activities for the applicant countries of Central and Eastern Europe and the New Independent States" and supports the Commission's intention to discuss with the candidate States economically and environmentally sound strategies which encompass the whole of their energy sectors and corresponding financing schemes for international support;

8. Notes the substantial scope for increasing energy efficiency and urges the candidate States to implement a

comprehensive energy strategy giving due consideration to efficiency and diversification with due regard to the potential of renewable sources of energy;

9. Supports the Commission's intention to use resources from the pre-accession funds for the development of energy sector strategies, including help to prepare for decommissioning of nuclear installations, and nuclear waste management as well as dealing with other consequences of early nuclear plant closure;

10. Emphasises the need to develop further methods relevant to the realisation of the objective of a high level of nuclear safety, noting the situation in this sector and relevant initiatives such as the assessment according to paragraph 5 and taking into account relevant international agreements, in particular the Convention on Nuclear Safety;

11. Emphasises that, in line with paragraphs 6 and 7, for the countries which operate reactors which cannot be upgraded to internationally accepted levels of safety at a reasonable cost, the energy sector strategies must provide for the earliest practicable closure of those reactors, including an agreed timetable for closure, consistent with the priorities contained in the Accession Partnerships and the requirements of the Nuclear Safety Account agreements.

12. The Union will keep under close review the above issues throughout the accession process."

These two resolutions raise a number of questions:

The Justice and Home Affairs Committee calls the safety of reactors to “corresponding to the technological, regulatory and operational state-of-the-art in the Union”. This is a departure from other recommendations from the Commission and it could offer clearer, but far more stringent guidelines for the Accession countries. In particular, as there are so few reactors being ordered and built within the European Union in the last decade a “state of the art” objective can be modelled on a few reactors, largely in France but also in the UK. For example Sizewell B in the United Kingdom, which was completed in 1995. At that time, the Government body responsible for overseeing public health and safety (including nuclear safety) - The Health and Safety Executive - stated that a large-scale release of radioactivity should not occur more than once every 10 million years, this is two orders of magnitude higher than that expected for Temelin in the Czech Republic, often referred to as a reference plant for VVER 1000 reactors.

The General Affairs Council makes two important interventions. Firstly, this is the first time that the Council of Ministers have called for the closure of the high-risk reactors (point 11). Given that some EU countries, especially in the Nordic region are reluctant to push the issue of closure of reactors and accession it is important that all the EU members have now agreed to this statement. Secondly, the resolution calls for pre-accession funds to be used for decommissioning and waste management (point 9).

The final declaration from Cologne Summit in June 1999 calls for the following: -

"The European Council emphasises the importance of high standards of nuclear safety in Central and Eastern Europe. It stresses the importance of this issue in the context of the Union's enlargement and calls on the Commission to examine this issue thoroughly in its next regular progress reports on the applicant countries, due in autumn 1999."

This highlights, once again, the importance of the annual assessments produced by Commission on the status of compliance with the Community Acquis.

THE EUROPEAN PARLIAMENT

In recent years a number of Committees in the European Parliament have expressed an interest in Accession and nuclear issues. The decision of April 1999 changed the powers and number of Parliamentary Committees. The new Committees expected to be most involved in nuclear and accession: -

- Foreign Affairs, Human Rights, Common Security and Defence Policy.
- Budgets.
- Committee on Industry, External Trade, Research, and Energy.
- Environment, Public Health and Consumer Protection.

In addition to the Committees, in September 1997, a working party was set up in the European Parliament's secretariat to provide documentary information on all the preparatory stages of the coming enlargement of the European Union (Task-Force Enlargement). The Task force is preparing a series of documents on enlargement, both through a series of briefing papers and a larger White Paper. In 1999, the Task Force produced a briefing "Nuclear Safety in the Applicant Countries of Central and Eastern Europe[20]". The report notes the following points in its conclusion.

- The Phare and Tacis nuclear safety programmes have achieved a great deal in seven years, but some actions have been self-contradictory.
- That countries which have more stable political and economic climates (the first wave countries) have reasonably well functioning regulatory regimes.
- The majority of contracts coming out of assistance programmes are made to Western European countries, while little use is made of eastern expertise, skills and materials.
- The Commission has made the achievement of safety standards comparable to those in existence in the West not a condition for accession to the EU.

The Committee that has been largely responsible for the co-ordination of preparing of opinions for the Parliament is the Committee formerly for Research, Technological Development and Energy – often referred to as CERT, but now the Committee on Industry, External Trade, Research and Energy.

The main resolutions that have been passed by the Parliament which affect nuclear safety are: -

Country Specific

Bulgaria:

- Resolution on the risk of serious accident following the restart of No1 reactor at the Bulgarian nuclear power plant in Kozloduy, 12th October 1995.

Czech Republic:

- Resolution on the Czech Nuclear Power Plant in Temelin, 6th May 1999

Slovakia:

- Resolution on the Mochovce Nuclear Power Plant, 16th February 1995.
- Resolution on the Mochovce Nuclear Power Plant. 16th March 1995.
- Resolution on the Planned Start-up of the Mochovce Nuclear Power Plant, 14th May 1998.

General

- East-West Co-operation Activities in Energy and Nuclear Security, of 11 July 1996
- The nuclear industries in the European Union (Illustrative nuclear programme according to Article 40 of the Euratom Treaty), 16 April 1997.
- Resolution on the Communication from the Commission to the Council and the European Parliament on nuclear sector related activities for the applicant countries of Central and Eastern Europe and the New Independent States (COM (98) 0134-C4-0314/98), 11th March 1999.

In the 1998/9 parliamentary session discussions were held in various Committees and the Plenary on the Communication from the Commission to the Council and the European Parliament on Nuclear Sector related Activity for the applicant countries of Central and Eastern Europe and the New Independent States (Com – 1998- 134 final). This resulted in the Resolution on the 11th March and the accompanying report, by the Committee on Research, Technological Development and Energy with Dr Gordon Adam as the Rapporteur (A4-0088/99).

The Resolution makes the following points: -

[20] The report also states that "the views expressed in this document are not necessarily those help by the European Parliament as an institution".

- Calls upon the Commission to agree an energy strategy for each of the CEEC and NIS countries under the partnership and co-operation agreements in which provision is made for the closure of "first generation nuclear reactors". Each plan should specify how alternative capacity is to be provided. NGOs and local representatives should also be involved in drawing up these plans.
- Calls on the Commission to seek and accord on nuclear safety standards and regulation for the construction and operation of nuclear power stations, the fuel cycle and transport conditions with the CEEC and NIS, within the framework of the International Convention on Nuclear Safety and with Euratom, if and when Euratom guidelines are established.
- Proposes that the accession negotiations with the countries of Central and Eastern Europe should ensure that compliance with these safety standards is guaranteed.
- Insists that safety assistance for "first generation RMBK and VVER 440/230 reactors" must be limited to only short-term safety improvements.
- Recognising the value of the technical co-operation and assistance given by the nuclear industry in the EU, requests the Commission to prepare a bi-annual report to the Parliament on work in progress in Community programmes, assistance by Member States, the contribution of EU industry and the Nuclear Safety Account handled by the EBRD.

The Parliament resolution and report, draws a distinction between the first and later generations of RMBK reactors. The Parliament draws on the conclusions of the Commissions High Level Panel of Experts Report of 1998 – the Contzen Report – which differences between the first generation and the second and third RBMKs. The resolution also requests that the Commission produce bi-annual reports for the Parliament on progress made and that the non-government organisations are included within the process. To date the Commission has not responded to these requests.

STOA

The Scientific and Technical Office of Assessment (STOA) is the body within the European Parliament infrastructure which undertakes independent technical reviews for Members of the Parliament. To date no reports have been written which review specifically nuclear facilities in the light of accession. However, one report, "Nuclear Safeguards and Nuclear Safety In The East" [21] describes the situation in the former Eastern bloc countries regarding the stocks of

[21] Mycle Schneider, Mathieu Pavageau, Bernard Laponche and Perline, of WISE, Paris PE 166.083 / fin. EN - November 1996

nuclear materials, the facilities containing them and the demand and supply of energy, particularly of nuclear power. It gives a critical appraisal of scope and results of more than five years of Western assistance and formulates respective recommendations; namely that all programmes should be subject to a full independent evaluation.

VETO

The enlargement process involves the different European Institutions and Member States and requires their approval. Importantly both the European Parliament and each Member State will have to give their assent on the accession treaties for each potential new member. Furthermore, in most cases this will require an act of the national Parliaments. It is therefore said that these debates on ratification will provide an opportunity for the populations in each Member State to express their view on enlargement.

Each Member State ultimately has the right to veto the entry of any country into the Union. Such a blockade would not be undertaken lightly but may nevertheless occur. The country which is most outspoken on the nuclear issue is Austria, who have been actively trying to fulfil their policy objective of a nuclear free Central and Eastern Europe. The Federal Government has been actively involved in trying to stop the construction of both Mochovce in Slovakia and Temelin in Czech Republic, as well has making technical submission on other reactors and nuclear facilities in the region. The Austrian Chancellor Viktor Klima, was quoted in June 1999 as saying Austria expressed the dire to become the "torch-bearer on anti-nuclear policies" within the European Union. The anti-nuclear sentiment of the Government is driven by an extraordinary level of opposition to nuclear power within the population.

On 6th July 1999 the Austrian Council of Ministers released their position paper on Nuclear Energy Policy in the European Context. The paper was produced to spell out the Government's long-standing foreign policy objective of a nuclear free Central Europe, in particular in the light of accession.

The paper stresses the need for legally binding closure plans to be drawn up for the non-upgradable reactors at Kozloduy in Bulgaria, Ignalina in Lithuania and Bohunice in Slovakia. Austria believes that these plans will be relevant in the formulation of the government's position vis-à-vis accession at the December Summit meeting in Helsinki. The paper states that "if there is no comprehensive and convincing closure plans" the Austrian Government will demand discussions with other Member States on the consequences for the accession process. The paper recommends that the closure dates mentioned in Agenda 2000 namely; Bohunice V-1 2000;

Kozloduy 1 and 2 in 2001; Kozloduy 3 and 4 in 2001/2; and the non rechannelling of Ignalina; be the bases for any shutdown plan.

For the second generation of eastern reactors, which Agenda 2000 proposes are upgradable to EU standards. The Austrian Government recalls the November 1998 Council decision that the reactors must conform to a technical "state of the art". The paper notes that the Minister for Women's Affairs and the Minister for the Environment will invite German Government officials, who undertook similar assessments following the unification of Germany, to carry out a fictitious licensing procedure for the Czech reactors at Temelin. The Czech Government will be asked to support this analysis with all necessary documentation. The paper then states that should the investigation show that the reactors do not conform to "state of the art", then the Austrian Government will point out that the reactors conforming to this standard is "a prerequisite for membership of the Union".

With elections due in the Autumn 1999, the Austrian Parliament was also busy discussing anti-nuclear measures preparing to change the Constitutions to outlaw the use of nuclear power in Austria and ban the transportation, production and construction of nuclear weapons. The proposal has the support of the five main political parties.

The strong action being taken by the Council of Ministers and Parliament is reflected in a recent public opinion poll. Two environmental groups, Global 2000 and Greenpeace released in June analysis that showed that over 80% of the population felt endangered by the reactors in Eastern Europe and wanted their government to make decisions on the Enlargement of the European Union dependent on the closure of these facilities.

RESOURCES:

Panel of High-Level Advisors on Nuclear Safety in Central and Eastern Europe and in the New Independent States. A Strategic View for the Future of the European Union's Phare and Tacis Programmes, October 1998. DG1A: http://europa.eu.int/comm/dg1a/nss/index.htm
Special Report No 25/98 of the European Court of Auditors on the operations undertaken by the European Union in the field of nuclear safety in Central and Eastern Europe (CEEC) and in the Newly Independent States. November 1998. http://www.eca.eu.int/EN/menu.htm
An Illustrative Nuclear Programme (PINC) according to article 40 of the Euratom Treaty, September 1997, ISBN 92-828-3465-4
Communication from the Commission to the Council and the European Parliament on Nuclear Sector related Activities for the applicant countries of Central and Eastern Europe and the New Independent, COM (1998) 134 final.
European Parliament for Dialogue on Accession: http://www.europarl.eu.int/enlargement/en/default.htm

CHAPTER 4:THE EUROPEAN REGULATORS.

At the beginning of 1999 a new association of the nuclear regulators of countries within the current European Union that have or had nuclear power plants (Belgium, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom) and Switzerland was publicly launched. In the preceding year meeting had taken place to established the association and begin working on it's first project. The association was born out of a desire to assist the European Union institutions during the enlargement process. This new body – the Western European Nuclear Regulators Association (WENRA) was established with the following objectives.

- To develop a common approach to nuclear safety and regulation, in particular with the European Union.
- To provide European Union with an independent capability to examine nuclear safety and regulation in applicant countries.
- To evaluate and achieve a common approach to nuclear safety and regulatory issues which arise.

The first publication from WENRA in March 1999 was "Report on Nuclear Safety in EU Applicant Countries" and is the collective opinion of the regulators on nuclear safety in accession countries with at least one operation nuclear power reactor. The report covers both the status of the regulatory regime and regulatory bodies and the current status of the nuclear power plants.

BULGARIA

Status of the regulatory regime and regulatory body

1. There have been improvements in the capabilities of the nuclear regulatory body (the Committee on the Use of Atomic Energy for Peaceful Purposes - CUAEPP) and in the legislative basis over the last 7 years.
2. However, much remains to be done to bring the regulatory regime up to Western European standards.

The main needs are:

- the budget and salaries for the CUAEPP should be improved to allow it to recruit and retain adequate staff, and obtain independent technical support when needed;
- the number of regulatory staff should be increased, with adequate training and experience in safety assessments and in site inspection duties;
- resources should be committed to the drafting and introduction of necessary new and revised legislation;

- The independence of the CUAEPP from bodies concerned with the promotion of nuclear power should be made explicit.

Nuclear power plant safety status

3. Since the early 1990s, a substantial amount of assistance has been provided to the Kozloduy site by international organisations and through bilateral assistance agreements. The utility has also invested considerable funds in safety improvement programmes. In particular, with the completion of further planned safety upgrades; it should be possible to achieve a level of safety for Units 5 and 6 which is in line with reactors of the same vintage in Western Europe.

4. The short term upgrading measures implemented at units 1-4 have improved the safety of these units. Further safety improvements are being implemented or planned. However, on the evidence available, the existing and planned safety upgrading programmes will not be sufficient to bring these units up to acceptable safety standards in Western Europe for older reactors.

5. There have been considerable improvements in the standards of operational safety at all the units and staff awareness of safety issues has definitely increased. However, continuous and long-term improvements are necessary to bring the operational safety at the plant up to a level comparable with good practice in Western Europe.

CZECH REPUBLIC

Status of the regulatory regime and regulatory body

1. The Czech Republic has taken the appropriate steps to establish a regulatory regime and regulatory body according to the principles adopted in Western Europe. Nevertheless, some improvements are still necessary.

2. It is recommended that the Government of the Czech Republic consider the following issues:

- the budget and salary conditions of the SÚJB should be improved so that it can obtain the necessary technical support and retain highly qualified staff;
- the working relations between the SÚJB and other governmental organisations and administrative departments should be clarified. In particular, the organisation for emergency preparedness and planning should be tested in national emergency exercise.

3. The SÚJB should establish a strong management line, in particular to ensure the rapid implementation of the necessary regulations under the Atomic Act.

Nuclear power plant safety status

Dukovany

4. The overall safety status of Dukovany can be summarised as follows:

- in the early years of operation, a backfitting programme was introduced to remove some of the safety deficiencies of the original design;
- further upgrading measures are underway or planned as part of an extensive modernisation programme. Due to burdens from the construction of Temelin NPP however, this programme will be implemented in stages depending on annual budgets;
- Dukovany NPP appears to be well operated, and the plant safety culture has been continuously improved. Several IAEA missions, and co-operation with WANO, have contributed substantially to the enhancement of safety; safety assessments are being conducted in a manner similar to Western practices;
- the current level of safety at the plant cannot be fully assessed due to lack of detailed information. However, subject to a detailed analysis of the fully modified plant and an experimental verification of the containment function, Dukovany NPP should be able to reach a safety level comparable to plants of the same vintage in Western European countries.

Temelin

5. Due to a lack of information the current status and prospects of the Temelin programme cannot be fully assessed.

6. However, there are concerns that the ambitious safety improvement programme might not be successfully implemented. Due to the complexity of repeated design changes, long construction time and the necessity to integrate technologies of very different origins, a major effort is necessary to prepare and assess a comprehensive safety case. This is a challenge for both the operator and the regulator.

HUNGARY

Status of the regulatory regime and regulatory body

1. There is no doubt that the Hungarian approach to licensing, regulating and controlling nuclear facilities is an advanced one. Legislation and other regulations are up-to-date, and compare favourably with the principles applied in Western countries. HAEA is also sufficiently independent from the organisations promoting nuclear energy.

2. There are some issues that need to be improved or clarified:

- to continue to maintain a stable, competent staff, the Hungarian Government should ensure that the salary level of the regulators more closely matches that of the utility;

- the HAEA should further develop the role of the site inspection department in order to avoid undermining the safety responsibilities of the operating organisation, and to ensure that all operational safety issues are sufficiently covered.

Nuclear power plant safety status

3. The following conclusions can be drawn:

- the safety characteristics of the Paks units have been evaluated in an in-depth, systematic manner;
- the basic technical structure of the plant is good from the safety point of view, and the key safety systems are comparable to Western plants of the same vintage. There are no major shortcomings in the present safety systems, but some minor issues remain to be resolved;
- Paks containment structures are among the best for this reactor type, and meet their original design targets by providing protection against all sizes of loss of coolant accidents. However, their leak-tightness is not as good as the leaktightness of containments in Western Europe. This would have some influence in the progress and consequences of potential severe accident scenarios;
- Paks has taken actions to mitigate beyond design basis accidents and severe accidents. These measures are in compliance with good Western European practice, but additional work is needed to ensure containment integrity following a severe accident;
- operational safety aspects are generally at a level comparable to Western plants of the same vintage. Some concern is caused by the experience from management changes related to the political changes in the Government;
- periodic safety reviews are conducted similar to Western practices, and have already led to an increase in safety;
- it is expected that after the implementation of planned safety improvements, which are in the design and preparation phase, the plant will be able to reach a level of safety which compares well with plants of the same vintage in Western European countries.

LITHUANIA

Status of the regulatory regime and regulatory body

1. The legal and regulatory system in Lithuania has developed substantially over a short period.

2. However, in some areas the system needs further improvement in order to be comparable with good practice in Western Europe. In particular:

- the nuclear law should be clearer about the interfaces between different authorities, and the co-ordination between these authorities needs to be improved;

- the organisational structure of the Ignalina NPP should be changed in such a way that the head of the operating organisation/utility is authorised under the Board to handle all safety relevant issues and is provided with the means to take full responsibility for safety;
- the resources of the regulator need to be strengthened to enable it to handle all regulatory issues without foreign assistance;
- technical support and access to nuclear safety research should be strengthened in order to provide the regulator with an adequate assessment capability;
- the responsibility for auditing and approving vendors and suppliers should rest with the operating organisation and not with the regulatory body;
- the work of the resident site inspectors should shift from detailed inspection to a system in which they audit the activities of the licensee.

Nuclear power plant safety status

3. The Ignalina reactors belong to the more advanced design generation of RBMK reactors and much has been achieved in the ongoing safety improvement programme. From the independent safety assessments completed so far, it appears that most of the deviations from Western European requirements could be reasonably addressed or compensated for by a continued safety improvement programme.

4. However, there remain fundamental weaknesses with respect to the type of accidents and transient events that the plant can handle with high reliability and without unacceptable environmental consequences. In particular, there are ongoing concerns regarding the lack of an adequate containment and the reliability of the reactor shut down systems. Although it is likely that many of the plant's safety deficiencies could be addressed by means of a further safety improvement programme, the lack of an adequate reactor containment remains a major problem which cannot realistically be solved.

5. This design weakness prevents the Ignalina reactors from being able to achieve standards of safety which are comparable to those required for older reactors in Western Europe.

6. Much has been achieved with respect to improvements in operational safety and safety management. However, further efforts are required on issues such as:

- the financial situation of Ignalina NPP should be improved to provide for all of the necessary safety improvement measures required for the remaining plant lifetime;
- issues relating to safety culture have been addressed but need stronger implementation. Thus, the management structure of Ignalina NPP needs further clarification, amongst other things, to ensure the necessary quality and safety culture at all levels;
- the internal communication and experience feedback procedures should be improved in parallel with the implementation of the new Quality Assurance system;
- should be evaluated and further developed.

7. The national technical support infrastructure is improving but will not be sufficient in the near term.

For supply and services, the Ignalina NPP will remain dependent on foreign companies. In addition, further Western assistance and Russian consultation will be needed for engineering work.

ROMANIA

Status of the regulatory regime and regulatory body

1. The regulatory regime and the regulatory body have both improved during the licensing process of the Cernavoda NPP. The roles, duties and responsibilities of organisations involved in nuclear safety are in line with those of similar organisations in Western Europe. In addition, the regulator is sufficiently independent of the organisations involved in the use and promotion of nuclear energy.

2. However, some improvements are necessary in order to reach a level comparable with good practice within Western Europe. In particular:

- the resources of the regulator need to be strengthened to ensure it can accomplish all its regulatory duties effectively. Further staff need to be recruited and trained. Staff working conditions should be improved and salaries increased in order to retain qualified personnel;
- the responsibility for auditing and approving vendors and suppliers should rest with the operating organisation and not with the regulator;
- nuclear emergency preparedness needs to be improved. Specifically, the regulator should assign more staff to this area and an emergency response centre should be established. In addition, national organisations should improve their emergency procedures and lines of communications.

Nuclear power plant safety status

3. The Cernavoda NPP has a Canadian designed CANDU 600 constructed and commissioned under the responsibility of a Western consortium. The safety design philosophy is similar to that of reactors in operation in Western Europe. However, the Western European regulators and their technical safety organisations have little experience of this design and no in-depth knowledge of the plant. Based on the information available, it is apparent that additional assessments are needed to confirm design safety margins against seismic events and the adequacy of fire protection. Also, a validated probabilistic safety assessment should be performed.

4. The Cernavoda plant managers and operators have a solid professional attitude and have assimilated a western safety approach and culture. However, this safety culture needs to be extended to all plant personnel and to the national service and support organisations. There is a need for improvement in some areas of plant operation such as accident management, emergency preparedness, training and operational experience feedback.

5. It is important that the Romanian government ensures that the current financial problems of the utility do not affect the ability of the management to maintain an adequate level of safety at the plant. Western support (especially from Canadian experts) should be made available when it is needed in the future.

SLOVAK REPUBLIC

Status of the regulatory regime and regulatory body

1. The Slovak Republic has taken the appropriate steps to establish a regulatory regime and regulatory body (the ÚJD) according to the principles adopted in Western Europe. Nevertheless, some improvements are still necessary.

2. It is recommended that the Government of the Slovak Republic consider the following issues:

- clarifying the relations between the ÚJD and the Authority in charge of radiological protection;
- clarifying the relations between the different governmental organisations involved in emergency preparedness and planning;
- increasing the budget of the ÚJD, in particular to allow full independent technical assessment capability;
- increasing the salaries of the ÚJD to allow the retention of expert staff.

3. The ÚJD should:

- devote necessary resources and priorities to the continued development of regulations under the Atomic Act and appropriate guidance;
- enhance independent safety assessment capabilities.

4. The first unit of the Mochovce plant has recently started operation and a number of modifications to upgrade it to Western standards for reactors of the same generation still need to be implemented. The ÚJD will have to continue to demonstrate its independence and credibility through the requirements it will impose on the operator for the completion of all safety modifications.

Nuclear power plant safety status

Bohunice V1

5. The following conclusions can be made for Bohunice V1 (units 1 and 2):

compared with the original design, the safety of Bohunice V1 has been greatly improved and further improvements are to be made. Many of the major shortcomings of the plant should eventually be corrected. However, some safety concerns still remain, for instance the adequacy of the confinement remains a key issue and the confinement would probably not mitigate the consequences of large LOCAs and severe accidents consistently with current Western practices for plants of the same vintage;

- operational practices are consistent with those in Western Europe;

- due to a lack of information, the current and planned level of safety of the Bohunice V1 units cannot be fully assessed. Bohunice V2

6. The safety of the V2 units seems generally adequate, although some safety issues still need to be addressed. Once the safety upgrades have been implemented (within about 3 years), the safety level of these units would probably be comparable with that in units of the same vintage in Western European countries, although, due to a lack of information, the current and planned level of safety of the Bohunice V2 units cannot be fully assessed.

Mochovce

7. Once the planned improvements are complete, the safety of Mochovce units will be comparable with that of Western plants of the same vintage.

SLOVENIA

Status of the regulatory regime and regulatory body

1. Since its creation in 1987, the Slovenian Nuclear Safety Administration (SNSA) has evolved and matured as a regulator, and there is a clear separation between regulation and promotion of nuclear energy.

2. In general, SNSA operates according to Western practice and methodologies, but there are some issues that need to be improved or clarified. In particular:

- SNSA needs to continue the revision of the existing legislation to ensure it is brought in line with current Western European practice. The current right of the licensee to appeal to the Minister on regulatory decisions may constrain and undermine the SNSA and this should be reviewed;
- an increase in SNSA salaries and an improvement in its financial stability would help to retain staff, increase assessment capability and allow speedier approval of safety improvements;
- the use of the same technical institute as a main contractor for both the regulator and the utility may lead to a conflict of interest and this needs to be guarded against;
- special attention needs to be paid to the interface with the Croatian authorities with regard to cross-border emergency arrangements.

Nuclear power plant safety status

3. Krsko is a Western designed facility and in general, the safety of the plant compares well with nuclear power plants operating in Western Europe. The NPP has a continuous backfitting and upgrading programme and many safety improvements have been completed. A few safety issues, for instance the seismic characterisation of the site, remain to be fully addressed. A key challenge for the near future is the replacement of both steam generators, coupled with a reactor power uprating. This will require an in-depth safety assessment. There is also a need for the utility to carry out a formal periodic safety review of the plant.

4. The site organisation, staff numbers, qualification and training are similar to those in Western Europe and the utility appears to show proper regard for safety. However, the utility is small and needs sufficient financial resources to allow it to continue to obtain adequate technical advice and support from outside organisations. The Slovenian Government needs to address the long-term financial stability of the utility to ensure an adequate priority for nuclear safety can be maintained.

RESOURCES:

The full report is available on the French Government Web Sites:
http://www.industrie.gouv.fr
http://www.environement.gouv.fr

CHAPTER 5: NATIONAL PROGRAMS

BULGARIA:

Current Status of Reactors:

There are six operational reactors in Bulgaria, all located at the Kozloduy site in the North West of the country. As can been seen in the table below there are 4 reactors of the VVER 440-230 design and two of the VVER 1000-320 type.

Table 5.1: Status of Bulgarian Reactors

Reactor	Design Type	Start Construction	Date of Commercial Operation
Kozloduy 1	VVER 440-230	1970	1974
Kozloduy 2	VVER 440-230	1970	1975
Kozloduy 3	VVER 440-230	1973	1981
Kozloduy 4	VVER 440-230	1973	1982
Kozloduy 5	VVER 1000-320	1980	1988
Kozloduy 6	VVER 1000-320	1982	1991

Source: Nuclear Engineering International.

Kozloduy 1-4:

In the early 1990s following the political changes in CEE, Kozloduy was in the news due to an increase in access to the power plant and an increased awareness of the risks they posed. The response by the Bulgarian and Western authorities was substantively different to this situation. The Bulgarians suggested that a $1 billion modernisation program needed to be carried out in two stages. The first was to last two years and cost $200 million. However, Western agencies took a different line publicly and in June 1991 the IAEA released a report which recommended that the first four units be closed on safety grounds. At that time, this was the strongest ever statement by the IAEA against an operating reactor. In August that year the German Environment Minister went further demanding that Kozloduy 1 and 2 be closed down.

The realisation of the dangers posed by the reactors led to the rapid approval of European Union funds from the Phare program. However, delays occurred to the contracts being signed due to intense bidding by Western firms as it was said that companies saw this as a prestige project and one which would open the doors to other work in Eastern Europe. These contracts were eventually awarded to a number of different companies, including Westinghouse, Empresario Agrupados (Spain), Electricité de France, Siemens and Belgoatom. In addition, the German Government ordered the dispatch of $11 million worth of spare parts from the closed Greifswald reactor.

On June 16th 1993, Kozloduy was the recipient of the first funds from the NSA, when ECU 24 million were awarded for short term operational improvements of units 1 –4. The agreement called for the Bulgarian Government to "stop electricity generation at Units 1 and 2 of the Kozloduy NPP as soon as the Chaira Pumping station is put on line, and rehabilitation of either Units 5 and 6 at the Kozloduy NPP or the Varna Power Station is completed in order to increase their safety and reliability, which is expected to happen not later than 1 April 1997". Furthermore, the Grant Agreement called for the cessation of operation of units 3 and 4 as soon as the energy situation allows it, but in any case "as soon as Units 5 and 6 of the Kozloduy NPP are rehabilitated and conversion of Sofia, Kostov and Republika district heating plans to combined cycle co-generation of heat and power is completed. Subjected to necessary financing being available, the Government expects this to be feasible by the end of 1998"[22]. Despite the agreement it was soon clear that the Bulgarian Authorities did not respect the intended closure dates, which have now passed without the closure of the reactors in question.

As with the grants from the Phare program the NSA funds were not distributed efficiently, due to political, legal and technical problems and it was only towards the end of 1995 that all the equipment was finally delivered to the site. The work was completed towards the end of 1997.

The Kozloduy plant has received more grants than any other accession country. However, far from guaranteeing the closure the extensive work is likely to make it more difficult. Ivan Hinovski, the vice president for R and D and nuclear for the national electricity utility said that over $100 million had been invested in the units 1-4 from foreign and national sources. Consequently he felt that the reactors were totally different and thus early closure not necessary. The reactors are currently in the middle of a further investment program being undertaken between 1998-2001. It is said that the program will cost $95 million.

Even before the entire NSA program was completed proposals were put forward by the Bulgarian officials for the lifetime of the reactors to be substantially increased. In June 1996, the chairman of the Parliaments Energy Committee, Konstantin Rusinov, called for units 1 and 2 to operate until 2004 and units 3 and 4 until 2010/12. Furthermore, the Governments latest draft energy strategy calls for the modernisation of the first 4 reactors as it states that: -

- The early closure of the reactors will lead to the collapse of the energy system, as there is insufficient capacity to cover peak winter demand.
- Electricity export is one of the most important sources of hard currency.

[22] Article III – Obligations of the Government and the Recipient, of the Nuclear Safety Account Agreement, June 16th 1993.

- The level of safety has significantly improved over the past few years and a program is being developed for further increases in safety.

Kozloduy 5 and 6:

Within the terms of the NSA agreement the final closure of units 1-4 is conditional upon the upgrading program of units 5 and 6. At the time the NSA was signed it was assumed, finance permitting, that upgrading of 5 or 6 would be possible by the end of 1995. In August 1995 a loan application was made to Euratom for ECU 100 million. This was to be supplemented by French, German and Russian export credit agencies and a national loan, the project is expected to cost $270 million. It is unclear when the work will begin as it has already suffered considerable delays since being first presented to Euratom in 1995. However, reports in the Bulgarian press in June 1999 suggest that work will not begin until the summer of 2000.

In March 1999 initial engineering contracts were signed with the European Consortium (Siemens, Framatome and Atomenergoexport (Russia)) however, problems still exist over the overall financing of the project. Concerns have also been raised regarding the Conditionalities of any Euratom loan, in particular over the need for a definitive closure date prior to the disbursement of the loan and the schedule for the proposed upgrades. At present it is proposed that the upgrading of 5 and 6 will be undertaken simultaneously over a five-year period, during the routine outages of the reactors. This would ensure a minimum time is lost of electricity production. However, it would also mean that the trigger points under the NSA agreement would not be reached until around 2005. Thus units 1-4 would be able to operate until that time and still conform to the NSA agreement. It is clear that this pro-longed upgrading strategy is not conforming to the spirit of the NSA agreement and is not acceptable to either the Commission nor the NSA administrators.

In addition to the program being undertaken by the European consortium Westinghouse has been awarded, in June 1999, a $75 million contract to replace computer control and monitoring systems. This will require a US export-import Bank (Ex-Im) guarantee. National Electricity Council (NEC) has said that they will fund $6 million worth of Westinghouse work pending the final agreement on funding for the larger contract. The contract for the supervision of the upgrading work on units 5 and 6 was awarded to Empresarios Agrupados of Spain and Magnox Electric of the UK in early 1998. The contract is to be funded by the Phare program.

Belene:

There is also a part built nuclear power station at Belene in the Danube basin, 250 km north of Sofia. When construction began in 1987 it was proposed that there would eventually be four reactors at the site; Commissioning was to begin in 1995 (unit 1), 1997 (unit 2) and after 2000 (units 3 and 4). However, in 1990 the pace of construction was slowed and then completely halted in mid 1991. Unit 1 is approximately 40% complete, which includes parts of the primary circuit in place. Reports differ as to how much has been invested on the construction and its subsequent preservation, ranging from $800-1300 million.

In 1995, the Bulgarian cabinet approved its energy policy until 2010. This called for the completion of Belene between 2005-2010. In March the following year, the expert council of the NEC approved in principle the construction of a second nuclear power station at Belene

Since the beginning of 1993 various Bulgarian officials, from the Energy Research Institute, the Energy Ministry and Committee of Energy have all confirmed that attempts have been made to renew the construction of Belene. In June 1996, the then Bulgarian Prime Minister, Jahn Videnov, told the Parliament that the Government would give its permission for construction to restart. The Bulgarian electricity utility, NEK, says that completion of unit 1 would cost $1.4 billion, including the installation of Western control systems. Previous reports suggest that U.S.-based Westinghouse Electric Corp, Germany's Siemens and France's Framatome have all expressed an interest in the project as have Russia's Minatom.

However, in May 1997 the council for the construction of the Belene nuclear plant recommended that plans to complete the unfinished station should be rejected.

Liability: On the 27th July 1994 the Parliament authorised Bulgaria's accession to the Vienna Convention and the Joint Protocol, both then entered into force on 24th November 1994. According to this legislation the liability of the operator of a nuclear installation in Bulgaria for third party nuclear damage is limited to the equivalent of 15 million SDRs (Standard Drawing Rights) and in relation to other activities 5 million SDRs. – See side box.

Nuclear Liability.

Despite the transboundary nature of nuclear damage there are a surprising variety of international treaties governing nuclear liability.

European Union countries are party to the Paris Convention on Third Party Liability in the Field of Nuclear Energy Agreement (1960) and to the Brussels Supplementary Convention (1963) under the auspices of the OECD/NEA which is limited to the member countries of these organisations.

Other countries are party to the Vienna Convention on Civil Liability for Nuclear Damage (1963) adopted under the auspices of the IAEA. Its membership is potentially universal but up until the Chernobyl accident the Vienna Convention had attracted only ten members, since then this has doubled mostly from Eastern Europe.

The proponents of the current regimes note the key purposes of the international agreements are: -

- Establish rules for single-point liability of the operator and thus channel cross border legal actions in by victims in other countries against the operator and therefore exclude the risk of liability to other parts of the nuclear industry, suppliers' etc.
- Create upper limits of compensation acceptable for the governments and the insurance industry.
- Establish the exclusive jurisdiction of courts of the contracting party where the accident occurred.

The Paris and Vienna Conventions are embodied with the same basic principles:

- Strict or absolute liability of the operator.
- Channelling exclusive liability towards the operator.
- Minimum liability.
- Limitation in time for submission of claims
- Unity of jurisdiction

The main difference between the two Conventions lies in the limitation of liability.

In 1986 at the time of the Chernobyl accident the Paris and Vienna Conventions existed in isolation to each other, consequently potential victims from one convention could not claim damage arising from an accident in a state party to the other convention. The 1988 Joint Protocol deals with civil liability for installations covered by the Paris or Vienna Conventions.

In September 1997 delegates from 80 countries agreed to a Protocol to amend the Vienna Convention and the Convention on Supplementary Compensation for Nuclear Damage. These made a number of changes to the Vienna Convention.

- New Definition of nuclear damage.
- Expansion of the Geographical Scope of Application.
- Increase in Minimum Liability Amount
- Change in the time period for claiming compensation.

The Convention on Supplementary Compensation allowed non-Vienna countries to join a unified international liability regime which provides an upper limit of liability and one which creates an international funding mechanism.

However, despite the attempts to unify the liability regimes they still suffer from the need to be universal – i.e. all potentially affected States must be signatories - if they are to be effective. This is highlighted by the situation in Austria.

On January 1st 1999 a new law on nuclear liability entered into force in Austria that runs counter to the Vienna and Paris Convention, to which Austria is not a signatory. The law allows for suppliers as well as operators to be sued for damages from nuclear facilities and establishes the jurisdiction of Austrian courts in cases of transboundary damage. The supporters of the nuclear industry were reported as saying that the law would reverse three decades of consensus that liability should be channelled to the operator which is said to be a crucial development of the commercial nuclear industry. Other non-nuclear countries, such as Luxembourg and Ireland were reported as considering passing similar legislation.

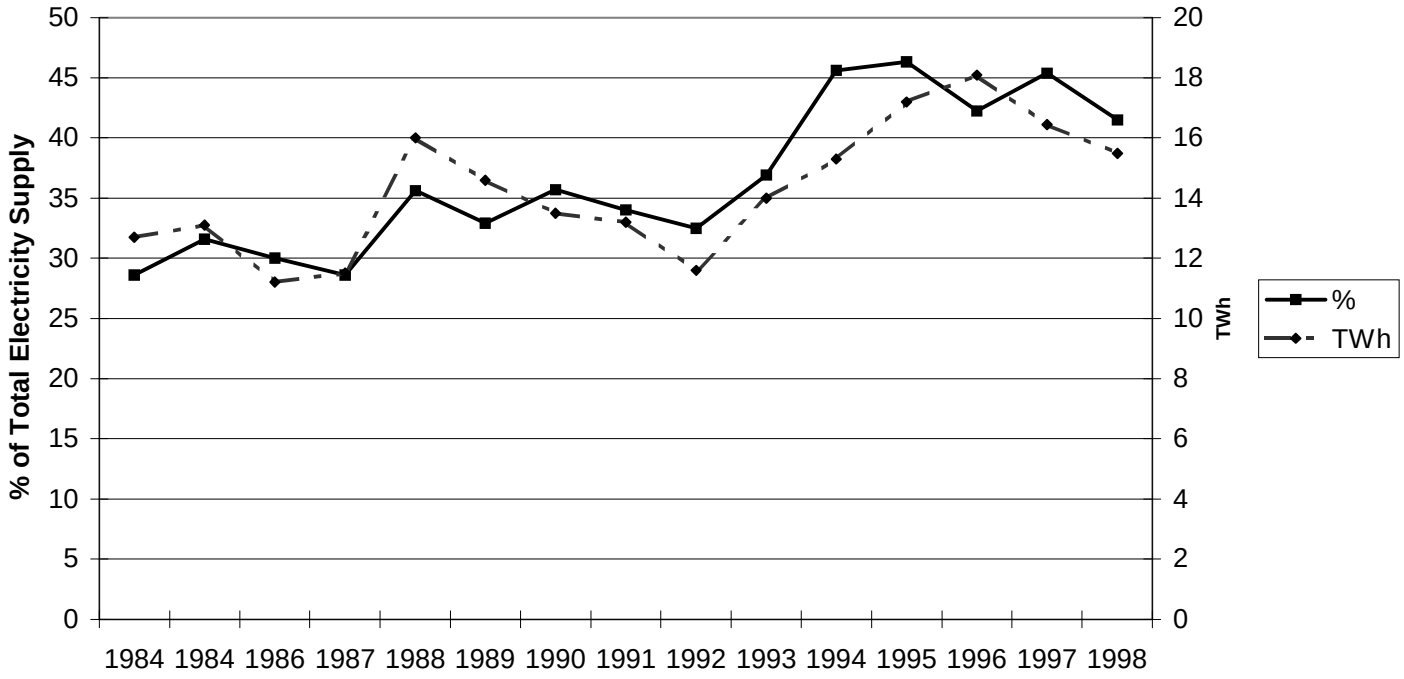
Nuclear Waste and Decommissioning: There is no specific agency established for license the decommissioning process, therefore the Committee on the Use of Atomic Energy for Peaceful Purposes (CUAEPP) is responsible for establishing policy and regulations. These regulations do not require the establishment of funding estimates and to date there is no published policy on decommissioning, nor is there any requirement for public involvement in the decision making process for decommissioning. However, prior to closure of a nuclear facility it is necessary that a detailed decommissioning program has been developed.

A fund has been established to pay for decommissioning and radioactive waste management. From the beginning of 1999, 8% of the price of electricity generated at Kozloduy is supposed to be put aside for decommissioning and an additional 3% for radioactive waste management.

Between 1979 and 1988 twenty-one shipments of spent fuel were sent from Kozloduy to Mayak. The first shipment, since the contract was renewed in 1997, of waste took place in September 1998, the second was due to take place in early 1999. Bulgaria pays $640 per kg of fuel and the first shipment cost $18.7 million excluding shipping and insurance costs. Five more shipments of spent fuel were expected in 1999 under the terms of the 1997 agreement. However, it is reported that Minatom wish to increase the price of reprocessing for its four foreign clients (Bulgaria, Czech Republic, Slovakia and Ukraine) to $1000 per kg. As with other countries with Soviet designed reactors, prior to 1989, all spent fuel was returned to Russia after a period of interim storage at the power plants to allow the used fuel to cool, usually for about five years. Consequently, many countries have not established medium or long-term plans for the disposal of high level radioactive waste. The current storage facilities for spent nuclear fuel are expected to be full in the near future, unit 1-4 in about seven years, and units 5-6 in four-five. Therefore the continual operation of the power plants and the continual production of waste in Bulgaria will cause problems for the existing spent fuel storage facilities. Consequently, as well as plans to re-start the sending of spent fuel to Russia, proposals exist for the construction of a dry store for the spent fuel.

Nuclear power plays a significant role in the supply of Bulgaria's electricity, as can be seen the figure below.

Figure 5.1: Development of Bulgarian Nuclear Electricity Production.



Source: IAEA

Nuclear and Accession:

The future of the first generation of Kozloduy reactors is given a high priority within the accession negotiations. The Accession partnership document released by the Commission in 1998 recommends the following action: -

Particular effort needs to be dedicated to the upgrading of units 5-6 of Kozloduy NPP. This is particularly urgent given Bulgaria's commitments in the framework of the NSA agreement on the phased closure of units 1-4 at the Kozloduy nuclear power plant. Long-term solutions for nuclear waste need to be found. Continued support to the safety authority should be foreseen.

While the November 1998 accession progress report by the Commission notes: -

The Nuclear Safety Account Agreement (NSAA) which Bulgaria has signed foresees early closure of Kozloduy NPP Units 1-4, subject to certain conditions which were initially foreseen to be fulfilled by 1998. The Accession Partnership requires the establishment of realistic closure commitments as entered into in the NSAA.

Bulgaria's energy strategy indicates that decommissioning of Kozloduy NPP units 1 to 2 will take place after the implementation of the modernisation of units 5 and 6 (expected around 2004) and for units 3 and 4 after 2010. These intentions are not in line with Bulgaria's international commitments in the NSA agreement. The Commission takes the view that Bulgaria must respect its commitments and close units 1-4 as soon as units 5 and 6 have been modernised.

Hard Negotiations:

Agenda 2000, somewhat surprisingly, puts forward new dates for the closure of Kozloduy 1-4: Units 1/2 in 2001 and units 3 /4 in 2001/2. These dates differed from the NSA agreement. However, as the NSA dates were dependent on the implementation of alternative energy sources the Agenda 2000 dates did not contradict the NSA but is said by the Commission to be setting a realistic closure date consistent with the NSA agreement.

In the first part of 1999 there was an apparent hardening of the positions of the European Union and the Bulgarian Authorities. In March the Bulgarian Parliament unanimously voted in support of the Government's energy policy. This includes plans to operate the reactors until the end of their nominal design lives of 30 years. This would mean that units 1 and 2 would operate until 2004 and 3 and 4 until 2010. The Government has further stated that it intends to invest $16 million in units 1-4 in 1999 as part of its ongoing upgrading program. Comparisons have been made in Bulgaria with the upgrading program currently being undertaken at Bohunice V-1. Ivan Hinovski, the NEK vice president in charge of R and D and nuclear has recently been quoted as saying that he believes that 80% of the Bohunice upgrading program has already been implemented at Kozloduy. Western commentators are not so ready to believe that the upgrading program has been implemented to such a degree and believe that a Bohunice type upgrade would cost around $500 million.

The Bulgarian Prime Minister, Ivan Kostov has been quick to defend the Kozloduy and visited the plant in March 1999. In an interview early that month he was reported as saying, "the aggressive demand to close the nuclear power plant will destroy even what little competitiveness the country now has". At the end of March the Bulgarian Energy Committee confirmed the opinion of the Parliament and Government and said that the reactors would operate until the end of their design lives.

As part of the ongoing negotiations on accession the first meeting took place of the European Commission and the Bulgarian energy authorities in May 1999. This new dialogue seeks agreement or at least mutual understanding of technical issues relating to the closure of Kozloduy 1-4. The issues discussed include demand and supply forecasts, costs of alternative energy sources and their potential sources as well as costs associated with early closure, such as decommissioning and social impact. The head of the Commission's delegation to

Bulgaria, Enrico Grio Pasquarelli, said that units 1-4 would have to be closed early than that proposed the Bulgarian Government.

The working group is expected to meet on a regular basis and are said to be aiming towards a greater agreement prior to the November 1999 publication of the accession progress report. This document will be discussed at the EU summit in Helsinki in December 1999. A number of countries which are presently in the second wave, such as Bulgaria, are hoping to have a reconsideration of this "categorisation" in Helsinki. Some staff within the Commission believes that the "Kozloduy" question is unlikely to be allowed to hold up the overall progress being made in Bulgaria to meet the Community Acquis.

The situation for Kozloduy 1-4 highlights one of the dilemmas of small grants within the overall nuclear safety programs. It has always been stated, at least publicly, by the Institutions giving the grants that the work that they fund is not intended to extend the lives of the reactors. However, on a national level and now to a large decree on an international level it is used to do just that. The safety improvements that may have reduced the risk of an accident are becoming part of the justification for longer-term operation. Continual operation will increase the risk of an accident, not only because the reactors are functioning longer, but also because the ageing of material – due to operational erosion and stresses – will increase the chances that they malfunction especially under high stress accident conditions.

CZECH REPUBLIC

There are four reactors, all of them VVER 440-213 model currently operational in the Czech Republic, sited at Dukovany in Southern Moravia. In addition, two reactors of the VVER 1000 design are under-construction at Temelin, in Southern Bohemia.

Table 5.2: Status of Reactors in the Czech Republic

Reactor	Design Type	Start Construction	Date of Commercial Operation
Dukovany 1	VVER 440-213	1978	1985
Dukovany 2	VVER 440-213	1978	1986
Dukovany 3	VVER 440-213	1978	1987
Dukovany 4	VVER 440-213	1978	1988
Temelin 1	VVER 1000-320	1983	Expected 2001
Temelin 2	VVER 1000-320	1983	Expected 2002

Source: Nuclear Engineering International.

Both nuclear power stations are owned by the Czech Electricity Utility – Ceske Energeticke Zavody -(CEZ) which is has majority (67%) state ownership. The Government intents to retain control (51% of the shares) of CEZ even when the privatisation process is complete. CEZ produces over 75% of the electricity in the Czech Republic, from nearly 11 GW of installed capacity. Although responsible for the transmission, with the exception of large-scale industrial uses CEZ does not distribute electricity to the final consumers, the eight regional electricity companies do this. In October 1998, CEZ was accepted as an associate member of the West European UCTPE electricity system. This follows the April 1998 decision to permanently connect the CENTRAL (Czech, Hungary, Poland and Slovakia) network to that of UCTPE,

Dukovany:

The Dukovany power plants operates as a base-load station and generated 12 TWh of electricity in 1998, 20% of the countries electricity, giving a total life-time production of 150 TWh. Near to the power station is the Dalesice water reservoir with has a 450 MW pump-storage hydro station associated with it.

Relative to other Soviet designed reactors the VVER 440-213 has a good operating record and Dukovany is no exception. Since the early days of operation the reactors have been exposed to international attention. Siemens of Germany was involved between 1984-6 in the supply of equipment to all units. Proposals were put forward in 1990 to replace the original instrument and control technology with ones built by Siemens/KWU. Although delays have occurred it is expected that this will still happen. In 1998, CEZ announced that a

substantial, 25 billion CZK (750 MECU) modernisation program would be undertaken by 2005. The upgrading program is designed to further increase the life of the reactors from thirty to forty years.

Temelin:

In 1980 it was proposed to construct four VVER 1000 at Temelin and the reactors were ordered from the Soviet Union in 1982. The construction was expected to take five years. However, following the political changes in November 1989 the situation was reviewed and in 1990 the project was reduced only two reactors.

In 1991, following a tender announcement bids were received from 11 foreign suppliers, including Siemens, Framatome, Asea Brown-Boveri and Westinghouse Electric Corporation, for the upgrading of the two Temelin reactors. In August 1991 CEZ announced that Halliburton would undertake an audit of the Temelin power plant, which was subsequently released in March of the following year. This recommended that the whole Instrument and Control (I&C) system be replaced and that a PSA analysis be undertaking. In October 1991, the U.S. Ambassador to the Czech Republic assured Czech officials that if awarded the bid, Westinghouse would have access to competitive financing for the project through the US Ex-Im Bank. Westinghouse had already applied to both the US Nuclear Regulatory Commission (NRC) for an export license for the instrumentation and control system and to the Ex-Im Bank for a preliminary commitment on a loan guarantee.

In February 1992, letters from the US Department of State and Commerce to Czech officials further encouraged the selection of Westinghouse to promote increased cooperation between Czech and US firms in nuclear energy and other industries. In March, Westinghouse followed up its earlier application to the Bank with a request for a preliminary commitment on a loan guarantee for the initial supply of nuclear fuel to Temelin. This preliminary commitment was approved in July 1992.

The US Ex-Im Bank amended the preliminary commitments on both requests in October 1992. Towards the end of 1992, CEZ signed letters of intent with Westinghouse to supply both the initial fuel for Temelin and the plants I&C system. Two Banks, Citibank and Belgium's Generale de Banque agreed to lend CEZ $317 million for the project, with the US Ex-Im Bank, Belgium's Office National du Decroire and the Czech Government guaranteeing the loan.

In February 1994, 1 month before the Ex-Im Bank gave final approval for the loan guarantee, a delegation representing the Austrian Chancellery visited the United States and met with about 60 groups over a 3-week period. The US State Department officials characterized the visit as an attempt by the Austrians to persuade U.S. officials not to guarantee the loan. On March 10, 1994, the US Ex-Im Bank approved a decision to

guarantee a loan of $317 million for the work to be performed by Westinghouse. However, it was only at the end of October 1996 that the Czech Government finally approved the state guarantee.

The support of the Ex-Im Bank was fundamental in Westinghouse being awarded the contract. The reason for this support was said to be because: -

- The project was the first attempt to integrate Western technology into a Soviet-designed VVER 1000 pressurized water reactor.
- US officials saw the opportunity to gain more than $330 million in US exports and to make the reactors safer.
- The Czech Minister of Industry and Trade and the Chairman of the Board of the Czech utility told US officials that the successful completion of the Temelin reactors could lead to future contracts for Westinghouse to upgrade other Soviet-designed reactors throughout Eastern Europe.

Construction Problems:

The project to complete the Temelin nuclear power plant has been afflicted with considerable delays and cost over-runs. These problems are due to a variety of causes, the political changes in the Czech Republic, the bidding procedures and securing financing, but most recently because of the technical problems that have arise as a result of the design changes. In particular the unexpected and serious technological complications resulting from the combination of different Russian and American components and technologies has caused the project to become significantly delayed during the 1990s. Since 1993, the accumulated delays reached 5 years and the cost overruns are 30 billions CZK (900 million ECU).

Table 5.3 : Cost overruns and delays of Temelin construction		
Year of announcement	total budget (billion CZK)	year of start-up
1981	20	
1985	30	1991
1990	50	1992
1993	68	1995
1995	72	1997
1996	79	1998
1997	85	1999
1998	99	2001
Source : EU Enlargement Watch		

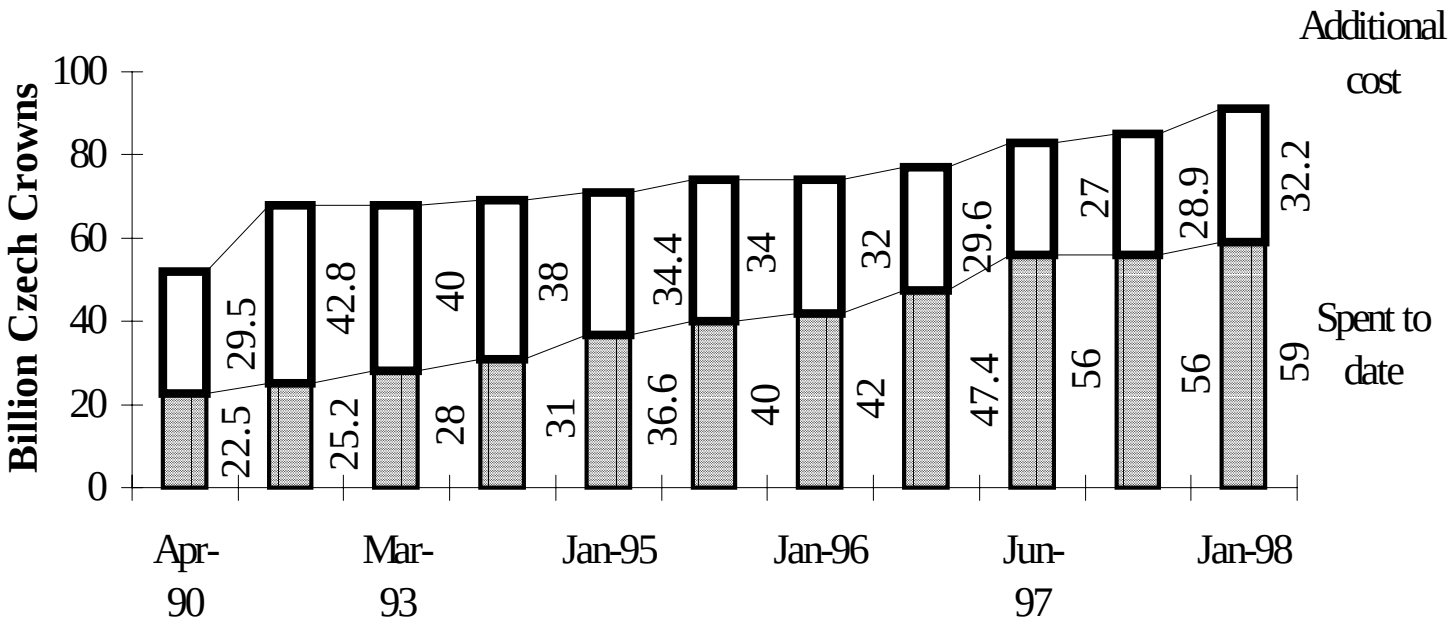
The beginning of commercial operation is now officially scheduled for May 2001 for the first reactor and autumn 2002 for the second.

CEZ categorise the following as main reasons for the technical delays.

a) System changes accepted with the aim of increasing the technical, operational and safety level of the power plant recommended by nuclear inspectorate and international bodies, e.g. the installation of the Westinghouse I&C system.
b) Changes that have lead on from the required changes in the first category, for example the required modification of the electrical systems or the strengthening of the requirements on the layout of the cabling system.
c) Changes caused by the termination of production at some facilities or by a change over of production program of some suppliers.

The necessary re-routing and retrofitting of the cabling system in order to comply with Western standards has proved to be one of the most costly and difficult ongoing problems at the Temelin plant. Estimates of the amount of cabling needing reinstallation have continually increased even within a relatively short period of time -see graph below. Additional 300 holes for the cabling have to be drilled through the existing concrete structure, which is further adding to the cost and delays.

Figure 5.2: Projected Cost Completion of Temelin



Source: CEZ and Mininstry of Industry and Trade CR

On July 1st 1998, the Czech government discussed the current situation at Temelin nuclear power plant and passed the following decision (No. 465).

"The government is concerned about the developments of construction of Temelin nuclear power plant. Especially worrying is the fact of another budget increase and delay.

The government also states that before final decision about Temelin is taken, it is necessary to prepare an evaluation of the project done by a team of independent experts.

The Minister of Industry and Minister Environment will submit a proposal of the independent evaluation process by a team consisting of Czech and international experts. The team will primarily focus on economical evaluation, including analysis of risks and contracts with suppliers. The proposal of this process will be submitted by 28th July."

The main elements of the report were proposed to include: -

1. Analysis of the Czech electricity market.
2. Assessment of the construction and operational costs of Temelin Nuclear Power Plant.
3. Contract.

4. Conditions of the construction.
5. Risks of Completion/Cancellation
6. Alternative scenarios.
7. Results and recommendations

Initially, the team was expected to complete its work by the end of November 1998. However, delays in the establishment of the evaluation team due to a change in Government and inter-departmental discussions on the make-up of the international panel, which initially was to include a representative from Non-Governmental Organisations, and changes in the structure of the report, lead to a. On November 23rd, 1998 the team finally began its work.

The draft of Team's final report was completed in February 1999. The report is highly critical of the project but did not recommend that the project be abandoned. The reports main conclusions are: -

“Decision-making on completing or not completing construction cannot, at the present time, be based on unambiguous economic arguments for one or the other approach. It is now apparent that the Temelín NPP must be viewed simply as a business plan and not as construction resulting from the urgent need for electrical energy in the country. If a problem does actually arise of significant gaps in the supply after closing down the coal-burning blocks with sulphur-removal equipment, it is economically not justifiable to construct a replacement source 10 or 15 years ahead of time and to bear the risks connected with uncertainties in predictions of future market demand. This is especially true at a time when the structure of the market in electricity is changing in all of Europe.

The Temelín NPP project is in such an advanced stage that every approach will have more negative than positive aspects. A correct decision could have been made only in the past. The current decision is not made from a position of finding the best approach, but rather the least unfavourable solution. Completion of construction can still bring greater economic benefits than stopping the construction, but is connected with considerable risks associated with future developments (increase in demand, price, etc.). If the danger of potential risks is actually realised, there could be even greater economic losses than those associated with stopping construction.”

Therefore, the Temelin team did not come up with a clear recommendation regarding the future of the power plant rather put forward different scenarios for the Government to consider. However, in a number of important areas the report pointed some of the problems associated with completion.

1) Although the official budget is 98.6 billion CZK it does not include other direct and indirect costs in the order of 12.1 to 13.6 billion CZK, making the final budget between 110.7 and 112.2 billion CZK.
2) At the end of March 1999, 75 billion CZK had been spent on Temelin.
3) Each year of additional delays will cost around 2.8 billion CZK.

In March 1999 the Czech Government discussed the final report of the Temelin Investigation Team and decided to prepare in detail two possible scenarios for Temelin - cancellation or continuation of construction. The scenarios were to be prepared by five Ministers by end of April and a final vote in May. On the 12th May the Government announced that it would continue to support the completion of Temelin. The cabinet approved the project by two votes, passing it eleven to eight. This was despite a strong appeal by President Havel for the project to be abandoned.

Liability: The procedural aspects of compensation for nuclear damage are governed by general legislation. However, these do not provide a specific definition of nuclear damage but do specify that this damage includes the cost of preventative measures or measures to restore the original state of the environment if these measures are justified. Third party liability for the operator is fixed at a maximum of 150 million SDRs (approximately 6 billion Czech crowns) per installation used for electricity generation, radioactive waste management and fuel processing plants. In order to adequately cover high liability claims a nuclear insurance pool was established in 1995.

The Czech Atomic Act provides for State guarantees to ensure compensation up to the established limits of liability if requests for compensation exceed the amount of mandatory insurance of the operator. The Czech Republic acceded to the Vienna Convention and Joint Protocol in March 1994 and they entered into force on 24th June 1994.

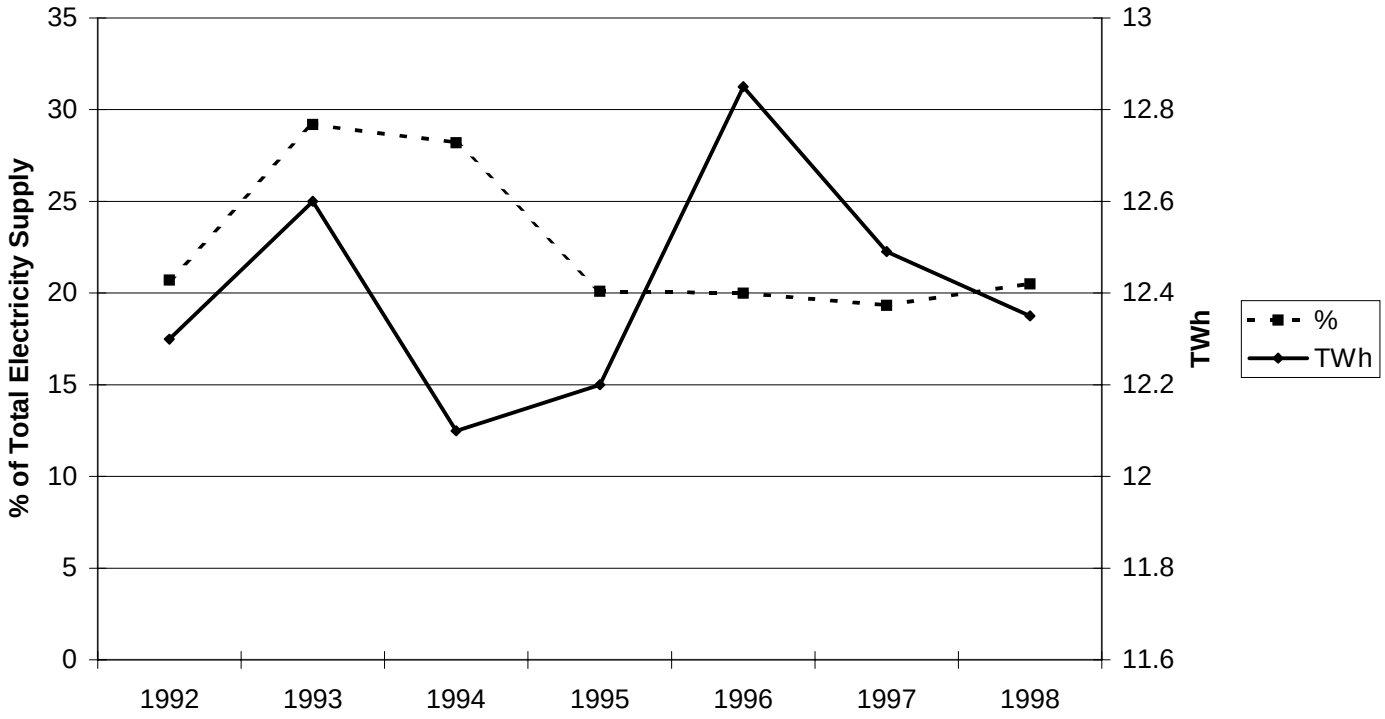
Nuclear Waste and Decommissioning: Any license for decommissioning is to be issued by the State office for Nuclear Safety (SUJB). There is no definitive decommissioning policy but the issue is dealt with on a case by case basis. According to the Atomic Law at the commissioning stage funding estimates for decommissioning are required. Furthermore, the licensee is required to inform the public on the assurance of both nuclear safety and radiation protection during decommissioning.

Until 1990s Czech spent fuel was sent to Bohunice (now in Slovakia) for interim storage prior to its final journey to Russia for reprocessing. However, following the split of Czechoslovakia in 1992 interim storage in Bohunice was not longer possible and construction began in 1994 for an interim storage facility at Dukovany. In fact spent fuel had to be returned from Bohunice to the Czech Republic. However, the new facility does not have sufficient capacity to hold the expected lifetime production of spent fuel from Dukovany. Consequently,

assessments are underway to enlarge the Dukovany site or build a separate facility at Skalka. Low and intermediate level radioactive wastes are currently stored on site at Dukovany.

Nuclear power plays a significant role in the supply of the Czech Republic's electricity, as can be seen the figure below.

5.3: Development of Czech Nucler Electricity Production



Source: IAEA

Noticeable is the consistent level of electricity production by Dukovany over the past six years and how its share of the electricity supply dramatically increased in the early 1990s. This was due to the slow down in the Czech economy and subsequent reduction in electricity demand.

Nuclear and Accession:

The Accession partnership document released by the Commission in 1998 recommends the following action: -

"Special attention must be given to timely implementation of nuclear safety programs in order to bring all the nuclear reactors to the safety levels generally accepted in the EU, and longer term solutions for waste have to be defined. The strengthening of the nuclear authority should be supported".

While the November 1998 accession progress report by the Commission notes: -

"Adequate attention should be paid to the respect of nuclear safety standards in order to bring all the nuclear power plants to the required safety level. In this respect it is important that the delays and cost overruns at the Temelin nuclear power plant do not affect the upgrading programs foreseen for Dukovany. Long term solutions for nuclear waste have to be developed."

The Czech Republic being part of the current first wave of countries is already preparing its nuclear facilities for entry into the EU. This can be seen at Dukovany where an upgrading program is already underway and a full replacement of the four reactors instrument and control systems are expected in the first half of the next decade. Reports suggest that the likely contractor will be Siemens, given their experience at both Paks in Hungary and Mochovce in Slovakia.

The most comprehensive international technical analysis undertaken on accession and nuclear safety from WENRA is somewhat surprisingly lacking in information on both Dukovany and Temelin. For Temelin WENRA goes further stating "it is not possible to fully assess the safety status and prospects".

Despite the Governments approval for the continuation of construction at Temelin the completion of the project is still not guaranteed. The International Temelin Team cited a number of unresolved technical problems and further potential problems coming to light during the pre-operational testing period. While the February 1999 decision of the Czech Supreme Court that the anti-Temelin groups were correct when demanding an environmental impact assessment for the modified project, may throw-up a series more hurdles for the completion schedule. In addition just prior to the Czech Government's May decision, the Austrian Chancellor claimed that Austria would contest that Temelin reached the necessary standards for accession. This was the first time that Member State of the EU has directly questioned the safety of a second generation VVER reactor in light of accession. The European Commission was expected to produce by March 1999 an assessment of second generation reactors, including Temelin, which would lay out the required safety standard. However, to date, this report has not been completed.

HUNGARY

Hungary has only one operating nuclear power plant at Paks located close to the Danube in the centre of the country, South of Budapest. The Hungarian nuclear industry seems to have had the most trouble free construction and operating record of all potential accession countries.

Table 5.4 : Hungarian Operating Reactors			
Reactor	**Design Type**	**Start Construction**	**Date of Commercial Operation**
Paks 1	VVER 440-213	1974	1983
Paks 2	VVER 440-213	1974	1984
Paks 3	VVER 440-213	1979	1986
Paks 4	VVER 440-213	1979	1987
Source: Nuclear Engineering International.			

In 1966 the Hungary and Soviet Union Governments first reach agreement on the construction of a nuclear power plant in Hungary. One of the primary motivations for the project was to utilise the Hungarian uranium deposits and thus increase energy independence. However, Hungary never developed its own uranium enrichment facility and relied on the Soviet Union and then Russia for its fabricated nuclear fuel as well as for its nuclear fuel disposal.

Paks has a high life-time load factor, ranging from 82.1% to 86.1% making it one of the highest performing nuclear power stations in the world. Furthermore, it has low frequency of emergency shutdowns per year, averaging about 1 per year in recent years.

Paks is owned by the State under the company name of Paks Nuclear Power Plant Ltd. The Hungary Electricity Board Ltd (MVM) owns 99% of the shares, with the remaining shared owned by the local authorities. Prior to 1989 MVM was in negotiations with the Soviet Union for the construction of two further reactors for Paks, which were to be of the VVER 1000 design. However, the political changes in the region lead to their abandonment. The current Hungarian energy policy does not envisage the construction of any new base-load power until at least 2010.

In July 1998 MVM stated that they were considering applying for the extension of the operating life of the reactors for a further ten years giving forty years in total. This would allow the reactors to operate through until 2022 until 2027. However, currently the licenses of Paks are awarded for a ten-year period, from the Hungarian Atomic Energy Agency (HAEA). In 1997 the HAEA awarded Paks, units 1 and 2, its ten-year operating permit. Therefore any decision of the future life-time of the reactors and will not be made until closer to 2007.

Throughout the operating life of the Paks reactors Western firms have been involved in upgrading and training programs. These include: -

- In 1987 the Finish firm IVO completed the construction of a full scope simulator.

- In 1990, the IAEA contracted the Spanish firm Tecnoatom, to supply an inspection system for inspection of the reactor pressure vessels.
- In 1993, under the terms of a Belgian-Hungarian energy agreement technical support, worth $660 000 was given to reduce risks relating to seismic activity and for the construction of a waster storage facility.
- In September 1996 Siemens of Germany, was awarded a DM 40 million contract for the installation of new computerised instrument and control equipment, to be installed on each reactor between 1999 and 2002. This contact is part of a 60 Billion-Forint (€250 million) investment plan proposed by MVM. This program is expected to increase the output of the station by 10-15% and is aiming to fulfil EU accession requirements.

At the end of February 1999 the State owned Hungarian Power Companies (MVM Rt) announced that two smaller gas fired power plants had been chosen, in preference to an expanded Paks, for satisfying the medium term demand needs. The gas stations were a 191 MW gas fired combine cycle combustion turbine and a 110 MW co-generation plant. Paks initially put in three bids for additional nuclear capacity.

- VVER 640, to be built partly by Atomstroiexport and partly by Siemens. This bid was abandoned early on due to problems with financing.
- Westinghouse AP 600
- Candu 6, by AECL.

The later two bids were rejected, as Paks were unable to supply all the necessary answers to questions raised on the environmental impact in the time allocated. In addition the nuclear projects could not compete with the electricity price offered by the gas plants.

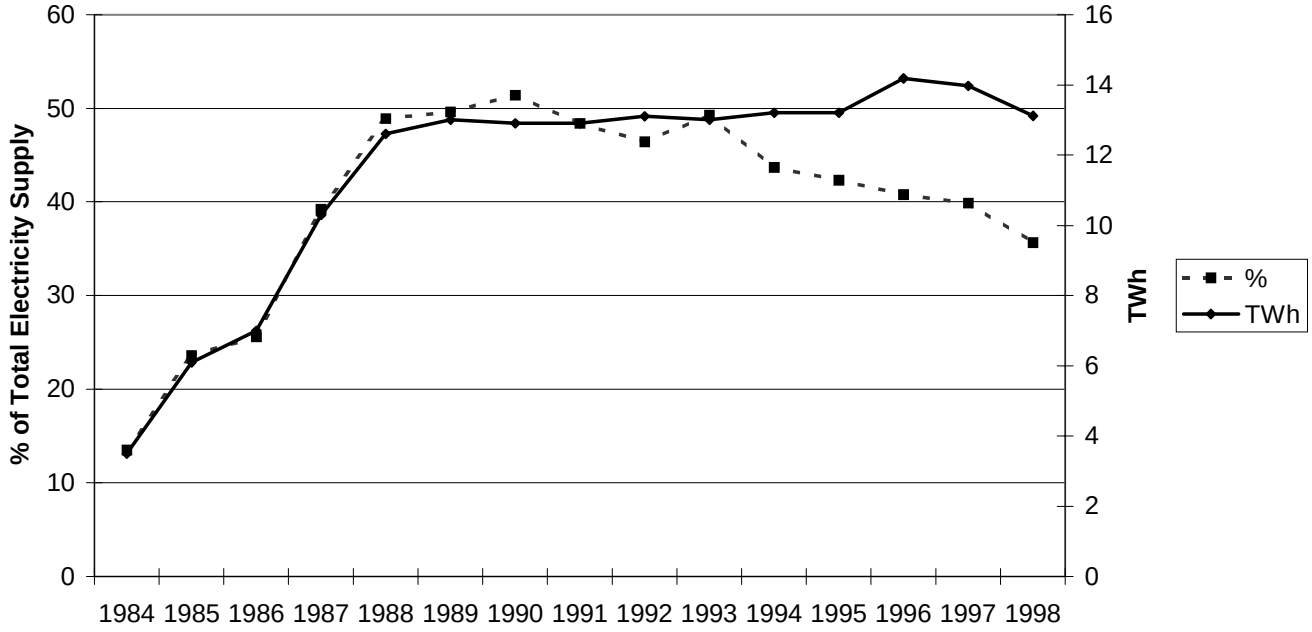
Liability: Hungary was the first country in CEE to acceded to the Vienna Convention and Joint Protocol, 28th October 1989 and March 26th 1990. Hungary signed the Protocol to Amend the Vienna Convention on 29th September 1997. The Atomic Energy Act, of 1996, which replaced that of 1980, implements these obligations on a domestic level.

The liability of the licensee is limited to 100 million SDRs for each accident at a facility and 5 million SDRs for accidents involving storage or transport of material. Nuclear damage in excess of this will be paid by the State up to a ceiling of 300 million SDRs. In 1996 a nuclear insurance pool was established which provides third party liability cover for Paks.

Nuclear Waste and Decommissioning: In 1997 the Government Decree (NR 108/1997) established a three-stage plan for the decommissioning of Paks: shutdown, preparation, and dismantling. This process is expected to take 70 years and requires a specific decommissioning license. At the beginning of 1998 a new body the Nuclear Financial Fund was established which would place a levy on each kWh of electricity from Paks. This will cover the cost arising from the final disposal of radioactive waste, the interim storage and final disposal of spent fuel and the decommissioning of facilities. As with other countries in the region the changes in Russia legislation forced Paks to construct an interim storage for its spent nuclear fuel, which was completed in 1997, at the Paks site.

Paks is generating 50% of the electricity in Hungary, as can be seen by the graph below. This is a considerable percentage of electricity coming from a single source and from a security of supply perspective is not beneficial

Figure 5.4: Development of Hungarian Nuclear Electricity Production



Source: IAEA

Nuclear and Accession:

The Accession partnership document released by the Commission in 1998 recommends the following action: -

Special attention must be given to timely implementation of nuclear safety programmes in order to bring all the nuclear reactors into line with safety objectives generally accepted in the EU. In addition, longer term solutions for nuclear waste need attention. Attention needs to be paid to the strengthening of the nuclear safety authority.

While the November 1998 accession progress report by the Commission notes: -

Nuclear safety standards should continue to be tackled appropriately, for example through the modernisation programme, in order to bring the nuclear power plant to the level required. Longer-term solutions for nuclear waste need attention and the independence of the nuclear safety authority should be ensured.

The operators are keen to promote Paks and point out that the reactors have consistently had a high standard of operation as the capacity factor for the reactors is averaging 90% (the capacity factor refers to the availability of the reactor). The WENRA report concludes that after the implementation of the planned safety improvements the plant should reach a standard similar to that of reactors of the same vintage in Western Europe. The only major shortcoming identified by WENRA is the containment system, which they claim is not as good as the leaktightness of containments in Western Europe.

While the WENRA report claims that the Paks reactors will conform to reactors of the same vintage in Western Europe, this falls short of the Council of Justice and Home Affairs Ministers that the reactors must conform to "reach a level corresponding to the technological, regulatory and operational state of the art in the Union". This highlights the need for a definitive safety standard. The Commission, as mandated by the Council of Ministers in December 1998, is currently preparing such a proposal.

LITHUANIA

Lithuania is host to the world's largest nuclear reactors, at Ignalina, where two RBMK 1500 MW are located. Initially four reactors were planned at Ignalina but only two were completed as construction of the third and fourth reactors was halted in 1989, due to public opposition and in 1993 dismantling of the structures began.

Table 5.5: Lithuanian Operating Reactors.

Reactor	**Design Type**	**Start Construction**	**Date of Commercial Operation**
Ignalina 1	RBMK 1500	1977	1983
Ignalina 2	RBMK 1500	1978	1987

Source: Nuclear Engineering International.

Ignalina was built as a regional reactor in the time of the Soviet Union and was largely operated and controlled by Russian. Following the political changes throughout the region Lithuania assumed ownership of the reactors on 27th August 1991. The reactors still export significant quantities of electricity to Belarus, Latvia

and Russia and also supply nearly 80% of the Lithuania's electricity. In 1993, the reactors contributed nearly 90% of the country electricity, the highest share of nuclear electricity ever recorded in a country. This peak in domestic consumption correlated to a decrease in electricity export for political and financial – lack of payment – reasons. As with other RBMKs there are concerns over the safety of reactors and Ignalina has been the focus of international pressure to seek early closure and additional safety measures.

Nuclear Safety Account.

In February 1994, Ignalina became the second reactor site to receive funding from the NSA, when an agreement for an ECU 35 million project was signed. The project involved the introduction of a number of short-term safety upgrades in the following areas: -

- New reactor trip signals.
- Fire protection devices.
- A training simulator.
- Environmental monitoring equipment.

In addition the agreement required that an in-depth safety assessment of both units be prepared under the supervision the Lithuanian nuclear regulator (VATESI). Although the safety report was the responsibility of the Ignalina station it was undertaken with the support of Eastern and Western Experts and was intended to be comparable to a Safety Analysis Report (SAR) which is produced in Western countries as part of the licensing process. The main elements of the report are included in the side box.

The parties also agreed that the lifetime of the Ignalina units would not be extended by the replacement of the fuel channels, at the time of the agreement it was expected that unit 1 would be closed prior to 2004 and unit 2 about five years later.

In order to facilitate the closure of the reactors it was agreed that the Lithuanian Government and the Ignalina Power Station would prepare a detailed programme for the rehabilitation of the power sector and for demand side management. The Agreement also called upon the Lithuanian Government to "make their best efforts to implement" the rehabilitation program to enable unit 1 to be closed by 2004.

Finally, the agreement called for the closure of Unit 1 by 30th June 1998, unless: -

a) The Lithuanian regulator, taking into account the recommendations of the panel of experts, agrees that the operation of the unit would be safe.

b) The level of electricity demand justifies investing in upgrades identified in the safety review on a least cost basis.

The main conclusions of the Panel of Experts were: -

1. Safety management and safety culture at the plant is in the early stage of emergence from the Soviet situation into a very different situation based more on Western practice. This is being assisted by Western organisations but is only progressing slowly. Maximum benefit is not being gained from operational experience, either from INPP (Ignalina Nuclear Power Plant) or from other plants. Plant configuration control is inadequate. …The management does not appear to encourage and promote an adequate safety culture.
2. Post-Chernobyl modifications made to the reactor have reduced the void coefficient to the point that there is no longer a significant power pulse during accidents caused by break of large pipe-work. This combined with relatively slow de-pressurisation rates means that the existing shutdown system is fast enough to cope with all design basis accidents.
3. The existing control and protection system (CPS) is structured in a way which makes complete separation of the control and protection functions impossible. Furthermore instrumentation associated with the CPS does not meet accepted requirements for segregation.
4. There is not an adequate demonstration that the reactor coolant circuit has been built and maintained to ensure high levels of integrity.
5. Apart from in the CPS, for which some uncertainty still exists, there were no single failures identified in the primary safety systems which would prohibit their functioning. Many of the safety support systems are, however, susceptible to single failures but none have been identified that would invalidate the overall safety function. Improvements in fire detection systems, fire cell separation and creation of separate fire compartments for safety and safety related systems are needed.
6. Several required design and procedural modifications have been accepted by INPP relating to: additional reactor trips, early initiation of the emergency core cooling system (ECCS) for all breaks, improved diversity in ECCS initiation logic, pressure relief in the steam compartments and in the reactor hall, drainage of radioactive pools in areas outside confinement, reduction in the number of allowable pre-existing fuel failures, and enhanced operator instructions and training for control of long term emergency cooling.
7. The lack of Western style containment at INPP is somewhat offset by the results for design basis accidents which show that all LOCAs (loss of coolant accident) where significant fuel failures could occur from fuel over-heating are located within confinement. However, the structural integrity of the confinement in accident conditions is not demonstrated and the leaktightness of unit 1 is poor.
8. The venting capacity of the reactor cavity is limited, even though it has been recently improved. Multiple pressure tube rupture (MPTR) can cause severe consequences if the venting capacity is exceeded. Any general fuel temperature excursion while at high pressure has the potential to rupture fuel channels. The probability of MPTR is low but needs to be further reduced by several of the improvements currently being instituted (trip on low flow in multiple fuel channels, automatic trip on low operational reactivity margin).
9. The time of contact between the pressure tubes and the graphite moderator has been estimated to occur between 1999 and 2002 for Unit 1 but the actual time of closure can only reliably be determined from measurement. Programmes are currently underway at INPP to measure the diameters of the channels and new equipment is under development to measure the channel to graphite gap from within the channel. Operation with contact is not shown to be safe and this has been accepted by INPP as a life-limiting phenomenon.
10. An indicative estimate of the cost of the modifications proposed in the SAR, and priorities for undertaking these modifications have been established and are estimated at about 120 Million US $ for both units including the full scale simulator. In addition about 125 person-years of operating staff will be required to implement all of the operational procedure and practices recommendations.

11. The fundamental design of this reactor relies on the operator to undertake essential safety actions and correct action is heavily dependent on the operators memorizing the required actions. Operator training needs to make more use of written procedures and simulators.

It was said that at the time this was the most comprehensive review of an RBMK reactor ever undertaken. The Project Management Unit for the NSA has now left the site at Ignalina as the project is very close to completion. The only part of the project still to be completed is the installation of a radiation monitoring systems in Belarus. Everything is expected to be completed by September 1999.

Within the NSA agreement, the re-licensing of Unit 1was supposed to be done by June 30th 1998, but was delayed until 17th May 1999 due to the technical assessment report taking a year longer than expected. In order to re-license the project VATESI, must take into account the recommendations of the Ignalina Safety Panel, and must be confident that the 73 proposed changes have been implemented. It was estimated that these changes, for both units would cost $120 million.

On the 7th May the Nuclear Safety Advisory Committee, established to assist VATESI met to discuss the progress made by the Ignalina operator in implementing the recommendations of the Safety Panel. The Committee stated that the operator had managed implement the majority of the changes necessary. However, the Committee drew attention to 38 outstanding safety issues that need to be resolved. VATESI stated that the re-licensing could not occur until all of these issues would have to be resolved prior to restart. These issues included: -

- Increase reliability of Scram function.
- Automatic reactor scram and Emergency Core Cooling System actuation for steam line breaks.
- Reactor Hall over-pressure protection.
- Detailed procedure for review of plant changes.
- Evaluation of plant under degraded voltage/frequency conditions.
- Fire hazard analysis.
- Justification of omission of shutdown accident assessment.
- Documentary justification for accidents initiated by equipment failure.
- Stresses on adjacent tubes in single pressure tube rupture.
- Revised administrative procedures to tighten requirements for providing harsh/mild environment boundaries.

Unit 2 was shutdown and stopped generating electricity in April and consequently after the 20th May, when unit 1 was finally shut, Ignalina was producing no electricity. This was only the second time since 1992 that neither of the reactors was in operation. Unit 2 was reconnected to the grid on June 14th, two weeks ahead of schedule.

Despite most of the attention being focused on Unit 1 there are pressing issues surrounding Unit 2 that still have to be resolved. Within the NSA agreement is the requirement of the installation of a secondary shutdown system for unit 2. To date, no decision has been taken on when and if this will be installed, despite pressure from the NSA and other interested international parties.

Gap Closures.

The NSA agreement clearly states that the reactors may not be re-channelled, which involves the replacing of the fuel channels and the re-aligning of the graphite moderator. This has shown to be necessary after about 10-20 years operation (depending of the power output of the reactors) and is due to neutrons distorting the fuel channel and graphite blocks. This is an expensive ($100 million/reactors), lengthy (18 months) and dirty (high workers doses) process, but it significantly increases the life of the reactor – by 10-20 years. Re-channelling has occurred at two of the four RBMK reactors at Sosnovy Bor in Russia. The ease of re-channelling is very dependent on how close the tubes are to gap closure. If the reactor is operated up until the last moment before gap closure occurs it is difficult to remove and replace the channels.

The key safety implications of Gap closure are: -

1) It will destabilise the reactors core
2) It cannot be detected while the reactors is operational and involves physical inspections.
3) Once gap closure occurs in one fuel channel others will quickly follow, the number closing each year is expected to increase exponentially.
4) If operation continues with gap closure it will lead to the bursting of a fuel channel. This leads to massive destabilisation of the core and if multiple fuel ruptures occur (between 3-10 out of over 1500 fuel channels) it will lead to a beyond design based accident. Given the lack of a secondary containment in RBMKs this will probably lead to significant off-site release.

The latest analysis of unit 1 at Ignalina undertaken by national and international bodies suggest that regulatory action (i.e. closure of unit 1) should occur in two to three years, dating from the Summer of 1998. Further analysis will be undertaken in mid 2000 when about 100 fuel channels will be removed for analysis. The assessing of this data will take a number of months and thus no decision may be taken until when the third quarter of 2000, when it is theoretically possible that gap closure will have already begun.

Economics:

The EU has established a working group with the Lithuanian Government to try and reach consensus on the costs and mechanisms for closing Ignalina. A report prepared by the Swedish consultancy Grufan Reje for the

Swedish international Project of Nuclear Safety (SIP) and the Lithuanian Government "A Study of the Cost of Closure of Ignalina Nuclear Power Plant in Lithuania, defined", concluded that the cost of premature closure of the power plant would be USD 3.3-3.9 billion. This analysis assumes closure of unit 1 in 2005 and unit 2 in 2010. Underlying this calculation is the assumption that due to the connection of the Baltic ring prices in Lithuania for electricity will reach European market levels, this represents a doubling in real terms of the electricity prices in Lithuania today. Although the reports conclusions are not universally accepted, it does highlight the high social cost associated with closure.

Loans for Ignalina

Ignalina, despite it's near term closure objectives has received a number of loans from international financial institutions:

- US bank "The Bank of New York" gave a loan of USD 9.992 million. The loan was insured by US Ex-Im bank and will be used to modernise the information system and to replace the old Soviet system "Titan" by US made equipment produced by DEC (Digital Equipment Corporation Inc.) and CPI (Computer Product Inc.). SAIC (Scientific Application International Corporation) prepared the project for system replacement.
- German bank "Kredit fur Wiederfbau" gave a credit of 7.99 million DM for purchase of CASTOR containers for spent nuclear fuel. Another German bank "Vereins und Westbank, AG" gave a loan of USD 30 million for the purchase of nuclear fuel in 1993. The loan was fully paid back in 1994.
- Ignalina also received a loan of 1.27 million USD from State guaranteed loans to the International Monetary Fund (IMF).

Electricity Export.

As has been stated Ignalina was built as a regional reactor and its capacity is too large for purely domestic consumption in Lithuania. Consequently, even today a large percentage of the reactors are used for export, about 70% of one unit. This electricity is sent to Belarus, the Baltic States and Russia. However, cash payments for the electricity export is low, either because of non-payment or because the contracts involve barter. In the case of Belarus, part of its electricity payments ($32 million worth of electricity in 1999) are met by the Russian supply of fuel to Ignalina. Thus the operator and Lithuanian Government is keen to export electricity to other countries, in particular to Western Europe to increase the cash payment and price for the electricity.

Consequently, in February 1998, the Lithuanian Ministry of Economy placed a tender announcement in the national and international press for bids to finance and construct an electricity inter-connector for the Lithuanian and Polish grids (and given the full interconnection between Poland and Western Europe, directly

into the UCPTE network). The Lithuanian Government guaranteed that a minimum of 6 TWh of electricity would be available for export for ten years. The tender was awarded to Power Bridge, but in March 1999 the Lithuanian energy utility indicated that they were dissatisfied with the developments so far and appeared to open negotiations with other interested parties. Once complete this connection will become part of the Baltic Ring, which is hoped to eventually fully interconnect all countries that surround the Baltic Sea. There is already significant electricity being exchanged between Sweden, Finland and Norway, this exchange in conjunction with liberalised electricity markets and a surplus of generating capacity is resulting in falling electricity prices. One consequence already seen is that the average prices on the Nord Pool spot market are lower than the production costs at most Swedish nuclear power plants. The introduction of Ignalina into the Baltic ring is likely to further reduce prices regional prices, but lead to an increase within Lithuania.

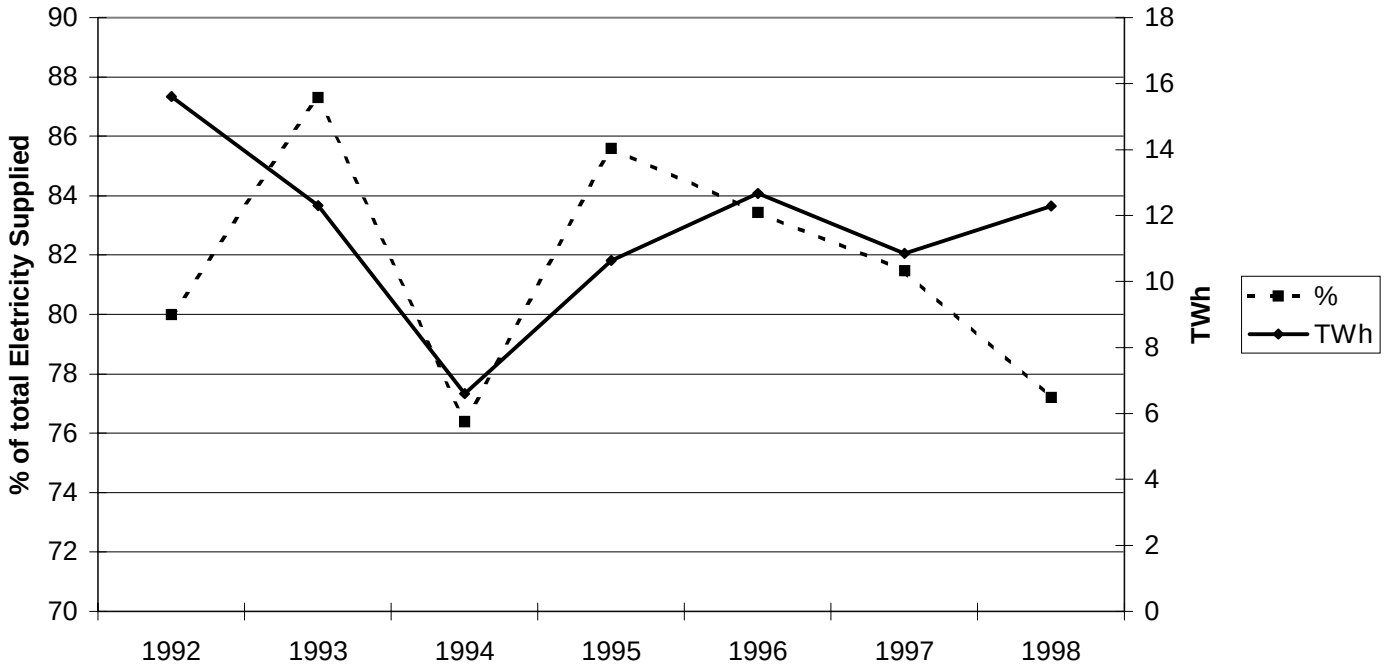
Liability: On November 14th 1996 Lithuania embraced the Law on Nuclear Energy which adopts the principles of the Vienna Convention. Lithuania acceded to the Vienna Convention on 15th September, which entered into force on 15th December 1992. Lithuania has also acceded to the Joint Protocol on 20th September 1993, which entered into force on 20th December 1993 and also signed the Protocol to Amend the Vienna Convention on 30th September 1997.

Nuclear Waste and Decommissioning: The nuclear Inspectorate (VATESI) is responsible for issuing the required decommissioning license. A decommissioning plan is required 5 years before the start of decommissioning of a nuclear power plant. In 1995 the Government established a decommissioning fund for Ignalina, which initially received 16% of the profits from the sale of electricity, however, this was reduced in 1996 to 4%, but was set to rise in 1999 to 6%.

Construction of an interim storage facility for spent nuclear fuel is currently underway using Canadian containers. Initially the contract was awarded to GNB from Germany who delivered a number of castor casks, but their contract was subsequently cancelled and replaced by AECL from Canada.

The graph below shows the uniquely high percentage of nuclear electricity within the Lithuanian.

Figure 5.5: Development of Lithuanian Nuclear Electricity Production



Source IAEA

Nuclear and Accession:

The Accession partnership document released by the Commission in 1998 recommends the following action: -

"Efforts are needed to prepare a comprehensive, long term energy strategy and to include provisions for spent fuel handling and decommissioning of INPP in the electricity tariff structure. A realistic plant decommissioning and closure plan for INPP, including longer term solutions for waste, needs to be prepared"

While the November 1998 accession progress report by the Commission notes: -

"According to the NSA requirements, Unit 1 of Ignalina Nuclear Power Plant should be closed unless the National Safety Authority confirms that continued operation would be safe and that the level of electricity demand justifies investment in upgrades identified through a safety assessment, on a least cost basis. The lifetime of Unit 1 and 2 should not be extended beyond the time at which their fuel channels should be replaced (i.e. in the very near future for Unit 1 and a few years later for Unit 2). The time limit for the issuance of a long term license for Ignalina Unit 1 by the Safety Authority has been extended by the NSA Assembly of Contributors

from June 1998 to 17 May 1999. The Commission has repeatedly made clear its opposition to rechannelling Unit 1 which would be contrary to Lithuania's NSA obligations. The Assembly of NSA contributors meeting in London on 7 October also felt that the Nuclear Safety Advisory Committee of Lithuania must"

The closure of Ignalina is a highly charged political issue for Lithuania and the European Union and in many ways is the test case for the closure of high risk reactors within the framework of accession, for a number of reasons: -

- The reactors are the same design as Chernobyl and therefore have the potential for widespread contamination in the event of a beyond design based accident, due to the presence of graphite, a flammable material in the reactor core.
- The international agreement with the NSA requires that re-channelling of the reactors does not take place. This is not dependent on other trigger projects, as in the NSA agreement with Kozloduy, and thus there is less movement for manoeuvring than in Bulgaria.
- The need for the re-channelling of unit 1 appears to be imminent, possibly as early as in 2000.
- Lithuania is keen to join Estonia within the first wave countries and thus needs to comply with the Community Acquis as quickly as possible.

In February 1999 EU officials told the Lithuanian Economy Ministers that if Lithuania does not close Ignalina by 2005 then Lithuanian couldn't begin negotiations to join the European Union. At the same time the Lithuanian Government presented to its Parliament (the Seimas) its long awaited energy strategy, which includes two possible scenarios for the future of Ignalina.

- The first would see the reactors not re-channelled and therefore closed in the near future (unit 1 probably by 2002 and unit 2 by 2007).
- The second would see both units re-channelled, and the NSA agreement broken, and thus operated for another 15-20 years.

The Parliament returned the Energy Strategy to the Government, in April 1999, asking that Government make some improvement. Reports from Lithuania suggest that the Government is expected to agree to the decommissioning of the first unit, by 2005, while deferring any decision of the second unit until a later date.

In April, the first meeting of the EU-Lithuanian working group established to discuss the future of Ignalina took place. The group was headed jointly by Lithuania's deputy economics minister Viktoroas Valentukevicius and Jean Trestour from the Commission's DG1A. It is reported that Trestour called for the Lithuanian Government to make a decision on closure of unit 1 before the end of 1999. The working group is designed to form

common opinions on the expected cost of closure of the reactors as well identify the replacement capacity needs and their potential financial sources.

As part of the negotiations an Energy Strategy Task Force was formed, led by Professor Vilemans, the Director of the Lithuanian Energy Institute. This task force prepared a report that looked at the effect of closure of Ignalina and made some unexpected conclusions.

On the question of export of electricity to the West, they concluded that the construction of a High Voltage link was not economically justified. The report claims that Lithuania has offered electricity from Ignalina at 2.5 USc/kwh. The additional cost of the HV linkage is 0.7 USc/kwh. Therefore, the cost to the Polish boarder is 3.2, which is only marginally cheaper than the current price in Poland of 3.6 USc/kwh. In addition, the paper reports that supplies from Scandinavia to Poland could be made for 2.1Usc/kwh.

For decommissioning, the paper notes that the cost will be around 13 billion Litas (Euro 3.3 billion) over a 80 to 150 year period. So far 100 million Litas have been collected. Therefore the Task Force recommends that only the ongoing costs of spent fuel storage and disposal are collected by the power station and that the historical waste should be treated as pollution and an international clean-up fund be created and invested to pay for decommissioning when necessary.

The paper also concludes that the expected remaining life for Unit 1 is one year at full load from October 1998, which is much earlier than other papers. The Task Force recommend that the Government approve the latest draft of the National Energy Strategy, which includes only one scenario for Ignalina that where unit 1 complies with the NSA. Furthermore, the Government should initiate negotiations with the international community over financing and decommissioning of unit 1.

ROMANIA

Romania has one operational reactor, a Canadian Candu 700, which was completed in 1996. Construction was started in 1980 and suffered from delays, in particular due to lack of funds.

The Canadian industry and Government have been negotiating with their Romanian counterparts the sale and construction of a Candu reactor for nearly three decades. Serious developments first occurred in November 1977 with the signing of a licensing agreement between Atomic Energy of Canada Limited (AECL) and Romanergo. This gave the design license to the Romania and allowed, for a fee of $5 million per reactor, their

construction. In 1978 the engineering and procurement agreements were initiated. At this stage it was proposed that the first reactor would cost around $800 million, with $100 million targeted towards Canadian firms.

In April 1979 a financing agreement was signed, with the Canadian Export Development Corporation (EDC) loaning $680 million and a consortium of bank a further $320 million. This financial agreement was for four reactors, but detailed agreements were signed for only one. In June 1982, the EDC stopped further disbursements of the loan. Throughout the 1980s AECL continued to have a small presence on site and allegations of forced labour and poor working conditions continued to plague the construction.

In 1991 the Canadian Government announced the formation of a new consortium between AECL and Ansaldo of Italy to rescue the first reactor. This involved a loan of $315 million through the EDC and $150 million from the Italian financial institutions of Medio Credito Centrale. In this second phase of construction, much of the original equipment had to replaced. It is reported that up to 25% of the original welds were replaced at a great cost of time and money.

Delays continued to trouble the plant and in March 1995 the Industry Minister sacked the head of RENEL – the State power company – and the entire Board of Director due to delays in commissioning of Cernavoda. The revised schedule envisaged the reactor would go on line in December 1994. Some estimates suggest that the delays cost as much as $12.5 million/month.

In February 1995 about 100 tonnes of natural uranium form the Canadian firm Zircotec arrived at the Black Sea port of Constanta. The reactor requires 500 tonnes of heavy water, 350 t leased from Canada and 150 tonnes from a production facility in the South of Romania at Halanga. This facility was the site of a massive explosion in 1994 that killed seven people. In September 1995 a second unit, with a capacity of 90 tonnes/year was introduced.

The loading of unit 1 began in May 1995, but more technical problems continued to delay the final criticality which was not reached until on 12th April 1996, two years later than planned. The plant was officially opened a week later by the Canadian Prime Minister. It is thought that the reactor cost up to $2.2 billion when finally completed in 1996.

Initially it was proposed that four[23] reactors would be built at Cernavoda. However, it now appears that this has been scaled back and concrete plans are only being implemented on unit 2. Estimates vary as to the current status of completion of the reactor, from 20-40%. It is estimated that the project will cost a further US$ 750 million. In April 1998 a consortium headed by Atomic Energy of Canada Limited (AECL) with ANSALDO – a division of the Italian company Finmeccanica - was awarded a $200 million contract. The contact is to be financed by RENEL, bank loans and loans from export credit agencies.

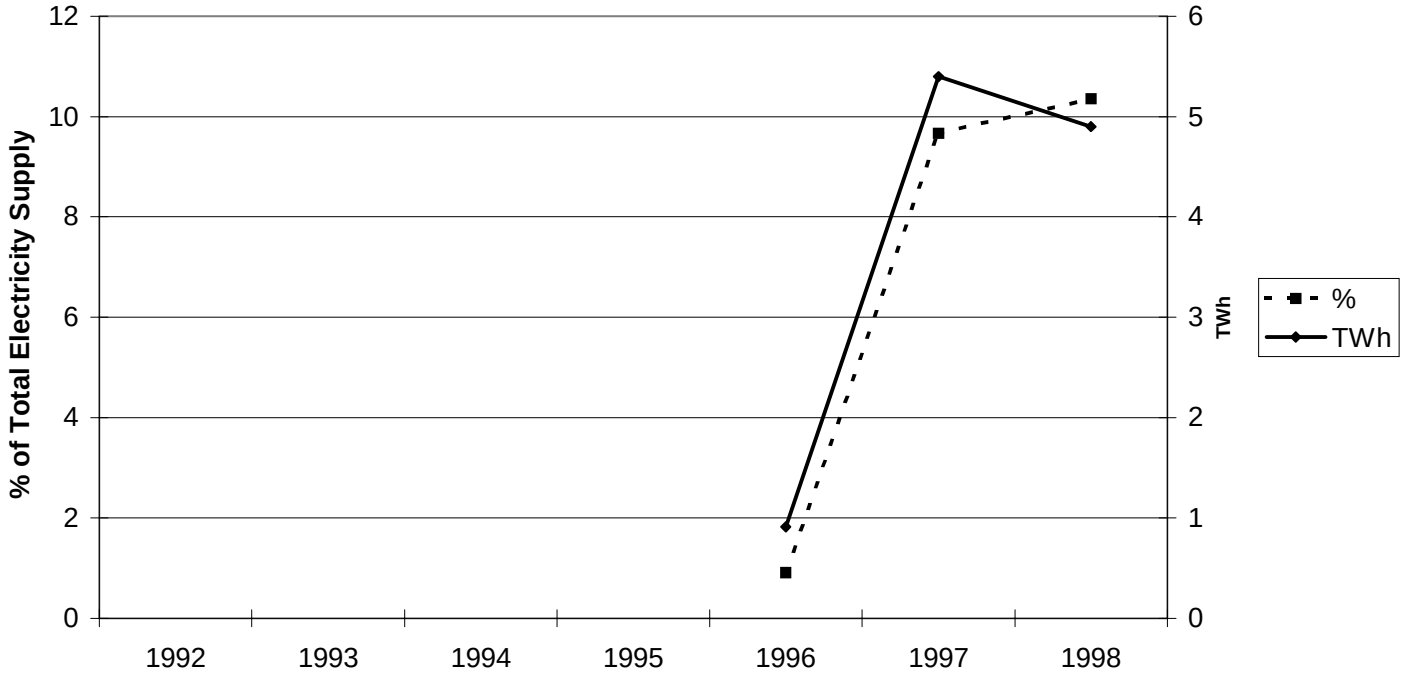
Liability: The 10th October 1996 Law on the Safety Conduct of Nuclear Activities does not cover third party liability in a detailed manner as the Government intends to introduce a draft Law on Civil Liability for Nuclear Damage. The 1991 Constitution provides that international treaties to which Romania is party to become part of Romanian Law. Romania acceded to the Vienna Convention and Joint Protocols on 29th December 1992 and they entered into force on 29th March 1993. Romania also signed the 1997 Protocol to Amend the Vienna Convention on 30th September 1997.

Nuclear Waste and Decommissioning: The National Commission for Nuclear Activities Control is responsible for the development of policy and the regulation of decommissioning. There is currently no specific decommissioning policy for nuclear facilities, but it said that one would be issued in the near future. At Cernavoda there is an interim storage facility for low and medium level radioactive wastes. The current proposal for spent fuel is that it will remain on site for ten years, but after this there are currently no firm plans. The contract with the AECL does not include final storage of spent fuel and thus Romania will have to independently develop proposals. Currently, analysis is being undertaken to assess the viability of both interim and final disposal facilities.

The figure below shows the development of electricity from Cernavoda since its start-up in 1996.

[23] The is some disagreement in the literature as to the number of reactors originally proposed at Cernavoda, some say four and others five reactors.

Figure 5.6: Development of Romanian Nuclear Electricity Production



Source: IAEA

Nuclear and Accession:

Compared to other reactors in the region Cernavoda is given a low priority. This is because it is the same reactor is licensed in Western countries and because Western firms were involved in its construction and thus it is said to reach International standards. The relatively low priority that this reactor is given is reflected in the partnership document and Accession progress reports. The Accession partnership document released by the Commission in 1998 recommends the following action: -

Special attention must be paid to energy efficiency and environmental norms. Nuclear safety standards, in particular those related to plant operation should be handled appropriately. The independence of the safety authority should be supported. Longer-term solutions for the storage of waste need to be found. There is a need to develop an overall energy policy

While the November 1998 accession progress report by the Commission notes: -

Unit 1 of the Cernavoda nuclear power plant (built with Western technology) is now in operation providing 8 % of the country's power. A decision regarding financing for Unit 2 is expected at the end of 1998. The nuclear sector is considered a national priority, and studies have shown that this is the least-cost option for power supply. In the long-term, 5 units are consequently planned at the Cernavoda site. Domestic uranium production was sufficient for local needs in 1997.

The newly-established energy regulatory authority and Nuclear Safety Authority which needs to develop a safety culture should be given the means to function properly and the Agency for Radwaste Management should be set up.

WENRA confirm that the Candu reactors at Cernavoda are similar to those operational in Canada and that the plant was designed and constructed under the responsibility of a Western consortium. However, they highlight the current financial problems affecting the Cernavoda utility and note that if these problems are not overcome it may have a detrimental impact on the safety of the reactors.

SLOVAKIA:

Slovakia has two nuclear power plants, Jaslovske Bohunice and Mochovce. Bohunice has four operating nuclear reactors and Mochovce one operating and one under-construction (due to be completed in September 1999).

Table 5.7: Reactors in Slovakia.

Reactor	Type	Start Construction	Date of Commercial Operation
Bohunice V1–1	VVER 440-230	1972	1978
Bohunice V1-2	VVER 440-230	1972	1980
Bohunice V2-1	VVER 440-213	1976	1984
Bohunice V2-2	VVER 440-213	1976	1985
Mochovce 1	VVER 440-213	1984	1998
Mochovce 2	VVER 440-213	1984	Expected 1999

Source: Nuclear Engineering International/NUSAC News

Bohunice:

Outside of Russia, Bohunice was the first nuclear power plant within Eastern Europe and the NIS. In 1958 construction started on the A-1 reactor. This was a gas cooled heavy water reactor that began commercial operation in 1972, but was closed in 1977 following a partial meltdown of the core. The plant is still awaiting decommissioning.

The V-1 reactors have a nominal design life of 25 years and were expected to close in 2003 and 2005. These reactor designs are classified as first generation and as such are targeted for early closure by the International community. As part of the agreements for the proposed funding for the completion of the Mochovce nuclear power plant, see below for further details, the Slovakian Government signed a resolution on the 14th May 1994 which committed Slovakia to closing V1 as soon as Mochovce entered commercial operation, or by the year 2000 at the earliest.

This agreement was made in 1994 in order to fulfil the requirements of the EBRD, whose energy policy states that the Bank can only fund nuclear projects "provided that they are directly linked with the closure of high-risk reactors operating in the country concerned". Eventually, the Slovakian Government pulled back from the funding and construction consortium involving the EBRD in part because of the conditionality of V-1 closure. However, the second funding and construction consortium for Mochovce although largely lead by Czech and Slovakian companies and Banks still involved Western partners from France and Germany. The German Government, that awarded a credit guarantee to cover Siemens involvement, insisted that the same binding commitments of Bohunice V1 closure existed.

Despite this in April 1999 the Government formerly announced that the 2000 closure deadline had been abandoned and that the reactors would operate as long as they were safe and no alternative plan for closure had been drawn up. The Government also argued that an increase in electricity demand in Slovakia made the closure of the reactors impossible. The Slovakian authorities believe that the extensive retrofitting program undertaken removed the need for early closure.

Between 1991-3 V-1 was subject to what has been called a small backfitting program. This involved the implementation of 81 safety measures and cost around 2 billion Slovak Koruna – Sk -(45 million Euro). The safety measures included; ensuring confinement tightness; anti-seismic resistance; reactor pressure vessel integrity; emergency power supply; fire hazard reduction etc. These measures were implemented to enable operation until 1995.

The Slovak Nuclear Regulatory Authority (UJD) issued two resolutions in 1994 regarding the pre-conditions for operation of V1 after 1995 until the end of their design lives. These resolutions pointed to 59 measures that needed to be implemented, 37 required analysis or assessment and the remaining 22 required major hardware modifications. On April 27th 1996 the operator of Bohunice, Slovenské Elektrárne (SE) signed a contract for further upgrading V1 with a consortium called REKON. This consortium consists of Slovakian and foreign firms including the Slovakian Nuclear Power Plant Research Institute, Inc. Travana and Siemens of Germany. REKON were awarded a contract of 5.5 billion Sk, (122 million Euro), with the total upgrading program costing 6.4 billion Sk (143 million Euro). This program is to be undertaken during extended refuelling outages between 1996-9.

The objective of this so-called "gradual reconstruction" is defined as "to achieve an internationally acceptable safety level with respect to Bohunice V-1 units and to create technical conditions for their operation throughout their planned life cycle". The areas targeted in this upgrading program are: -

- Primary circuit integrity upgrade
- Confinement integrity improvement
- Control and monitoring system upgrade
- Strength improvement of the burst can structures to withstand overpressure during a loss of coolant accident in two pipes of over 500 mm.

According to the UJD, in their submission to the International Nuclear Safety Convention Secretariat, after the gradual reconstruction the probabilistic assessment for the core damage frequency is expected to decrease from 1.7×10^{-3} to 5.39×10^{-5} a 31-fold decrease.

The Bohunice V2 reactors were originally expected to operate until 2014 and 2015, but are now being considered for a ten-year life extension. According to the UJD an upgrading program is currently being implemented at V2. The first stage 1997-2000 is described as short-term measures. The second stage 2000-6 is to ensure that the plant resolves all safety problems on level II and III of the IAEA's extrabudgetary program on the safety of VVER reactors. This second stage will also undertake measures for the potential life extension and increase in output from the reactors.

Mochovce:

The Mochovce nuclear power plant is located 120 Km from Bratislava, in Southern Slovakia. Construction started in 1984 but was gradually stopped in 1990 due to a lack of funds, at which time there were four reactors under-construction. It is difficult to accurately assess what stage of completion the reactors were at that time as it is open to interpretation, however the EBRD stated that Unit 1 – 90% complete; Unit 2 – 80% complete; Unit 3 – 50% completion; Unit 4- 40% complete – all to the original design standards.

In 1991 the Czechoslovakian Government asked the EBRD to consider funding the completion of units 1 and 2 and in 1993 following the split with the Czech Republic, the new Slovak Government confirmed this request. In 1992 Electricité de France (EdF) began an extensive audit of the existing plant infrastructure and equipment with SE. Bayernwerk AG, also became involved in the project and the two Western organisations proposed that they provide funds, expertise and a completion guarantee to complete Mochovce to international safety standards.

In May 1994 the project sponsors made a formal request to the EBRD and one of the potential co-funders Euratom consider financing the completion of units 1 and 2. The project sponsor were to be company called EMO a.s., which was jointly owned by SE and EdF. EdF had control over the company with 51% of shares; it

was proposed that EMO might later also include the Russian Ministry of Atomic Energy (MINATOM) and Bayernwerk. EMO would repay the loan by leasing the plants to SE once the project was complete. A turnkey contract was to be signed with EdF/Slovelec, a 100% EdF affiliate established under Slovak Law. EdF/Slovelec as the prime contractor would deal with the sub-contractors, including a consortium formed by Framatom, Siemens and Skoda Praha. The estimated cost of this project was some 1.4 billion-DM, as can be seen below.

Table 5.8: Initial Costs for the Proposal for the Completion of Mochovce.		
Item	Amount	Percentage
Safety Improvements	347.6	23.9
Electro-mechanical completion	266.5	18.4
Civil works	78	5.4
Waste treatment	45.3	3.1
Site protection	32.7	2.3
Pre-service inspection	14.7	1.0
Design and management	210.7	14.5
Various	29.5	2.0
Construction Contract	1025	70.6
Pre-operating Costs	38.6	2.7
Insurance	26.6	1.8
Development Costs	92.7	6.4
Interest during construction	221.2	15.2
Loan fees	48.0	3.3
Total Costs	1452.1	100
Source: EBRD		

The funding for the project was expected to come from a variety of national and international sources as can be seen below.

Table 5.9: Proposed Financial Consortium for Initial Mochovce Completion Project		
Finance Source	Amount	Percentage
EBRD	412.5	28.4
Euratom	366.3	25.2
Export Credit, France (Coface)	188.0	13.0
Export Credit, Germany (Hermes)	93.5	6.4
EdF International Senior Debt	91.7	6.3
Bayernwerk Subordinate Debt	91.7	6.3
EdFI subordinate Debt	58.3	4.0
EdFi Quai-equity	91.7	6.3
Lease Payments	57.5	4.0
Total	1451.2	100
Source: EBRD		

The project passed initial review in the EBRD in June 1994. This lead to the beginning of one of the largest public consultation processes undertaken in Europe, which finished in February 1995 and included: -

- A petition signed by 1.3 million people opposing the project.
- 200 technical critiques of the project.
- 8 000 letter opposing the project.
- 105 pressure groups from 14 countries registered their opposition.

Despite the opposition from outside and inside the Bank, the Board of Directors was scheduled to discuss and vote on the project in March 1995. A number of countries, lead by Austria, were likely to vote against the project but despite this the project was expected to receive overall approval as no G7 country was opposing it and the majority of EU countries were supportive. However, a week before the Board discussion the Slovakian Government asked for the project to be suspended. The project was formerly withdrawn from the Bank on the 5th September 1996. The Slovakian Government removed the project because it claimed that it found the conditions that the EBRD and other Western funders were placing upon them "unacceptable". These conditions included.

- The closure of Bohunice V-1 by 2000.
- The overall project cost of 1.4 billion DM.
- The rapid increase in electricity tariffs, needed to repay the loan.

Towards the end of 1995 a second set of financial and construction consortium were prepared which were to eventually complete Mochovce. The new consortium was said to be able to complete the project for 1 billion DM, 30% less than the previous model. The main financiers for Mochovce were: -

- Two Slovakian Banking consortium including VUB (6.3 billion crowns) and Slovenska Sporitelna, ($95 million).
- Czech Banks, Komercini Banka ($200 million) and Ceska Sporitelna (100 million DM)
- German credits from Kreditanstalt fuer Wideraufbau, (130 million DM)
- French Bank Societe Generale (64 million DM)
- Russian credits of $150 million for nuclear fuel and upgrading documentation.

The general contractor for the project completion is Czech Skoda with Siemens and Framatom delivering safety equipment. EdF also became involved in June 1996 when they signed a technical assistance and co-operation agreement with Mochovce.

In April 1998 the first fuel was loaded into unit 1 of Mochovce. SE claimed that the safety standard of the reactor was based on analyses from the IAEA and the IPSN/GRS (French and German Regulators) joint venture Riskaudit and that 70% of the measures recommended had been implemented. The Slovak Prime Minister Vladimir Meciar met with Austrian Chancellor Viktor Klima and gave an assurance that an international team of risk specialists, lead by Dr Wolfgang Kromp, would be able to conduct a detailed assessment of the plant prior to start-up.

In May representatives of the French and German regulators made public their analysis of the Mochovce safety level. They concluded that Mochovce was at least at the level of the Hungarian reactors at Paks, if not above. However, Dr Kromp came to different conclusions, claiming that the reactor should not be started until serious doubts about embrittlement of the reactor pressure vessel had been cleared up. As a result the Austrian Chancellor warned Slovakia that its chances of joining the European Union would be in jeopardy should Mochovce be started. While Austrian's Foreign Minister met with EC President Jacques Santer to ask for EU intervention. In addition the European Parliament passed a resolution which called for a suspension of the start-up procedure.

Despite the opposition from Environmental groups and neighbouring Austria the first Unit went critical 9th June and was connected to the grid in July. The second unit was initially scheduled for completion in April 1999, but has been delayed until October. In November 1998 Economy Minister Ludovit Cernak said after visiting Mochovce that the third and fourth reactors of the Mochovce would not be completed.

Liability: The former Czechoslovakia did not have legislation dealing specifically with nuclear third party liability, but the Civil Code applied to especially dangerous activities. This legislation is still applicable in Slovakia. The Slovak Republic acceded to Vienna Convention and Joint Protocols on the 7th March 1995; they entered into force on 7th June 1995.

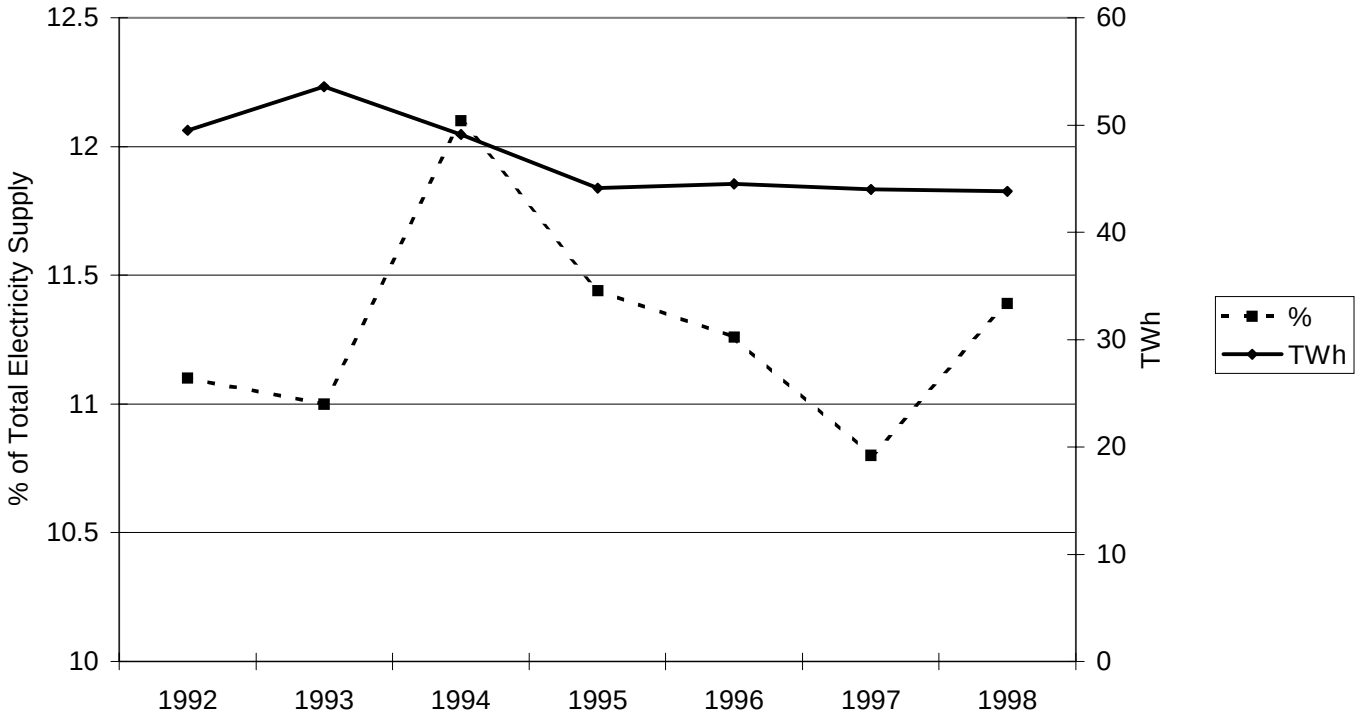
Nuclear Waste and Decommissioning: The Nuclear Regulatory Authority is responsible for overseeing the decommissioning. The new Atomic Energy act will require a number of changes in decommissioning policy, including: -

- The granting of a special decommissioning license by the regulatory authority
- The development of a specific decommissioning policy.

It has not yet been decided whether each reactor site will have an interim storage site for spent fuel or if there will be only one. Mochovce was constructed with a five years operation storage capacity, while Bohunice is thought to have a similar amount of storage space left (5 years).

The graph below does not reflect the start-up of Mochovce as only limited power would be produced in the initial stage of operation. If both reactors are operational and all Bohunice reactors are also still operational, then nuclear share of electricity may rise to 60% or more.

Figure 5.8: Development of Slovak Nuclear Electricity



Source: IAEA

Nuclear and Accession

The Accession partnership document released by the Commission in 1998 recommends the following action: -

The completion of Mochovce nuclear power station according to internationally agreed safety principles, and implementation of a realistic programme for the closure of the Bohunice plant...Nuclear safety requires continued particular attention. Safety standards should be tackled appropriately and realistic programmes implemented quickly. Longer-term solutions for waste need attention. The independence of the safety authority should be supported.

While the November 1998 accession progress report by the Commission notes: -

The Bohunice Nuclear Power Plant units 1 and 2 are expected to be licensed for long term operation in 1999 after a major upgrading programme. This plan is neither in line with the Accession Partnership nor with a

Slovak Government Decree from 1994, which provides for the shutdown of the units 1 and 2 as soon as Mochovce comes into commercial operation.

As the Accession progress report notes, the reversal of the Governments decision, in April 1999, to close Bohunice V1 was not unexpected. Even before the Slovakian Government pulled out of the EBRD/Euratom funded completion of Mochovce there was real doubts that such a significant upgrading program, nearly 200 million Euro would be undertaken for only a few years of operation.

However, the Slovakian Government's reversal on the closure of V1 will not effect the reactors standing in Agenda 2000, which makes clear that all the VVER 440-230 and RBMK reactors fall in the category of reactors which cannot be upgraded and thus must be closed. The WENRA report the containment system is unlikely to mitigate the consequences of a loss of coolant accident as consistent with current Western practises for reactors of the same vintage.

Despite this it is clear that the operators and owners of Bohunice-V1 feel that the upgrading programs that have and are being undertaken, justify their longer-term operation. This is clearly reflected in the Government's recent statements on Bohunice. In June 1993, the Slovak Minister of Economy, Ludovit Cernvak told a press conference that V1 would operate until 2010-2015. Cernvak did add that Slovakia would be willing to shutdown V1 earlier, if outside funding were available to cover the losses. However, the international community and in particular neighbouring Austria do not share this opinion. Recent public opinion in Austria and statements by the Government make it likely that the closure of Bohunice V1 will remain an important issue in the accession negotiations.

In the other cases of the first generation of reactors, Kozloduy and Ignalina, the Commission has established a working group to seek clarity on a number of issues around closure. The Commission believes that these are a useful part of the negotiation process to seek closure. As the agreements for Kozloduy and Ignalina were both made on the international level, through the NSA, and because the closure of Bohunice V1 was until April formerly still in position no such working group has been established in Slovakia. However, it is said that this will occur.

Slovakia is in a difficult position. It is clear that its exclusion from the first wave of accession countries was largely due to democracy issues. However, with the formation of a new government in September 1998 progress has been made in this area and it is clear that the new Slovakian Government is looking more towards Brussels its predecessor. This progress may be undermined on the Bohunice issue, one which neighbouring Austria appears unlikely to let go. In June 1999 the Austrian Consumer Protection Minster Barbara Prammer

called for the closure of Bohunice V-1 by 2000 and said that without this commitment it would be necessary to question Slovakia's inclusion in the first wave countries. The Slovak Government is hoping "re-categorisation" will occur at the Helsinki Summit in December 1999.

SLOVENIA:

Slovenia has one Westinghouse 632 MW reactor situated on the banks of the Sava River, 75 km from Ljubljana located at Krsko

Table 5.10: Slovenia's Operating Reactor			
Reactor	Design Type	Start Construction	Date of Commercial Operation
Krsko	PWR 640	1974	1983
Source: Nuclear Engineering International			

Krsko is in a unique position in that it is owned jointly by two countries, Slovenia and Croatia, each having a 50% stake and consequently each is supposed to receive half the electricity produced. In 1970 the Executive Councils of Croatia and Slovenia first agreed the construction of two nuclear reactors, the first was to be built at Krsko. The following year the tender for its construction was announced with Westinghouse being awarded the contract in 1973, at that time it was said that the construction would take five years. In 1974 an agreement was signed between Elektroprivreda of Croatia and Savskega elektrarne of Slovenia giving each partner the right to 50% of the electricity produced and provide legal provisions in the event that either partner withdrew or caused delays in construction. In December 1974 Josip Tito laid the first symbolic parts of the foundation. Despite the reactor going critical in September 1981, commercial operation was not achieved until 1983, due to regulatory and technical problems.

The Krsko design is said to be based on the safety requirements of the US Nuclear Regulatory Commission (NRC) of 1973 and Westinghouse, as the main contractor, was responsible for the design implementation and construction and testing phases. Since its operation two significant safety reviews have been undertaken at the plant. The first, the International Commission for Safety Analysis of Nuklearna Electrarna Krsko (NEK) – the reactors owner and operator. This Commission was paid for by the Governments of Austria, Italy and Slovenia and published their report in 1993. This made 74 recommendations on technical and procedural changes required to increase the safety operation of the plant, which were made mandatory by the Slovenian authorities. In 1994 a program was undertaken to assess if the reactors conformed to the US NRC requirement of 1973.

One of the main technical problems facing the reactor is the cracking and leaking of its steam generators, as are exhibited in many of the similar reactor designs around the world. At the end of 1995 degradation of the two

steam generators was detected and led to a decision to replace them. In 1996 a tender was announced and in January 1997 the Siemens/Framatome consortium agreed to supply NEK with two replacement steam generators. Delivery of the replacement units is scheduled for 2000 and is expected to cost 205 million DM ($115 million). NEK is seeking a 6% power increase (45 MW) along with the new steam generators.

The Slovenian Government policy has as a long-term aim of the abandonment of nuclear electricity and it is therefore not anticipated that any more nuclear power plants will be constructed. In October 1995 a proposal in the National Assembly calling for a referendum on the shutdown of Krsko was defeated following the withdrawal of support by the Liberal Democracy of Slovenia Party. As a result a public campaign was launched by environmental non-government organisations to gather the necessary 40 000 public signatures for a referendum. Those seeking the closure of the reactor failed to get close to the signatures needed, obtaining less than 10% of what was required.

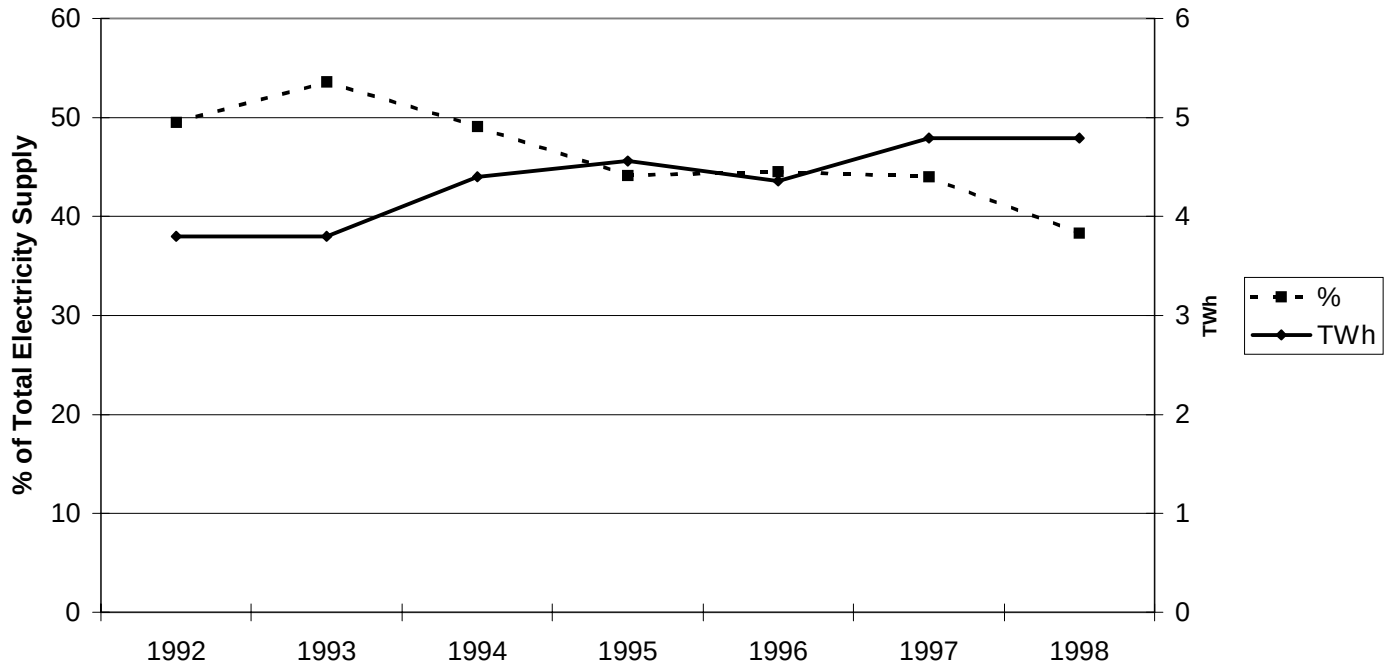
In 1998 a dispute occurred once again over the non-payment of bills and the tariffs being charged by NEK to the Croatian utility. This lead in early August to NEK cutting the 300 MW of supply to Croatia and the subsequent export of electricity from Slovenia to Italy. However, the dispute over the commercial arrangements is a small part of a much bigger dispute. In July 1998 NEK announced that it planned to solely finance the replacement of the steam generators and declared that the Croatian utilities did not own half of Krsko. Rather that the original agreement made the two sides equal partners in receiving the electricity for a 30 year period but not as owners.

Liability: The Constitutional Law on Enforcement of the Basic Constitutional Charter on the Autonomy and Independence of the Republic of Slovenia, adopted on 23rd June 1991 provides that all laws adopted in the past by the Federal Yugoslavian Government, which are not incompatible with Slovenian legal system, will remain enforce pending the adoption of appropriate legislation by its Parliament. This includes the 1978 Act on liability for nuclear damage. Slovenia succeeded to the Vienna Convention on 7th July 1992 and entered into force on 25th June 1991. It also acceded to the Joint Protocol on 27th January 1995 and it entered into force on 27th April 1995.

Nuclear Waste and Decommissioning: The decommissioning of a nuclear facility must follow the same process as the construction of a new facility and therefore must go through the same licensing procedures. The Ministry of Environment and Physical Planning issues a decommissioning license after receiving an endorsement by the nuclear safety administration. In 1996 the Government agreed the plan for the decommissioning of Krsko.

Slovenia has no final repository for radioactive wastes but has two intermediate storage facilities, which with waste conditioning are expected to have the capacity to store all the waste produced by Krsko. A final storage is being planned for this and the decommissioning wastes. A decision on the final disposal of the spent nuclear fuel has been differed until the end of the operational life of the reactor. However, the current facility is expected to be full by 2002 and will require the re-racking of the facility to allow further storage.

Figure 5.8: Development of Slovenian Nuclear Electricity Production



The figure below shows the quantities of electricity produced by Krsko.

Source: IAEA

Nuclear and Accession:

The Accession partnership document released by the Commission in 1998 recommends the following action: - *Slovenia should adhere to and/or fully implement international nuclear agreements. Long-term solutions for nuclear waste from Krsko Plant need to be found. The independence of the safety authority should be supported.*

While the November 1998 accession progress report by the Commission notes: -

Nuclear safety standards should continue to be handled appropriately, longer term solutions for nuclear waste

will have to be found and the independent status of the Safety Authority should be monitored.

Within the Accession process priority has not been given to the nuclear power program in Slovenia as the reactor is of Western design. The WENRA report states that "the safety of the Krsko plant compares well with NPPs in operation in Western European countries" and that the reactor has been the subject of a continuous backfitting process.

However, it is noted that as with other countries in the region measures will have to be taken to ensure the safety storage of radioactive wastes and new constructions will be required for low and intermediate level wastes.

It appears that one of the major problems facing Krsko is that of ownership and therefore the long-term financial security of the facility. The ongoing problems could have an impact on the day to day operation and the longer term financing of waste management and decommissioning.

RESOURCES:

General:

The Source Book on Soviet-Designed Nuclear Power Plants 5th edition, Nuclear Energy Institute: http://www.insc.anl.gov/neisb/neisb5/

US Department of Energy Site for Soviet-Designed Reactor Safety: http://atom.pnl.gov:2080/

Nuclear Waste Bulletin: Update of Waste Management Policies and Programmes, No 13 December 1998, OECD/NEA

Overview of Nuclear Legislation in Central and Eastern Europe and the NIS, OECD/NIS, 1998.

"An overview of radioactive waste management in Central and Eastern European Countries". A Working Document of DG XI - Environment and Nuclear Safety. XI/475/97 September 1997

Country Specific:

Czech Republic:

Technical Memorandum Regarding the Temelin Nuclear Power Plant, Updated 1996. Prepared by the Advisors of the Government of Austria, December 1996.

Nuclear Safety: U.S. Assistance to Upgrade Soviet-Designed Nuclear Reactors in the Czech Republic (Letter Report, 06/28/95, United State General Accounting Office/RCED-95-157).

Completion of Construction of NPP Temelin. Summary Report. Elaborated by: CEZ, a.s. May 4th 1998.: http://www.cez.cz/

TIS (Temelin Information Service) news and analysis related to Temelin Nuclear Power Plant and other nuclear industry activities in Czech Republic, from the Czech branch of Friends of the Earth.

Final Report of the Team of Experts for Independent Evaluation of the Project to Complete Construction of the Temelín Nuclear Power Plant, 28th February 1999.

Czech Submission to Nuclear Safety Convention. http://www.sujb.cz/National_report/

Annual Reports of SUJB: http://www.sujb.cz/Annual_Reports/

Hungary:

Hungary Submission to the Nuclear Safety Convention: http://www.haea.gov.hu/html/national_report.html

Hungarian Atomic Energy Authority: http://www.haea.gov.hu/html/hungarian_atomic_energy_author.html

Lithuania:

Ignalina RBMK-1500: A Source Book, Extended and Updated Version, Ignalina Safety Analysis Group, K.Almenas, A. Kaliatka, E. Ušpura. Lithuanian Energy Institute, 1998 (ISBN 9986-492-35-1)

Romania:

Campaign for Nuclear Phaseout (Canada) http://www.cnp.ca

Slovakia:

Slovakian Submission to the Nuclear Safety Convention: http://www.ujd.gov.sk/bezpen.htm
Nuclear Regulatory Authority of Slovakia: http://www.ujd.gov.sk/maineng.htm

Slovenia:

Slovenian Submission to the Nuclear Safety Convention: http://www.sigov.si/cgi-bin/spl/ursjv/porocila/ang/National_Reports.html

Slovenian nuclear Safety Agency: http://www.sigov.si/ursjv/uvod.html

CHAPTER 6: EXISTING WESTERN NUCLEAR SAFETY PROGRAMS

In 1990 a new era of international assistance for reactors in Eastern Europe began. Prior to this international involvement existed largely through the IAEA and on a bilateral and more commercial basis. In particular a number of firms, Westinghouse (USA) and Atomic Energy Canada Limited (AECL) became the lead constructors in reactors in Slovenia and Romania respectively.

Following the political changes in Eastern Europe, the European Union established the Phare program (Poland and Hungary Assistance for the Reconstructing of the Economy) in 1989. This was later expanded to include the CEE and Baltic countries and became in the nuclear field, particularly active in Bulgaria. Since then the number of bilateral projects has increased and a number of new multilateral initiatives have been established for example; the Commission's Tactical Assistance for the CIS (Tacis); the Nuclear Safety Account (NSA); and the G24 Nuclear Safety Assistance Co-ordination Union (NUSAC).

However, there is no single body or institutions appointed to the task of co-ordinating the Western approach to nuclear safety in CEE and the CIS. This is surprising given both the significant sums involved, in excess of 1.8 billion Euros and the stated importance that this issue has within the EU and the G7.

IAEA

The IAEA was established in 1957, as is a specialised agency within the United Nations system. The Agencies function is to both promote nuclear power by hosing forums for scientific and technical co-operation and to regulate through an international Inspectorate for the application of nuclear safeguards and verification measures.

The Agency also operates a number of extra-budgetary programmes including one on the safety of WWER (VVER) and RBMK nuclear power plants. This program was established in 1990 and was initially targeted towards the VVER 440-230s. However, the scope was extended in 1992 to include all VVER designs as well as the RBMK reactors. The program's objectives are: -

- To identify major design and operational safety issues
- To establish consensus on priority safety improvements.
- To improve assistance in the review of the completeness and adequacy of safety improvement programmes and the resolution of generic safety issues.

The program has been responsible for the publication of numerous technical reports on RMBK and VVER reactors and has established two steering Committees, one each major reactors design.

GRANTS

G24

Following the appeal of the G7 at their July 1991 Summit for greater co-ordination of the response to problems of nuclear safety in CEE and the then Soviet Union, the G24 established a working group on nuclear safety in September that year. Initially the group concentrated on CEE, but this was extended twelve months later to include the countries of the NIS. The co-ordination body has become known as the G24 Nuclear Safety Assistance Co-ordination (NUSAC) and is hosted by the European Commission's DG XI.

The goal of NUSAC is to promote an efficient use of resources by developing a consistent approach and avoid duplication. The specific functions are said to be: -

- To bring together all parties involved in the assistance programs. Countries from CEE and NIS play a key role in activities.
- The focus of the group is policy rather than technical issues.
- To facilitate the movement from technical assistance to co-operation.

Its Brussels based secretariat is charged with: -

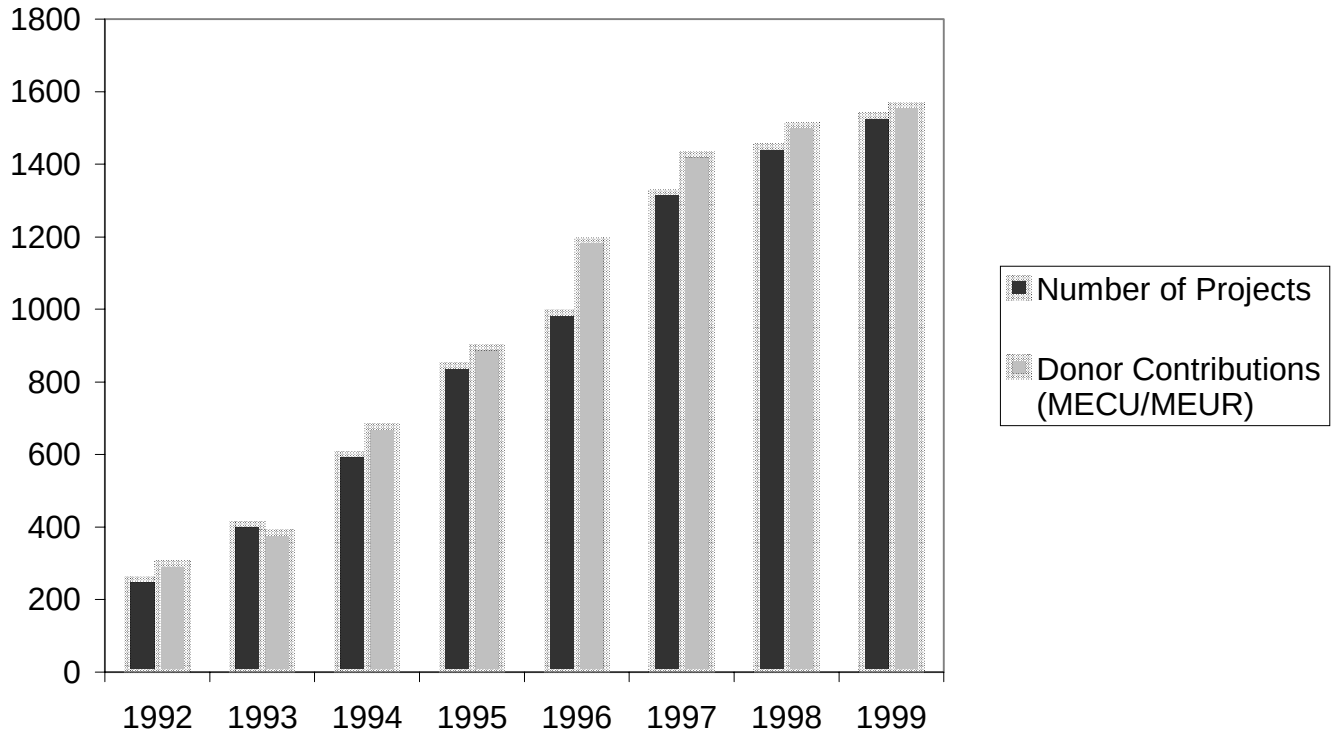
- Administering a database of bilateral and multilateral aid programs and servicing the Database Correspondent's Group.
- Producing annual country by country reports and annual reports on changes in legislation, particularly relating to liability and nuclear safety.
- Provide the public with information through a regular bulletin – NUSAC News and via the Internet.

As noted the secretariat manages a database that contains details of the bilateral and multilateral nuclear safety initiatives. The summary of the data-base are available on the G24 web site (http://europa.eu.int/comm/dg11/g24home.htm) as well as electronic versions of their bulletin, NUSAC news, which supplies information on assistance programs and regulatory changes in CEE and NIS countries.

The table below shows the accumulative development of assistance programs since the conception of the NUSAC database. It is important to note that this figure and others from NUSAC represents only the financial assistance from bilateral and multilateral grants programs and therefore excludes loans and national

contributions for nuclear safety and upgrading programs.

Figure 6.1: G24 NUSAC Database - January 1999 Total Number of Projects and Total Donor Contribution



Source: NUSAC

Currently, there is a change in emphasis being developed by Western agencies, whereby projects are said to be moving away from assistance towards co-operation. This change in approach is partly as a response to lower financial assistance by Western Governments and Institutions and also a realisation that technical expertise often lies in the Eastern European countries and thus it is more effective to take account of this knowledge and to develop joint projects.

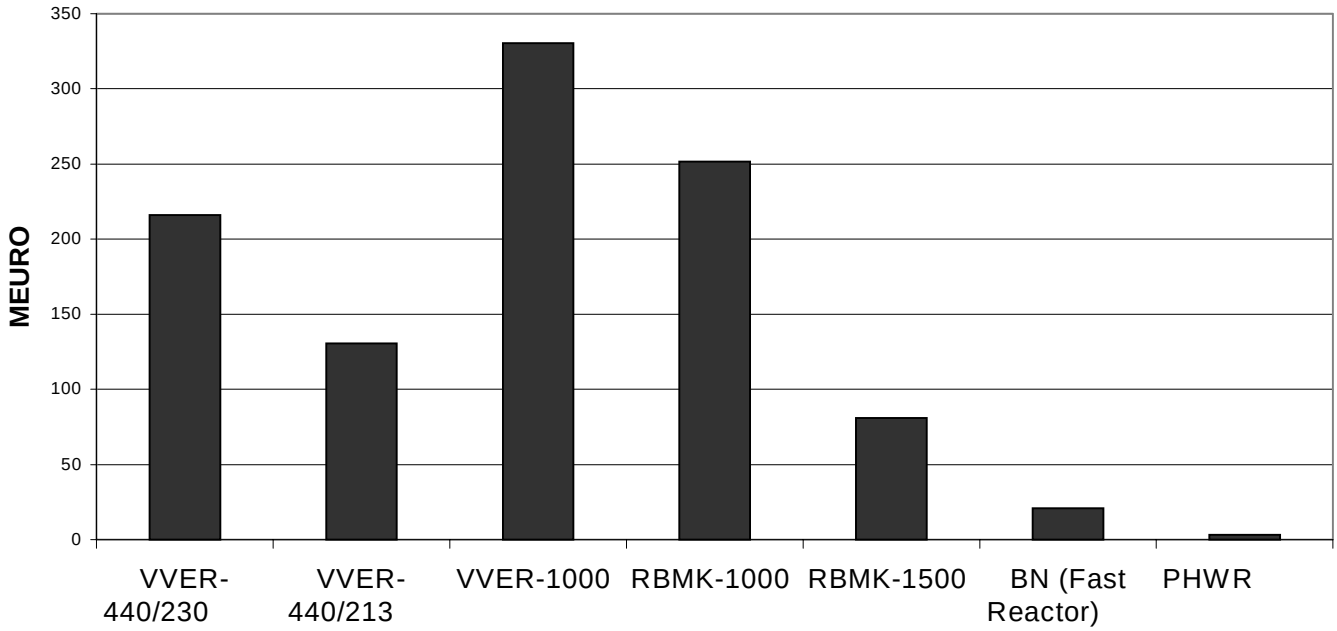
However, senior officials from the France's Institute of Protection and Nuclear Safety (IPSN) warned against a reduction in funding for Eastern Europe in early 1999. In particular they did not believe that programs for assistance in nuclear waste management programs should take priority of nuclear safety. IPSN believe that the safety assistance programs should continue on four principles: -

- Strengthening ties between safety authorities and technical safety organisations to help the former counterweight operators in national policy.
- Continuation of concrete technical assistance to operators.

- Development of so-called “two-plus-two” programs that associates operators and safety authorities from a Western and an Eastern Country.
- A greater up-front involvement of safety authorities in defining safety improvement plans financed by the EU.

Between the four major designs of rectors, the VVER 440-230; VVER 440-213; VVER 1000; and RBMKs, there is not a significant difference in the levels of funding from the G24, as can be seen in the figure below.

Figure 6.2: Expenditure by G24-1992-1999 by Reactor Type



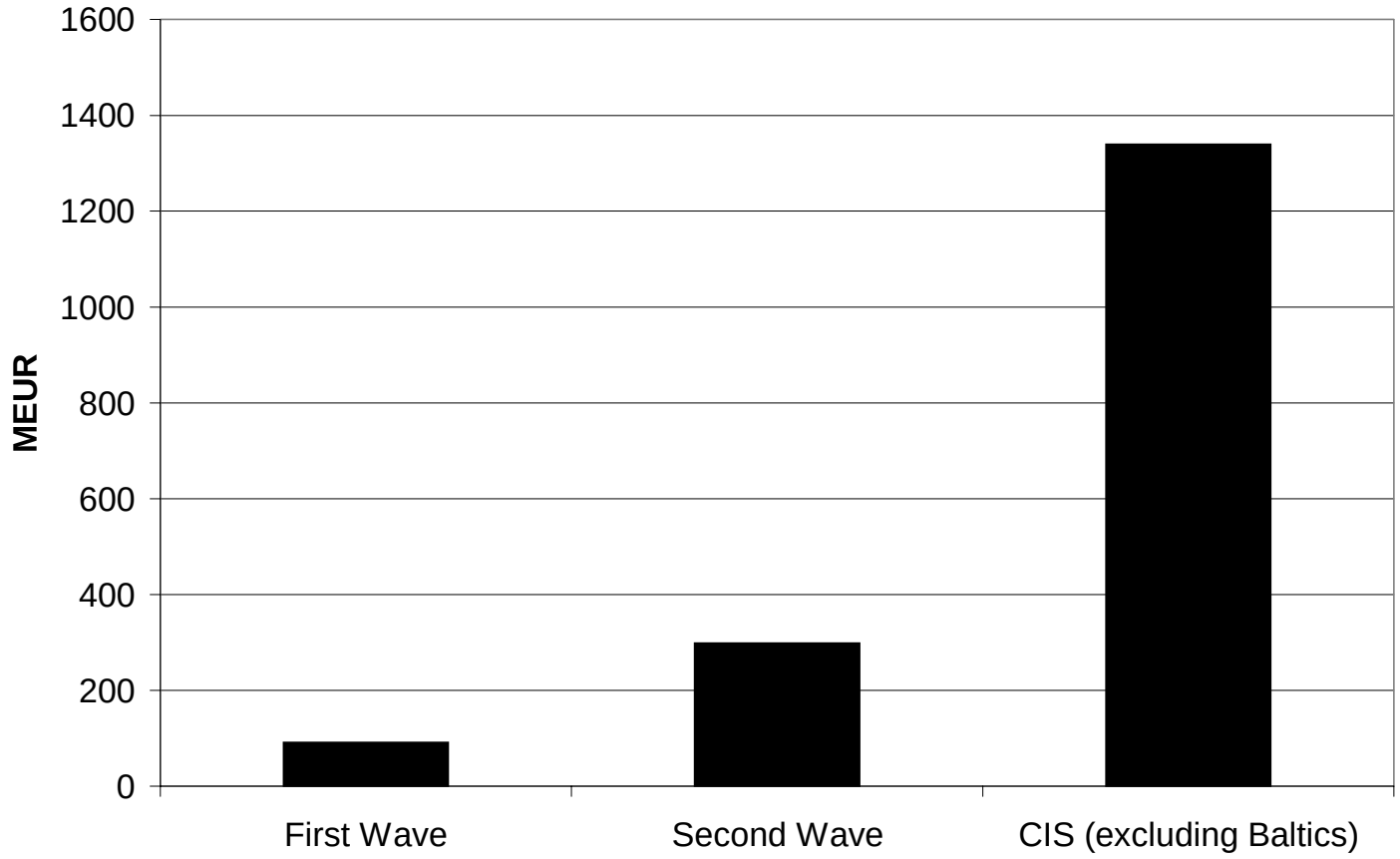
Source NUSAC

The table below shows how the assistance programs are distributed within accession countries. As can be seen it is largely those countries of the current second wave (in bold) which receive the largest funding.

Table 6.1: Funding for Nuclear Safety Programs for Accession Countries.		
Country	**Number of Projects**	**MEUR**
Bulgaria	186	125.00
Hungary	145	39.15
Poland	23	2.43
Romania	57	11.31
Slovenia	28	2.80
Czech Republic	185	46.26
Slovak Republic	241	52.65
Estonia	13	1.36
Latvia	13	1.61
Lithuania	154	115.16
Source: NUSAC		

The trend of funding programs further east is reinforced in the figure below, which compares, first and second wave countries with the countries of the CIS.

Figure 6.3: International Nuclear Safety Program Expenditure



Source: NUSAC

G7

The countries of the G7 are the major bilateral funders as can be seen in the table below.

Table 6.2: National Contributions to Eastern Europe Nuclear Safety Programs		
Country	**Number of Projects**	**Total Expenditures (MEUR)**
United States	295	490.03
Japan	14	128.73
Germany	121	161.83
France	61	87.48
UK	121	42.13
Sweden	38	40.83
Canada	18	24.77
Italy	2	23.62
Finland	29	17.00
Norway	26	13.02
Switzerland	11	12.59
Belgium	19	5.53
Netherlands	4	4.67
Denmark	1	4.03
Spain	16	2.57
Austria	1	0.08
Source NUSAC		

- The G7 countries are in bold.

The G7 have, along with the European Commission, are the main political and economic force behind the Western initiatives in CEE. Historically, and in a tendency that is increasing, most of the G7 funds have been targeted towards countries of the CIS, almost exclusively to Russia and Ukraine. The G7 countries have funded 960 MEUR worth of projects to date, which is considerably more than the 390 MEUR of projects funded by bilateral means of EU countries. However, the EC programs to date total 724 MEUR.

Since 1991, the Heads of State annual Summits of the G7, now the G8, as since 1998 the summit has been extended to include Russia-, have discussed Eastern European nuclear safety. Below is a summary table of the final communiqués statements of nuclear safety.

Table 6.3: Summary Of G8 Communiqués 1992-1999 On Nuclear Safety	
Germany 1992	"The safety of Soviet Designed nuclear power plants gives cause for great concern... The new States concerned in the former Soviet Union and the countries of central and Eastern Europe must give high priority to eliminating this danger". "A special effort should be made to improve the safety of these plants. We offer the states concerned our support".
Japan 1993.	"We welcome the progress made in the nuclear safety programme agreed at the Munich Summit... We invite the World Bank, together with the IEA, to continue the dialogue with each of the countries concerned, and working with other lending institutions including the EBRD and the EIB, to support them in developing longer term energy strategies. Our aim is to agree as quickly as possible on a framework for co-ordinated action by all those involved following a country by country approach. We will review the progress make in 1994".
Italy 1994.	"We welcome the progress made in the nuclear safety programme, agreed by the Munich and Tokyo summits, concerning [nuclear safety] the countries of Central and Eastern Europe and former Soviet Union". "An effective framework for co-ordinated action is now in place. The World Bank, working with other lending institutions including the EBRD and the EIB, and with the IEA, is helping countries develop long term energy strategies...The IFIs are invited according to their mandate to make full use of their lending possibilities for this purpose". "We remain committed to the existing international initiatives to promote an early closure of high risk reactors. The closing down of the Chernobyl nuclear power plant is an urgent priority".
Canada 1995.	"We welcome progress to date in improving levels of nuclear safety in the countries in central and Eastern and the Newly Independent States. We congratulate President Kuchma of Ukraine on his decision to close the Chernobyl nuclear power plant by the year 2000".
France 1996	"We have taken an important step toward enhancing international co-operation so that the use of nuclear energy is conducted all over the world consistently with fundamental principles of nuclear safety. We reaffirm our commitment, made in Moscow, to the highest internationally recognised nuclear safety level. In this regard, we underline that nuclear safety has to prevail over all other considerations".
USA 1997	"We reaffirm our commitments from the 1996 Moscow Summit on Nuclear Safety and security to give an absolute priority to safety in the use of nuclear energy. We note that further substantial progress is still required in the countries of Central and Eastern Europe and in the Newly Independent States, especially by strengthening regulatory authorities, enhancing reactors safety and improving safety culture. We consider further joint efforts to this end a major priority. In this regard, we attach the greatest importance to the full implementation of the Nuclear Safety Account Agreements."
UK 1998	Considering the new competitive pressures on our electric power sectors, we reaffirm the commitment we made at the 1996 Moscow Summit to the safe operation of nuclear power plants and the achievement of high safety standards world-wide, and attach the greatest importance to the full implementation of the Nuclear Safety Account grant agreements. We reaffirm our commitment to the stated mission of the Nuclear Safety Working Group (NSWG)
Germany 1999	We renew the commitment we made at the 1996 Moscow Summit to safety first in the use of nuclear power and the achievement of high safety standards worldwide. In this regard, we attach great importance to the results of the Nuclear Safety Convention peer review meeting and to the International Atomic Energy Agency Conference on Strengthening Nuclear Safety in Eastern Europe.

1993 G7 Report on Nuclear Safety:

At their Munich summit in July 1992 the G7 once again expressed concern about nuclear safety in CEE and the NIS and called for a specific program of action including.

- Operational Safety Improvements
- Near term technical improvements based on safety assessments

- Improvements of nuclear safety regulations
- Examination of the potential for upgrading plants of more recent design.
- Examination of the scope for replacement less safe plants by the development of alternative energy sources and the more efficient use of energy.

The Summit asked for the presentation of safety and economic studies at the following years Summit in Tokyo. The EBRD, International Energy Agency (IEA) and the World Bank were asked to assess the options available to reduce nuclear risk in CEE and the NIS. The production of the report was a reflection of the need for a more co-ordinated approach. The report, only looked at countries with the high-risk reactors (RBMK and VVER 440-230s), so for accession countries this only affects, Bulgaria, Lithuania and Slovakia.

The report put forward three major scenarios for reducing nuclear risk in Eastern Europe. The three scenarios envisaged the following timetables for the closure of the first generation of reactors in accession countries.
Low nuclear scenario: All high-risk reactors by 1995;
Medium nuclear scenario: Bohunice V-1 closed by 1995: Ignalina closed by 2000: Kozloduy 1-4 closed by 1998;
High nuclear scenario: Bohunice V-1 closed by 1995: Ignalina closed by 2000: Kozloduy 1-2 closed by 1998, and 3-4 by 2010.

The main conclusions of the report were: -

- Of total electricity generating capacity in six countries (Armenia, Bulgaria, Lithuania, Russia, Slovakia and Ukraine) of about 298 000 MW, approximately 20,600 or 7% are of a higher risk type.
- It would be technically and economically feasible to meet electricity demand in the six countries while closing these higher risk plants by the mid-1990s (Low Nuclear Scenario). The investment costs, including nuclear safety upgrades under this scenario would be about $18 billion during 1993-2000 ($2.3 billion per annum) provided moderately-paced economic and energy reforms are pursued to manage electricity demand and improve efficiency, and the primary alternative to nuclear power is gas-fired thermal plant.
- The investment cost under a High Nuclear Scenario, which includes upgrading and maintaining all high risk and other nuclear plants in operation, would be about $24 billion during 1993-2000 ($3 billion per annum) assuming the same pace of reforms and consequently electricity demand.
- The Low Nuclear Scenario involves lower capital costs, and addresses the problem of nuclear safety more aggressively but the fossil fuel costs (mainly natural gas) would be about $3 billion high per annum than for the High Nuclear Scenario.

- For a variety of reasons, including balance of payments concerns and different views about nuclear risks, many decision-makers in the countries hosting the reactors favour the High Nuclear Scenario.

The report largely focused on supply side options and does not investigate demand side management options to facilitate the closure of reactors. The table below shows what the expected costs would have been in each scenario put forward by the World Bank/EBRD/IEA.

Table 6.4: Total Investment Requirements by Type of Plant for All Countries 1993-2000 (US$ billion) [1992 prices] – Base Case Demand Scenario.

	Nuclear Upgrade		Nuclear Construction		Thermal/Hydro		Total
	RBMKs &230s	1000s &213s	Plant Compl.	New Plants	Plant Rehab.	New Plant	
High Nuclear Scenario	2.9	2.6	3.9	3.6	6.8	4.3	24.1
Medium Nuclear Scenario	1.9	2.2	2.3	3.6	6.6	8.3	24.9
Low Nuclear Scenario	0.7	2.1	0.0	0.0	6.5	8.9	18.2
Source: WorldBank/IEA/EBRD							

It is interesting to note that the upgrading costs for the second generation of seems to be roughly in line with the Commission's cost estimates as outlined in Agenda 2000.

Estimates for the cost of upgrading the reactors were: -

RBMK:	35-45 US$/KW	short-term
VVER 440-230:	90-180 US$/KW	short-term
VVER 440-213:	350-480 US$/KW	long-term
VVER 1000:	147-209 US$/KW	long-term

Although it has never been publicly specified, it is thought that that the Eastern countries and Western donors had probably been hoping for a nuclear assistance program based somewhere between the medium and high nuclear scenario. The analysis was supposed to be a framework strategy for existing international work on nuclear safety in the region, as well as to stimulate new approaches and increase financial support. The report's main conclusion was that the closure of the high-risk reactors was possible on the short term, in the low nuclear scenario, in just two years. However, whatever scenario the international community adopted, it is clear that the objectives of the 1993 paper have not been met. As noted it is difficult to make a judgement as to the total financial input into the CEE and NIS, as the G24 database is purely grant related and so funding from national sources and loans are not included. However, all scenarios did foresee that some of the first generation of reactors would be closed by 2000, something that has not been achieved.

Moscow Nuclear Safety Summit 1996:

To coincide with the 10th Anniversary of the Chernobyl disaster, in April 1996, the G7 and Russian Governments organised a special summit on nuclear Safety in Moscow. The final statement from the Summit made the following statements regarding the safety of reactors: -

Safety of Civilian Nuclear Reactors:

6. Nuclear Safety has to prevail over all other considerations. We reaffirm our commitment to the highest internationally recognised safety level for the siting, design, construction, operation and regulation of nuclear power installations.

11. National efforts have been made in the countries of Central and Eastern Europe and the Newly Independent States to improve nuclear safety levels, often in co-operation with multilateral and bilateral programmes. In this regard, we acknowledge these important efforts to upgrade reactor safety and improve safety culture, but note that further substantial progress is still required. We reaffirm our commitment to co-operate fully for this purpose.

Energy Sector Strategies in transition countries:

16. Efficient market-oriented strategies for energy sector reform are essential to promote nuclear safety. This will generate adequate resources for investment in safety upgrades and maintenance, and encourage energy conservation. All countries in transition should pursue such market-oriented reforms and investment strategies based upon least cost planning, giving due regard to nuclear safety and environmental criteria and to energy efficiency and conservation.

Importantly, the final declaration did not call for the closure of high-risk reactors. This may well be entirely due to the need to include the Russian view, which does not believe that the first generation of reactors need to be closed on safety grounds. However it also reflects a change in emphasis from some G7 countries that closure of the first generation of reactors is an important goal but maybe not the priority of the nuclear safety initiative.

Nuclear Safety Account:

In February 1993, the G7 asked the EBRD to establish the Nuclear Safety Account (NSA) as a mechanism to fund operational safety and technical safety improvement measures not covered by existing bi-lateral programs. The Board of the EBRD approved the decision and the NSA became effective on 14th April 1993 for three years. In April 1996 the NSA was extended for a further three years and then again in April 1999.

The NSA was established to provide grants for short-term operation safety and not to extend the life of the

reactors. Funds have been targeted towards reactors that are said to present the highest level of risk, which can be significantly reduced by cost-effective short-term safety improvements. Therefore funds have been focused on the VVER 440-230 and RBMK designs. Where funds have been awarded agreements were initially sought with the countries concerned on timetables for the shutdown of these reactors.

Any country may contribute to the NSA and as of December 1998, 14 countries and the European Union had made pledges totally ECU 257.2 million.

Table 6.5: Contributions to Nuclear Safety Account.

Country	**Amount (MECU)**
Belgium	1.5
Canada	12.3
Denmark	2.0
European Union	20.0
Finland	4.0
France	55.5
Germany	37.5
Italy	21.2
Japan	23.3
Netherlands	4.2
Norway	4.0
Sweden	9.0
Switzerland	10.9
United Kingdom	25.5
USA	26.3
Total	257.2
Source: NSA	

By the end of 1998 four projects had been funded by the NSA these are: -

- June 1993: An ECU 24 million project for the VVER 440-230 reactors at Kozloduy in Bulgaria.
- February 1994: An ECU 35 million project for the RBMK reactors at Ignalina in Lithuania.
- June 1995: An ECU 30 million project for the RBMK reactors at Leningrad in Russia and a ECU 45 million project for the VVER 440-230 reactors at Kola and Novovoronezh in Russia.
- November 1996: An ECU 118 million project for the RBMK reactors at Chernobyl in Ukraine.

For more details on the projects see country sections.

The stated objectives of the NSA are to seek the closure of some reactors and ensuring that the projects that it is financing do not lead to an extension of the lifetime of the reactors. Despite these clear statements the NSA has not had its desire effect and all the reactors to which grants for early closure have been awarded to are still operational. The grant for the Russian reactors did not even include a closure deadline as it was said that the

Russia authorities would not have accepted any conditionalities on the grant and thus there were none. The reasons that the reactors have not been closed are often cited as: -

- The "leverage" that can be achieved by the small grants, tens of millions of Euro, is small, especially given the generating capacity of the reactors concerned. In most cases the reactors in question, even taking the relatively low prices obtained for the electricity generated, the annual revenues of the power station is roughly an order of magnitude higher than the grants awarded.
- Not all of the bilateral and multilateral assistance programs have demanded the same closure timetable as the NSA and thus do not increase the leverage.
- Financial assistance, loans or grants, by International Financial Institutions (IFIs), for the energy sector in the countries concerned have not targeted investments that will facilitate the closure of reactors and/or have not ensured that loans and grants have the same conditionalities of the NSA.

The four projects that are being funded have a combined budget of ECU 252 million. Unless the group of donors makes further funds available no other projects can be undertaken. Should the NSA wish to expand the sites and countries in which it operates it could give funds to Bohunice V-1 in Slovakia; Medzamore in Armenia; or some of the other Russian reactors. However, there are strong arguments why this will not occur. In Bohunice, the reactors are already in the process of a significant upgrading program, about € 150 million, which is well in excess of what the NSA could contribute. The Medzamore reactor was restarted in October 1995 after a seven-year closure, and is not thought to be a suitable candidate. Finally given the inability to gain closure agreements in the previous NSA grants it is unlikely that this will be repeated in Russia.

Given the lack of suitable reactors it is unclear what the future of the NSA holds after it has administered the existing grants. Some believe that the NSA should redirect its focus towards assisting in the decommissioning of facilities by channelling both expertise and finance to countries with closure agreements. Which would be in line with the recommendation by the Council of Ministers from December 1998.

Phare Program.

Between 1990 and 1998 Phare developed approximately 300 nuclear safety projects, with a total commitment of nearly €200 million.

Table 6.6: Phare Nuclear Safety Program Commitments (million Euro)				
YEAR	**Bulgaria**	**Lithuania**	**Regional**	**TOTAL**
1990	-	-	3.74[1]	3.74
1991	12.70	0.50	3.50 [2]	16.70
1992	16.30	-	13.00 [3]	29.30
1993	8.90	1.40	14.90 [4]	25.20
1994	11.40	-	19.60 [5]	31.00
1995	7.00	-	20.00 [6]	27.00
1996	6.00	-	-	6.00
1997	-	-	12.00	12.00
1998	6.00		25.00	31.00
Total	68.30	1.90	111.74	181.94
Source : European Commission				

1 Czechoslovakia (3.5 MECU) and Poland
2 Slovakia
3 Czech Republic, Slovakia and Hungary (out of the Regional Programme, 7 MECU for Bulgaria are accounted in the corresponding column)
4 Czech Republic, Slovakia and Hungary (out of the Regional Programme, 5.1 MECU for Bulgaria are accounted in the corresponding column)
5 Czech Republic, Slovakia and Hungary (out of the Regional Programme, 5.1 MECU for Bulgaria are accounted in the corresponding column)
8 Czech Republic, Slovakia and Hungary

Although this represents a significant share of the total international financial assistance it is relatively small compared to the funds that the Commission earmarked for countries in the CIS, through the TACIS program.

Table 6.7: TACIS Nuclear Safety Program: Commitments millions Euro)						
YEAR	**Russia**	**Ukraine**	**Kazakhstan**	**Armenia**	**Regional**	**TOTAL**
1991	45.80	7.20	-	-	-	53.00
1992	38.00	22.00	-	-	-	60.00
1993	48.50	32.00	-	-	7.50	88.00
1994	38.00	45.00	-	-	2.00	91.00
1995	38.00	55.50	-	-	2.50	96.00
1996	43.50	59.50	2.00	10.00	2.50	117.50
1997	37.50	21.50	2.50	1.50	5.00	68.00
1998	17.40	56.70	5.00	0.50	4.20	33.80
TOTAL	306.70	299.40	9.50	12.00	25.70	657.30
Source: European Commission.						

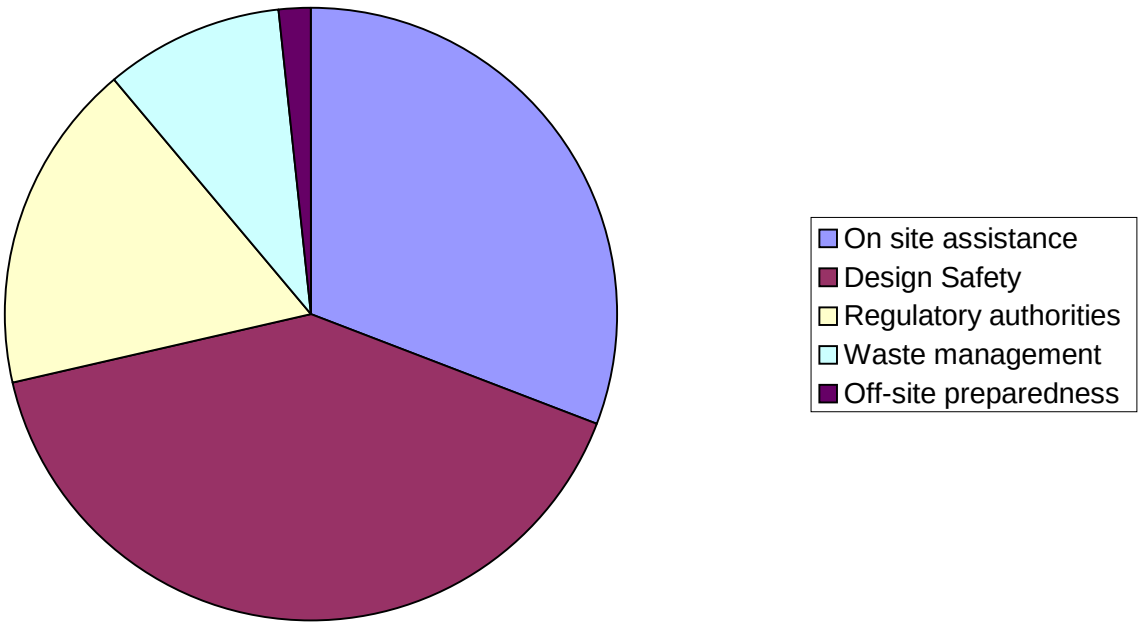
Although the Phare funds have been committed not all the work has been completed as can be seen in the table below.

Table 6.8: Status of PHARE Funding in Nuclear Safety Program (February 1998)			
Year	Commitments	Contracted	Payments
1990	3.74	3.74	3.74
1991	16.70	16.50	16.50
1992	29.30	28.90	26.90
1993	25.20	25.00	23.60
1994	31.00	28.50	16.90
1995	27.00	23.70	7.70
1996	6.00	5.95	0.5
1997	12.00	1.20	1.20
1998	31.00	-	-
Total	181.94	132.29	95.84
%	100	72.71	52.67
Source: European Commission.			

The PHARE program has identified five areas, which it prioritises, its work, these are: -

- On-site assistance and Operational Safety
- Design Safety
- Off-site emergency preparedness
- Regulatory authorities and their technical support organisations Waste Management

Figure 6.4: PHARE Budget 1990-1998 (Million of Euro)



Source: European Commission

MULTILATERAL LOANS:

To date no IFI has awarded a loan for nuclear power stations in Eastern Europe. A number have been considered or are under active consideration. The lack of approval for projects can be put down to a number of factors, including: -

- Lack of universal support from the shareholders of the institutions. Within the European Union over 50% of the countries are either non-nuclear or have a legislative phase-out program for their nuclear power stations.
- Nuclear power has not thrived in a liberalised electricity market, due to its long construction time and economic uncertainties, in particular waste management. Many of the financial institutions are encouraging the development of the free market, and thus may not see nuclear as a priority within their lending portfolio.
- The Institution's Policies may exclude the lending to nuclear power stations or make the procedures lengthy and difficult.

EBRD

The London based European Bank for Reconstruction and Development (EBRD) was established in 1991. The Bank's stated objective is "to foster the transition towards open market-oriented economies and to promote private and entrepreneurial initiative in the countries of central and eastern Europe and the Commonwealth of Independent States (CIS) committed to and applying the principles of multiparty democracy, pluralism and market economics". The Bank is mandated to apply sound banking and investment principles in all of its operations. In addition the Bank has included in its founding agreement a requirement to "promote in the full range of its activities environmentally sound and sustainable development". As such the Bank requires that all its investment and technical co-operation activities undergo environmental appraisal as part of the overall financial, economic, legal and technical due diligence.

Despite its clear mandate to promote environmental protection in its activities the Bank has come under significant scrutiny and criticism from environmental pressure groups and some Governments for its policy on nuclear power. The Bank was one of the first regional development Banks to not exclude lending for nuclear power plants or nuclear facilities. The Bank's energy policy[24] states: -

"In the context of such strategies, and in addition to ordinary non-nuclear resources projects suitable for EBRD financing, the Bank may also assist from its ordinary resources projects to complete or upgrade modern

[24] Energy Operation Policy, 7th March 1995

nuclear stations (of the VVER 213 and 1000 types), provided that they are directly liked with the closure of high-risk reactors operating in the country concerned (such linkages would be enshrined in the relevant legal agreements)".

In order to try and ensure high standards and simultaneously reduce criticism the Bank insisted upon a significant number of conditions for each nuclear loan, including: -

- The same least cost criteria (including a review of supply and demand side energy alternatives) as non-nuclear projects. The economic (and financial) analysis must include the long-term cost, if appropriate, of reprocessing, long term disposal of wastes and decommissioning.
- Financially Viable.
- The Procurement Policies and Rules must apply.
- The same standards of environmental due diligence as other projects must apply.
- The standards applied for the construction, management and operation of the plant would have to be fully in line with the fundamental principles set out by the International Atomic Energy Agency.
- The reactors must be acceptable under Western-type licensing practises.
- The projects must have received the approval of the relevant nuclear safety authorities.
- The countries concerned should become parties to the Nuclear Safety Convention and the Vienna Nuclear Liability Convention

The EBRD's involvement in the proposed funding of nuclear facilities has to date been restricted to two projects. Firstly, in 1995/6 the Bank considered becoming the co-lender for the completion of two nuclear reactors at the Mochovce nuclear power plant in Slovakia. Secondly, a project is still under consideration in mid 1999, the completion of two reactors in Ukraine, Khmelnitsky 2 and Rovno 4 (known as K2/R4).

In Mochovce, following a the public participation process, in which over 1.2 million citizens from Eastern and Western Europe (largely from Austria) registered their opposition to the project, the project was withdrawn by the Slovakian Government and was consequently never present to the Bank's Board of Directors for consideration. The project would have been the largest loan at that time for the EBRD and was without doubt its most publicly controversial, with allegations in the press from former EBRD staff of manipulation of the data for the least cost assessments. The project was eventually funded by Czech, Slovak, Russian, French and German sources, -- see Slovakian section for more details.

Euratom:

In March 1977 the Council of the European Communities agreed on "empowering the Commission to issue Euratom loans for the purpose of contributing to the financing of nuclear power stations"[25]. Initially, this was restricted to nuclear facilities inside the Union with an initial credit ceiling of 500 million European units. This was later given a fixed ceiling of ECU 4 000 million. In March 1994 the remit of the fund was changed "to authorise the Commission to contract Euratom borrowings in order to contribute to the financing required for improving the degree of safety and efficiency of nuclear power stations in certain non-Member States"[26] The Council was quite clear for one reason for this change.

> *Whereas, following the slowdown in the nuclear energy sector and the changes in nuclear energy policy by some Member States, there will not be a strong demand for the remaining finance from nuclear energy projects in the Community over the next few years.*

In 1994, the Euratom loan facility had only used ECU billion 2.8 from a total lending ability of 4.0 billion. In order to guarantee that Western firms would benefit the Council decision insisted that Euratom could only fund projects where "a major proportion of the capital goods item or service, which is to be financed" be provided by a Community enterprise. The criteria for projects eligible for loans were very broad requiring only that the projects had “received a favourable opinion from the Commission in technical and economic terms”. Euratom loans cannot be used as the sole source of finance for any project can only fund a maximum of 50%. If EBRD co-financing is involved the two institutions can only fund up to 70%. Any Euratom loan will require a Government guarantee by the recipient state.

- Therefore the Commission has to undertake both a technical (Safety) and economic review of the projects. The Phare/Tacis Nuclear Safety Expert Group (NSEG) undertakes the Safety analysis, under the direction of DG1A. This body is comprised of representatives of Member States. The economic analysis is undertaken by the Commission who prepare the assessment of the justification of the project taking into account a specific recommendation from the European Investment Bank on the Economic and financial aspects. The full Cabinet of Commissioners makes the final decision of the Commission.

To date, Euratom has considered five projects for loan financing, but despite this as of mid 1999 no Euratom funds have been used in CEE or the NIS. The projects considered so far are: -

[25] Council Decision, 77/270/Euratom, Official Journal of the European Communities, No L 88/9, 6th April 1977.
[26] Council Decision, 94/179/Euratom, Official Journal of the European Communities, No L 84/41, 21st March 1994.

Kozloduy: In August 1995, a loan of ECU 100 million was applied for as part of an ECU 220 million upgrading program for the two VVER 1000 reactors. The remaining financing was proposed to come from French, German and Russia export credit agencies. It was also proposed that Westinghouse would also undertake a separate upgrading program. So far funds have not been made available through Euratom, four years since the original application.

Mochovce: In 1994 Euratom were proposed to fund 25.2% of a 1451 million-DM project for the completion of units 1 and 2 at Mochovce. The other financiers were proposed to be the EBRD (412.5 DM million); French Export Credit Agency – Coface – (188 DM million); German Export Credit Agency – Hermes - (93.5 DM million) and industrial financing. However, the Slovakian Government withdrew the project from the EBRD and consequently Euratom in the spring of 1995.

Kola: Proposals were developed for Western assistance for replacing the instrument and control technology at the Kola 440-213 reactors. However, the project details were not significantly development and the project was abandoned at a relatively early stage.

Kalinin: The total cost of completion of Kalinin 3, at the time of the loan application in December 1995, was ECU 670 million, Euratom's share was ECU 335 million. According to the Court of Auditors in February 1998 consideration for the project was slowed down due to the failure of the Russian authorities to supply all the financial information necessary for project evaluation.

Khmelnitsky 2 and Rovno 4: According to the Court of Auditors in July 1995 a loan of ECU 623 million was applied for as part of an ECU 1 265 million loan for the completion of the two Ukrainian VVER 1000 reactors. However, by the beginning of 1999, the project financing costs were, according to the European Investment Bank, EUR 1 713 million, the Euratom share however had been decreased to EUR 437.5 million (25.5%). The other proposed financiers are, EBRD (EUR 175 million); Russia (EUR 164.3 million); Ukraine and Export Credit Agencies (the shares of these funders is still unclear).

Euratom Reform:

There are those who believe that it will be necessary to reform Euratom to remove its promotional function as they claim it is antiquated and no longer necessary. One reason which has been put forward for Euratom reform is the Enlargement of the European Union. In their discussion paper "The Euratom Treaty in the context of EU Enlargement" the Irish Government puts forward the following recommendations: -

"Each Member State would bind itself to an agreement that existing nuclear reactors which do not meet internationally recognised standards must be closed. If this is not feasible for social or economic reasons the plants should be upgraded or modernised to meet those standards. Intensive energy conservation measures should also be pursued in parallel with programmes directed at addressing safety in existing nuclear installations."

Over and above the view from a number of Member States that Euratom needs to be reformed, the question of Euratom Loans still has to be resolved. As has been mentioned there are a number of Euratom loans under consideration, notably for Khmelnitsky 2 and Rovno 4 (Ukraine) and Kozloduy 5 and 6, which if they go ahead will require the remaining lending ability of Euratom. The Commission notes that if Euratom Loans are to be used within the accession process the funds lending facility will need to be extended. The further extension of the Euratom loan facility will be a litmus test to assess the likelihood of a wider program of Euratom reform.

Summary of Community Programs

The Phare and the Tacis program are the largest grant making programs for nuclear safety in their respective regions. The Commission has stressed that nuclear safety in Eastern Europe is of importance both in the context of accession and in order to protect the long term future of the nuclear program within the European Union. It is important therefore to look at how much funding nuclear receives in comparison to the whole Community energy and nuclear programs. The table below is a summary of energy programs in 1996.

Table 6.9: Total European Union Energy Program Funds for 1996 (MECU)				
Area	Program	Grants	Loan	Credit Guarantees
Policy Action	THERMIE	141		
	SAVE	9		
	ALTENER	8		
	SYNERGY	9		
Research and Development	JOULE	116		
	Nuclear fission	43		
	Nuclear Fusion	212		
	Joint Research Centre	78		
	INCO	7		
International Co-operation	PHARE	53		
	TACIS	138		
	Asia	7		
	Latin America	8		
Trans-European Networks	TENS	22		
Structural Operations	Community Support Frameworks	416		
	Community Initiatives (REGEN/REGIS)	89		
ECSC Support	Research, Readjustment, social measures	112		
European Investment Bank	European Union		4975	
	Third Countries		702.4	
ECSC			97.3	
European Investment Fund Guarantees	European Union			88
	Third Countries			182
Total		**1468**	**5774.7**	**270**
Source: European Commission				

From this table it is possible to make the following observations: -

- Most of the funds, 75% are available through loans from the EIB, of this 86% went to Member States.
- In 1996, the nuclear safety programs in CEE and CIS was ECU 123 million this represents less than 10% of the total energy grants.
- That fusion research continues to receive the largest proportion of the research and development funding (15%). This is larger that the nuclear safety programs in both CEE and CIS.
- That Structural Funds contribute one third of the total energy grants. Once countries have entered the EU these funds will be available to them.

World Bank

The World Bank has no specific Nuclear Energy Policy. However, it refers to nuclear power both on its Web site in the section on questions and answers – see separate box - and in its Environment Assessment Sourcebook[27]. This lays out the options available to Task Managers when confronted by decisions concerning nuclear power. The main conclusions of the sourcebook on nuclear technology are:

- The Bank took the position that, as the financier of last resort, it was unnecessary for its funds to be used for this purpose.
- Given the limited number of suppliers at this time, procurement on the basis of International Competitive Bidding was not possible.
- Cost typically had come in at two to three times the original estimates, delays had been substantial, and production problems had resulted in output well below capacity.
- It was a technology, which if used safety, would require vigorous standards of construction, maintenance and operation – areas which developing countries have serious problems.
- The economic case is clear: under present cost structures, the Bank would not finance new plants because they are uneconomic. In the unlikely event that nuclear plants become economic, the Bank would not finance them since there are other sources of funds available and, as financier of last resort, Bank funds are not required.
- Nuclear plants in the power sector would not be economic; they are likely to be large "white elephants".

[27] Environmental Assessment Sourcebook, Volume III, Guidelines for Environmental Assessment of Energy and Industry Projects, Environmental Department, WorldBank Technical Paper Number 154, , 1991, ISBN: -0253-7494

Questions and Answers on the World Bank on Nuclear Energy– Fall 1998

Q. Will the Bank fund nuclear energy and, if not, why not?

A. The Bank has never financed a nuclear power station. Nuclear power produces no particulates, sulphur, or greenhouse gas emissions and thus appears to offer a clean, non-fossil-fuel alternative for power generation. However, world experiences with high investment costs, time-consuming and costly approval processes, lack of sustainable waste disposal options, risks of major accidents-together with the Chernobyl disaster-have raised grave doubts about the future viability of nuclear power. Private investors shy away from such risky high-cost investments.

Financing for nuclear development is usually available from suppliers' credits and export financing agencies.

Q. Given its work on shadow prices of carbon, at what price does the Bank believe that nuclear energy is warranted in the fight against global warming?

A. The issues surrounding nuclear power go beyond economic costs alone. Nuclear energy is not acceptable in many parts of the world because of concerns over reactor safety, disposition of nuclear wastes and proliferation of fissile materials. The trade-offs are thus complex and cannot be boiled down to a single carbon shadow value.

Consequently, the World Bank has not lent for any nuclear power plant in CEE and at the present time is unlikely to do so.

European Investment Bank.

The European Investment Bank (EIB) was established in 1958 to serve as the financing institution for the European Community. Although established for the European Union it lends to non-Member States in Africa, the Mediterranean, Asia and Latin America. In addition it lends to eleven countries in CEE but not to NIS. In CEE the Bank's aim to support the development and conversion of these countries economies with a view to progressive rapprochement (to the EU) and integration.

Between 1986 and 1995 the EIB lent or gave credit guarantees totalling over ECU 150 billion, making it one of the largest international financial institutions in the world. About 90% of these funds were allocated for Member States. The EIB is expected to play a major role in funding accession countries conformation to the Community Acquis.

The existence of Euratom, as a potential lender, for nuclear projects probably reduces the pressure on EIB to lend for nuclear projects. However, as mentioned in the Euratom section, the EIB does play a role in assessing the financial viability of projects for the Commission.

Nordic Investment Bank

The Nordic countries that own the Nordic Investment Bank (NIB) have differing views on nuclear power and consequently the NIB does not have a nuclear energy policy. Given the strong statements against nuclear power made by a number of these countries it is likely that some members of the Board of Directors would object to loans for nuclear power projects. In addition, given the relatively small lending ability of the NIB against the usually large borrowing requirements of nuclear projects, it is unlikely that the NIB would be involved in nuclear power projects and to date has not given any technical assistance grants.

However, the NIB is more active in dealing with the radioactive waste problems and is involved in ongoing discussions with a number of Governments, including the Russians on this issue.

Export Credit Agencies

Western Government export credit agencies (ECAs) have been active for decades in Eastern Europe. Initially through the funding of the reactors in Slovenia and Romania which are of western designs. However, in recent years the number of projects and ECAs involved have increased considerably. The major reactor projects that have been funded are shown in the table below.

Table 6.10: Export Credit Agency Involvement in Nuclear Power Projects in CEE.	
Nationality of ECA	Reactor Funded
Belgium	Temelin
Canada	Cernavoda 1
	Cernavoda 2
France	Kozloduy 5 and 6
	Mochovce
Germany	Kozloduy 5 and 6
	Mochovce
Italy	Cernavoda 1
USA	Ignalina
	Kozloduy 5 and 6
	Temelin

The details of these loans have been covered in the country profiles.

The ECAs procedural openness various considerably. In the case of the US, Export-Import Bank, historically the largest ECA supporting nuclear power, gives considerable information on its WWW site on its policy guidelines (http://www.exim.gov/envnuct3.html). This includes a specific policy on Soviet designed reactors, which states: -

- Ex-Im Bank supports the G-7 policy to encourage the early shutdown of RBMK and VVER-440, Model V 230 nuclear power plants because they utilise a reactor that is not enclosed in a containment vessel and lacks an adequate emergency core cooling system. In accordance with G-7 policy, Ex-Im Bank will only support exports which improve the near term and operational safety of these types of plants and which do not extend the useful life of the plants.

- The Soviet-designed VVER-1000 nuclear plants are designed with a containment vessel and an adequate emergency core cooling system. The Soviet-designed VVER-440, Model V 213 nuclear plants contain an adequate emergency core cooling system. Exports for projects involving VVER-1000 and VVER-440, Model V 213 nuclear plants will generally be considered eligible for Ex-Im Bank support, subject to evaluation with reference to Ex-Im Bank guidelines for these projects.

The formation of the socialist/green coalition in Germany in September 1998 has impacted on the Government's ECA (Hermes). The coalition agreement between the two parties' calls for all future export guarantees to respect social, ecological and development aid criteria. How this will be interpreted is still to be seen.

RESOURCES

IAEA Extra-budgetary Programme on the Safety of WWER and RBMK Nuclear Power Plants: http://www.iaea.or.at/worldatom/program/safety/nens/

NUSAC: http://europa.eu.int/comm/dg11/g24home.htm

Nuclear Safety Account: http://www.ebrd.com/english/opera/nucsafe/index.htm

Phare: http://europa.eu.int/comm/dg1a/phare/index.htm

Tacis: http://europa.eu.int/comm/dg1a/tacis/index.htm

EBRD: http://www.ebrd.com/

World Bank Power Sector: http://www.ifc.org/depts/html/power.html

World Bank Questions and Answers: http://www.worldbank.org/html/extdr/faq/faq.htm

European Investment Bank: http://eib.eu.int/

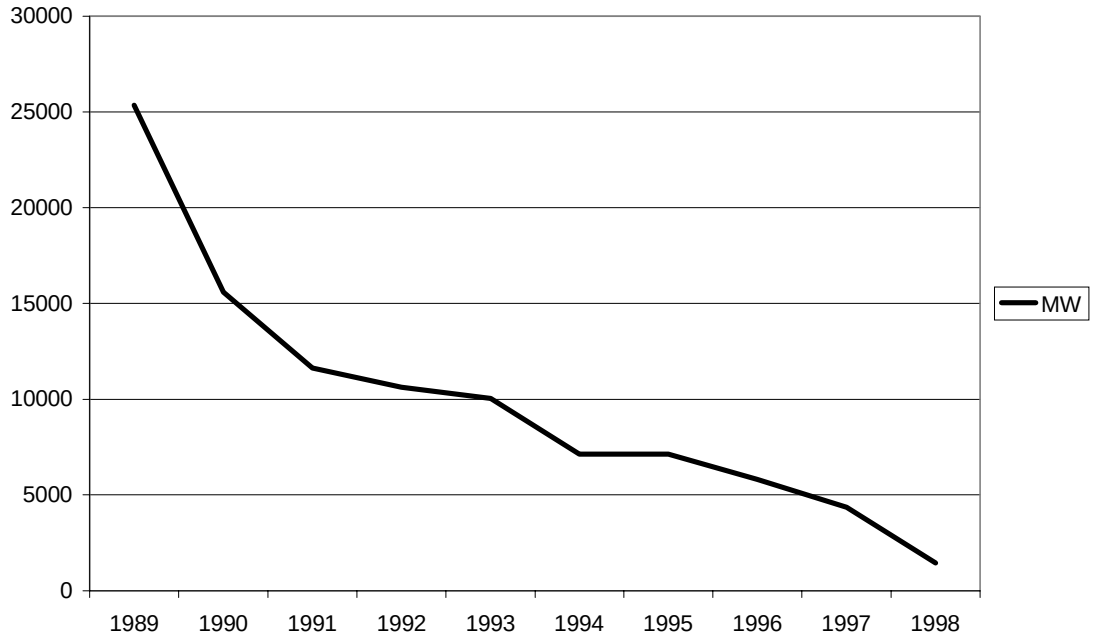
US Export-Import Bank: http://www.exim.gov/envnuct3.html).

CHAPTER 7: THE IMPACT OF ACESSION ON THE NUCLEAR INDUSTRY OF THE EUROPEAN UNION.

CURRENT STATUS OF NUCLEAR POWER IN EUROPEAN UNION

Despite its historical strength within the predecessors of the EU, nuclear power is on the decline. The industry's decline within the EU results partly from the fact that later entries to the EC, such as Austria, Greece and Denmark are less supportive of nuclear technologies than were its founding members. However, the main reasons for this decline are the increasing liberalisation of the European electricity market and the widespread recognition that nuclear power should no longer receive support from the State at the high level it had previously enjoyed. This, along with the introduction of less expensive, quicker to put into service and less contentious electricity sources, has made nuclear power less or uncompetitive and resulted in a dramatic halt in orders for new nuclear power plants, as can be seen below.

Figure 7.1 : Capacity of Nuclear Reactors Under Construction in European Union



Source: European Commission

The collapse of new orders in the EU is total and by the end of the millennium there will be no reactors under construction within any EU Member State, a situation not experienced since the conception of the EEC.

Reviewing the current status of the nuclear industry in each Member State shows the demise of the nuclear industry.

See side box.

Current Status of Nuclear Industries in EU.

Non-Nuclear:

Austria, Denmark, Greece, Ireland, Luxembourg, Portugal.

Phased – Out.

Italy: Referendum in November 1997 halted new construction, in 1990 Parliament approved measures to dismantle the countries three operational reactors.

Phasing – Out.

Netherlands: The Dodewaard nuclear power plant was disconnected from the grid on 26 March 1997 exactly 28 years after it was opened. Borssele, the country's only other nuclear power plant is scheduled to close in 2004. The Netherlands plans to meet its electricity needs by making greater use of natural gas.
Sweden: The country decided in a referendum in 1980 to phase-out nuclear power by 2010. This timetable has slipped and the debate is now on future of Barseback, the first reactor to be closed. In June 1999 the Supreme Court ruled that the closure of Barseback is valid and will be closed in November 1999. Unit 2 will be scheduled to close in July 2001.
German: The Coalition Agreement between the Social Democratic Party of Germany (SPD) and the Green Party (Bündnis90/Die GRÜNEN) Bonn, 20 October 1998 agreed that the phase out of the use of nuclear power will be comprehensively and irreversibly regulated by law within this legislative period. However, the speed at which this is to happen is still unclear.

Ongoing Nuclear Power Programs.

Belgium: The Government has appointed a special commission to review phasing out nuclear energy. Belgium has seven nuclear units, with a 1997 nuclear share just over 60%.
Finland: The Finnish parliament rejected a fifth unit in 1993. However, the new Government, elected in 1999 may debate the issue. Finnish Prime Minister was non-committal, reiterating that "the government program does not include any obstacles to the further construction of nuclear power generating capacity, although parliament will have the power to decide on the issue". The governing coalition is split on the issue, with the Conservative Party in favour while the Greens are strongly against.
France: Civaux –2 is scheduled for completion and connection to the grid in 1999. When completed it will be last reactor in Western Europe. The government has authorised the first stage of decommissioning of the Superphenix prototype fast reactor.
Spain: In 1983 the Government initiated a moratorium on construction of new plants, stopping work on five reactors. In April 1991, the Government reaffirmed the moratorium on nuclear construction. However, in 1998 the Spanish environment minister, Isabel Tocino, made a dual commitment to increasing nuclear output and extending the operating lives of Spain's nine existing nuclear power plants, as the key points in the country's plan to reduce greenhouse gas emissions and meet its Kyoto Protocol commitments.
UK: In December 1995, British Energy announced the cancellation of the two proposed stations. In March 1997, the proposals for the construction of a low and intermediate level radioactive waste dump; the program had already cost £250 million.

At the beginning of the 1990s the nuclear vendors hoped that CEE would be a lifeline for their moribund industry. It was expected that Western pressure and subsequently funds would be made available to: -

- Overhaul the operating reactors – large scale retrofitting
- Complete existing reactors.
- Replace the Soviet designed reactors with Western models.

Calculations by the EBRD, IEA and World Bank in the 1993 showed that investment to reduce nuclear risk would be over $20 billion dollars (see table 7.4) while others put the figure much higher. It is clear that none of the reduction in nuclear risk scenarios envisaged in the 1993 report have been carried out. In particular grants and loans from Western institutions have not matched the predicted requirements, in the areas of replacement power capacity, completion of reactors and upgrading.

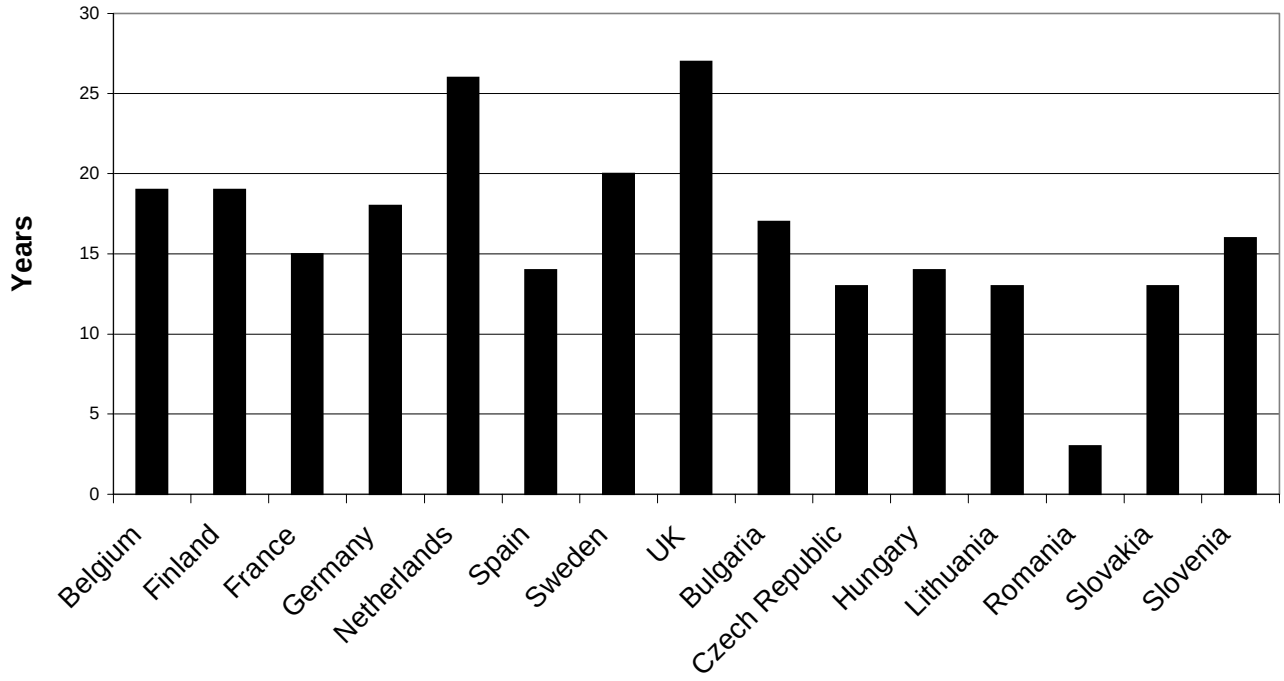
In some cases, notably in the Czech Republic, Hungary and Slovakia significant upgrading work has taken place, however, this has largely been by drawing on the countries existing technical expertise and financial resources. While the completion of reactors that were envisaged have not taken place yet (Greifswald and Stendal – former Eastern Germany; Belene – Bulgaria); or have been largely funded and undertaken by Eastern European organisations (Mochovce – Slovakia).

NEW NUCLEAR BUSINESS:

As has been noted, the construction of nuclear reactors in the EU has stopped and with no orders on the horizon, no new construction programs are expected in the near term. The nuclear component manufacturers are increasingly turning their attention and skills to part replacements and extending the life of the existing reactors (Plant Life Extension – PLEX). Given the high capital costs of nuclear power plants such developments have always been in the interests and to the benefit of the plant owners, but the current situation increases the research into possibilities of PLEX and is pushing the boundaries for extending the reactors operational life.

Already within the EU reactors are being operated in excess of 40 years – the Magnox reactors in the UK – and the average operating age of the EU fleet is 19 years. In CEE the average age is about 20% less at 14 years. – As can be seen the graph below.

Figure 7.2: Average Operating Life of Existing Reactors



Source: Nuclear Engineering International.

The average age difference of the CEE and EU reactors is likely to increase in the coming years for two reasons.

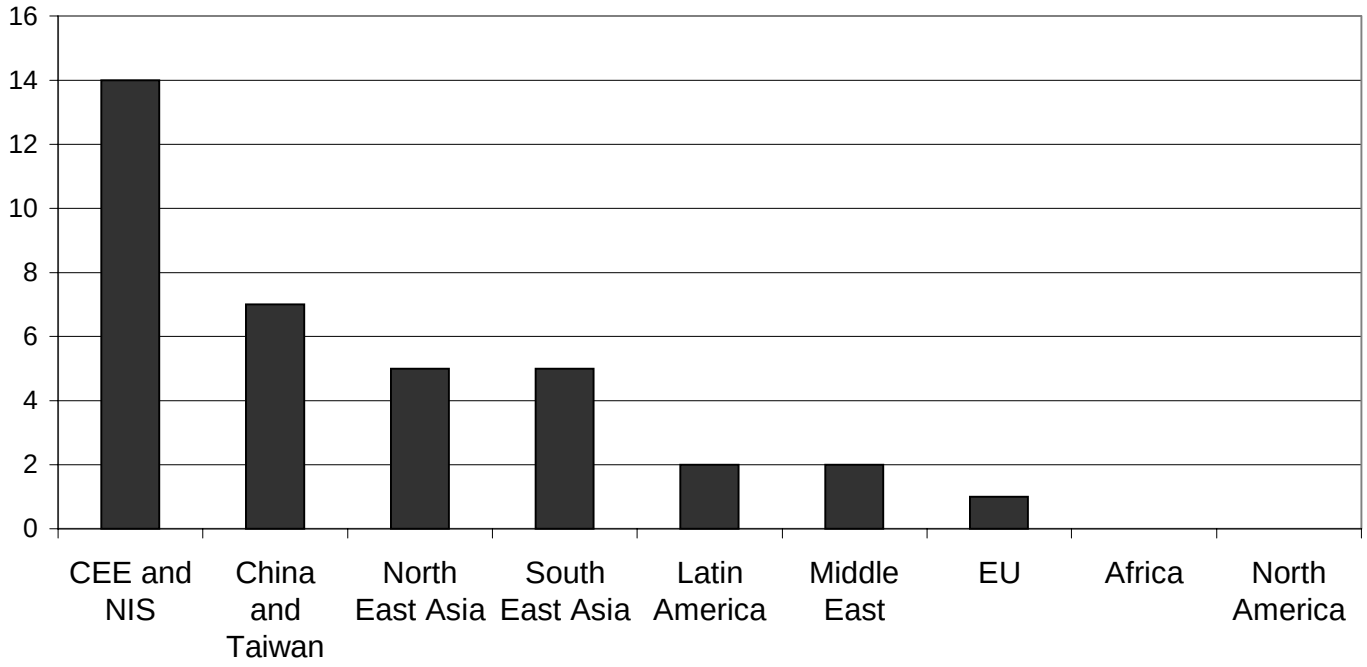
- Firstly, if the first generation of reactors currently operating in CEE is removed from the calculations (as they are supposed to be closed within the framework of accession) then the CEE reactors are on average 40% than those in the EU.
- Secondly, as has already been mentioned the construction program in the EU has stopped, the last reactor at Civaux is scheduled to come on line in 1999. However, in CEE there is a number of reactors under-construction.

Table 7.1: Reactors Under Construction in Central and Eastern Europe

Country	Number of Reactors	Locations
Czech Republic	2	Temelin
Romania	1	Cernavoda
Slovakia	1 or 3	Mochovce

The figure below shows both how few reactors are under construction around the world but also, that CEE and the NIS is the main region where expansion of the nuclear industry is taking place.

Figure 7.3: Nuclear Power Reactors Underconstruction at the end of 1998



Source: IAEA

Although there are many problems with investing in CEE countries, such as lower electricity tariffs and in some cases low collection rates, in many ways the prospects for nuclear power looks better in this region than in the existing European Union.

ELECTRICITY MARKETS

Within the European Union's energy sector there are three key developments presently underway.

1) The Enlargement of the European Union.
2) The liberalisation of the EU's Energy Markets
3) The construction of links between previously separated energy networks.

The Enlargement of the European Union:

The reform of the energy sector to confirm to the EU's Acquis is expected to be an expensive and long-term project. The table below summarises the Commission's opinion, through Agenda 2000 of the status of the Energy sectors on the outset of Accession negotiations.

Table 7.2: The Commission's Opinion of the State of the Energy Sector in Accession Countries with Nuclear Power programs.	
Bulgaria	For energy, increased efforts must be achieved to prepare for accession, in particular on monopoly operations, price fixing and state intervention in the solid fuel sector. Bulgaria as a nuclear power station at Kozloduy, which produces around 40% of the country's electricity. It must in the medium term modernise the units for which this is possible, so that they meet internationally accepted standards; and keep its understanding to close those which cannot be modernised according to the conditions set in the 1993 Agreement. Bulgarian must make a number of modifications to its legislation to comply with Community rules in the nuclear sector and to respect international regimes.
Czech Republic	On energy, the Czech Republic has a substantial nuclear power program, which is due to expand further. The modernisation program needed to bring the nuclear plants at Dukovany and Temelin up to internationally accepted safety standards must be completed within 7-10 years. The Czech Republic should be able to comply with the rest of the Acquis in the medium term, given further work on energy pricing, state intervention in the solid fuel sector and access to networks.
Hungary	For energy efforts are still needed in respect of monopoly operations, price fixing, accession to networks and state interventions in the solid fuel and uranium sectors. Hungary has a nuclear power station at Paks which produces nearly 40% of the country's electricity. It needs to modernise this in the medium term in order to bring it up to internationally accepted safety standards. It will also need to find a solution for nuclear waste.
Lithuania	In the energy field, Lithuania is heavily dependent on nuclear power generation. It has committed itself to closing the nuclear plant at Ignalina, and must maintain the agreed timetable for this. In the meantime it must make the necessary short-term adjustments to bring safety procedures to internationally accepted standards. No other major problems are foreseen for Lithuanian accession in this sector, though there is a need for further work on monopolies, access to networks and energy pricing.
Romania	For energy efforts are still needed on price fixing, state intervention in the solid fuel and uranium sectors and the operation of monopolies. Romania has at Cernavoda a nuclear power station which produces around 8% of the country's electricity. It was built in accordance with western technology. A solution will need to be found to the problem of nuclear waste
Slovakia	As for energy, work is still needed on operation of monopolies, price fixing, and access to networks and state intervention in the solid fuel sector. Slovakia has a nuclear power station at Bohunice that produces nearly 50% of the country's electricity: and it constructing a new power station at Mochovce. It must in the medium term modernise two of the units at Bohunice to bring them up to internationally accepted safety standards; and must take the appropriate measures to close the units which cannot be modernised. A long-term solution needs to be found for nuclear waste.
Slovenia	In energy efforts are still needed on monopoly operations, price fixing, access to networks and state intervention in the solid fuel sector. Slovenia has a nuclear power plant station at Krsko, which it shares with Croatia, and which produces 20% of its electricity. It was built according to western technology. A solution needs to be found for its nuclear waste.
European Commission. 1997.	

Agenda 2000 notes that the reform of the energy sector is a fundamental part of the economic and social restructuring of CEE. At present there are significant differences between the energy sectors in the EU and CEE relating to the legacy of past events, e.g. low efficiencies in production, distribution and consumption, lack

of investment and inadequate legal and regulatory frameworks. The Commission notes that considerable investment will have to take place, most of which will come from the private sector.

The energy sector presents special challenges for accession countries in their attempts to confirm to the Acquis, in a number of areas: -

- There is no clear guidelines or even agreement from current Member States on how best to regulate a partially competitive and partially regulated market.
- In some instances there is the need to control the market for reasons of security of supply and promote energy efficiency which will require understanding of the justification for government intervention.
- The identification of the legitimate information needs of government in managing a competitive market can be contentious and a difficult process.

Analysis has been undertaken for the former Eastern Germany, which concluded that bringing standards of the East to that of Western Germany would cost around ECU 70 billion. Therefore, the full cost of the energy Acquis will be substantial, but has not been assessed for each country in all areas. This is said to be because firstly it is difficult to get information and it is difficult to make comparisons across countries. Secondly, it is difficult and not necessarily logical to separate costs of harmonisation from the costs of general modernisation and restructuring.

It is clear however, that a significant part of the final cost for conforming to the Acquis will relate to the investment required for environmental harmonisation. In 1997 an economic analysis undertaken on behalf of the European Commission concluded that conforming to the Environmental Acquis in most sectors, but not nuclear, would cost around ECU 120 billion, as can be seen in the summarising table below.

Table 7.3 Best Estimates for total environmental investments in the CEE

Sector	Total Investment (Billion ECU)	Cost/capita (ECU)	%GDP
Urban Waste Water	33.1	270	0.62
Industrial waste water	5	48	0.11
Drinking water	17.5	168	0.39
Air	53	483	1.07
Waste	9.7-23	93-218	0.21-0.5
Total	122	1168	2.9

Source: EDC Ltd and EPE asbl, April 1997

Therefore, in the Coal sector the installation of technology to reduce atmospheric emissions from the power sector will require the largest investment of any single sector as be seen above, costing ECU 50 million. For nuclear power stations the technical standard required is less clear and consequently estimates for the investments required are more varied and range from ECU 4-5 billion (European Commission – Agenda 2000) to ten of billion ECU from NGOs.

The Commission outlines its current position on accession and the environment in its document "Guide to Approximation of European Union Environmental Legislation". This lists the 70 or so Directives and 21 regulations that make up the body of EU legislation those new members will have to align their national legislation and administrative practises too, the so-called environmental Acquis. For the energy sector their approximately 20 Directives and regulations that must be conformed to. The Commission has stated that "*while the adoption of the Union's environmental rules and standards is essential, none of the candidate countries can be expected to comply fully with the Acquis in the near future, given their present environmental problems and the need for massive investments"*.[28]

The strategies presently being developed and implemented will therefore set in train investment plans that are likely to have consequences for decades to come. The operating lives of the existing operating facilities may be significantly altered to conform to EU legislation – they may either be cut short as facilities are retired early or their operational lives extended following retrofitting.

Liberalisation of the Union's electricity and Gas markets.

Electricity:

In February 1999, the EU's Directive on Rules for the Internal Market in Electricity entered into national law. This Directive requires the gradually opening up the electricity market to competition and enables consumers to purchase their electricity from a variety of sources, including foreign utilities. Although considerably water-down from the Commission's original, the Directive requires over a fixed period the phased implementation of competition within the market. The main rules of competition are: -

- Member States will initially, February 1999, open up 22% of their national markets, which is calculated as consumers using more than 40 GWh/yr.
- The threshold for competition will decrease in three-year trenches. Firstly, three years after the date of Directive's implementation, 27% of the national market will be open to consumers, affecting users of

[28] Agenda 2000 Volume 1 – Communication: For a Stronger and Wider Union, 15th July 1997, Doc/97/6, page 65

greater than 20 GWh/yr. In a further three years the threshold will be lowered again, to 9 GWh/yr to allow one third of the market to compete in the market.

- After this further assessments will be made by the Commission and decided by the Council as to whether to open up the market even further.

In some countries such as Sweden and the UK there is already no minimum thresholds for electricity and individual households can chose their electricity supplier. Therefore although the Directive appears conservative, it is expected that the market will encourage a much greater exchange of electricity than is minimally required.

Gas:

In February 1998 Member States reached a common position on the gas internal market with the Directive Concerning Rules for the Internal Market in Natural Gas. This is similar to the electricity market Directive, in that it will gradually open up the market for consumers to choice their supplier. One important difference is that Member States will have to make a choice between a system of 'negotiated access' and 'regulated access'. 'Negotiated access' would require transportation companies to negotiate 'voluntary commercial agreement in good faith' with eligible customers wishing to use the system. 'Regulator access' would give eligible customers the right to use transportation systems on payment of published, regulated tariffs.

The Directive proposes that the market be opened up starting in mid 2000 to customers with an annual consumption in excess of 25MMcm. In Mid 2003, customers must consume 15MMcm and mid 2008 5MMcm. However, as with the electricity market this is the minimum requirements and many countries will move more rapidly to a liberalised market.

Trans-European Energy Networks:

The European electricity networks have never been fully interconnected. Prior to 1989, due to different operating frequency ranges and reserve capacities there was very little movement of electricity across the politically divided continent. The main regional connections were: -

- The Union for Co-ordination of Production and Transmission of Electricity (UCPTE): most of the Western European countries.
- The Unified power System/Interconnected Power System (UPS/IPS): former Soviet Union countries.
- Central Network: Czech Republic, Hungary, Poland and Slovakia.
- NORDEL: Nordic Electricity Grid.

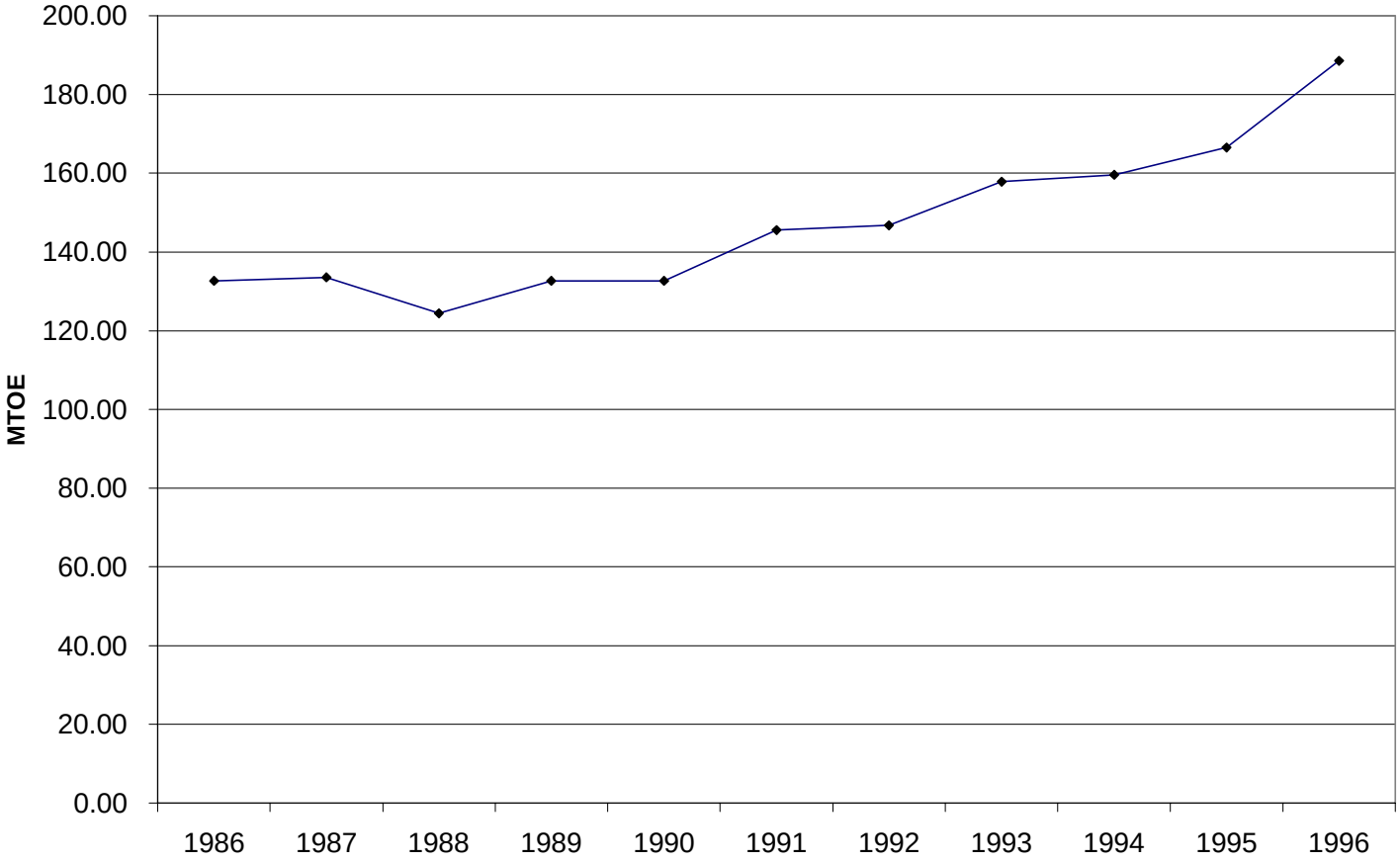
Today, however, it is radically a different picture, with the Central Network now fully integrated into the UCPTE and parts of the NORDEL network also become permanently connected, in particular with the development and construction of the Baltic ring. These connections have created a regional electricity block and a new acronym TESIS (Trans European Synchronously Interconnected System). In addition trial connection are underway to join up parts of the UPS grid with TESIS in Western parts of Ukraine. Paving the way for a fully compatible European grid, well beyond the geographical area of the current round of enlargement.

POTENTIAL CONSEQUENCES:

Dependency on Imported Energy:

Natural gas is the fuel of choice for new construction throughout the European Union, as can be seen below. The reasons for the so-called "dash for gas" are economic, financial and environmental. However, this is having a significant impact of the overall energy balance within the European Union. In 1996 the EU imported 39% of its gas from three major suppliers. These are the NIS (41%); Norway (31%); and Algeria (25%), with only the remaining 3% coming from a variety of other sources. This level of dependency has been relatively stable over the past years (35% in 1985 and 42% in 1990). This stability is despite increase in gas use as can be seen below.

Figure 7.4: Natural Gas Consumption in EU



Source: European Commission.

The relative plateau of the percentage of imported gas that has been seen in the last few years is due to a significant increase in domestic production, notably from the UK and the Netherlands. Their increase in production resulted in a 4.4% increase in production in the EU in 1995 and 13.2 % in 1996. However, overall gas imports into the EU are expected to increase dramatically. The Commission predicts that this rapid rise in imported fuel will further increase to 74% by 2020, an increase from 6% in 1974[29].

Furthermore, as the main sources of Gas are not in the proposed new members of the Union, the enlargement will not decrease this dependency on energy import but will increase it. In particular, the introduction of the electricity market in CEE is likely to have on the short term the same results as in the Union and lead to an increase in gas use. According to Commission gas imports, mainly from Russia are expected to double in CEE by 2020.

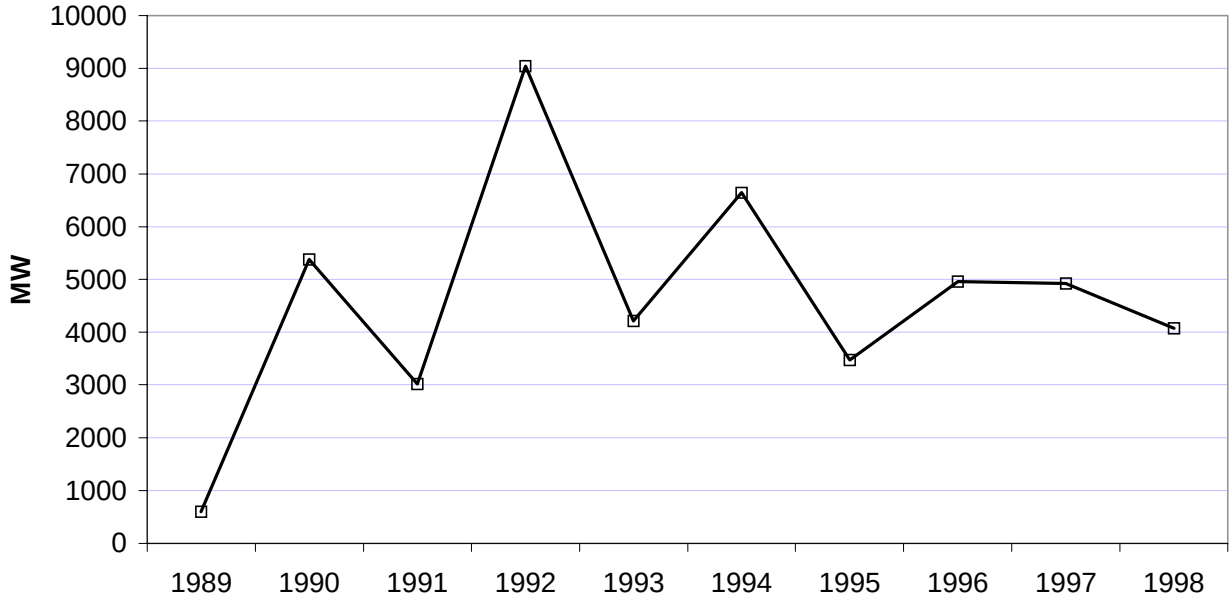
Increasing Dependency on One Energy Source.

As has been mentioned there is an increasing use of natural gas for electricity generation. Gas is being used both to replace of existing capacity, mainly coal and to a lesser degree nuclear while also being used to cover

[29] European Energy to 2020, A Scenario Approach, Energy in Europe, Special Issue, Spring 1996, DGXVII, page 15

new demand. As has been shown previously the construction of nuclear power plants in the EU is all but stopped. While the ordering of new fossil fuel power stations which use only coal has also decreased. The figure below shows how the orders of new gas stations in the EU continues with ferocity.

Figure 7.5: Gas Power Stations Ordered in European Union Member States 1989-1998



Source: European Commission.

The Enlargement of the EU is again unlikely to significantly reduce this trend and may accelerate it. In particular, by the time of entry it is not expected that any nuclear power stations in the current CEE will be under-construction and many may be forced to close under the Accession agreements. It is likely that their replacements will be gas fired.

Disparity of Environmental Standards:

Agenda 2000 notes the full compliance with the environmental Acquis could only be expected in the long to very long term. As has been shown in Figure 8.3 the most expensive medium to conform to the Acquis will be air, of which emissions from power stations will be the largest share. The lower environmental standards will have, on the short term, lower production costs. This may allow the sale of electricity throughout the Union that is produced in facilities that have lower environmental standards than that required in the EU. The electricity will physically be able to be imported through the Union, due to the TENs network and cannot be prevented, once accession countries have jointed the Union, due to the liberalisation of the European electricity market. This would lead to a distortion of the European electricity market and an increase in production in areas with lower environmental standards. This may especially be the case for nuclear power programs that have less

specific requirements than other sectors, e.g. there are specific requirements for coal stations regards their So2 emissions as opposed to the general safety guidelines for nuclear power plants. The potential importation of electricity from reactors can most graphically be seen in Lithuania. Negotiations are underway to construct an export line from Lithuania to the Poland. This will allow the exportation of 6TWh of electricity annually to the EU electricity grid.

Furthermore, international agreements designed to slow down the potential impact of climate change may be circumvented. Under the Kyoto agreement signed at the end of 1997, countries will be able to sell their unused CO_2 emission permits. During the negotiations, targets for reductions in CO_2 emissions were set for 2010. If a country believes that by 2008 it will have lower CO_2 emissions than agreed, it is expected to be able to sell its "under-pollution" to another party. Before emissions' trading has started, it has been undermined by the so-called problems of "hot air" as some feel that the targets for a number of countries, in particular in Eastern Europe and the former Soviet Union, were set too low. This will allow emissions permits from these countries to be sold to third parties without any CO_2 abatement effort at all. By 1995, Russia had already reduced its CO_2 emissions from fuel combustion by 34% and Ukraine by 36%, compared to 1990 levels**.** These reductions came about not through conscious efforts, but instead through a drop in industrial output. Projections for 2010 indicate that more than 80% of all the potential CO_2 permits on offer, corresponding to about 2% of emissions in 1990, will come from Eastern Europe and the former Soviet Union. The biggest suppliers of 'hot air' permits are Ukraine and Russia. The maximum "hot air" on offer will be around 113m tons from Ukraine, 86m tons from Poland and 72m tons from Russia[30]. The countries of CEE and CIS therefore have a far greater potential to reduce CO_2 emissions than is reflected in the Kyoto emissions reduction goals.

As well as enabling countries to trade CO_2, the Kyoto agreement may encourage the export of electricity. CO_2 is credited at the source of production. Therefore, Russia or Ukraine could generate electricity and have the subsequent CO_2 emission credits, but then export the electricity. Such a system may have economic advantages for foreign utilities, especially if they are close to their CO_2 ceiling. Deals like this are likely to happen, especially with the increasing cross-ownership of utilities and generating companies. For example, a German utility that has already reached its CO_2 ceiling may import its electricity from Ukraine, where it is generated at a power station also owned by the same German utility. Thus, the German utility would not have to implement CO_2 abatement technology and would still be generating all the electricity, while at the same time benefiting from less stringent environmental standards.

[30] Flexibility Mechanisms: Which Path to Take to Kyoto? Fanny Missfeldt. RECIEL, Volume 7, Issue 2, 1998, page 131

CHAPTER 8: CONCLUSION

AWAKENING TO THE DANGERS OF EASTERN NUCLEAR TECHNOLOGY.

Three events in the 1980's and 90's set in train a process of attempting to reduce nuclear risk in Central and Eastern Europe and the former Soviet Union. These events were: -

- The accident at Chernobyl unit 4 in April 1986.

This re-activated anti-nuclear feeling across the world and lead to many initiatives to remove nuclear power in Europe, including the abandonment of nuclear power in Italy and the halting of numerous order and construction programs. Chernobyl showed the European public that accidents involving nuclear power plants had long lasting and transboundary impacts. Furthermore, it reinforced an already held view that existed in Western Europe that Soviet designed technology was not as competent as that of the West and that Soviet society was coming apart. Some historians even attribute the Chernobyl accident to the beginning of perestroika and glasnost introduced by Mikhail Gorbachev.

- The political changes in CEE and NIS in 1989 and 1992.

The opening of the boarders into Eastern Europe increased the access of western media and businesses into the Eastern European nuclear power plants. This lead to a rash of high profile stories showing the poor state of the nuclear facilities. These dangers were increased at that time due to the political changes and in particular the removal and/or departure of many of the Russian operators. The political changes and subsequent reform of the industrial sectors also lead to significant reductions in the energy and electricity demand in the region.

- The closure of reactors in former Eastern Germany in 1989 and 1990.

The re-unification of Germany resulted in the closure of all operating Soviet designed reactors, the five VVER 440s at Greifswald (four 230 designs and one 213 reactors) and the non-completion of the partially built VVER 440-213 and VVER 1000 reactors at Greifswald and Stendal respectively. Their closure was and has been seen as a benchmark for the safety of the VVER reactors as detailed technical and economic assessments were undertaken to review the feasibility of the reactors receiving an operating license with Germany and hence the European Union. It also reinforced the view that Soviet designed reactors were significantly inferior, in terms of safety standard, that reactors in Western Europe.

Western European and International Institutions took up the cause and very soon funds were being pledged to repair reactors in Eastern Europe and the former Soviet Union, much of the initial and subsequent work was

lead by the European Commission through the Phare and subsequently Tacis programs. The G7 expressed concern and in 1993 developed scenarios for reducing nuclear risk across the region. These scenarios required tens of billion of dollars of investment for replace capacity and large scale retrofitting and completion programs. These events lead many to believe that some of the Soviet designed reactors in Eastern Europe would be closed before 2000.

REACTORS NOT CLOSED AND CONTINUED CONSTRUCTION.

However, despite these developments many of the reactors targeted for closure, the RBMKs and VVER 440-230s are still operating. In fact, the only reactors which have been closed are at the Chernobyl nuclear power station where unit 2 was closed in 1992 following a fire and unit 1 was closed in 1996 – the last remaining operational reactor, unit 3 is scheduled for closure in 2000. At other stations, mothballed reactors have even been re-opened, as occurred at Medzamore in Armenia. In Central Europe, far closer to the Western public, reactors have not been shutdown and agreements seeking their closure have been ignored or circumvented.

Following the Chernobyl accident many of the construction programs in CEE and the CIS were suspended or abandoned due to public pressure. The political changes in 1989 lead to the continuation of this suspension for economic reasons. However, today many of the construction programs have been restarted and reactors are being completed. In particular in Mochovce in Slovakia one reactor was completed in 1998 and the other is due for completion in 1999, despite significant opposition from neighbouring Austrian, other countries in the EU and environmental groups across Europe. While in the Czech Republic the completion of Temelin continues, if slowly, again against the wishing of neighbouring Austria.

REASONS FOR CONTINUED SUPPORT OF NUCLEAR PROGRAMS IN CEE.

Economic:

The desire by Eastern countries to continue operating their reactors is not surprising and is largely but not exclusively driven by economics. The decrease in electricity demand in the early 1990s did not lead to the closure of reactors, far from it, but resulted in an increase dependency as other power stations were switch off and the nuclear share of electricity supply increased. As base-load power plants nuclear reactors can generate huge revenues for their operators. Estimating these revenues is not possible without detailed information as to the levels of cash collection, barter payments and the tariffs. In particular, the tariffs vary significantly between different consumer groups. Despite this the table below gives rough estimates of the potential revenue that

nuclear power stations in CEE could generate. Therefore, the electricity sales from CEE nuclear power plants could generate revenues of around € 4 billion per year.

Table 8.1 : Potential Revenue Generation of Nuclear Power Plants in CEE			
Country	TWh / year - 1998	Euro/kWh (medium sized industry)	Total Revenue million Euro
Bulgaria	15.49	0.051	789
Czech	12.35	0.024	296
Hungary	13.12	0.077	1010
Lithuania	12.29	0.035	430
Romania	4.90	0.044	216
Slovakia	11.39	0.067	763
Slovenia	4.79	0.086	412
TOTAL	64.33		3916
Source: FT Power in Eastern Europe/IAEA			

In addition to the straight revenue generating capacities of the reactors, the relative costs of other fuels make nuclear power even more attractive under current conditions; in particular the changing political landscape resulted in higher gas and fuel costs. In some cases the Russian gas monopoly –Gazprom- was charging higher prices to Central European countries than it was to members of the European Union, despite longer transit. As a large percentage of the costs associated with gas generated electricity are fuel based, any increase in gas prices will impact of the overall electricity price. Therefore increases in gas prices will increase the incentive to continue to operate the reactors, from a balance of payments perspective.

Due to the large construction costs there is a tendency to operate nuclear power stations as long as possible. This can be seen across the board in Western facilities as plant life extension programs (PLEX) are proposing to increase the operating lives of facilities to fifty or even sixty years. Recent analysis in the West has found that PLEX can cost as little $10-50/installed kW, compared to the cheapest non-nuclear alternative for base-load electricity is $400-500/kW. In Eastern countries the desire to prolong operation is no less and may be fiercer. Plant life extensions are being discussed for all the currently operating VVER 440-213 reactors in Bohunice V-2; Dukovany and Paks.

Funds established to pay for decommissioning and waste management have only recently been established and the rules and subsequent payments are not always, even today, fully complied with. Therefore, strong economic arguments are put forward to delay early closure to enable these accounts to gather revenue.

Political:

Over and above the desire to reduce their balance of payments deficits by decreasing gas use, many CEE countries wanted to reduce their dependency of Russia for their fuel. Until recently, the only major supplier to Central Europe was Russia. This situation is changing rapidly, both due to the construction of pipelines from the CIS, thus diversifying the routes and decreasing the transit risks and the construction of new pipelines from sources outside the CIS into CEE countries. In 1998 the Czech Republic agreed to receive gas from Norway breaking the Gazprom monopoly in CEE. However, until recently it has been said that it is politically unacceptable for countries to increase their dependency by switching off their nuclear power plants.

In most cases Russian suppliers are also responsible for the delivery and removal of nuclear fuel. But as this occurs only about once a year it is perceived as a smaller dependency that the daily supply of gas. Although there is logic to this argument even the occasional supply of fuel is has political ramifications. There is only one manufacturer in the world for RBMK fuel, Russia, and given the current market there is unlikely to be another. In the 1990's Russia used the threat of non-delivery of nuclear fuel to Ignalina as a way of gaining concessions for Belarus on the price charged for electricity supplied from Ignalina.

Prestige:

The development of the electricity network and nuclear power was seen as a fundamental part of the Soviet Union and thus were prestige technologies. Furthermore, as with Western nuclear programmes, there are links with the military programs, from the design and development of technology to the supply of uranium and the extraction of plutonium. Thus both with the industry and within certain parts of the governing classes there is little desire to see the reduction of the status of the nuclear industries.

Western European Nuclear Interests in CEE:

New Markets:

Some Western players are also interested in seeing the continuation of the eastern reactors for commercial and strategic interests. Within the European Union the nuclear construction program has stopped. 1999 will see the completion of the last reactor currently under-construction, in France at Civaux. Although there is an active PLEX program this is probably in of itself insufficient to support the order needs of the Western nuclear construction industry. As a consequence the Western nuclear industry is actively seeking orders throughout the world and in particular in recent years in South East Asia, China and Eastern Europe and the NIS. However, the currency collapse in South Eastern Asia and the NIS have significantly reduced the opportunities for foreign

investment, while in China current plans exclude further sales for the next few years. Therefore an expansion into Eastern Europe is becoming increasingly attractive for Western European firms.

Eastern Europe along with the NIS has the highest number of reactors under-construction anywhere in the world. In addition and in many ways more importantly many of these projects have had construction suspended often for financial reasons. Western firms, with support of their Government export credit agencies are therefore able to offer both technical assistance and financial support for the completion of the reactors. Furthermore, given the need for CEE countries to conform to Western European standards the experience of engineers from EU countries is invaluable. Consequently, Eastern Europe is unparalleled in the opportunities it creates for Western European firms to complete part built reactors. This has already been seen in Mochovce and Temelin, and there are still a number of part built reactors at Mochovce and Belene which have already been considered for completion by Western firms.

The process of enlargement requires that new members confirm to the environmental Acquis within the nuclear sector and that the safety of the nuclear reactors and the management of nuclear waste is comparable to that prevailing in the EU. This will require both investments, which offers opportunities for Western firms, and expertise in interpreting and implementing EU legislation. Retrofitting programs are currently being undertaken or being proposed at all second generation reactors (VVER 440-213 and VVER 1000), Kozloduy 5 and 6 in Bulgaria; Dukovany and Temelin in Czech Republic; Paks in Hungary: Bohunice V-2 and Mochovce in Slovakia.

Closure of First Generation of Reactors:

The closure of the first generation of reactors has advantages and disadvantages for the Western nuclear industry. On the negative side, the first generation of reactors have received the majority of the bilateral assistance funding – 56%. Should the reactors be closed it is unlikely that the funds presently earmarked for the first generation of reactors would be transferred to other areas of nuclear safety. Rather, should the reactors that are more notorious be closed and the level of western public interest decrease, the funding for the whole nuclear safety programs might decrease.

Accession and conforming to the overall Acquis will lead to significant inward investment in all sectors. Conforming to the environmental Acquis alone is expected to cost about € 120 billion. Such investment demands will reduce the likelihood of the construction of new nuclear reactors, which are capital intensive, thus reducing the chances that any replacement capacity for the first generation of reactors will be nuclear. Thus closure of the first generation of reactors will reduce the share of nuclear in the electricity supplied.

Finally, in each accession country it is one company, usually state owned, that operates all the nuclear power stations, which is different from many EU countries. Any increase in pressure from Western Institutions to seek the closure of the first generation of reactors may have an impact of the goodwill of Eastern operators to offer contracts for work in other nuclear sectors to Western firms. This was hinted at Kozloduy in Bulgaria, were unit 1 was restarted on January 20th 1997 following the publication of a report by an international safety expert, which concluded that Kozloduy unit 1's reactor pressure vessel was not a life limiting factors. This international panel was made up of representatives of Siemens, the Russian Kurchatov Institute and Bulgarian Academy of Science. The resolution of this long-standing conflict with Western Experts was said by Bulgarian officials to leave the plant management freer to concentrate efforts to its new program to upgrading Kozloduy 5 and 6, of which German and Russian firms are expected to be involved.

Nuclear Waste:

In the era of the Soviet Block Russia supplied and received back spent nuclear fuel to countries CEE and the NIS. Consequently, these countries did not develop high level radioactive waste management strategies or facilities. In the 1990s this changed with the passing of decrees by the Russian Government which required that after reprocessing all wastes had to return to the country of origin, similar to the modern reprocessing contracts in Western Europe – at France and the UK. In addition, the price of reprocessing in Russia was reported to have increased significantly, from $650 to $1000/kg. As in other areas, there is political trend to reduce dependency on Russia in the energy sector and thus a desire to become more independent and thus deal with nuclear waste domestically. Consequently, in most accession countries Western firms have been active in the construction of high-level waste and other waste storage facilities.

Decommissioning:

Despite these reasons why a number of firms might be against closure there are also a number of positive financial and political motivations for the Western nuclear industry to seek the closure of facilities. There is an increased awareness that many of the reactors will not closed unless financial assistance and technical expertise is forthcoming from the West to deal with decommissioning. A forerunner to such assistance is seen in a similar project in Ukraine, where an international initiative is underway to help pay for the construction of a second sarcophagus around Chernobyl as part of an assistance package that seeks the closure of the last reactor in 2000. Similarly, but much smaller Western technological assistance programs are being undertaken at Ignalina and Kozloduy to assess closure and decommissioning plans. The operators of reactors targeted for closure are quick to point out that their early shutdown will reduce the revenue that they generated some of which is put aside and necessary for decommissioning. Clearly given the current levels of grants from Western

sources the international community is not in a position to fully fund the decommissioning of reactors. However, discussions are taking place to look how meaningful assistance can be given in this area, as requested by the December 1998 Council of Ministers statement of Nuclear and Accession. One suggestion has been put forward is to refocus the NSA into funding decommissioning projects. However, such a more would require replenishment of the NSA's funds and it is far from clear whether the international community wishes to do this.

Over-riding Political Desire for Closure?

By far the strongest motivation for closing the first generation of reactors is political. The continual discussions of the dangers of these reactors have a negative impact on all nuclear facilities. Publicity showing that reactors are dangerous in Eastern Europe will reinforce to a section of the population the potential dangers of nuclear technology in general. This was widely seen following the accidents at Three Mile Island and Chernobyl, when these events lead to an increase in anti-nuclear sentiment across Europe. In both cases they resulted in decisions to close down national nuclear power programmes. There is a real concern, which is almost certainly correct, that should another significant accident occur then the nuclear industry in the EU would not recover from its current slump. Even taking into account the political and potentially economic impact of climate change and the Kyoto agreements.

Competition for Community Business:

In addition to the direct "hardware" opportunities in Eastern Europe mentioned above, enlargement will impact upon the nuclear industry within the Union, in a number of ways.

- Community Grants.

The European Union currently sponsors a number of programs, which support the nuclear industry, through funds for research and development, demonstration programs and technical assistance. The programs have become increasingly accessible for countries from CEE during the pre-accession negotiations. Under the fifth framework program the nuclear programs are in excess of € 1.5 billion. In particular firms from CEE countries are likely to bid for work within the Tacis program where their experience with Soviet designed reactors and first hand experience of Russian procedures will increase their chances of being awarded contracts.

- Euratom loans.

Entry into the EU will enable CEE equipment suppliers to be eligible for Euratom loans both for the development of their domestic nuclear industry and for export. Euratom loans require that the majority of equipment be supplied by Member States. As has been seen loans to CEE and NIS are prevalent in the Euratom pipeline. Again CEE companies experience with Soviet designed reactors may give them considerable advantages.

- Equipment Suppliers.

Competitions and take-overs have reduced the number of suppliers of heavy electrical equipment and those that construct nuclear power plants. Within Western Europe, the major companies that construct nuclear power stations are ABB, Framatom, Siemens and Westinghouse (which are now part owned by BNFL of the UK). Within Eastern Europe Skoda are the largest of the domestic producers and have shown their ability to win orders over competition from Western firms, at Mochovce in Slovakia. Accession will give firm from CEE greater access to Western European PLEX markets and increased development of strategic alliances with EU suppliers.

European Electricity Market:

In addition to affecting the nuclear industry itself the accession of countries with nuclear power will have ramifications for the electricity sectors as a whole. In particular the accession process and final entry into the Union will impact on the single European Electricity market. Rapid technological developments are taking place within the framework of the Trans European Electricity Networks. Already, the formerly separate Western (UCPTE) and CEE (CENTRAL) grid are fully integrated, while the Baltic ring is being developed at pace. These will allow the full exchange of electricity between the EU and the majority of accession countries. The TENS program also sees the connection of the Balkan accession countries to the EU grid, although at a slower paced than in other areas.

All of these connections allow the exchange of electricity and already electricity sales occur between Member States and accession countries. However, once accession has taken place, under the terms of the Electricity Market Directive, which entered into force in February 1999, sale of electricity from former accession countries cannot be prohibited. As with all other power sources in Member States, the electricity is free to be sold, above a threshold level, to any customer within the Union. The Commission has stated and others concur that new

members prior to entry into the Union will not implement the full environmental Acquis. Furthermore, research has shown that the power sectors, excluding nuclear, will be the most expensive for full environmental alignment. Under these conditions it is likely that power stations including nuclear will be operating at lower environmental standards than that required on power stations in existing members. As lower environmental costs have on the short-term, lower operational costs, this may distort the functioning of the single market. Overall there is a significant price difference in CEE and EU. Most striking is the difference in electricity prices for households, where prices in CEE are about three times lower than the EU average. However, despite the significantly lower household price in CEE the average household energy bill as a percentage of the total household income in CEE is three to four times higher than the EU average. In the industrial sector, energy prices in CEE are only 25-30% lower than the EU average. Therefore, in the EU, industrial energy prices are lower than household energy prices, whereas the reverse is true in CEE countries.

The differences between the electricity prices in CEE will decrease over time. However, in the interim there may be an increase tendency for electricity to be exported from the current accession countries into the current EU States as generators may increase their revenue from foreign sales. As the EU average industrial electricity price is 0.069 Euro/kWh, and the CEE average, for countries with nuclear power plants is 0.054 Euro/kWh. Therefore, where the electricity from nuclear power plants in CEE be sold in the EU it would generate about € 5.4 billion, additional revenue of € 1.5 billion per year.

The strategic importance of the grid in CEE is not limited to its own potential for export but it's undeniably importance as for region for transit. As has been noted, there are many advantages in investing in the electricity supply industry in CEE, however these are often amplified in the NIS –, as are the risks. In particular Russia and Ukraine have significant over-capacity of the existing generation facility and in the gas of Russia have access to fuel in abundance. The current price received by the generator for their electricity is extremely low, due to low tariffs and high levels of non-payment or payment in barter. Clearly, it would be attractive for the generators to be able to export this power to increase foreign currency payments.

In addition Russia's abundance of fossil fuels, in particular of the fuel of choice, gas make it an attractive investment for the non-traditional power producers. In the world of global markets, more and more oil and gas companies, who are already significant investors in these industries in Russia, are entering the field of electricity production and holistic energy suppliers. Should these companies chose they could consider generating electricity in Russia for export to CEE or the EU and compete with Western Europe's traditional utilities. Although any future grid battles will not be solely related to the nuclear power plants the political role of nuclear cannot be ignored. In all cases in CEE the nuclear power plants are still owned state owned, as are the grids.

The potential intervention of the CEE nuclear power plants into the EU electricity market will have an impact on its current electricity producers and consumers. To date the operation of nuclear power plants in CEE have only commercially impacted on Western European nuclear vendors and constructions. Enlargement will bring a new set of industrial interests into the discussions. Many of the Western European electricity producers will see the potentially cheaply produced electricity as a distortion of the single market. This may lead to increased industrial lobbying to have fully unified environmental standards and enforcement of the Agenda 2000 criteria prior to full access to the electricity market and thus entry into the EU.

The entry of new countries into the Union requires the unanimous support of the current members of the EU and the European Parliament. For many countries, in particular the smaller non-nuclear ones, this is one of the few times that they have a real say on nuclear safety issues in CEE, or so it is perceived by the population in these countries. While no country has yet declared that they will veto entry of countries which fail to conform to the requirements of Agenda 2000, such a threat is not far from the position being discussed by the Austrian Council of Ministers in June 1999.

In the late 1990's the nuclear industry in CEE has not seemingly been affected by calls from Western Europe for closure of the first generation reactors. While the later generation of reactors are currently undergoing upgrading programs which are as much to do with increase in efficiency and PLEX as an attempt to reach Western safety standards. The enlargement of the EU brings with it new players in the field of nuclear safety of CEE, the national Governments and Parliaments of all members States and electricity producers across the Union. How these will eventually impact on the CEE nuclear programs prior to accession is far from clear but it is unlikely to be business as usual scenario.

ANNEX 1: AGENDA 2000'S COMMENTS ON NUCLEAR PROGRAMS IN ACCESSION COUNTRIES.

Bulgaria:[31]

Bulgaria operates a nuclear power plant at Kozloduy, producing around 40% of the country's electricity. It consists of six reactors of Soviet design: units 1 to 4 are VVER 440-230 reactors and units 5 and 6 are VVER 1000-320. **The design and construction standards of the VVER 440-230 reactors are considered not to meet the safety objectives generally acceptable in the EU. The VVER 1000-320 are of more recent upgradable type.** Considerable investment in these reactors has been undertaken since 1990 to help improve their safety for the remainder of their operation.

Under the 1993 Nuclear Safety Account Agreement, managed by the EBRD Bulgaria undertook to cease operating the reactors 1-4 as soon as alternatives for energy supply would become available. In 1993, it was expected that these four reactors could be closed by that time. The Bulgarian Government has yet to adopt its position on a revised time-table for the decommissioning. At present there are no known plans for the closure of Units 1-4 before the end of their design lifetime (2004, 2011).

The design and construction standards of the two VVER 1000-320 reactors are considered to be closer to meeting safety objectives generally acceptable in the EU. Investment in modernising these reactors is expected to start in 1998.

The construction of two other VVER 100 reactors at Belene was suspended in 1990 owing to lack of funds. The Government has stated that it has permanently shelved the completion of the Belene plant. One research reactor is also in operation in the country.

The nuclear power sector is monitored by the Committee on the Use of Atomic Energy for Peaceful Purposed (CUAEPP), whose tasks are lid down in the Law on the Use of Atomic Energy for Peaceful Purposes. Over the past years, the CUAEPP has received substantial technical assistance, among others from the Union, for the strengthening of its working methods and for human resource development.

Nuclear fuel is supplied by Russia. In the past, it was partly fabricated from indigenous uranium and shipped to the then Soviet Union for processing. This is no uranium enrichment or fuel fabrication in the country. Spent fuel is not currently shipped back to Russia, but is stored on site in a pool. The construction of a facility for intermediate dry storage is planned. A policy on final storage of spent fuel needs to be developed. The cost of spent fuel treatment and plant decommissioning is presently not reflected in the electricity tariffs. A fund has been created for that purpose, but no payments had been made to it by early 1997. There is a need for a new national disposal facility for the radioactive wastes from Kozloduy and other producers.

Nuclear safety requires continued particular attention, with rapid implementation of agreed realistic programs including closure where necessary. Longer term solutions for waste need to be found.

Czech Republic:[32]

The Czech Republic has four Russian designed VVER 213 nuclear reactors at **Dukovany (modernization programme is ongoing) the safety of which is considered to be close to safety objectives generally**

[31] Agenda 2000 – Commission Opinion on Bulgaria's Application for Membership of the European Union. DOC/97/11, Brussels, 15th July 1997, page 83.
[32] Agenda 2000 – Commission Opinion on the Czech Republic's Application for Membership of the European Union. DOC/97/17, Brussels, 15th July 1997, page 76.

accepted in the EU once upgrading programs are implemented. There are two VVER 1000 under construction at Temelin (with integration of US technology). Around the year 2000 the share of nuclear in electricity production may increase from 22 to 40%. Three research reactors are also in operation, using fuel fabricated in Russia.

Concerning uranium mining, the obligation for the national electricity company to buy in the event of nuclear fuels import, an equivalent amount of domestic uranium in principle infringes upon the rules of the nuclear common market but will be phased out by 2000. Uranium supply (if not from domestic source), enrichment services and fuel fabrication services are covered by contract with various foreign firms in several countries. The common nuclear materials supply contracts conclude after accession. It would be desirable for the Czech Republic to continue with its plans to diversify its supply sources.

Spent nuclear fuel is presently stored on site. A longer-term interim is projected to start around 2005 for both Dukovany and Temelin fuels. A decision on whether to reprocess spent fuel or dispose of its as a waste is not expected before 2015.

Hungary[33]:

The Paks nuclear power station of Russian design produces 40% of the country's electricity and the four reactors of the VVER 440-213 type will be close to objectives generally accepted in the EU once the already planned upgrading programs (300 MECU) will be implemented of which two-thirds relates to safety upgrades. Two research reactors, using Russian fabricated fuel are also in operation.

Hungary uses domestic uranium for its nuclear power plants, but additional supplies, enrichment services and fuel fabrication are all procured from Russia. Hungary's accession would increase the EU's dependency on Russian uranium and enrichment. The common nuclear materials policy of diversification of sources of supply would however apply to contracts concluded after accession.

According to agreements between Hungary and Russia, spent fuel is to be shipped back to Russia. Nevertheless, an interim dry storage facility (50 years operation) is under construction at Paks. Selection of a site for final disposal of High Level Waste and spent fuel is ongoing, with the objective target to have the installation operation by 2040. The construction of a storage facility for low level waste and intermediate level waste, to be ready by 2002, is proceeding. The inclusion of the final disposal and decommissioning costs in the electricity price is foreseen for the near future.

Upon accession, Hungary would need to comply with the provisions of the Euratom Treaty, in particular those relating to supply of nuclear materials, the nuclear common market, safeguards, health and safety and international agreements. It is already party to the relevant international regimes in these fields and has legislation in force or in preparation which implements these regimes in its national legal order, and has a full-scope safeguards agreement in force with the IAEA. No major difficulties are therefore expected in applying the relevant Community legislation in the above areas. Special attention has to be given to the timely implementation of nuclear safety programs. The independence of the safety authorities should be supported.

No major difficulties are foreseen for compliance with Euratom provisions. Nuclear safety standards should be tackled appropriately in order to bring the nuclear power plant to the level required; and longer term solutions for nuclear waste need attention.

Lithuania:[34]

[33] Agenda 2000 – Commission Opinion on Hungary's Application for Membership of the European Union. DOC/97/13, Brussels, 15th July 1997, page 82

Lithuania operates two large RBMK nuclear reactors (Chernobyl type) at Ignalina, producing 85% of the country's electricity in 1995 and exporting electricity to neighbouring countries. Improvements are ongoing at the plants mainly through the assistance of the Nuclear Safety Account of the EBRD. The assistance is linked to an extensive Safety Report made with support of Western experts. This report provides many recommendations to be implemented by the plant to get the safety Authority license for further operation. The intention is to operate the plant until the limit for channel re-tubing is reached. Re-tubing is precluded by the Nuclear Safety Account Agreement, but the position of the government needs clarification. A review of the safety report by independent experts insists on the implementation of all urgent recommendations before restart after their present annual shutdown for maintenance. Comprehensive and realistic programs including closure as necessary have to be agreed upon and implemented in due course. After closure of the reactors, an important decommissioning programme will have to be implemented.

The safety measures recommended by the recently issued safety report, the capability of the Lithuanian regulatory body for nuclear energy (VATESI) to implement the western-style licensing regime need to be strengthened as a priority.

Nuclear fuel is directly imported and manufactured in Russia, partly in exchange for the electricity exported to Russia. These arrangements seem potentially uncertain and since accession by Lithuania would increase an enlarged EU's dependence on Russia, there could be security of supply concerns. Attempts to diversify nuclear fuel supplies have so far not been successful for technical and economic reasons. The common nuclear materials supply policy of security through diversification of sources will apply to contracts concluded after accession. Spent fuel is stored in ponds at the plant site. Future intermediate dry storage is under development. Provision for spent fuel handling and decommissioning is in the process of being included in the electricity tariff structure.

Upon accession, Lithuania needs to comply with the provisions of the Euratom Treaty, in particular with those relating to supply of nuclear material, the nuclear common market, safeguards, health and safety and international agreements. Lithuania is not yet party to all international regimes in these fields (notably the Nuclear Suppliers Group and the IAEA scheme for extended reporting on certain nuclear materials transfers) or has not yet implemented them fully in its legal order, but draft legislation is under preparation. Lithuania has a full-scope safeguards agreement with the IAEA. Hence in these areas, no major difficulties in apply Community legislation are expected. The development towards an independent safety authority should be further supported.

No major difficulties are foreseen for compliance with Euratom provisions. Lithuania has to implement certain international nuclear regimes or implement them in its legal order. The safety of the Ignalina nuclear power plant requires continued particular attention and rapid implementation of the programmed closure of the nuclear power plant and long term solutions for waste need to be found.

Romania:[35]

Romania's first nuclear power plant (Canadian Type CANDU, built with Canadian and Italian participation) is now in operation at Cernavoda, accounting for 8% of electricity produced in 1996. The Government considers the construction of unit two in the next five years a goal of material importance. Also the construction of the other units which would conform to safety objectives generally accepted in the EU are foreseen in the longer

[34] Agenda 2000 – Commission Opinion on Lithuania's Application for Membership of the European Union. DOC/97/15, Brussels, 15th July 1997, page 73

[35] Agenda 2000 – Commission Opinion on Romania's Application for Membership of the European Union. DOC/97/18, Brussels, 15th July 1997, page 79

term, but the financing scheme is not yet established. The natural uranium used to fuel the reactor is mined and processed into fuel in Romania and Canada.

If Romania continues to cover its uranium needs through domestic production, this would be a positive factor for the long-term security of supply of an enlarged EU. The common nuclear materials supply policy of security through diversification of sources applies, for contracts concluded after accession. Spent fuel from Cernavoda nuclear power plant will be stored for the first years of operation at the plant site. Long-term solutions are not yet defined.

Upon accession, Romania needs to comply with the provisions of the Euratom Treaty, in particular those relating to supply of nuclear material, the nuclear common market, safeguards, health and safety and international agreements. Possible difficulties may reside in the fact that it is not clear whether Romania has fully implemented some international regimes in these areas (notably the Vienna Convention on civil liability for nuclear damage, the Physical Protection Convention and the Nuclear Supplier Guidelines). Romania also has full-scope safeguards agreement with the IAEA, so no major difficulties in applying Community legislation in this area are expected. The Western designed nuclear plant does not present problems but specific attention should be given to operational safety. The independence of the safety authority should be supported.

No major difficulties are foreseen for compliance with the Euratom Treaty but Romania should implement some international nuclear rules. Nuclear safety standards, especially those related to plant operation, should be handled appropriately and long-term solutions found for waste.

Slovakia:[36]

Slovakia operates at Jaslovske Bohunice two VVER 440-230 (first generation) and two VVER 440-213 (second generation) nuclear reactors representing nearly half of the electricity production. For Units 1 and 2 after a short term improvement programme, they are currently further upgraded (1996-1999) and should then increase the safety level towards EC safety standards. Finally, the early A1 prototype reactor, had to be shut down prematurely in 1977 and is currently being decommissioned. Its spent fuel is being to Russia. At Mochovce, two VVER 440-213 reactors are under construction with some participation of Western firms and they should be on stream within the next two years.

Two more units of the same type are foreseen on the site for the first decade of the next century. The safety of this nuclear power plant is considered to be close to safety objectives generally accepted in the EU, once the upgrading program will be completed. There is not uranium mining or nuclear fuel fabrication.

A Government Resolution proposed nuclear fuel supply diversification from 1999 onwards. Accession by the Slovak Republic would increase the EU's dependence on Russian uranium and enrichment. But the plan to diversify its supply sources in the future would be in line with the common nuclear materials supply policy of security through diversification of sources which would apply to supply contracts concluded after accession.

Spent fuel from Bohunice was shipped back to the USSR until 1986 but has since been stored in pools at the site. All spent fuel from the A1 reactors will be returned to Russia by 1999 in the frame of a former Czechoslovakia -–USSR agreement. An increase in the storage capacity of the existing pools is under study. Longer term intermediate storage and final disposal options of spent fuel are also being studied. Low level and medium level waste repository is under licensing at Mochovce.

Upon accession, the Slovak Republic will need to comply with the provisions of the Euratom Treaty, in particular those related to supply of nuclear material, the nuclear common market, safeguards, health and safety

[36] Agenda 2000 – Commission Opinion on Slovakia's Application for Membership of the European Union. DOC/97/20, Brussels, 15th July 1997, page 90

and international agreements. It is party to all relevant international regimes and conventions. The Slovak Republic also has a full-scope safeguards agreement with the IAEA, and in this and other areas above, no major difficulties in applying Community legislation are expected. Nevertheless the problem of nuclear safety has to be dealt with and realistic programs, including effective closure when necessary, have to be agreed upon and implemented. The independence of the safety authorities should be supported.

No major difficulties are foreseen for compliance with Euratom provisions. Nuclear safety requires continued particular attention. Safety standards should be tackled appropriately and realistic programs implemented quickly. Longer term solutions for waste need attention.

Slovenia[37]:

One US Pressurised Water Reactor at Krsko supplies 20% of the electricity needs in Slovenia and exports 50% of its electricity to Croatia. This jointly Slovenia-Croatian owned nuclear plant is supervised by the Slovenian Nuclear Safety Administration within the Ministry of Environment and Physical Planning. Though not required by the Acquis, an independent supervisory structure would be desirable. Slovenia should implement this principle included in the Nuclear Safety Convention recently ratified. Investments have been made to ensure that nuclear safety is maintained at a high level. The fact that this power plant is built on a fault line has led to further seismological in its surroundings. One research reactor is in operation in Ljubljana.

Nuclear fuel, on the basis of Slovenian uranium, was fabricated in the USA, where also the enrichment services were largely purchased. Spent fuel from reactors will be shipped back to the USA.

The Common nuclear materials supply policy of security through diversification of sources will apply to Slovenia for supply contracts concluded after accession. From a long term supply perspective in an enlarged EU it would desirable for Slovenia to procure at least part of its uranium needs on the basis of long term contracts.

Spent fuel from Krsko is stored in the plant pool and its capacity may be increased. Interim storage in dray casks could also be envisaged. Some of them could be sorted in Croatia which benefits from the electricity produced at Krsko. However, the long term final disposal of spent fuel is not yet defined and should therefore be further analysed. The government has started to collect funds for the decommissioning of the Krsko plant at the end of its operation.
Upon accession, Slovenia would need to comply with the provisions of the Euratom Treaty, in particular those related to supply of nuclear materials, the nuclear common market, safeguards, health and safety an international agreements. The country has not yet adhered to or fully implemented all the relevant international regimes in these fields. Inter alia Nuclear Suppliers Guidelines, IAEA extended reporting an accession to the Nuclear Energy Agency of the OECD but has a full-scope safeguards agreement in force with IAEA. No major difficulties in apply Community legislation in these areas are however expected. Specific attention should be give to the operation safety of the Nuclear Power Plant. The independence of the safety authority should be supported.

No major difficulties are foreseen for compliance with Euratom provisions but Slovenia should adhere to, or implement fully, certain international nuclear agreements. Nuclear safety standards should be handled appropriately and long term solutions for nuclear waste will have to be found.

[37] Agenda 2000 – Commission Opinion on Slovenia's Application for Membership of the European Union. DOC/97/19, Brussels, 15th July 1997, page 83.

ANNEX 2: SAFETY ASSESSMENT OF SOVIET DESIGNED REACTORS IN ACCESSION COUNTRIES.

Generic safety characteristics and safety issues for RBMK plants

Status of safety documentation

1. Western knowledge of the design characteristics of RBMK reactors has increased considerably since the Chernobyl accident in 1986, and especially after 1991 through participation in multilateral and bilateral safety assessment projects. However, full, in-depth, safety analysis reports, based on independently validated computer models, etc., according to Western standards have not yet been completed for any RBMK reactor, although some, e.g. Ignalina, have better safety documentation than others. Consequently, the depth of expert knowledge of these reactors is lower than with Western designs.
2. The 14 RBMK reactors in operation belong to three different design generations, built to comply with different generations of safety standards of the former Soviet Union. There are considerable differences between the different generations of RBMK reactors and even significant differences among reactors within the same generation. It was a conclusion from the International RBMK Safety Review that it is essential to perform plant-specific safety studies, including a Probabilistic Safety Assessment, of each reactor using state of the art computer codes and methodologies in order to get an accurate assessment of the safety level. However, basic features of the core design, the reactor cavity and the primary system designs are common to all RMBKs, although there are differences in the design of engineered safety systems. This fact implies that some specific safety issues are common to all units.

Containment issues

3. The most important design related safety issue is the lack of a containment or the lack of complete containment of the primary system, depending on design generation. The reactor core is enclosed in a separate cavity, designed to handle serious damage to a very limited number of the 1661 fuel channels.

Unlike Western designs, the reactor vessel is not enclosed in a containment designed to cope with all the energy that could be released in an accident. Accident sequences, involving simultaneous rupture of tens and more fuel channels, would lead to unacceptable consequences. Even in the most modern RBMK designs, there are other important parts of the primary system which are not protected by a full containment. Moreover, the performance of the partial containment enclosing parts of the primary circuit in RBMK reactors of later designs has not been fully validated. Thus, RBMK reactors do not have the basic design features required in Western European reactors, because the last physical barrier, the containment, is at least partially missing.

Core characteristics

4. The general complexity of the large core, with strong spatially dependent interactions between thermal-hydraulics and neutronics, puts a particular burden on the Instrumentation & Control systems. The need for several localised core control systems requires powerful computing systems to process the necessary operational data for control and protection. Furthermore, complex 3-D codes are necessary for circulation of core dynamics.
5. After the Chernobyl accident, a series of design changes were agreed by the Soviet authorities. Some of these were felt to be so urgent that they were implemented on all plants. It was planned that other changes would wait until the mid-life refurbishment of the reactors. The main design changes involved the reduction of the positive void coefficient, improvements to the reactor protection system and display of the reactivity margin. The decrease in void coefficient was to be achieved by increasing the fuel enrichment from 2% to 2.4% and by the introduction of 80-100 additional absorber rods in the core. In the technical specifications the number of effective control rods required in the core was increased from 26 to 48.These changes have reduced the void effect to less than 1 b. Furthermore the reliability and speed of the shut down system has been improved and a new fast acting scram system with 24 rods was installed.
6. These improvements as well as other safety issues have been thoroughly evaluated and monitored in the IAEA Extrabudgetary Programme on the Safety of VVER and RBMK Plants. As an example, it was established during the Programme that the two installed shut-down systems could not be regarded as fully independent and

diverse. Furthermore, the fast acting scram system cannot maintain the reactor in a subcritical state in the event of a loss of coolant accident in the control and protection system channels. Such an accident was considered by the designer as a Beyond Design Basis Accident with very low probability. However, it has been concluded that in order to ensure a satisfactory reliability of the reactor shutdown function, backfitting of an additional completely independent and diverse shut down system is necessary in all RBMK reactors.

7. A new type of fuel with burnable poison has recently been introduced in most RBMK reactors, giving more stable core characteristics, without additional absorbers, and has greatly reduced the need to constantly control the power distribution in the core.

Redundancy, diversification and separation of safety systems

8. Although there is a high redundancy and diversification in most of the first line safety systems in the later RBMK designs, there is also a lack of physical and/or functional separation of some electrical systems, Control and Protection System (CPS), certain valves and the emergency core cooling pumps. This makes most of the RBMK units vulnerable to common cause failures.

Primary system characteristics

9. The specific RMBK core design, consisting of graphite bricks penetrated by 1661 fuel channels and a number of CPS channels, creates particular problems. The large mass of graphite (2 000 tons) provides a good heat absorbing capacity but has a definite disadvantage in its burnability, which was clearly demonstrated in the Chernobyl accident.

10. The primary system includes large pressure vessels distributing the coolant flow to smaller vessels and to a large number of parallel pipes connecting each core channel. The system also includes a large number of valves. This raises at least two problems:

- The possibility of blockage events, especially blockage of a group distribution header reducing the flow to about 40 fuel channels. The operating history of RBMK has shown a few blockage incidents, which fortunately did not develop into serious events. Fuel channel blockage is a major contributor to the risk of a severe accident;
- Material degradation due to the large number of pipes and welds. The RBMK pressure circuit suffers from all the expected material problems and degradation mechanisms, especially intergranular stress corrosion cracking, that have been seen in Western BWRs. A large number of defects have been found in RBMK pipework and some leakages have occurred.

11. The RBMK has certain design advantages over other reactors. For instance, there is about double the water inventory of a typical western BWR, while the fuel ratings are about 75% of those in a BWR and about 60% of those in a western PWR. These features play a significant role in determining the slow heat-up of fuel in many accident scenarios. On the other hand, the large water inventory means that there is also more stored energy to be handled by the containment and pressure relief systems.

Gap closure issues

12. A specific RBMK ageing issue is the gas gap closure. The pressure tube in each fuel channel is sup-ported inside the channel in the graphite block by a series of graphite rings. It is arranged so that there is a gap of 3 mm between the graphite block and rings at the beginning of plant life. In this gap, a mixture of helium and nitrogen is circulated to improve the heat transfer from the graphite to the coolant and to monitor the tube integrity. Under the influence of irradiation during normal operation, this gap slowly reduces. Continued reactor operation after the gap has reduced to zero could challenge the integrity of the fuel channels and make re-tubing impossible. The average time to gap closure varies between about 15 to 20 reactor years depending on operating conditions. Mid-life re-tubing was foreseen in the RBMK design and has been carried out at Leningrad units 1-3 and Kursk unit 1.

References

1. Almenas K., Kaliatka A. & Uspuras E., Ignalina RBMK-1500. A Source Book. Ignalina Safety Analysis Group. Lithuanian Energy Institute, 1998.

2. Hall S. F. & Gabaraev B. A. RBMK Safety Review. Volume 1: Executive Final Report, March 1994.

3. Review of Safety Issues for NPPs with RBMK Reactors of 1st and 2nd Generation. IAEA Report RBMK-SC-053, March 1998.

Generic safety characteristics and safety issues for VVER plants

1. The first VVERs were built at Rheinsberg in Germany and Novovoronezh in Russia. Rheinsberg was rated at 70 MWe and operated from 1966 to 1990. The two units at Novovoronezh were rated at 197 Mwe and 336 MWe, and operated between 1964-1988 and 1970-1990, respectively.

2. The first standard series of VVER's has nominal electrical power of 440 MW, and the second standard series has a power of 1000 MW.

3. There are two generations of VVER 440 reactors which are based on different safety philosophies. Of the older generation VVER 440/230s, there are 11 units still operating, while five have been permanently closed down. Of the second generation VVER 440/213 type, there are currently 15 units operating.

4. In addition, two non-standard VVER 440 units have been in operation in Finland since 1977. In the contract for these plants, the Soviet vendor was required to meet Finnish regulations which were based on US safety rules. The original VVER design was therefore modified by incorporating safety features that provide defence-in-depth against the same type of design basis accidents that are postulated for Western designed plants. The control and protection systems were designed and supplied by Western companies. Many vital mechanical components were also purchased from Western manufacturers. Plant lay-out, civil structures (including fire protection and ventilation systems), and electrical systems were designed by the engineering staff of the owner utility. Western type QA was applied throughout the construction project, including quality control at the factories within the former USSR.

5. In the VVER 1000 series, there is a gradual design development through the five oldest plants, while the rest of the operating plants, the VVER 1000/320s are quite similar with each other. There are 20 operating VVER 1000s.

Extent and validation of VVER accident analysis

6. In-depth safety evaluation of VVER-440 plants has been done in a number of countries. This evalua-tion includes analysis of postulated transients and accidents with validated computer codes. Accident analysis of the Finnish VVER-440 plants has been carried out since the early 1970s by several Finnish teams and also by a German consultant.

7. The expected behaviour of the VVER-440 reactor core has been confirmed at the Finnish plants by a comprehensive instrumentation and monitoring system. Studies of Finnish irradiated fuel have confirmed the predicted fuel properties. The ability to calculate the behaviour of the nuclear steam supply system during normal operation and small transients (such as reactor trip, reactor coolant pump trip and loss of feedwater) has been verified in extensive commissioning tests and by analysing operational events.

8. The validation of accident analysis codes for VVERs, has been carried out by several organisations in different countries since the mid-1970's. This is based on integral experiments conducted at VVER-specific thermal-hydraulic test facilities such as REWET and PACTEL in Finland and PMK in Hungary.

9. The most recent comprehensive analysis of the Finnish VVER-440 plants was done in connection with periodic re-licensing in 1997, using a validated state-of-the-art computer code package. Independent calculations for verification of the analysis were done by the Finnish regulator and its consultants. Similar analysis have been done for other VVER-440s by competent teams in particular in Hungary and the Slovak Republic.

10. The transient and accident behaviour of the VVER-1000 reactor has also been investigated quite extensively. For instance, a feasibility study on licensability of an improved VVER-1000 design was done in Finland in 1992. It included a full scope analysis of postulated design basis events. The analysis was updated by a Finnish team in 1995 to support an application to build a similar plant in China.

11. Other VVER-1000 analysis have been done by Western experts for instance in Germany for a plant which was never completed, and for the Temelin plant under construction in the Czech Republic.

12. In conclusion, the accident analysis of both VVER-440 and VVER-1000 designs is considered sufficient to provide an adequate understanding of the generic safety characteristics of the plants.

VVER 440/230

13. In the EU candidate countries, there are six nuclear power plant units of this type: four in Bulgaria and two in Slovakia.
14. The design of the VVER 440/230 was based on the assumption that a double-ended guillotine break of the main circulation line or the pressuriser surge line in the reactor cooling system is not possible. Instead, the accident assumed as the design basis for the safety systems was a break of a pipe directly connected to the main circulation lines. Following on from this basic assumption, all pipe joints to the main circulation lines were equipped with throttling devices. This would limit the maximum leak rate from any broken primary circuit pipe to the equivalent of a guillotine break of 32 mm diameter. This was the basis for designing VVER 440/230 safety systems, and consequently the capacity of the emergency core cooling systems is very small. It also meant that the design did not feature a substantial, Western-style, containment around the reactor cooling system to limit potential radioactive releases in a loss of coolant accident. The as-built confinement system of VVER 440/230s has little overpressure capability and its leaktightness characteristics are poor.
15. Although a large break in a reactor coolant circuit has never occurred at any nuclear power plant, a large break LOCA is generally postulated as a design basis for safety systems in Western designed nuclear power plants.
16. In addition to the inadequate safety systems, the VVER 440/230 plants had two other major safety concerns:

- Internal hazards such as fires or floods, and external hazards such as seismic events or plane crash, were not adequately considered in the original design. Thus the redundant parts of the safety systems were not adequately separated from each other, and are vulnerable to common cause failures. Some important safety systems were installed close to high-energy systems or in high fire risk area (e.g. the turbine hall). Consequently, an event in one part of the plant could result in complete loss of vital safety functions;
- The auxiliary systems, such as electrical power supply or cooling systems which support the safety functions, were designed with inadequate redundancy. Consequently, a single failure in a critical component of an auxiliary system could result in a loss of the support function and also a loss of the main safety function.

17. Some additional safety concerns are common to all VVER plants being operated in the EU applicant countries:

- The original quality of electrical equipment and Instrumentation & Control equipment was inadequate, and the equipment was not qualified to function in accident conditions;
- The reactor pressure vessel wall is exposed to higher irradiation by fast neutrons than most Western designed reactor pressure vessels, and therefore the embrittlement of the vessel material proceeds more quickly;
- The design of the main barrier between primary and secondary coolant inside the steam generators (primary collector) is less robust than the tube sheet in Western PWRs, and the possibility of large primary to secondary circuit leak therefore needs to be taken into account in the design of the safety systems.

18. The safety concerns with VVER 440/230 plants are discussed in detail in an IAEA report (Ref. 1). All the plants have addressed these concerns to various degrees by backfitting and design changes.
19. When assessing the overall safety of the VVER 440/230 plants, it should be noted that these plants, like all VVER 440s, have some inherent safety characteristics which are superior to most modern Western plants. The principal safety characteristic of all VVER 440 plants is the large volume of primary coolant. These reactors have more than twice as much coolant per megawatt as any Western designed NPP. This allows major transients to occur without damage to the reactor core, e.g. interruption of all AC power supply to plant equipment for at least six hours, or a complete loss of heat sink for a similar time. This large coolant volume also mitigates any anticipated transients so that the coolant pressure stays well below the opening set point of the safety valves. This safety feature provides an effective protection against the possible escalation of many transients to more severe events.
20. Other significant inherent safety features are:

- Small and robust reactor core: any oscillations in spatial power distribution quickly die away, and do not require active control as in larger reactor cores;
- Low peak fuel temperatures with good retention of fission gases within the ceramic fuel pellets;
- Low heat flux from the fuel to the coolant giving a very large margin to critical heat flux in normal operation and during abnormal transients, and slow temperature increase in loss of coolant accidents;
- Robust design of main components and piping, including the main circulation lines of the reactor cooling system, which are made of austenitic stainless steel;
- The ability to isolate any failed loop of the reactor cooling system, and after isolation to bring the plant to safe shutdown using normal operating procedures;
- Compared to Western PWRs, risks during shutdown associated with a reduced coolant inventory are limited in a VVER 440 because there is no need to decrease the water level in the primary circuit during a refuelling or maintenance outage.

21. The following conclusions can be made regarding the safety of VVER 440/230 plants:
The original plant design has inadequate systems to cope with potential accidents, and its safety is not acceptable to Western European standards;

However, all VVER 230s currently operated in applicant states have been significantly modified to varying degrees as compared to the original design. To become acceptable to Western standards, they need to reach a comparable level of protection as achieved for fully upgraded VVER 213 reactors, and they require extensive improvements to the Emergency Core Cooling System, to the Residual Heat Removal System and to the containment functions, and the technical feasibility of such upgrading programmes remains to be demonstrated and assessed. Therefore, the current or anticipated safety after implementation of all modifications should be considered on an individual basis;

- The generic safety issues identified by the IAEA have been addressed to varying degrees at all the plants;
- It is possible to remove most of the safety concerns by refurbishment, but it requires a major investment. However it does not appear feasible to backfit the plants with a reactor containment that could achieve the leaktightness required of Western PWRs. This means that protection against accidents leading to activity release in the containment cannot be guaranteed in a way required in Western European plants and that the current leak rates would probably not mitigate the consequences of large LOCAs and severe accidents consistently with current Western practices;
- Due to the inherent safety features of the VVER-440 design, the transients and accidents caused by equipment failures are less severe, and their rate of progress is relatively slow compared with Western PWRs, giving operators more time to take corrective actions. However, it is difficult to quantify the safety gain associated with this.
-

VVER 440/213

22. In the EU candidate countries, there are 11 nuclear power plant units of this type: four in Hungary, four in the Czech Republic, and three in Slovakia. One more unit is expected to start up in Slovakia in 1999.
23. The accidents used as a design basis for the VVER 440/213 safety systems are similar to those postulated in Western plants, including a double-ended guillotine break of the main circulation line in the reactor coolant system. The safety systems are quite similar to those in Western PWRs. Mostly, they consist of three redundant parts, and any of those parts could provide the intended safety function. This goes beyond many Western designed plants which have only two redundant parts in their safety systems.
24. VVER 440/213 reactors have bubbler condenser type pressure suppression containments. This is a unique Soviet design and there remain doubts about its performance during design basis accidents. Although this has

been studied analytically and with model tests, there is a common desire to confirm the results with additional large-scale tests.
25. Another concern is the containment leaktightness, as the leak rates measured in integral tests have been generally significantly higher than allowed for Western containments. On the other hand, the comparison with Western containments is not straightforward because of the pressure suppression system. So far, the behaviour of the bubble condenser containment under severe accident conditions has not been addressed.
26. Compared with major safety concerns of the older VVER 440/230 plants, design improvements include:

- Internal and external hazards have been addressed to various degrees on a plant specific basis, and there are major design differences between the plants. There are still concerns in this area, but to a lesser extent than for the VVER 440/230s;
- Protection against single failures in the auxiliary and safety systems has generally been provided by design, although improvements in detail have been required as a backfitting measure.

27. The safety concerns with VVER 440/213 plants are discussed in detail in an IAEA report (see Ref. 2 and 4).

Most of these concerns have been addressed on a plant specific basis.

28. All the inherent safety characteristics discussed in connection with VVER 440/230 plants are equally valid for the VVER 440/213 type. Extensive model testing and safety analysis has been done in several countries, including recent analyses with state of the art computer codes. These analyses have confirmed the safe behaviour of the reactor core and its cooling system in all abnormal transients. Furthermore, I has been confirmed that these plants can be brought to safe shutdown following accidents which are generally assumed as design basis events for modern nuclear power plants.
29. The following conclusions can be made regarding the safety of VVER 440/213 plants:

- The original plant design had safety deficiencies which would not be acceptable by Western
- European standards. At all the plants, most of the safety deficiencies have been addressed by back-fitting and plant modifications;
- An unresolved general issue is the performance of the reactor containment during design basis accidents. The necessary experimental tests are being planned as a PHARE project;
- Should the efficiency of the containment functions be clearly demonstrated, it should be feasible to upgrade the safety of the VVER 440/213 plants to a level comparable with many of the plants currently operating in Western Europe. This upgrading should adequately address all the safety issues identified by the IAEA.

VVER 1000/320

30. In the EU candidate countries there are two nuclear power plant units of this type in operation, both of them in Bulgaria. In the Czech Republic, two further units are being built that were originally of a similar design but have been extensively modified during construction.
31. The VVER 1000 plants were designed to similar safety requirements as Western plants, and have equivalent safety systems. However, it is doubtful whether the overall safety level of the VVER 1000 plants is as high as the safety of the VVER 440/213s. The reason is that the higher power VVER 1000 plants have lost the inherent safety features of the smaller VVER 440 plants.
32. The main safety concern regarding the VVER 1000 plants lies with the quality and reliability of individual equipment, especially with the instrumentation and control equipment. Also the embrittlement of the reactor pressure vessel needs continuous attention and action will need to be taken if it approaches a hazardous level.
33. The main barrier between primary and secondary coolant inside the steam generators is a greater safety concern than in the VVER 440 plants, and it has been necessary to replace a number of steam generators when failures have been observed in this barrier. It remains to be demonstrated by further successful operating experience that design improvements have solved these problems.

34. The plant layout has weaknesses that make the redundant system parts vulnerable to hazardous sys-tems interactions and common cause failures caused by fires, internal floods or external hazards.

35. The safety concerns about the VVER 1000 plants are discussed in detail in an IAEA report (Ref. 3; also Ref. 5).

36. The following conclusions can be made regarding the safety of VVER 1000 plants:

- The original plant design had deficiencies which would not be acceptable by Western European standards. At all plants, many of these deficiencies have been addressed by backfitting and plant modifications;
- It is feasible to upgrade the safety of the VVER 1000 plants to a level comparable with many of the plants being operated in Western Europe. This upgrading should adequately address all the safety issues identified by the IAEA.

References

1. IAEA-TECDOC-640, Ranking of safety issues for WWER-440 model 230 nuclear power plants, February 1992.

2. IAEA-EBP-WWER-03, Safety issues and their ranking for WWER-440 model 213 nuclear power plants, April 1996.

3. IAEA-EBP-WWER-05, Safety issues and their ranking for WWER-1000 model 320 nuclear power plants, March 1996.

4. Sicherheitsbeurteilung des Kernkraftwerks Greifswald, Block 5, WWER-440/W-213, GRS-83, August 1991.

5. Sicherheitstechnische Bewertung des Kernkraftwerkes Stendal, Block A, Type WWER-1000/W-320, GRS-99, May 1993.