1 SUMMARY

To finalize two nuclear power plants at Khmelnitsky and Rivne (K2/R4) the Ukrainian state-owned power company Energoatom had asked the European Bank for Reconstruction and Development (EBRD) for respective loans.

According to the guidelines of the EBRD a public participation procedure has to be undergone and had been announced by Energoatom on 18 August 1998.

The Austrian Government requested and received the project documentation from Energoatom. The present report prepared for the Austrian Government examines the methodology, the validity of both data and conclusions drawn from the project documentation. It was prepared by a team of experts co-ordinated by the Federal Environment Agency. It also examines the extent to which the EBRD procedures have been met. The highlights of the findings are summarized below. **In conclusion, the released project documentation falls short from providing convincing evidence that the overall objectives of the EBRD are met.**

1.1 Least Cost Study

The report by Stone & Webster (S&W), made available by the project sponsor Energoatom in the Project Documentation, concluded that K2/R4 is the best use of the available capital, or 'least cost', and, not least on that basis, the EBRD has given provisional approval for the project to go ahead. Before that in February 1997, a Panel of independent experts commissioned by the European Bank for Reconstruction and Development concluded that **"However, a comprehensive analysis of S&W shows that completing these reactors would not represent the most productive use of US$1bn or more of Western funds"**.

The type of model used by S&W can be highly sensitive to even small changes in input assumptions and the uncertainty surrounding the key variables means that there is a high risk that the results produced by such a model will be wrong. S&W's conclusions stem directly from the assumptions fed into the model. The conclusion of the present report, namely that the completion of K2/R4 is not least-cost, is based on an assessment of the assumptions made for the following variables:

1.1.1 Electricity Demand

According to forecasts of power demand turn on estimates of when sustained economic growth will return, and of the pattern that industrial restructuring will take then. The International Monetary Fund's economic forecast for Ukraine was revised downward in early September 1998 to reflect the Russian contagion, from 3 % to 1 % growth for 1999, 3 % in 2000 and 4 % in 2001. Vienna Institute for Comparative Economic Studies (WIIW) is currently forecasting essentially zero growth in 1998, 1 % in 1999 and 2.5 % in 2000-2004. Growth will remain low for the foreseeable future, with the consequence that demand for energy overall, and electricity in particular, will likely fall further and then recover only slowly; even 5 % economic growth after 2003 does not necessarily imply energy consumption above 1995 levels in 2010. **Consequently, there is still a considerable surplus of installed generating capacity (nearly 100 per cent), and the need for an additional base load plant such as K2/R4 is a long way off, beyond 2010.**

1.1.2 Expected Completion Costs

There can still be little confidence in any of the various elements of the estimated costs of completing and operating K2/R4. This basic lack of confidence in the cost estimates makes K2/R4 a high risk investment. Experience with the Temelin and Mochovce nuclear plants, in the Czech and Slovak Republics respectively, illustrates the severe problems in completing nuclear plants of Soviet design. The need for a major modernisation programme at K2/R4 suggests that a similar development could be expected there.

However, it is not clear that the modernisation programme is as final as argued. There has, for example, been no survey of the condition of the dormant plants, and without such a survey, cost estimates are particularly speculative.

There is significant evidence based on probabilistic safety analysis (PSA) results from other WWER-1000/320 units and the lack of treatment of relevant issues, identified by Institute of Risk Research Vienna (IRR), in the K2/R4 Modernization Programme (MP) to conclude that the project do not meet the internationally excepted safety level, such as INSAG-3 of the IAEA (International Nuclear Safety Advisory Group of the IAEA, Report No. 3).

Higher costs than quoted in the present MP for implementing more comprehensive measures to solve these issues have to be expected.

1.1.3 Expected Lead-time of K2/R4

Any delays beyond the completion dates, based on the expected completion time of 30 months, at the time of loan disbursements will have further financial consequences. **Interest during construction will directly increase. In addition, there is the possibility that Energoatom will have to start repaying the loans before there is any sales revenue from the new plant, a problem that has affected Temelin in the Czech Republic.**

1.1.4 Operating Costs and Performance of K2/R4

The S&W report significantly over-estimates the reliability of K2/R4 and seriously under-estimates the running costs. It assumes the load factor for K2/R4 will be 75 per cent, well above the level any of the WWER-1000 plants in the FSU and Eastern Europe has achieved.

The S&W report assumes a production cost for K2/R4 (operations and maintenance costs and fuel costs) of about US$13/MWh. Official US data for American plants suggests that an assumption of double that, US$26/MWh, would be more appropriate.

The likely savings from building K2/R4 are highly sensitive to the running costs of the nuclear power plant. For example, using S&W data, K2/R4 will operate at half the cost of a cheap, efficient Ukrainian fossil-fired plant, while basing the costs on US experience, the savings disappear.

1.1.5 Assumptions on Existing Fossil Fuel Plant and New Capacity Options

The assumption that a significant capacity of the existing fossil fuel plant will be retired by 2004 is crucial in justifying an apparent need for new capacity from 2007 onwards, which will be met by K2/R4. **Combined cycle gas turbines (CCGTs) are likely to entail far fewer economic risks because much stronger guarantees on performance and costs are available from the equipment suppliers.**

1.1.6 Fossil Fuel Prices

The procedure of allocating a probability to the future price level for fossil fuels in the S&W report is highly dubious and these sensitivity tests have little validity – it is not possible to estimate the probability for a variable which is essentially unpredictable. However, the S&W report does show that the case for K2/R4 is highly sensitive to the price of gas. Using more realistic assumptions on the construction cost and performance of CCGTs, it is likely the model would show that any fall in the price of gas would make K2/R4 very bad investments compared to CCGTs, even if S&W's assumptions on K2/R4 were accepted.

1.1.7 Least Cost Alternatives

There is no lack of economically attractive projects in the Ukrainian energy sector on which US$1bn or more could be spent more productively than on completing K2/R4.

The need for safety upgrades at the 11 existing WWER-1000 stations is pressing. If the safety upgraded increase reliability, the extra output of the existing nuclear stations would make K2/R4 even more uneconomic. However, if the safety upgrades did not increase output, K2/R4 would be no more reliable than the existing WWERs.

Also an extensive fossil fuel power plant rehabilitation program to complement the government's plan to concentrate coal production on the lower-cost mines and put the coal industry on a commercial footing is essential.

CCGTs, which are largely factory-built and which have a long record of international experience with comparable plants, appear to be a much lower risk option for new capacity than K2/R4, which will mainly require site work.

It is difficult to quantify the effects of improved electricity efficiency in a least cost model, but to ignore the potential, as S&W do, further strains the credibility of the conclusion that K2/R4 is least cost**.**

The commitment of the World Bank and EBRD to the Energy Efficiency Plan suggests that efficiency improvements are likely to be least cost. A low risk least cost strategy would be to direct capital investment to a large number of less expensive projects.

1.1.8 Conclusion on the Least Cost Criteria

In the light of a comprehensive analysis of the assumptions of S&W and the economic developments in Ukraine, completing K2/R4 is likely to prove a costly and risky diversion from addressing the urgent problems that the Ukrainian electricity sector is facing. Whether or not Chernobyl is closed, it is unlikely that there will be any need for K2/R4, especially if the reliability and efficiency of the existing nuclear and fossil-fired plants can be improved.

The 1995 Memorandum of Understanding (MOU) between G7 and Ukraine seemed to offer a sure way to close Chernobyl by offering grants to cover the direct costs of cleaning up the site and guaranteeing US$1.8bn of much-needed Western loans for investment in projects in the Ukraine electric power sector. The MOU was right in addressing Ukraine's urgent need for capital, but unfortunate in appearing to tie most of the capital to K2/R4. Abandoning K2/R4 now would clear the way for the flow of investments to more profitable and less risky projects, of which there are plenty.

1.2 Safety Report

There is no basis for Mouchel to assert **comparability of the K2/R4 safety level with western NPPs**. No PSA is available for K2/R4 for comparison purposes. No comparison of K2/R4 with any specific set of western nuclear safety standards is presented. No comparison of K2/R4 with the IAEA NUSS criteria is presented. In contrast, there is significant evidence (in the form of PSA results from VVER-1000/320 units) and the lack of treatment of relevant issues in the K2/R4 modernization program to believe that the Core Damage Frequency (CDF) for K2/R4 will exceed the INSAG CDF safety target of 10^{-4} per year and that K2/R4 will exceed the INSAG large release frequency target of 10^{-5} per year by more than a factor of ten. These results will occur due to SG collector failure and Steam Generator (SG) tube rupture **alone**, not accounting for any of the other various sources of severe accident risk. It cannot be concluded, therefore, that the K2/R4 upgraded designs, as set forth by the project proponents, will meet western safety principles.

There is no basis for Mouchel to assert **risk superiority for K2/R4 over Chernobyl Unit 3**. The doses from normal operational releases are **lower** for Chernobyl due to the 30-km exclusion radius. The large release frequency for K2/R4 cannot be shown on the basis of current information to be less than for Chernobyl Unit 3 and may be higher, based on the PSA results from Temelin (VVER-1000/320) and Ignalina (RBMK).

The **beyond-design-basis-accident (BDBA)** contained in the EIAs is flawed and misleading. The selected accident is identified by IAEA as an accident **within** the design basis, not **beyond** it. There are a host of BDBAs which are easily identified for VVER-1000/320 units which result in severe accidents (and some of which result in severe accidents with containment bypass), which were ignored by the EIAs without explanation. There is no basis for concluding that the selected accident is “the most representative” of the BDBAs. It is only representative of a group of accidents which have little public or environmental impact because they are assumed to be fully mitigated by plant safety features and/or operator recovery actions. Moreover, the BDBA analysis lacks an assessment of containment ultimate capacity, which is also needed for the accident management programme.

The EIAs fail to examine any **project alternatives** except replacement of Chernobyl by K2 and R4.

The Institute of Risk Research (IRR) has identified **30 significant safety issues in all safety relevant areas (General, Reactor Core, Systems, Components Integrity, Instrumental & Control, Electrical Power, Containment, Accident Analysis, External Hazards, Internal Hazards and Operation),** which are **not adequately addressed in the K2/R4 Modernization and Upgrade Program**. A comprehensive treatment of these issues is a precondition to reach the minimum acceptable safety level, e.g. formulated by IAEA in the INSAG-3 targets for core damage frequency and frequency of large releases. To satisfy western nuclear safety principles is one of the EBRD criteria for funding.

1.2.1 Conclusions on the Safety Report

Before making a decision to fund the completion of K2/R4, EBRD must in compliance with its own guidelines (acceptable safety level) require that Energoatom demonstrates how significant safety issues not adequately addressed in the K2/R4 Modernization and Upgrade Program will be resolved before start-up. Without solving these significant safety issues K2/R4 will not reach a minimum acceptable safety level as formulated by IAEA in INSAG-3.

Instead, it is recommended to assess possible alternatives on the basis of safety and risk assessments.

From the risk reduction point of view one **readily identifiable and reasonable nuclear option** is to fund a program of PSAs, reliability upgrades, and safety upgrades for the existing eleven operating VVER-1000/320 units in Ukraine. If the 1.725 billion **USD currently** estimated as necesarry for completion and commissioning K2 and R4 (the estimate will almost **certainly** rise) could be instead used to improve safety **at already operating** VVER-1000/320 units in Ukraine, this would provide a safety improvement budget of almost 157 million USD per unit. In the process, the safety of eleven NPPs already operating in Ukraine would be improved, instead of just two **additional** units as the K2/R4 proponents would have it. Further, unlike the proponents proposal, which would have 730 million USD spent on activities by western firms, much of the money in the alternative plan discussed here would be spent indigenously in Ukraine or in Russia, which would benefit both economies with an infusion of hard currency and which would achieve greater total safety improvements overall.

1.3 Environmental Impact Assessment

In order to investigate the possible impact of a severe accident at Rivne 4 or Khmelnitsky-2 a release of 20 % of the total core inventory of caesium-137 was assumed. This is an average accident scenario corresponding to releases described in literature ranking from zero to 50 %. As meteorological input fields were already available for the year 1995 from another study, that year has been taken as the reservoir from which the worst situation for Austria was selected. The results of this calculation show that a severe accident at K2 or R4 could lead to a contamination of distant regions in Europe with contamination maxima even higher than those caused by the Chernobyl accident in 1986.

Currently the Ukraine has no radiation monitoring and warning system comparable with Western standards.

With respect to the protection of the public it is irresponsible to use nuclear power plants, as long as the Ukraine does not have a reliable state of the art monitoring and warning system. Completion of a countrywide monitoring and warning system working with independent data lines should be subject of the Western financial and technical assistance even if the funding is not determined for K2/R4.

Airborne emissions will be higher than those of German reactors. The impact of the discharge of radioactive waste water and heat to rivers can also be considerably high. A management plan for all the radioactive waste generated by the NPP does not exist.

The accident risk and the expected environmental impact of routine operation of K2/R4 does not allow the conclusion that this project will be environmentally sound.

1.3.1 Conclusions on the Environmental Impact Assessment

With respect to international requirements for environmental impact assessment procedures the presented documentation for the K2/R4 completion project is not satisfying. This is valid namely for the Espoo Convention, which requires information about the risk of an adverse transboundary impact, also for projects where the transboundary impact is expected only in case of an accident. The EIA has failed to examine the potential threat imposed by K2/R4 regions outside the Ukraine.

In Western countries a project of this scale would not be licensed based on such insufficient information.

1.4 Procedures

The Austrian Government informed the EBRD that Austria wished to be included in the public participation procedure concerning the K2/R4 project. In its reply dated 14 August 1998 the EBRD noted that "with respect to issues of notification and the application of the Espoo Convention, the bank is committed to encourage Ukraine to engage in a broad public participation consultation process based on openness and transparency. In this respect the Bank understands that Ukraine will supply in a timely manner neighbouring countries with the results of the EIA and least cost studies. These materials will also be open to other countries through the Secretariat of the Espoo Convention (UN ECE) which has indicated its willingness to assist in this exercise.". Until mid of November 1998 no documentation was available from the Secretariat of the Espoo Convention and no clarification of questions about the role of the Secretariat was received by Austria.

Furthermore the documents available from Energoatom and EBRD differ from each other. Some parts of the project documentation were released later than 18 August 1998.

1.4.1 Conclusions on the Procedures

It can be concluded that some critical deficiencies occurred during the public participation procedure so far, which leads to the recommendation, that the process and in parts the guidelines concerning public participation procedures of the EBRD should be revised and improved as soon as possible.