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AND THE EUROPEAN PARLIAMENT

Nuclear Safety

in the Context of the Electricity Sector

in Central and Eastern Europe

and in the CIS

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1 - Summary

Nuclear energy production in the CEEC/CIS[1] 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.

The purpose of this Commission paper is not to produce a further nuclear energy report in addition to those already issued by various institutions and international organisations, but to draw operational conclusions on the basis of existing information, taking into account, inter alia, the economic development of the CEEC/CIS and the security of energy supply to the European Union.

Although it is clear that Soviet-designed nuclear installations generally pose safety problems, the situation varies according to reactor types and to the way they are operated, as well as the countries concerned :

- VVER-230 and RBMK reactors show fundamental design deficiencies which cannot be fully overcome, whereas VVER-213 and -320 reactors can be substantially upgraded, notwithstanding the questionable design of some plant components;
- the regulatory, technological, engineering and industrial environment varies from one country to the other;
- the substantial nuclear electricity dependence in some countries acts as a further constraint contributing to a continuation of potential risk.

The diversity of local situations makes it necessary to adopt different approaches, which should nevertheless be part of a coherent framework, in order to maximise the effectiveness of the financial assistance made available by the European Union and more generally by the international community to assist CEEC/CIS countries in their own efforts to solve nuclear problems. This report is intended to contribute to the achievement of this coherence.

The safety analyses are well advanced. In addition to urgent activities which are justified by exceptional and transitory situations, it is now necessary to develop a longer term perspective, including investment and industrial co-operation. Union assistance activities will have to contain certain requirements in order to reinforce their coherence and effectiveness including :

- guidelines to be agreed with each of the recipient countries, 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 shut down of less safe reactors as early as is feasible.

[1] Central and Eastern European Countries and the Commonwealth of Independent States.

2 - Introduction

This paper is based on existing information on the status of nuclear power plants in the CEEC/CIS, including a recent report[2] issued by the World Bank, the IAEA and the EBRD at the request of the G7. This paper is not intended to propose a complete solution to the nuclear safety problem in these countries. Rather, it underlines the Union's concerns, places nuclear matters in a global energy context, briefly describes the nuclear safety situation in these countries, reviews the assistance activities of the European Union and of the international community and recommends guidelines to the Union.

This paper allows the Commission to inform the Council and the Parliament about its own work and the Union to contribute to the G-7 and G-24 exercises.

The CEEC and CIS, viewed in aggregate, are rich in all energy resources with noticeable national variations. Energy in general, and the electricity sector in particular, will be a key ingredient in the development of these countries, both reflecting and affecting the speed of economic reform. However, these countries are faced with energy industries which have suffered long term under-investment and which are generally operating in unstable environments.

Many of the CEEC/CIS depend to a greater or lesser extent on self generated or imported nuclear power. While Russia has intimated its nuclear reactors are safe, the international community universally recognises that there are fundamental weaknesses in the design and operation, particularly in old reactors, in comparison to those in the West.

Russia, possessing the largest number of the oldest reactors, has publicly stated that it intends to continue with large-scale development of its own nuclear power technology. In the mean time it intends to continue to use its oldest reactors to the end of their design lives, notably the RBMKs[3], of which it has eleven currently in operation. This position was recently confirmed by Mr Mikhailov (Minister of Minatom) at the European Parliament. Russia has therefore established a nuclear reactor rehabilitation programme and intends to carry it out, if necessary without external financial support. As concerns Ukraine, its parliament recently voted to continue operating the undamaged Chernobyl nuclear reactors (RBMK), overturning an earlier vote to close down the whole site.

To varying degrees, other countries also have rehabilitation programmes. While some countries are largely able to cope with this task within their own engineering and industrial capability, others require comprehensive external assistance since historically they have been dependent on Russian technology and expertise. Consequently the CEEC/CIS, while recognising the commonality of certain problems and the need for co-ordination, must be viewed separately in terms of assistance required from the West.

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[2] *Nuclear Safety and Electric Power in Armenia, Bulgaria, Lithuania, Russia, Slovakia and Ukraine*, May 1993. The summary of this report is contained in annex C.

[3] See section 4.2 for more detail.

The European Union's assistance is driven by certain basic 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, cf. annex C).

Since 1990 the European Union has been assisting CEEC/CIS to improve the safety of their less safe Soviet-designed reactors, in particular through the PHARE and TACIS programmes for a total of 314 MECU. At the G7 summit in Munich, a strategy to improve nuclear safety was agreed, containing immediate measures and longer term safety improvements. A number of countries of the G24 are working bilaterally with the same objective. Co-ordination of this effort is pursued within the process of the G24, managed by the Commission.

3 - The energy context in the CEEC/CIS

The efficient supply and consumption of energy services is vital for stable economic development and for maintenance of an acceptable standard of living. Taken in aggregate, the CEEC/CIS have enormous energy resources, but on an individual country basis there are great differences in energy wealth, with most fossil fuel reserves on Russian territory. Among those countries that have few indigenous energy resources, and are historically dependent on Russia for their energy supply, there is a desire to create greater energy autonomy, and to diversify their supply base.

3.1 - Electricity sector overview

Most of the CEEC/CIS are in economic crisis, and overall energy demand is in decline. In the electricity sector, the most realistic forecasts suggest that demand will continue to fall, and that 1988-1989 levels of electricity consumption will not be reached before the turn of the century or later, with, of course, considerable variation depending of the speed of reform in each country.

The electricity sector is a key factor in the economic recovery of these countries, since any electricity shortage may have a very damaging impact on economic growth, and experience shows that efficiency improvements, the modernisation of industry and increasing prosperity lead to an increasing share of electricity in the overall energy balance. Most of the CEEC/CIS have electricity consumption profiles which still reflect the predominance of heavy industry, with typically half or more of power consumed by industry. As the economies develop and wealth increases, this balance is expected to change to a predominance by the domestic and tertiary sectors, in line with EU experience in recent years. This shift in electricity demand should be offset by a reduction in energy intensity accompanying the gradual implementation of economic pricing and market competition.

Inter fuel substitution can reduce dependency on risky nuclear generation, but has some constraints. The typical alternatives to nuclear power are (i) local coal and lignite and (ii) imported natural gas - except in the case of Russia. The potential problems could include :

- Substitution by coal and lignite will be accompanied by increasing pollution, unless considerable investment is made in new technology.
- Substitution by natural gas (i) has some negative environmental impacts, although less than other options, (ii) requires development or extension of an expensive supply infrastructure, (iii) in the short to medium term, exacerbates rigidities in supply options, and (iv) has negative effects on the balance of payments for net importers.

3.2 - Nuclear power within the electricity sector

The dependence on nuclear generated electricity for some of the CEEC/CIS is presented in the following table (1991 data). It should of course be noted that these figures are rather variable from year to year.

Country	Total electricity generation (1991) TWh	Nuclear dependence (%)
Bulgaria	40	34
Czech and Slovak Republics	85	29
Hungary	37	43
Kazakhstan		1
Lithuania	19.5	60
Russia[4]	1067	11
Ukraine	256	27

Source: IEA report

In developing strategies to address nuclear safety issues in the CEEC/CIS, it is necessary to have a consistent framework for all the countries concerned, within which specific approaches are needed for individual countries, according to local conditions. For example the approach (at least in the short/medium term) cannot be the same with Russia, with large fossil fuel reserves, Lithuania, dependent on its export revenues, and Ukraine, where excess installed generation capacity allows for some flexibility.

As electricity production from existing nuclear reactors has low marginal cost, it is likely to remain the least cost option, in the short or medium term, particularly for those countries otherwise dependent on fossil fuel imports. In the event of the closure of their unsafe reactors and sustained electricity demand, countries would have to invest in new generation capacity, and in some cases increase their purchase of imported fuels to be paid for in hard currencies. Adoption of Western environmental standards will also necessitate implementation of expensive technologies, which would not be compensated by any revenue collection.

Many of the CEEC/CIS countries claim nuclear power is an important element in safeguarding their long term self-sufficiency. Using Russian technology would, even if the safety systems are improved in the more recent designs, increase dependency on Russia, while using Western European designs (or others) would be safer but more costly.

[4] Note that most of the NPPs are located in the Center/Northwest regions and less safe reactors (RBMK and VVER-230) alone account for 17% of the total electricity production of these regions.

4 - Status of Nuclear Safety in the CEEC/CIS

4.1 - General Safety Assessment in the CEEC/CIS

There is a general deficit as regards "safety culture" as it is understood in Western countries, where it encompasses all elements and actors contributing to safety, including manufacturers, utilities and safety authorities. The following section spells out some of the problems noted in this respect in the CEEC/CIS. The situation can vary substantially from country to country depending, inter alia, on the respective levels of technological competence, quality of suppliers, organisation of public authorities and degree of safety culture. It is not within the scope of this document to present a specific assessment per country or per power plant.

4.1.a - Regulatory Framework

The importance of legally based, independent, technically strong and well resourced regulatory authorities is internationally recognised as a necessary basis for safety.

Regulatory authorities

The centrally-planned economy of the ex-USSR did not favour the development of independent nuclear regulatory authorities. The problem is generic but has country specificities related to the presence or absence of an appropriate scientific and technical infrastructure to provide specialised support to nuclear safety authorities, as well as adequate staffing and budgeting.

Exploratory missions by nuclear regulators of Union Member States have confirmed the need for Union co-ordinated near term assistance to nuclear safety authorities and a long term co-operation aimed at the diffusion of a safety culture by means of the Regulatory Assistance Management (RAM) and Concertation on European Regulatory Tasks ("CONCERT") Groups.

Regulations

In CEEC/CIS, basic legislation on institutional and technical arrangements is sometimes incomplete and administrative procedures are generally loose, and the necessary independent role of safety authorities is not yet firmly rooted. This inadequate regulatory environment causes concerns as does the non-adherence of some countries to international conventions on nuclear safety (see subsequent sections).

4.1.b - Design Safety

Design

Before addressing the main characteristics and deficiencies of each type of reactors (see section 4.2), it can be noted that Soviet-designed reactors generally do not apply the rules and practices common in Western countries, particularly the defence-in-depth principle. This principle consists of (i) preventing accidents by the quality of design and construction, (ii) controlling the installation to prevent it from leaving its normal operational limits and bringing it back within those limits if necessary by adequate safety systems, and finally (iii) designing safeguard systems capable of limiting the consequences of accidents.

The defence-in-depth principle is inadequately followed from all three points of view for the VVER-230 and RBMK reactors, and from the first two points of view for the VVER-213 and -320.

Construction
Generic problems are to be noted as concerns the construction of power plants and the production of equipment. These arise from the general lack of quality assurance policy for equipment manufacturing in factories and for proper installation, control and on-site testing. The overall reliability of hardware therefore suffers from this non systematic approach of quality.

4.1.c - Operational Safety

Safety culture
The general management of nuclear power plants is suboptimal and does not properly ensure a smooth flow of information. In particular, NPPs[5] are over-staffed and there is no clear identification of responsibilities. The discipline-based relationships between different layers of hierarchy do not allow for necessary openness and efficient incident detection and follow-up.

Procedures
Operational procedures describe the actions to be taken when operating a power plant. In clear contrast to Western practices, technical specifications and operational procedures (in particular under accident, transient or test conditions) can be insufficient or even non-existant. The modus operandi relies heavily on the operators' expertise and therefore increases substantially the human error factor.

Maintenance
Maintenance ensures equipment reliability at any time. This implies regular control and test during its lifetime with preventive control or upgrade and full follow-up of various operations, as well as accumulation of experience for all units of the same design. This systematic maintenance was not properly carried out in the former Soviet Union. The present disruption of relationships between suppliers, designers and operators complicates further a proper maintenance of the equipment. The quality of maintenance can vary substantially from site to site even between reactors of the same type.

Training
It is recognised that operators generally have an excellent academic background. However, their on-going training is insufficient in quality and quantity. Programmes of staff training are not well defined and training and retraining sessions are rare due inter alia to the lack of facilities such as full scope simulators.

4.2 -Types of reactors and their safety problems

With some exceptions[6], power plants in operation or under construction in the CEEC/CIS are of Soviet design. The most widespread reactor in the CEEC/CIS is the VVER, a pressurised water reactor the principle of which is similar of that Western PWRs. The second type of reactor is the RBMK, which exists in Russia, Ukraine (Chernobyl) and Lithuania. Two fast breeder reactors exist, in Kazakhstan and Russia. In addition, a large number of low power

[5] Nuclear power plants.
[6] Slovenia operates a Westinghouse 660 MWe PWR at Krsko and Romania is constructing five 680 MWe PHWR (Pressurised Heavy Water Reactors of Candu type) under a Canadian license.

research or irradiation reactors must be taken into account within the framework of a general safety assessment, although they are less worrying due to their reduced power.

4.2.a - VVER reactors

Three generations of VVER exist : the VVER-230 (440 MWe), the VVER-213 (440 MWe) and the VVER-320 (1000 MWe). Each generation has various models : each individual NPP is therefore somewhat different and has specific characteristics which must be taken into account in the definition of safety improvements. The VVER-230 type is the oldest and therefore the least safe. VVER-213 and -320 are of more recent design.

VVER-230

Ten units are still in operation in Bulgaria, Slovakia and Russia. According to specific expert findings including IAEA[7] missions, general deficiencies include :

- absence of a global confinement system (replaced by casemates with discharge valves);
- insufficiency of safety injection systems;
- vessel embrittlement due to high neutronic irradiation and poor knowledge of actual conditions of the oldest vessels;
- sensitivity to common mode failure due to insufficient physical separation of redundant safety systems;
- general unreliability of instrumentation and control as well as emergency power supply systems.

A series of of specific analyses regarding several of these issues are currently under way under the TACIS programme

VVER-213

VVER-440/213 reactors show typically the same deficiencies as the previous VVER-230 generation but to a lesser degree. One should note that the global (third) confinement barrier is compensated by a bubble condenser pressure suppression system whose efficiency is yet to be demonstrated. The general unreliability of instrumentation and control systems should also be mentioned.

A full safety assessment mission of the IAEA as well as important analyses under the TACIS and PHARE programmes are being carried out and will deliver conclusions on other safety aspects in the course of 1994.

VVER-320

This is the latest generation of VVER in operation, and although the design of these reactors is very close to that of the Western PWRs, the insufficiencies of the control system common to all Soviet-designed reactors remain, and are a particular cause for concern owing to the dynamic behaviour of the core.

The general design of these reactors still needs to be further analysed, particularly as experts have noted a reduction of safety dimensioning margins compared to previous generations. Detailed studies on VVER-320 design aspects will shortly be launched under the TACIS programme.

4.2.b - RBMK reactors

The 1986 Chernobyl-4 accident has highlighted the fundamental design deficiencies of RBMK reactors as well as the lack of appropriate operating procedures. Since then, some improvements have been made both in hardware and operational safety. The IAEA has

[7] *Ranking of safety issues for WWER-440 model 230 nuclear power plants*, IAEA-TECDOC-640, February 1992.

carried out missions[8] to investigate some of the changes planned and implemented; these findings are consistent with the following deficiencies.

This reactor is a pressure tube boiling water reactor with a graphite moderator; it was originally built for the production of military grade plutonium. Fifteen reactors of this type exist in three successive generations classified according to their power.
The principal problems to be noted concern :

- the core instability due to positive void coefficient at low power and the possibility of spatial flux oscillations favoured by large core dimensions;
- the insufficiency of the control and shutdown systems;
- the absence of safeguard systems to cope with the simultaneous rupture of several channels;
- the absence of a global containment.

Pending results of further ongoing safety analyses expected in the course of 1994, in particular through the largely Union-financed RBMK consortium, it cannot be clearly stated yet whether improvements can ever bring RBMK reactors to internationally accepted safety standards.

4.2.c - Fast Breeder Reactors

Fast breeder reactors use highly enriched uranium as fuel. Two units are in operation : the BN-350 loop reactor (350 MWe) located in Kazakhstan and intended mainly for the desalination of sea water, and the BN-600 pool reactor (600 MWe) in Russia.

Without prejudice to further analysis of fast breeder reactor safety, it seems that Soviet-designed installations do not have redundancy systems to evacuate residual heat and therefore show a substantial risk of core fusion. In addition, the installations have been designed to resist layer sodium fires but not combined layer - spray sodium fires, which might endanger the integrity of the building in case of an accident. Little is yet known about the validity of dimensioning calculations or whether accidental situations have been properly taken into account at the design phase.

4.2.d - Other reactors in a design phase

Little is known about the development of new reactors in Russia. According to Russia's new 20-year nuclear plant construction plan[9], a new improved RBMK-1000 unit should be constructed at Kursk, VVER-320 reactors should have safety enhancements and be commissioned at the turn of the next century and new VVER type reactors should be introduced (VVER-630, VVER-600). It should also be noted that small district heating nuclear power plants are envisaged (ACT-500, 500 MWth) as well as small graphite moderated reactors cooled by light pressurised water of 32 MWe each at Bilibino.

4.3 - Other nuclear installations

4.3.a - Fuel processing

Before 1990, central and Eastern European countries used to send to the USSR the uranium ore they produced and to buy from the USSR enriched fuel. Given their national resources, the Czech Republic might become an ore exporter, while Hungary and Romania will be able to cover their national needs. Other CEEC depend on foreign imports for their ore supply.

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[8] *Safety Assessment of proposed improvements to RBMK nuclear power plants* - IAEI-TECDOC-694 - March 1993.
[9] Source : Nucleonics Week, 21 January 1993.

Uzbekistan, Kazakhstan, Russia and Ukraine produced in 1992 some 8,500 tons of natural uranium[10], while it is understood that Kyrghyzstan and Tadjikistan are active in the processing and milling of ores from Kazakhstan and Uzbekistan. All four known enrichment plants are located in Russia and represent about 25% of the world enrichment capacity.

Before 1990, the CEEC sent their spent fuel back to the USSR for reprocessing. Three reprocessing plants, located in Russia, are known. Since 1990 Russia has asked to be paid in hard currencies for its services, and the Czech and Slovak Republics as well as Bulgaria are developing handling and storage capacities for spent fuel. Ukraine is developing similar plans.

4.3.b - Waste treatment

Until recently, most radioactive waste has been stored without proper processing and packaging at production sites. Significant quantities of liquid waste have been injected into the ground or released in lakes, rivers and oceans.

This approach to waste treatment poses a serious environmental and health problem for all countries concerned which they must address urgently. The first waste treatment facilities are now under construction[11].

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[10] Source : the Uranium Institute.

[11] Westinghouse has won a USD 10 million contract for the installation of the first western plant in the CEEC (Bulgaria) for the treatment of low level waste.

5 - Current International Nuclear Safety Assistance to the CEEC/CIS

5.1 - International co-ordination

Following the report of early 1991 from the IAEA ASSET mission to Kozloduy, it became evident that the safety of some Soviet-designed reactors was substantially insufficient due to the above-mentioned shortcomings and was potentially endangering local and neighbouring populations. Western countries realised the urgency of the nuclear safety problem in the CEEC/CIS and started devising programmes to assist the countries concerned in quickly tackling the matter.

G7

On the basis of intensive preparatory work by a special working group, the G7 endorsed at the Munich summit in July 1992 the following urgent action programme for nuclear safety in the CEEC/CIS :

Immediate measures should be taken in the following areas :

- operational safety improvements
- near-term technical improvements to plants based on safety assessments
- enhancing regulatory regimes

Longer term safety improvements should be based on the examination of :

- the scope for replacing less safe plants by the development of alternative energy sources and the more efficient use of energy
- the potential for upgrading plants of more recent design.

It was evaluated that 700 million dollars were needed over three years in order to finance the most urgent safety improvement measures.

The G7 nuclear safety working group continues to monitor the general progress of actions linked to the improvement of safety in the CEEC/CIS, and concentrates now on the development of medium term safety improvements.

G24 co-ordination

After the G7 summit at Munich, the Commission received the mandate to co-ordinate the assistance to CEEC/CIS of the group of the 24 industrialised countries in the field of nuclear safety. Recipient countries from CEEC/CIS take part in the G-24 co-ordination mechanism on nuclear safety, as well as international organisations, such as the International Atomic Energy Agency (IAEA), the International Energy Agency (IEA), the World Bank and the EBRD/multilateral nuclear safety fund.

The co-ordination mechanism established in September 1992 involves :

- a plenary Working Group composed of bilateral and multilateral donors and all recipient states. It provides an advisory forum and develops orientations and recommendations for specific actions, and a Steering Committee composed of representatives from 10 major donors. A Secretariat staffed by the Commission and seconded national experts, whose main tasks are to provide adequate organisation and documentation and to maintain and develop the G-24 database, which is open to all participants and due to be accessible on-line at the end of this year, with the aim of collecting data on the national programmes of recipient countries.

A number of technical working groups are addressing priority issues for co-ordination, such as, for example, the Kozloduy NPP, training or RBMK reactors.

5.2 - European Union Programmes

To date the European Union has committed the following budgetary resources to nuclear safety for the CEEC/CIS :

Nuclear Safety	(million of ECU)
1991	73
1992	108 (1)
1993	133.2 (2)
Total	314.2

(1) including a Union contribution of ECU 20 million to the International Science and Technology Centre (ISTC) in Moscow.

(2) including a Union contribution of ECU 20 million to the Multilateral Nuclear Safety Fund recommended by the G7 at the Munich Summit.

The Commission intends to commit the necessary funds in 1994 - subject to the approval of its budgetary proposals - to bring its total contribution for improving nuclear safety over the four years from 1991 to 1994 to about ECU 450 million (appr. USD 540 million), which represents more than 75% of the USD 700 million total recommended to meet urgent needs by the G7 nuclear safety working group prior to the Munich summit (for the period 1991-1993).

5.2.a - TACIS and PHARE Programmes

PHARE[12] and TACIS[13] programmes have been operated since 1990 and 1991/92 respectively under different Council Regulations. They cover assistance to CEEC/CIS in all economic sectors, including energy. In this respect, technical assistance is carried out related to energy policy advice, modernisation of fossil fuel production, rehabilitation of classical thermal power plants, energy saving and efficiency, etc.

As concerns nuclear safety, the EU has developed the most important assistance programme in the world which covers in particular (i) design studies aimed at upgrading existing less safe power plants (mainly VVER-230 and RBMKs) but also related to NPPs of more recent design, (ii) on-site assistance at nine sites (in Russia, Ukraine and Bulgaria) with practical safety related projects, including purchase of urgent equipment, (iii) assistance to safety regulatory authorities.

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[12] Poland Hungary Assistance to the Restructuring of Economies : EC economic assistance programme covering 11 Central and Eastern European countries (Albania, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).

[13] Technical Assistance to the Commonwealth of Independant States and Mongolia.

Much expertise is drawn from within the Union to assist the Commission in managing the programmes. The Twinning Programme Engineering Group (TPEG) is comprised of the main nuclear operators of the EU and acts as one important technical advisor to the Commission. Close contact is maintained with other branches of the industry, such as NPP constructors and enterprises involved in waste management or the fuel cycle. Regulatory authorities of the Member States are active as a main interlocutor for general regulatory matters.

TACIS and PHARE nuclear safety programmes, managed by the directorate general for external economic relations in close collaboration with the other specialised directorates general at the Commission, are explained in further detail below.

TACIS

♦ The TACIS 1991 programme (ECU 53 million) consists of 35 projects, which are mainly generic safety studies, i.e. they cover specific types of reactor, mainly the less safe RBMK and VVER-230 series.

The purpose of this assistance was to develop a common understanding between Western and CEEC/CIS experts of the main safety-related design deficiencies and to transfer the modern Western know-how and experience in order to best identify technical problems and to devise appropriate solutions.

It should be noted that generic studies are generally based on analyses of particular sites, with the findings being extrapolated to similar reactor types. In practice, the majority of the studies are and will continue to be conducted in Russia. The table below gives a breakdown of the studies by reactor type and the type of organisation helped:

(million ECU)	*Safety authorities*	*Operators*
RBMK	4	4.6
VVER-230	5	22.8
VVER-213/1000	1	-
All types	3.2	7.6 + 6.8 (training)
Total	**13.2**	**41.8**

♦ The TACIS 1992 programme is divided up as follows and takes account of the priorities proposed by G7 and the setting up of a Master Plan[14] with the assistance of the TPEG. It comprises four parts:

Safety of nuclear power plants	(ECU million)
1 - Operational safety (on-site assistance)	38
2 - Design safety (generic studies)	10
3 - Assistance to safety authorities	6.5
4 - Master Plan	3.5
(5 - Contingencies	2)
Total	60

After difficult negotiations between the Commission and the Russian and Ukrainian authorities, the latter agreed for the first time in spring 1993 to accept concrete on-site assistance as recommended by the G7.

[14] See below and section 6.3.

On-site assistance implies the long term presence of experts at NPPs and the implementation of concrete safety improvement measures. This assistance, which in practical terms has involved the presence of one or two Union operators for each of eight sites in Russia and Ukraine since June 1993, covers two aspects:

- the human factor, man-machine interface (operational procedures, training, etc.) and more generally safety culture;
- improving safety equipment (inspection and control, supply of basic equipment), up to 40% of the budget.

The following sites are covered by EU assistance :

Russia

• Smolensk	RBMK
• Sosnovy Bor (St Petersburg)	RBMK
• Kola	VVER-230, VVER-213
• Kalinin	VVER-320
• Balakovo	VVER-320
• Beloyarsk	Fast breeder

Ukraine

• Rovno	VVER-213, VVER-320
• South Ukraine	VVER-320

At the present time, the first phase of this activity is completed or near completion and EU utilities have drawn up with the beneficiary the technical specifications for the procurement of equipment. In a second phase in early 1994, equipment will be supplied and the actual implementation of corresponding assistance measures will be carried out in a third phase.

Other 1992 activities cover the continuation of generic safety studies (including on the fuel cycle) and assistance to the national regulatory authorities, as well as funding for a "Master Plan" covering :

- framing an overall strategy for planning, building, running and decommissioning power plants, for and with the CEEC/CIS authorities;
- defining Union assistance in the medium term;
- additionally (after taking stock of current work) carrying out studies to aid the overall policy review required by the Master Plan. This will look at plant operation in the context of the nuclear chain, from mineral extraction through fuel processing to waste management, and reconsider nuclear generation of electricity compared with alternative energy sources via studies of input costs, prices and environmental impact.

♦ The TACIS 1993 programme will be submitted for opinion to the Member States by the end of the year. Plans include a continuation of the on-site component (both general assistance and specific projects) at the eight sites and inclusion of a ninth site (Zaporozhe, Ukraine). In addition, it is anticipated that design safety projects will be complemented and assistance to the Russian and Ukrainian regulatory authorities strengthened. Waste treatment and fuel cycle studies are proposed, as well as safety assessments of fast breeder reactors.

PHARE

The PHARE programmes for 1990, 1991 and 1992 include both on-site assistance and generic studies.

PHARE Nuclear Safety Programme (ECU million)	1990	1991	1992
1 - Operational safety (on-site assistance)	-	6	15.8
2 - Design safety (generic studies)	3.8	8.5	5
3 - Assistance to safety authorities	-	1	6.5
4 - Regional waste management policy	-	1.2	2
Total	3.8	16.7	29.3

- **Bulgaria**

For 1991, the EU financed an emergency programme on the Kozloduy power station (VVER-230 reactors), under the supervision of the WANO[15]. This included the twinning of Kozloduy with a power station in the Union and a detailed engineering study which led to a thorough overhaul of the power station during the shutdown of the reactor (outage programme).

A consortium of technical support organisations from Union safety authorities contributed its expertise to a review of the power station's safety. This action was continued in the form of assistance to safety authorities. As a result of the substantial improvements achieved, Kozloduy unit 2 (VVER-230) was connected to the grid at the end of December 1992 after a one year outage period.

A small amount of aid has been earmarked for units 5 and 6 of a much more recent model (VVER-320). ECU 14.8 million has been allocated to Kozloduy in 1992 bringing the total amount since 1990 to ECU 27.5 million.

- **Czech Republic**

At Temelin, where the more modern VVER-320 reactors are under construction, assistance has been targeted on providing necessary management capacity for the delivery of instrumentation and control (I&C) systems. A study of the instrumentation and control at VVER-213 units at Dukovany is being carried out. Training was arranged for the Czech safety authorities.

- **Slovakia**

Operations at Bohunice, which has both VVER-230 and VVER-213 units, focused on improving the safety of the emergency cooling and containment systems of the VVER-230 reactors. A study was also launched for the instrumentation and control for the VVER-213 reactors. Extensive assistance is being given on the Bohunice site (VVER-230 and 213 reactors), involving on-site presence of a large number of experts.

- **Hungary**

The Paks power station (VVER-213) is, in the opinion of observers, one of the best run plants in Eastern Europe and receives no direct assistance yet (safety studies have been proposed under the PHARE regional programme).

- **Lithuania**

The two units at Ignalina are of the more recent RBMK type (1500 MWe). PHARE has already provided assistance in training operators for this plant. The first phase of the development of a compact simulator to enhance this training is being financed and is underway. In addition, a project of assistance to regulatory authorities will begin shortly.

[15] World Association of Nuclear Operators.

- **All PHARE countries**

Generic safety studies (ECU 5 million) cover the most recent reactors (VVER-213 and 320) in co-ordination with TACIS, given that TACIS programme funds safety improvements on the VVER-230 series.

In 1992 the safety authorities were singled out for particular attention, receiving ECU 6.5 million. PHARE 1993 will cover regional (and country) actions in a continuation of 1992 activities, with an emphasis on RBMK, VVER-230/213 and waste management.

5.2.b - Euratom loans

Following the invitation of the European Council held in Lisbon on 26 and 27 June 1992, the Commission presented (9 December 1992) a proposal for a Council decision amending Decision 77/270/Euratom to authorise the Commission to contract Euratom borrowings in order to contribute to the financing required for improving the degree of efficiency and safety of nuclear power stations in certain non-Member countries.

A Council decision should be made according to Article 203 of the Euratom treaty. On 7 June 1993, the proposal received the Council's agreement in principle. The proposal is still with the European Parliament for consultation.

While a ceiling for Euratom borrowings has been fixed by the Council at 4000 MECU, by 1.10.1993 2876 MECU of this limit had been employed, leaving considerable borrowing facilities available for financing nuclear power station improvements.

5.3 - Other Assistance Programmes

5.3.a - Bilateral

The contributions for the period 1991-1993 based on the data recorded by the G-24 regarding firm commitments or better are as follows[16]:

	Firm commitments (ECU million)	Financing decisions taken (ECU million)
European Union	314	181
Belgium	4.8	1.4
Denmark	2.0	2.0
France	26.7	26.4
Germany	47.6	37.5
Italy	24.0	11.0
Netherlands	0.4	0.4
Spain	1.9	1.9
United Kingdom	14.8	14.5
Canada	26	6.2
Japan	64.8*	64.8
Nordic countries	22.0	22.0
Switzerland	6.2	6.2
United States	32.7	32.7
IAEA	7.4	7.4
Total	595.3	415.4

source : G24 (Commission) dated : 21 October 1993

*over 10 years.

[16] including contributions to the multilateral nuclear safety account (see below).

Assistance activities are being carried out by bilateral donors along the lines of the G7 recommended action programme, and include for instance twinning, training of operators, assistance to safety authorities, safety assessments and analyses, transfer of codes, full scope VVER-320 simulators, fire protection and some supply of safety equipment.

5.3.b - Nuclear Safety Account

The Munich Summit recommended the setting up of a Multilateral Fund which is destined to complement bilateral engagements (cf. § 46 of the Munich Declaration) and concentrates on urgent upgrading operations for the least safe reactors (RBMK and VVER-230 types).

On 27 January 1993 an agreement was reached on the rules which govern the Nuclear Safety Account (or Fund) : these essentially entail the existence of an account administered by the EBRD and managed by the Assembly of donors or an Operating Committee that might be set up; both will reach decisions by consensus.

The Fund has been operational since April 1993, when the minimum level of contributions was reached. The table below lists in detail the amounts assigned to the Fund. It should also be noted that many non-members of the G7 have already contributed to the Fund.

	Total Contributions to the Nuclear Safety Account (ECU million)	1993 Contributions to the Nuclear Safety Account (ECU million)
European Union	20**	20**
Canada	4.7	4.7
Denmark	2	2
Finland	1.5	0.5
France	15	15
Germany*	31.4	10.5
Italy	9.9	9.9
Japan	9.0	3.0
Netherlands	1.5	1.5
Norway	2.0	2.0
Sweden	3.0	3.0
Switzerland	5.4	5.4
United Kingdom	11.5	11.5
United States	1.5	0.5
Total	118.4	89.5

source: EBRD dated : 15 October 1993

* with the condition that the German contribution does not exceed 15% of the overall contribution over three years.

** firm commitment.

On the basis of IAEA studies and especially of the assistance of the PHARE programme, which has over the past three years devoted more than 27 MECU to studies and particularly to on-site assistance at Kozloduy, the first action agreed upon by the Fund on 16 June 1993 for a total of ECU 24 million consists of the supply of equipment for reactors 3 and 4 at the plant (the most recent VVER-230 reactors). In return, the Bulgarian authorities have undertaken a commitment of principle to dismantle reactors 1 and 2 by 1997. A second action under preparation concerns the reactors in Ignalina, Lithuania. Furthermore, projects are to be developed in Russia and eventually in the Ukraine.

It must be kept in mind that the Nuclear Safety Account complements the existing bilateral programmes, including EU activities.

5.3.c - International Organisations

IAEA

The International Atomic Energy Agency (IAEA) has intensified its relationships with CEEC/CIS since the political changes in these countries. The Agency has been able to carry out several inspection missions (e. g. ASSET and OSARTS) in these countries. IAEA analyses define and rank the main safety deficiencies but do not design or evaluate desirable engineering upgrades.

Fellowship programmes have been complemented by focused actions such as probabilistic safety analysis for VVER reactors or severe accident analysis for VVER-213. Additional extra budgetary activities have been developed for the safety analysis of VVER-230 series in 1991 (completed), followed by similar exercises for VVER-213, VVER-320 and RBMK (on-going programmes).

EBRD

The European Bank for Reconstruction and Development (EBRD) administers the Nuclear Safety Account. The Bank is financing projects in the energy sector including the rehabilitation of traditional thermal power plants. It is currently considering the financing of the completion of the Bohunice NPP in Slovakia.

IBRD

The International Bank for Reconstruction and Development (IBRD, or World Bank) has been active in the energy sector in the CEEC/CIS. It has not financed projects in the nuclear power sector and has no plans at the moment to do so.

At the request of the G7, the World Bank has produced in collaboration with the International Energy Agency and the EBRD a comprehensive economic analysis[17] on the nuclear and electricity sector in these countries and devised investment scenarios.

5.3.d - ISTC

Since the end of the cold war, Russian and other CIS weapon scientists and engineers have seen their activities sharply curtailed. They consequently live and work in very unstable conditions, increasing the risks of proliferation of dangerous technologies.

In order to counter these developments, the Agreement establishing an International Science and Technology Centre (ISTC Agreement) was concluded between the European Community, the USA, Japan and the Russian Federation. It was signed in December 1992 but is currently still awaiting Russian ratification.

The Centre, once operational, will develop, approve, finance, and monitor science and technology projects permitting the redirection of the skills of weapon specialists towards civilian projects in the fields of, inter alia,

- environmental protection;
- energy production; and
- nuclear safety.

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[17] *op. cit.*

The Community budget will finance projects for an amount of ECU 20 million from the 1992 TACIS funds, once the Agreement enters into force.

5.4 - Difficulties in Implementing Assistance Programmes

5.4.a - Liability

International nuclear liability conventions[18] stipulate that the responsibility for all damages caused by a nuclear incident are borne exclusively by the operator of the plant concerned (channelling). Suppliers of services or equipment to NPPs are therefore protected against legal action.

As most recipient countries are not party to the Vienna convention[19], both Western donors and contractors involved in technical assistance and safety upgrading operations risk exposure to legal actions, including by third parties, for nuclear damages which might occur in recipient or third countries. There is thus an urgent need for the recipient countries to accede to the Vienna convention, while introducing and implementing the relevant national legislation.

Meanwhile, there is clearly a need to find an effective interim solution that provides realistic coverage but does not discourage recipient country efforts to move rapidly towards accession. The Commission has therefore requested recipient governments to directly indemnify contractors vis-à-vis third parties in case of nuclear damages. While the Commission views such indemnity statements as the best possible solution in the short run, some contractors consider them to lack satisfactory legal coverage and economic credibility.

In particular, Commission negotiations with the Russian and Ukrainian authorities to obtain such statements have been underway since early 1993. So far only a limited indemnity has been provided by the Russian Federation covering neither the installation of equipment nor the changing of operating procedures. The Russian authorities have pledged to sign a full indemnity statement by the end of 1993.

While it has been possible to launch TACIS projects, it must be stressed that these projects are now entering in-depth phases (equipment supply, etc.) and risk being prematurely terminated if a satisfactory full indemnity is not received.

5.4.b - Industrial Property

It must be stressed that EU assistance programmes are dependent on a joint collaboration with the recipient. Therefore, existing information should be made available by the recipients to EU experts for the purpose of carrying out properly the assistance activities.

At the basis of the programmes is the concept that information and data generated under EU-financed projects should be accessible and disseminated as widely as possible to other countries concerned in order to ensure maximum benefit and efficiency of allocation. To this end the Commission has obtained a free license to project outputs for the use of its programmes.

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[18] The situation regarding civil nuclear liability in Western Europe is based primarily on the regional (OECD) Paris Convention (1960) and the complementary Brussels Convention (1963). The Vienna Convention (1963) provides for a regime at the international level.

[19] See section 6, below.

However, the choice of Russian subcontractors is often very limited, as existing information and data relevant to Soviet-designed NPPs is usually in the possession of only one or two Russian institutes. These institutes, interested in safeguarding their market advantage, are therefore inclined to prevent a wide distribution of design data (the distinction between input and output data is naturally problematic) and even try to turn their monopoly into financial leverage.

Clearly such moves must be opposed, since it is fundamental that this information is made readily available under EU assistance to third countries which operate Soviet-designed reactors.

5.4.c - Co-ordination within recipient countries

The disruption of old structures, under which nuclear production was centrally managed with no independent control, has led to a substantial disorganisation within various bodies and more importantly between them (safety authorities, utilities, designers, constructors). This situation is particularly apparent in CIS countries and renders negotiations and co-operation difficult at all levels, as there is generally insufficient co-ordination between the different actors involved. Political instability can add further uncertainties and unreliability to medium or long term prospects.

5.4.d - Availability of EU experts

Unlike other areas of assistance, there are very few independent consultants in the nuclear safety field, as utilities and constructors often rely on internal expertise. Therefore, experts for assistance programmes have to be drawn directly from EU companies or administrations that have to divert highly experienced and valuable staff from their normal tasks, while at the same time needing to carry out their usual activities with all due efficiency and professionalism.

As a consequence, there is a general limited availability of experts which in some instances, causes delays to programmes or does not allow the full development of all desired activities.

5.4.e - Link with Macroeconomic Policy

Assistance programmes cannot be fully effective if nuclear power plants in the recipient countries lack the financial means to procure for example basic spare parts and are forced to reduce maintenance and other safety relevant measures for economic reasons. It is therefore crucial that nuclear plant operators are enabled to work economically, which in turn is largely a function of achieving adequate revenues via appropriate electricity pricing.

6 - Future developments in nuclear safety in the context of the energy sector

6.1 - Energy sector development and international assistance

The production of electricity of nuclear origin must be considered in the context of competition with alternative sources of electricity, i. e. traditional power plants.

Union assistance and co-operation will be developed with the CEEC/CIS in the energy sector, including nuclear safety, in the framework of the various bilateral co-operation or association agreements entered into with these countries.

6.1.a - Economic scenarios

The World Bank-IEA-EBRD report[20] contains a wealth of data and analysis on the electrical power supply situation in the six countries covered, which were chosen because they have less safe reactors (VVER-230, RBMK) : Armenia, Bulgaria, Lithuania, Russia, Slovakia and Ukraine.

Economic studies show that future energy demand is hard to predict, because of uncertainties over the speed and extent of economic recovery, and the rate of decline of energy intensity which is expected to accompany the adoption of market economy conditions. The World Bank report takes account of this uncertainty, and highlights the differences between official government forecasts of energy demand, which are high, and those of external experts, which are substantially lower.

The World Bank report develops, for each country addressed, three nuclear scenarios, describing the extent of utilisation of the old reactors (RBMK and VVER 440/230 types). These scenarios (which include the use of old and new reactors) - high, moderate and low - taking into account three assumptions of the level of future electricity demand, lead to an evaluation of the capital investment and annual fossil fuel costs of each (refer to the World Bank report summary).

There are considerable (acknowledged) uncertainties attached to assumptions made in calculating the cost of each scenario. For instance load forecasts and future fossil fuel prices are very difficult to predict, and investment evaluations (including safety upgrades) rely on specific assumptions concerning local content, imported components and the impact of industrial co-operation, including economies of scale. It is rather more likely that these countries will use their internal resources or develop industrial co-operation in preference to paying for imported equipment.

6.1.b - Promotion of regional co-operation in the field of energy

The momentous changes in the CEEC/CIS have tended to create national energy policies dominated by self-sufficiency concerns which will be increasingly costly to all the economies. The PHARE and TACIS programmes are already active in promoting co-operation and co-ordination of (i) generation expansion planning (it should not be economically logical for one

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[20] *op. cit.*

country to build new thermal plant if spare capacity exists in adjacent countries) and (ii) network interconnections and power exchanges[21,22].

These efforts should be pursued, along with the definition and implementation of regional schemes with multi-national financing and assistance in implementation of suitable framework for market-based international transactions.

6.1.c - Energy efficiency

A reduction in general energy demand can favourably impact in the medium term on less safe nuclear reactors due to the effect of inter fuel substitution. Within the electricity sector a significant reduction in power demand can create conditions conducive to (i) reactor outages allowing long term safety improvements to be made, or (ii) definitive reactor shut down.

Demand reduction first depends upon suitable institutional and organisational reforms (removing institutional disincentives, clarifying the respective roles of Ministries, utilities and industries, establishing economic pricing structures), and then upon technical and technological assistance (audits in industries where replication potential is high and local supply of energy services can be envisaged, improvement in energy metering and revenue collection etc.). It should be noted that the scope for achieving energy efficiency improvements in the CEEC/CIS is generally very large, as exemplified by the high energy consumption per GDP and per capita in these countries relative to the Union.

The PHARE and TACIS programmes should continue to place emphasis on energy efficiency actions, and will coordinate as necessary with other programmes, particularly THERMIE and SYNERGY, which have established programmes impacting on energy efficiency in the CEEC/CIS.

6.1.d - Electricity sector restructuring

The present price charged for electricity in some countries does not reflect true total costs, which should take into account the costs of safety improvements and new investments. This market distortion should be corrected gradually through the adoption of adequate pricing policies and the efficient collection of bills, especially from industry. Therefore governments of the CEEC/CIS should make every effort to promote the improvement of utilities management, which may, where appropriate, be facilitated by establishing them as separate economic entities, where this is not yet the case.

Extensive modernisation of and new investment in the conventional thermal power sector (and hydro units, where applicable) is needed whatever decisions are taken on nuclear generation, for the following reasons:

- Rehabilitation or re-powering of existing thermal units will widen electricity generation options for these countries and, through efficiency gains, reduce their future fuel expenses. This should decrease incentives to continue operation of less safe NPPs;
- Many conventional units are close to the end of their normal design lives;

[21] These countries will see a gradual increase in the share of domestic and commercial electricity consumption in the overall demand, which will result into more "peaky" load curves, necessitating specific peaking generation, and will make even more attractive international exchanges of power for peak-shaving purposes.

[22] Development of interconnection gas and electricity networks will as well mutltiply exchange partners. This should attenuate the motivations for national "self-sufficiency", since those are often provoqued by the perceived risk of depending completely on the will of an unique supplier.

- The distorted price structure has been discouraging investments in generation efficiency which should be highly profitable;
- In most cases, insufficient attention and resources have been dedicated to the quality of construction and maintenance, and this needs to be addressed.
- Reliability and availability of the non-nuclear sources of electric power should be ensured even in scenarios where nuclear generation is continued (peaking constraints, security of nuclear auxiliaries supply, back-up during shut-downs for maintenance etc.).
- As awareness of environmental constraints grows, evolution towards the adoption of Western European (equivalent) standards will entail extensive improvements to power stations.

IFIs[23] including the European Investment Bank already finance investment projects for alternative sources of electricity which can concern either rehabilitation of existing plants or green field operations. Prefeasibility studies could be financed under EU funds.

A clear priority should be given to investments which are conducive to the early shut down of less safe nuclear power plants. In particular, green field investments should preferably be located in such a way to effectively substitute existing less safe nuclear power plants.

6.2 - Responsibilities for nuclear safety

It is internationally recognised that overall responsibility for nuclear safety rests with the country in which a nuclear installation is located, and that liability is strictly channelled to the operator of the installation[24]. As recipient countries are solely responsible for any decision taken on their nuclear installations, any assistance or investment financed by the international community to countries operating nuclear installations should not imply any liability to be borne by the providers of assistance.

6.2.a - Vienna convention

EU suppliers of equipment or services should be indemnified against any consequence of a nuclear accident. Therefore every effort should be given to the legal codification of the above principles, i.e. the accession of the recipients to the Vienna convention and the introduction and implementation of the corresponding national legislation.

Poland and Romania are Parties of the Vienna Convention and Joint Protocol, with full provision for channelling and strict liability in national law. Slovenia, Hungary and Lithuania are Parties to the Vienna Convention but as yet have no implementing national legislation. Finally, however, all of the other countries involved have no international commitments or national laws that provide channelling or strict liability.

Therefore, practical pressure must be brought to bear upon these recipient countries in order that they adopt as quickly as possible the relevant legislation. Moreover, in the meantime, they have to enter bilateral arrangements with donors to ensure full indemnity covering the latters' assistance efforts.

6.2.b - European Energy Charter : Nuclear Protocol

The Charter was signed on 17 December 1991 by almost fifty parties (including the Community as a whole and all the Republics of the former USSR, except one) and was

[23] International Financial Institutions.

[24] This is expressed in particular in the Vienna convention (refer also to section 5.4.a).

considered as the first step towards a more elaborate binding agreement. The signatories consequently undertook the negotiation of a Basic Agreement which would define the horizontal and institutional provisions necessary for the operation of the Charter and a number of specific protocols including nuclear energy and its safety aspects.

Negotiations of a protocol "on principles governing the peaceful use of nuclear safety facilities" are today well advanced, within the framework of a working group. The section of the text devoted to co-operation and co-ordination, as well as that on "principles of responsible nuclear conduct" are almost finalised.

The draft protocol specifies the measures that the signatories intend to take in order to ensure safety throughout the nuclear fuel cycle. This involves in particular the creation of a suitable legislative or statutory framework, the appropriate operation of licensing and regulatory authorities; the rules on liability and financial responsibilities; industrial co-operation; the establishment of emission and security standards; permanent training for personnel, emergency plans; impact assessments; etc. A commitment to subscribe to the most relevant international Conventions in the nuclear field is also provided for.

Negotiations of this nuclear protocol have been suspended since mid 1992; however, the negotiators considered that it is necessary to wait for the finalisation of the Basic Agreement in order to ensure consistency between the Agreement and provisions contained in the nuclear protocol. Despite this temporary suspension, the negotiations are sufficiently advanced to allow a conclusion of the nuclear protocol, almost at the same time as the Basic Agreement.

6.2.c - International Nuclear Safety Convention

In 1990 the Netherlands put forward the proposal that the IAEA should convene in 1991 a high-level technical conference on nuclear safety. A conclusion of this Conference was that a state's responsibility for safety of nuclear installations should be formally reinforced by an ethical commitment to the international community based on common safety guidelines. The challenge of agreeing on clear objectives, scope, obligations and benefits of such a commitment was left open.

A 1991 IAEA resolution started preparation of the elements of a nuclear safety convention, which should act as an incentive for the parties to increase the safety of civil nuclear power plants. Given the advanced stage of the draft convention, a resolution of the IAEA General Conference of October 1993 has proposed to call a diplomatic conference in early 1994 in order to finalise and sign the convention. On 26 September 1993, the Commission submitted to the Council a proposal for a negotiation directive to represent the Community at the conference. It is important that the Community as such becomes party to this Convention.

6.3 - Development of Nuclear safety Assistance from International Donors

Short term priorities concern the safety improvement of existing units of less safe design, in particular VVER-230 and RBMK.

Medium and long term perspectives cover the strengthening of safety measures for the newest reactors due to be operated until the end of their design life or to be built and commissioned. Due consideration is to be given in the development of alternative sources of energy.

The Commission is currently finalising a draft Master Plan which will be discussed with the Member States and the recipient countries and will provide an overall and flexible framework for coherent joint recipient-donor collaboration towards improvement of nuclear safety under the PHARE and TACIS programmes. Eventually, this Master Plan might be extended so as to serve as a reference document for discussion with all donors and recipients in the framework of the G24 co-ordination. In any case, it must be underlined that the EU's assistance is guided by the principle of help for self-help. Moreover, the overall responsibility for nuclear safety remains with the recipient countries.

6.3.a - Assistance in improving the safety of existing less safe nuclear installations
Whatever the actual shutdown date of less safe reactors should be, urgent assistance is to be granted to improve their safety. It is unlikely that commercial instruments can be used to finance short term measures, as the return on investment will be dubious for those power plants which should be closed down before the end of their design life time. Therefore grant financing should be devoted to short term urgent improvements in addition to the measures which the recipient countries should carry out themselves.

Grant assistance can be meaningful only if adequate efforts are undertaken by the recipient including :

- installation of minimum legal framework;
- provision of sufficient budget and staff for regulatory authorities;
- restructuring of utility and power plant management;
- sound co-operation as concerns the dissemination of NPP information and study results.

The EU assistance in improving safety of existing less safe nuclear installations will continue to be developed along the lines of the G7 action programme and will be based, inter alia, upon the following principles :

i. Assistance should allow the transfer of know-how and expertise from Western experts, as well as recipient staff training (e. g. through twinning programmes). The size of the EU budget allocated to this type of expert assistance should be maximised yet needs to take into account the limits of available expertise from the EU which can be mobilised and has the relevant experience for nuclear safety assistance programmes.

ii. As appropriate, the work of specialised institutions of the recipient countries might be financed in co-operation with Western enterprises, provided that it adds value to existing data and information, which should be made available free of charge as a matter of principle.

iii. The provision of safety equipment should be the primary responsibility of the recipient. Assistance in equipment purchase will be given as a transitory measure only in areas where EU technology clearly contributes to the safety and if no local solution is available. Depending on the structure of actions, the proportion of equipment supply in assistance programmes could reach 50%.

iv. Special technical assistance should be made available for the process of definitively shutting down less safe nuclear plants. Possibly a separate fund would need to be established for this specific purpose.

6.3.b - Medium term assistance and industrial co-operation as a way to improve the general safety of the present and future nuclear park

It is clear that some recipient countries are committed to develop their civil nuclear sector and will commission, build and operate reactors of recent design.

As concerns financing the corresponding investments, a gradual approach should be followed which would involve less foreign financing than outlined in the World Bank report[25] and concentrate more on developing local sources of financing. In particular, industrial co-operation with recipient countries should be promoted.

Areas of medium term assistance

For the newest reactors, technical expertise should be financed under EU programmes preferably if they concern :

- assistance to the work of safety authorities related to these reactors;
- investment project feasibility studies;
- industrial co-operation, mainly through joint-venture financing.

Types of financial mechanisms

Technical assistance to safety authorities will be financed through grants. As concerns safety related equipment, pure grant will normally be excluded but the softening financial terms of EU supply contracts might be considered. This could for instance consist of interest rate subsidies, cost-sharing with the recipient, co-financing with bilateral aid or financing up front costs for IFI-financed projects.

Such financial support of equipment supply would commit the end-user, as he will have to participate in the project with his own resources (e. g. used for repayments of softened loans). Leverage effect will also be ensured for the corresponding EU grant funds, as they come in addition to other sources of finance. This scheme would develop the transfer of EU know-how and expertise.

Generally, financing of normal investments should be made on a commercial basis, with a strong involvement of IFIs and commercial banks. Therefore EU grant funds are normally not justified for these actions. Euratom loans will be preferably developed for these kinds of projects.

Project identification

Both the Union and beneficiary countries must channel these financial resources into an aid and investment programme which assures the rational use of funds. For actions in the medium term, it will be desirable to establish, in co-operation with beneficiaries and the competent enterprises, a reference programme for the improvement of power stations with pressurised water reactors (PWRs), this programme to be made up of fields of activity arranged in a hierarchy according to their impact on safety and the added value which Community technology will be able to provide.

This approach to programming will allow specific actions on industrial co-operation and investment to be put into perspective, thereby ensuring the permanent monitoring of the utilisation of the financial resources of the Union and permitting the enterprises concerned, in the Union or in the beneficiary countries, to develop the necessary co-operation measures.

This approach implies the active participation of the beneficiary countries' authorities, first of all because it is for them to present eligible projects, but also and especially because they will

[25] *op. cit.*

have to promote the requirements of co-operation to the relevant enterprises; this co-operation will have to favour training and technology transfer.

6.3.c - Conditionality of assistance in the nuclear safety field

While the EU has a clear and immediate interest in helping CEEC/CIS countries in improving the safety of their nuclear installations, grant assistance should be embedded in a larger framework which incorporates objective safety conditions and takes account of long-term EU interests. Some degree of linkage of assistance to certain conditions seems appropriate, in particular to ensure the maximum efficiency and rationality of nuclear safety assistance programmes.

At all stages of the programmes, it is the Commission's intention to favour and bring about an environment conducive primarily to the early shutdown of less safe reactors.

It is of course clear that differences of opinion between the EU and recipient countries do exist with regard to the safety of existing nuclear reactors, their actual design life time, new investments, electricity demand forecasts, etc. For instance, adopting a position of immediate shutdown of less safe reactors as a prerequisite to the continuation of assistance programmes would probably be ineffective at this stage.

A more realistic, graded approach might involve the identification of acceptable, reciprocal milestones in the actions of the EU and recipient countries based on a number of priorities and with the ultimate aim of rendering shutdowns economically and politically feasible. These milestones must be linked to incentives or corrective measures proportionate to actions taken or not taken. Linkages must be highly credible and should therefore correspond to measurable indicators of achievement (or non-achievement) whose fulfilment (or non-fulfilment) actually leads to direct responses from the EU.

Several distinct levels in the use of linkages can be identified as well as the corresponding incentives/corrective actions :

Strategic

On a strategic level, general conditions must be identified which correspond to EU interests of improving safety to the greatest extent possible and which are achievable by the recipients. These include inter alia the development of realistic pricing policies for electricity and fissile materials, the restructuring of utilities, investment in alternative energy sources, energy efficiency, and transmission of energy between regions, the creation of an efficient regulatory framework, the proper staffing and budgeting of regulatory authorities, and concrete commitments to create appropriate conditions which would enable the early shutdown of less safe reactors.

Corrective actions which could be linked to the non-fulfilment of such conditions might include the suspension of the programme or a part thereof, or even include actions taken with relation to other assistance areas or on a political level. The anticipated response should naturally reflect a realistic political will on the part of the EU and a reasonable chance of impact on recipient plans.

Incentive actions which could be also be linked to the fulfilment of these conditions on a strategic level include large scale investment projects, and the scope and size of Union assistance.

Programme
On the level of assistance programmes encompassing various projects, maximum overall effectiveness should be ensured, not only at the level of each recipient country, but also for the whole region, in particular through coherent planning and multilateral co-operation, as well as smooth exchange of experience, information and results. As indicated above, the Commission is drafting a Master Plan to this end.

Various assistance and national upgrade activities on any given individual reactor should concur to substantially increase the total safety of this reactor whatever its remaining lifetime might be. Every effort should be made to avoid extending the actual remaining lifetimes of the reactors.

Corrective corresponding measures might include suspension of a category of projects (e. g. design studies), or suspension of the programme, or reduction of the assistance budget in the future, or restriction of future actions to specific areas (e. g. reduced scope of equipment supply), or reduction of co-financing share.

Incentives could include for instance general support to national recipient industries, for instance through the dissemination of inventions or findings with industrial applications in other fields.

Operational
At an operational level, the linkage of projects to certain technical conditions can be more clearly defined and immediately required, not least to ensure the full effectiveness, or in some cases even the continuation, of the project itself. Assistance conditions should include inter alia clear recipient contributions (facilities, staff), satisfactory legal protection against potential third party legal claims, reasonable subcontracting guidelines, acceptance of EU contracting and purchasing procedures, etc.

Responses proportionate to these conditions might include inter alia suspension of individual projects or subcontracts, cancellation of project follow-ups, suspension of a category of projects, etc.

Incentives could include broader scope of co-operations with Union partners.

6.4 - Aspects of the supply of nuclear materials relating to the CEEC/CIS

The conditionality described in the previous section is linked not only to the efficiency and rationality of improvement programmes in the field of nuclear safety, but is also linked to the longer term interests of the Union. One area of potential future concern for the Union is the supply of nuclear materials, and more particularly the stability and security of their markets.

For the Union, to which annual deliveries of natural uranium to users is some 12,000 tonnes (out of a total requirement of some 15,000 tonnes), and which has to import around 80% of its natural uranium requirements, long term security of supply has depended until now on a sufficient diversity of suppliers and the development of new production capacity in a number of countries possessing important reserves, amongst which are the CEEC/CIS.

Russia, Kazakhstan, Uzbekistan, to a lesser extent Ukraine and potentially Tadjikistan and Kyrghyzstan, possess natural uranium reserves with current production levels in excess of domestic needs. They are therefore seeking to establish themselves on the international market, if only to avoid the further increase of their stock levels, currently estimated at 200,000 tonnes, which is the equivalent of several years of world consumption.

Moreover, while construction in the nuclear power sector following the accident at Chernobyl is slowing down, it is likely that the production and treatment of nuclear materials is continuing, thus increasing the already enormous stocks of enriched uranium.

For the immediate future, the Union considers that its dependence on these countries should not exceed a reasonable limit, of the order of 20% of its total requirements. At the same time, the USA has closed its markets to deliveries at prices lower than $13/lb (the CIS currently sells at arounbd $7/lb).

The Russian presence on the international market has been, until now, less evident in enriched uranium than in natural uranium. However, it is the stock of material arising from the disarmament process which, added to that emerging in the civil sector, could in time put irresistible pressure on the market. A completely new situation could arise, in which one country, Russia, would have available stockpiled material corresponding to a relatively large number of years of world consumption, whose cost would be virtually nothing compared to that available elsewhere. The USA will to a large extent find itself in the same situation without, however, the same need to market its stock.

Faced with this situation, the Union must tackle the problem of the supply of nuclear fuel in its totality, and seek solutions in concert with the principal states concerned. It could, for example, examine the possibility of utilising the powers available under Article 72 of the Euratom Treaty - which in particular provides for the establishment of commercial stocks by the Union - so as to contribute to international control of the situation.

In anticipation of potential future market instabilities, the Commission will continue to promote the development and to support the implementation of safeguards and controls of nuclear materials and installations in the CEEC/CIS. This will include the training of and dialogue with competent State authorities and nuclear operators, with the aim of modernising the accountancy and control systems in order to minimise the risk of proliferation of nuclear materials and sensitive technology. This co-operation and support in the field of nuclear safeguards between the Union and the countries concerned should be vigorously pursued.

7 - Conclusions and recommendations

Conclusions

1. Nuclear power plants in the CEEC/CIS, most notably the oldest designs, do not satisfy current design and operational safety standards in the West. Nuclear fuel cycle and waste treatment facilities are either non-existent or else do not meet Western standards.

2. However, the nuclear energy and nuclear safety situation in the CEEC/CIS cannot be divorced from the wider energy picture, in which the future energy demand is rather unpredictable. Despite high inflation, energy prices are still too low to make energy efficiency investments attractive, and energy supply and use remains inefficient. Many of the smaller countries are dependent on increasingly expensive energy imports, and are therefore emphasising energy autonomy.

3. Consequently all these countries are, to a greater or lesser extent, dependent on nuclear generated electricity. Despite the wishes of the international community, immediately closing less safe nuclear power plants will be economically very difficult, as illustrated by the recent decision of Ukraine to continue operation of the undamaged RBMK units at Chernobyl, reversing an earlier contrary decision. In view of this, the Union cannot practically make the quick closure of NPPs a definitive precondition for aid, since neither technical aid nor the working of the energy market will guarantee the supply of the required electricity.

Recommendations

1. Given these realities, the Union should pursue nuclear safety through the actions of the PHARE and TACIS programmes, and efforts should be made to overcome the delays which are being experienced due to the lack of co-ordination or commitment in some recipient countries, particularly Russia and Ukraine. Member states could, through bilateral relationships with beneficiary countries, assist the Commission by encouraging specific conditions for assistance in the nuclear field to be met, namely:

   - In accordance with international practice, recipient countries should explicitly accept all the nuclear responsibility for potential damages resulting from a nuclear accident, whatever the involvement of EU consultants or suppliers.

   - Results arising from EU-financed projects should be made available as necessary to all involved parties for the purpose of improving safety at other installations.

2. More generally, a graded set of conditions and corresponding corrective measures should be established in order to ensure the effectiveness of EU assistance programmes and the general improvement of nuclear safety in recipient countries, which concur with the ultimate objective of closing down as early as is feasible the less safe reactors.

3. The Union should continue its support for the development of legally based, independent, technically strong and well resourced safety authorities in the CEEC/CIS. The coherence between the short-term assistance and the long-term co-operation between European safety authorities should be mainly ensured through the mechanism of the Groups for Regulatory Assistance Management (RAM) and Concertation on European Regulatory Tasks (CONCERT).

4. In order to facilitate the implementation of an integrated global approach, the Commission will further promote, through the PHARE and TACIS programmes, two-way exchanges of engineers and key personnel between the Union and the CEEC/CIS.

5. In addition to activities directly concerning nuclear power plants, assistance will also be provided to reduce radioactive pollution due to fuel cycle activities and to develop safe spent fuel and waste management systems at national and regional levels.

6. The Union should intensify co-ordination of assistance with non-member States through the G24 mechanism, including the future evaluation of assistance efforts.

7. As specifically concerns less safe civil nuclear installations, grant assistance managed by the Commission should be continued under the following terms and within the framework of a multiannual and regional approach, in co-ordination with other donors:

   - All urgent expert assistance identified will be financed as far as possible, but needs to take into account the limited availability of appropriate EU nuclear specialists.

   - Equipment will be granted preferentially in areas where the Union adds a clear technological value to existing local capabilities. Except in cases of extreme urgency, no supply of equipment will be made which would be conducive to a substantial prolongation of the life time of the power plant.

   - Projects of the Nuclear Safety Account should be developed in a complementary way to bilateral activities.

8. As specifically concerns relatively safer nuclear power plants, it is important, in the longer term, to move from studies to investment. In view of this, the Commission will establish an integrated, global approach which leads to industrial investments. Such an approach must encourage efficient co-operation between the Union and the beneficiary countries in order to build bridges between the different technologies. Assistance will be given in order to ensure the safest possible production of electricity of nuclear origin in the CEEC/CIS :

   - Operational safety, including training and assistance in plant management will be directly financed through grant funds.

   - Supply of EU equipment of urgent safety relevance can benefit from preferential terms of financing using grant funds.

   - Joint-ventures between EU and beneficiary country enterprises will be promoted particularly if their activities are of direct relevance for nuclear safety.

   - Euratom loans should be used as soon and as extensively as possible, with priority given to safer reactors.

- Normal investment projects should only be assisted by EU grant funds at the feasibility stage, leaving IFIs and commercial banks with the responsibility of project financing.

9. In the wider energy field, Union financial instruments, including TACIS and PHARE, should aim to counteract the perceived need for energy self sufficiency and create the conditions in which the CEEC/CIS can consider closing older nuclear plants. This should be done by continuing (notably through regional programmes) to promote co-operation and co-ordination of gas interconnection, power generation planning, network interconnections and power exchanges between neighbouring countries.

10. The Union financial instruments, should continue to put particular emphasis on energy efficiency in all sectors, notably through economic energy pricing, in recognition of the large potential for reducing electricity demand, and the impact of this on closure of less-safe nuclear plants.

Annex A - Nuclear power plants in central and eastern Europe and in the CIS

VVER 230/440

Unit / Country	*Generation / Power*	*Coupling to Grid*	*Status*
Kozloduy-1 (Bul.)	230 (440 MWe)	07.1974	*operational*
Kozloduy-2 (Bul.)	230 (440 MWe)	09.1975	*operational*
Kozloduy-3 (Bul.)	230 (440 MWe)	12.1980	*operational*
Kozloduy-4 (Bul.)	230 (440 MWe)	05.1982	*operational*
Bohunice-1 (Slova.)	230 (430 MWe)	12.1978	*operational*
Bohunice-2 (Slova.)	230 (430 MWe)	03.1980	*operational*
Kola-1 (Rus.)	230 (440 MWe)	06.1973	*operational*
Kola-2 (Rus.)	230 (440 MWe)	12.1974	*operational*
Novovoronezh-3 (Rus.)	179 (300 MWe)	12.1971	*operational*
Novovoronezh-4 (Rus.)	179 (417 MWe)	12.1972	*operational*
Oktemberyan-1 (Arm.)	230 (417 MWe)	12.1976	shutdown
Oktemberyan-2 (Arm.)	230 (440 MWe)	12.1979	shutdown

VVER 213/440

Unit / Country	*Generation / Power*	*Coupling to Grid*	*Status*
Paks-1 (Hun.)	213 (440 MWe)	12.1982	*operational*
Paks-2 (Hun.)	213 (450 MWe)	09.1984	*operational*
Paks-3 (Hun.)	213 (460 MWe)	09.1986	*operational*
Paks-4 (Hun.)	213 (460 MWe)	08.1987	*operational*
Dukovany-1 (Cz.)	213 (440 MWe)	02.1985	*operational*
Dukovany-2 (Cz.)	213 (440 MWe)	01.1986	*operational*
Dukovany-3 (Cz.)	213 (440 MWe)	11.1986	*operational*
Dukovany-4 (Cz.)	213 (440 MWe)	06.1987	*operational*
Bohunice-3 (Slova.)	213 (430 MWe)	08.1984	*operational*
Bohunice-4 (Slova.)	213 (430 MWe)	08.1985	*operational*
Mochovce-1 (Slova.)	213 (440 MWe)	-	under construction
Mochovce-2 (Slova.)	213 (440 MWe)	-	under construction
Mochovce-3 (Slova.)	213 (440 MWe)	-	under construction
Mochovce-4 (Slova.)	213 (440 MWe)	-	under construction
Kola-3 (Rus.)	213 (440 MWe)	03.1981	*operational*
Kola-4 (Rus.)	213 (440 MWe)	10.1984	*operational*
Rovno-1 (Ukr.)	213 (402 MWe)	12.1980	*operational*
Rovno-2 (Ukr.)	213 (416 MWe)	12.1981	*operational*

VVER 320/1000

Unit / Country	*Generation / Power*	*Coupling to Grid*	*Status*
Kozloduy-5 (Bul.)	320 (1000 MWe)	11.1987	*operational*
Kozloduy-6 (Bul.)	320 (1000 MWe)	03.1989	*operational*
Temelin-1 (Cz.)	320 (1000 MWe)	-	under construction
Temelin-2 (Cz.)	320 (1000 MWe)	-	under construction
Balakovo-1 (Rus.)	320 (1000 MWe)	12.1985	*operational*
Balakovo-2 (Rus.)	320 (1000 MWe)	01.1988	*operational*
Balakovo-3 (Rus.)	320 (1000 MWe)	12.1988	*operational*
Balakovo-4 (Rus.)	320 (1000 MWe)	-	under construction
Balakovo-5 (Rus.)	320 (1000 MWe)	-	under construction
Balakovo-6 (Rus.)	320 (1000 MWe)	-	under construction
Kalinin-1 (Rus.)	320 (1000 MWe)	05.1984	*operational*
Kalinin-2 (Rus.)	320 (1000 MWe)	12.1986	*operational*
Kalinin-3 (Rus.)	320 (1000 MWe)	-	under construction
Kalinin-4 (Rus.)	320 (1000 MWe)	-	under construction
Novovoronezh-5 (Rus.)	320 (1000 MWe)	05.1980	*operational*
Novovoronezh-6 (Rus.)	320 (1000 MWe)	-	under construction
Novovoronezh-7 (Rus.)	320 (1000 MWe)	-	under construction
Kostroma-1 (Rus.)	320 (1000 MWe)	-	under construction
Kostroma-2 (Rus.)	320 (1000 MWe)	-	under construction
Tatar-1 (Rus.)	320 (1000 MWe)	-	under construction
Tatar-2 (Rus.)	320 (1000 MWe)	-	under construction
Khmelnitski-1 (Ukr.)	320 (1000 MWe)	12.1987	*operational*
Khmelnitski-2 (Ukr.)	320 (1000 MWe)	-	under construction
Khmelnitski-3 (Ukr.)	320 (1000 MWe)	-	under construction
Khmelnitski-4 (Ukr.)	320 (1000 MWe)	-	under construction
Rovno-3 (Ukr.)	320 (1000 MWe)	11.1986	*operational*
Rovno-4 (Ukr.)	320 (1000 MWe)	-	under construction
South-Ukraine-1 (Ukr.)	320 (1000 MWe)	12.1982	*operational*
South-Ukraine-2 (Ukr.)	320 (1000 MWe)	01.1985	*operational*
South-Ukraine-3 (Ukr.)	320 (1000 MWe)	09.1989	*operational*
South-Ukraine-4 (Ukr.)	320 (1000 MWe)	-	under construction
Zaporozhe-1 (Ukr.)	320 (1000 MWe)	12.1984	*operational*
Zaporozhe-2 (Ukr.)	320 (1000 MWe)	07.1985	*operational*
Zaporozhe-3 (Ukr.)	320 (1000 MWe)	12.1986	*operational*
Zaporozhe-4 (Ukr.)	320 (1000 MWe)	12.1987	*operational*
Zaporozhe-5 (Ukr.)	320 (1000 MWe)	08.1989	*operational*
Zaporozhe-6 (Ukr.)	320 (1000 MWe)	-	under construction

RBMK

Unit / Country	*Generation / Power*	*Coupling to Grid*	*Status*
Chernobyl-1 (Ukr.)	1 (1000 MWe)	09.1977	*operational*
Chernobyl-2 (Ukr.)	1 (1000 MWe)	12.1978	shutdown
Chernobyl-3 (Ukr.)	2 (1000 MWe)	12.1981	*operational*
Chernobyl-4 (Ukr.)	2 (1000 MWe)	12.1983	shutdown
Kursk-1 (Rus.)	1 (1000 MWe)	12.1976	*operational*
Kursk-2 (Rus.)	1 (1000 MWe)	01.1979	*operational*
Kursk-3 (Rus.)	2 (1000 MWe)	10.1983	*operational*
Kursk-4 (Rus.)	2 (1000 MWe)	12.1985	*operational*
Kursk-5 (Rus.)	3 (1000 MWe)	-	under construction
Leningrad-1 (Rus.)	1 (1000 MWe)	12.1973	*operational*
Leningrad-2 (Rus.)	1 (1000 MWe)	07.1975	*operational*
Leningrad-3 (Rus.)	2 (1000 MWe)	12.1979	*operational*
Leningrad-4 (Rus.)	2 (1000 MWe)	02.1981	*operational*
Smolensk-1 (Rus.)	2 (1000 MWe)	12.1982	*operational*
Smolensk-2 (Rus.)	2 (1000 MWe)	05.1985	*operational*
Smolensk-3 (Rus.)	3 (1000 MWe)	06.1990	*operational*
Ignalina-1 (Lit.)	2 (1500 MWe)	12.1983	*operational*
Ignalina-2 (Lit.)	2 (1500 MWe)	08.1987	*operational*

Fast breeder

Unit / Country	*Generation / Power*	*Coupling to Grid*	*Status*
Shevchenko (Kaz.)	350 (150 MWe)	07.1973	*operational*
Beloyarsk-3 (Rus.)	600 (600 MWe)	04.1980	*operational*
Beloyarsk-4 (Rus.)	800 (800 MWe)	-	under construction
South-Ural-1 (Rus.)	800 (800 MWe)	-	under construction
South-Ural-2 (Rus.)	800 (800 MWe)	-	under construction

Annex B - Energy policy and security of supply to the European Union

The development of Union energy policy should be founded on four basic principles, all of which have relevance to nuclear safety in the CEEC and CIS, and the Union's relations with those countries. Those are: (i) international interdependence in global energy markets, and the reduction of uncertainty through producer/consumer dialogue, and notably application of the principles of the European Energy Charter, (ii) the market principle, (iii) the relationship between energy and the environment, which transcends national boundaries, and (iv) the security of supply of energy to the Union to maintain a high level of energy services.

There are potential security of supply implications of rising dependency on imported energy. It is predicted that Union total primary energy demand will rise at between 1.3% and 1.6% p.a. to 2005, and that import dependency will rise from around 50% in 1990 to perhaps 75% by 2020. Within this picture is the Union's increasing consumption of natural gas (by up to 60% by 2005), largely due to the use of gas in power generation. Meeting this demand will require that imports double, from some 108 bcm in 1991 (about 40% of total consumption) to nearly 200 bcm in 2005.

The single largest supplier of natural gas to the EU is the CIS (principally Russia), accounting for about half of all imports (or 17% of total consumption), and this is likely to rise with increasing demand. Any action taken to shut high-risk nuclear power plants in the CEEC and CIS and to substitute combined-cycle gas turbine plants would result in increased gas consumption.

Supposing (an extreme example) that all high-risk nuclear reactors were shut, there would be an overall additional gas requirement of (very approximately) 30 bcm/year. Although this amount represents only 3 - 4% of the total CIS production of about 800 bcm/year, it is nevertheless some 60% of the CIS's current gas exports to the EU. A dramatic increase in gas use for power generation by the CEEC and CIS could therefore exert some pressure on the continental gas market.

An obvious concern of the Union therefore, is for the political stability and reliability of major suppliers, which highlights the importance of energy in the evolving geopolitical framework and in external relations. For instance, with regard to regards natural gas, export from the CIS to the EU via trans-boundary pipelines involves several countries, so security of supply depends on political stability in a large region as well as single countries. The EU can exercise influence over the political stability of the region, notably through its various bilateral agreements and the European Energy Charter, but also most importantly through energy trade and investment, which will be a key means of ensuring economic progress.

NUCLEAR SAFETY AND ELECTRIC POWER IN ARMENIA, BULGARIA, LITHUANIA, RUSSIA, SLOVAKIA, AND UKRAINE

Strategies and Financing - Summary Report

Abstract

This report makes the following main points:

- Of a total of nearly 300 gigawatts (GW) of generating capacity in six countries (Armenia, Bulgaria, Lithuania, Russia, Slovakia, and Ukraine), approximately 19 GW or 6% (9% without Russia) are at plants with higher-risk nuclear reactors (RBMK or VVER 440/230 types). There is a spectrum of alternative strategies for addressing the nuclear safety aspects of these and other nuclear plants; the table below summarizes the costs and characteristics of three such strategies.

- The Low Nuclear Scenario addresses the nuclear safety risks most aggressively by closing higher risk nuclear plants by the mid-1990s or shortly thereafter, depending on individual country circumstances. Total power sector investment requirements under this scenario would be about US$21 billion from 1993 to 2000. This strategy involves higher fuel costs, an adverse balance of payments (BOP) impact, which increases from the mid-1990s, and resistance within the countries.

- Decision-makers in the five fuel-importing countries have general concerns about the BOP effects of higher fuel imports, which the Low Nuclear Scenario would exacerbate. They are also concerned about increasing dependence on Russia for fuel supply and, for these and other reasons, favor greater reliance on nuclear energy. In Russia, current energy policy has opted for a high nuclear course because of views that the risks of their nuclear reactors are not excessive while costs are favorable, because of concerns about future fuel exports, and because of a preference to close older coal-fired plants.

- A High Nuclear Scenario (which approximates the stance taken to date by most of the Governments concerned) would include upgrading and continuing operation of all existing nuclear plants to the end of their design lives, as well as expanding nuclear capacity. Total power sector investment requirements under this scenario would be about US$28 billion over the 1993-2000 period. Due to lower fuel costs, the High Nuclear Scenario has lower overall costs in narrow economic terms and involves less BOP impact, but is the riskiest from the safety point of view and involves the largest investment financing with a high proportion of this being for nuclear plant, with the risk of future cost escalation due to increasing safety standards. This strategy would face serious constraints in foreign financing.

- If it would not be feasible to implement the Low or High Nuclear options due to country resistance and/or financing problems, a phased or Moderate approach might be considered whereby the higher risk plants are shut down by about 2000. This strategy would involve higher nuclear risks than the Low Scenario, but would have investment ($23 billion), fuel costs and imported fuel requirements which fall in between those of the Low and High Scenarios.

- The differences in investment costs between the Low, Moderate and High Nuclear Scenarios are not large. Investment requirements alone cannot be a basis for decisions about the appropriate strategy. While faster closure of higher risk plants and less reliance on new nuclear capacity have adverse implications for operating costs and the balance of payments, they lead to a faster reduction in nuclear safety risks.

- Under either the Low or Moderate Strategy, assuming that at least the latter would prove feasible, it would be practical to address financing strategies in tranches. In the first stage (1993-1995), the investment requirements of $6.2-7.2 billion could possibly be financed by power utility cash generation and government contributions (about US$3.4-3.7 billion), the international financial institutions (about US$1.3-1.5 billion); export credit agencies and commercial banks (about US$1.3-1.5 billion); multilateral and bilateral grant assistance for nuclear safety upgrades (about $0.5-1.0 billion); and possibly some private investment (assumed to be negligible in the short term). Investment programs and financing strategies for 1996-2000 would have to be addressed in the light of progress under the first phase. Those countries willing to pursue a suitable agenda for nuclear safety, policy reforms, and power system planning would deserve stronger support. Some countries, however, would be less able to take on additional debt. Funding to assist the countries for the increased cost of fuel imports could be considered in the context of macroeconomic adjustment programs, but also as support for nuclear safety strategies.

- The extent to which reform is pursued will largely determine the future course of energy prices, electricity demand and, hence, investment requirements. Efficient electricity pricing and other power sector reforms are also crucial to mobilizing financial resources. Targeted efforts to improve electricity end-use efficiency could reduce future fuel and capital requirements, and there is a case for international assistance to promote these efforts.

- Effective mobilization of funds would benefit from coordination between the countries and the various sources so that coherent strategies are followed regarding safety investments, alternative supplies, and plant closures.

Costs and Characteristics of Alternative Nuclear Scenarios

	Low Nuclear	Moderate Nuclear	High Nuclear
Higher Risk Plants closed by:	1995-97	2000	2010 +
Risk of Nuclear Incidents:	Lowest Risk	Higher Risk	Highest Risk
Investment Cost ($ billion, 1993-2000)	21	23	28
Of which:			
Nuclear upgrades and completions (%)	25	33	63
Conventional (%)	75	67	37
Annual Fossil Fuel Cost ($ billion, 1995-2000 average)	12.9	11.6	9.8
Annual Fossil Fuel Import Cost ($ billion, 1995-2000 average)	3.2	2.8	2.3
Country Viewpoints	Resistant	Might consider	Preferred