SUMMARY OF THE MEETING

Successful liquid metal cooled fast reactors have been designed, constructed and operated. Two examples are the BN-600 in Russia and the 1200 MW(e) Superphénix in France. The BN-600 reactor with a power output of 600 MW(e) has been running successfully for 15 years. The Superphénix is the first large size LMFR. Recently, LMFR development activity has slowed, particularly in the USA. But many experts believe that LMFRs should be pursued as a complement to advanced light water reactors in order to provide options for energy production in the 21st century. A report issued two years ago by the Club of Rome stated that "....... the use of coal and oil is probably more dangerous to society, because of the carbon dioxide they produce, than nuclear energy. There are therefore strong arguments for keeping the nuclear option and for the development of fast breeders ..."[1]. The objectives of development of the LMFR are to improve fuel economics, to find optimal solutions for the back-end fuel cycle, to achieve a high degree of reliability and to achieve high degree of safety — a reactor system which, not only during normal operation but also in case of an accident, could exclude any radiological impact that would require evacuation of the public. An additional important mission for the LMFR may be to burn plutonium resulting from the dismantling of nuclear weapons.

In considering the objective of achieving economic competitiveness, LMFRs are being designed for as long a life as possible. Efforts are also being made to develop techniques and technology which can shorten the construction period. As to the argument that the existing fast reactors are too expensive, it should be noted that this was true in the early development for all demonstration or prototype nuclear power plants before scaling up to commercial size. It is simply too early to say that the LMFR is not economic, particularly in the present situation where antinuclear activists tend to discourage all investment in the nuclear field. Other reactor technologies achieved lower generating costs when commercial scale units were produced; one cannot say that this will not happen in the case of fast reactors.

Advanced LMFRs are being developed in several countries with different designs. General Electric (USA) has very recently decided to focus on a mid-size (840 MW(th)/311 MW(e)) modular reactor fuelled with a ternary metal alloy. Modular reactors allow significant simplifications and enhancement of passive safety features. The metallic alloy fuel also allows a larger design margin with maintained benign response to accident conditions. This also permits the use of compact pyro-metallurgical processes for fuel recycle. Russia, Japan, India and western European countries are developing monolithic reactors of 500 to 1600 MW(e) sizes, with oxide fuel. The 15 years of commercial experience in Russia with the BN-600 and with the improved BN-600M project indicate a potential for large cost reduction and for improved reliability. Examples of the innovative safety features of the advanced designs are: passive decay heat removal systems, passive reactor shutdown, and stable thermal and reactivity response characteristics.

The management of radioactive waste is one of the key issues in today's political and public discussions of nuclear energy, especially the disposal of high level radioactive waste. Reprocessing (which is justified by the fast reactor technology) reduces the mass of waste by about a factor of 25 by removing the actinides from the waste (leaving only the fission fragments). Many experts believe that this recycling/reprocessing in LMFRs would allow 'burning' of the extremely long life transuranic radioisotopes, thereby reducing the required

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[1]King, A., Schneider, B., The first revolution : A report by the Council of the Club of Rome, Simon and Schuster, 1992.

isolation time for the high level waste from hundreds of thousands of years to hundreds of years. Research and development (R&D) for enhanced plutonium consumption and actinide burning is being conducted in France, after the restart in 1994 of the Superphénix. Similar R&D activities are performed in the CAPRA (concept to amplify plutonium reduction in advanced fast reactors) reactor which may be widely used for plutonium recycling and electricity generation.

The early development of LMFRs was conducted on a national basis. However, for advanced LMFRs, international co-operation may be very important and the IAEA has an important role to play in promoting international co-operation. Especially in R&D, international co-operation with the pooling of resources and expertise helps to reduce/share the costs. To encourage development of LMFRs, the IAEA's project 'Liquid Metal Cooled Reactors' promotes technical information exchange and co-operation between Member States, offers assistance to interested Member States, and publishes reports available to all Member States. International co-operation on fast reactors under the aegis of the International Working Group on Fast Reactors (IWGFR) has had an influence on the principles of design and on the general features of fast reactors in Member States. Early experimental reactor parameters vary widely, but those of the commercial sized plants are quite similar. Even with the initiation of a wholly new development (e.g. in the USA of a modular reactor) it is interesting to observe that their parameters are close to those of the large monolithic reactors. To some extent this is due to the IWGFR exchange of information on experiences, both good and not so good. It also proves that the laws of physics and the principles of good engineering frequently lead to the same optimal solution.

The worldwide investment already made in the research and development of the LMFR technology exceeds US $40 billion and this research has significantly improved our understanding of LMFR safety and safety analysis methods. These methods have been used to evaluate the safety characteristics of the existing and advanced fast reactors. It has been found that some LMFRs currently operating need to improve their safety, but it is also predicted that future LMFRs can achieve a very high degree of safety. However, in spite of the progress made in LMFR technology and in particular in LMFR safety, the quest for excellence calls for further work. These proceedings contain the new technical directions for the next generation designs, significant R&D results as well as recent experience from operating plants.