International co-operation in thermal reactor safety research

by H. Andres and E.V. Gilby*

The nuclear power community has always taken pride in its excellent safety record. This record stems in large part from comprehensive research and development programmes aimed at improving understanding of the complex processes and inter-relationships governing the behaviour of nuclear power plants. Steady improvements have been made in the overall design of such plants as well as in specific safety features and precautions. Moreover, these programmes have resulted in an increasing similarity in safety approaches taken by Member States.

Safety research requires considerable resources, highly skilled manpower, and sophisticated and expensive equipment and instrumentation. The advantages of sharing resources and avoiding unnecessary duplication in work are obvious. It was therefore logical that countries with a nuclear industry began to co-operate in research of common interest, exchanging information, initiating co-operative research projects and harmonizing research programmes. Bilateral and multilateral agreements such as those between the members of the Nuclear Energy Agency of the OECD (NEA), the European Communities (CEC), and the Council for Mutual Economic Assistance (CMEA) provided a basis for better co-operation, and enabled the smaller members of these organizations to participate in an benefit from efforts undertaken by the organizations as a whole.

Although co-operation within these groups of countries is well established, there has not been much interaction between them. In addition, another group, the developing countries, who do not belong to any of the above organizations but which are of growing importance in nuclear matters, have not been involved in these co-operative efforts.

Recognizing this situation, the Agency has intensified its efforts to encourage co-operation on the largest possible geographical scale, taking advantage of the unique fact that its membership comprises all of these different groups of countries. Member States expressed support for these efforts at the 1979 meeting of the General Conference of the Agency in New Delhi.

* Mr Andres is a staff member in the Safety of Nuclear Installations Section of the Agency's Division of Nuclear Safety. Mr Gilby, who was formerly with the UK Atomic Energy Authority, is now with Gilby Associates, Cheshire, UK.

Practical steps for implementation

It is evident that the success of such an ambitious undertaking can only be expected on the basis of a sufficient common interest, expressed through the direct involvement of Member States in practical implementation.

To explore the areas of common interest in reactor safety research, particularly among countries that have had so far few contacts with each other in this field, the Agency invited developing countries, Member States belonging to the OECD/NEA, CEC, CMEA, and representatives of these organizations themselves to take part in a Technical Committee on Thermal Reactor Safety Research. This committee met from 1 to 4 December 1981 in Moscow, and included 22 participants from 11 countries and three organizations. After considering information presented by its members on safety research activities carried out in their own countries or international organizations, the committee agreed on a list of topics important for safety research, concluding that it represented a sufficient basis upon which an increased information exchange and co-operation could be built.

Among the topics listed were:

- Containment problems related to hydrogen generation, fission product behaviour, structural strength (including integrity), and thermohydraulics.
- Fuel behaviour under accident conditions.
- Radioactive releases.
- Loss-of-coolant accidents.
- Early diagnosis of failures.
- Reliability methodology in risk assessment.
- The man-machine interface.
- Primary circuit integrity.

The committee recommended that the Agency should organize in 1982 a specialists' meeting on a specific research topic. The group was fully aware that similar efforts were being made by OECD/NEA, CEC, and CMEA within their respective memberships, but the proposed meeting was seen as a pilot project by which the IAEA's larger platform could be demonstrated.

Responding to the recommendation, the Agency organized a "Specialists' Meeting on Early Diagnosis of Failures in Primary System Components of Nuclear Power Plants", which was hosted by Czechoslovakia and held in Prague in June 1982. It attracted 48 specialists from 12 countries and two organizations, and the

Scope of the IAEA Specialists' Meeting/Workshop on *Hydrogen Behaviour and Control and Related Containment* Loading Aspects (USSR, September 1983)

Hydrogen generation
Hydrogen transport and mixing
Hydrogen combustion
Effects of hydrogen burning on the containment and other safety equipment
Hydrogen detection, mitigation, and control
Accident analysis aspects related to hydrogen
Regulatory perspectives and positions on hydrogen control

papers showed a good regional balance. They covered aspects of plant diagnosis systems, diagnosis of vibrations, acoustic emission, loose parts monitoring, and experiments with instrumented fuel assemblies. The participants welcomed these new avenues of exchange, and in an evaluation session they also expressed satisfaction with the informal "workshop" style of the meeting, which allowed ample time for detailed discussions. They recommended that the Agency organize another meeting on the same topic after a period of two years.

When the Technical Committee on Thermal Reactor Safety Research held its second meeting in October 1982, participants concluded that the specialists' meeting had been very successful and had lived up to their expectations. The committee encouraged the Agency to develop further this type of activity, and identified a number of topics for further specialists' meeting, including two to be held in 1983. The first of these is "hydrogen behaviour and control and related containment loading aspects", which will be discussed at a meeting to be held in the USSR in September 1983. Its scope, which is shown in the Box, serves as an example of the subject matter of such meetings. The second topic, "experimental and modelling aspects of small-break LOCA", will emphasize experimental work and verification and application of computer codes. This meeting will be held in Hungary in October 1983.

These research meetings are valuable not only because they present and discuss current research in particular fields, but because they seek to establish a consensus on the technical understanding of the topic and to develop recommendations with respect to what are the most pressing problems, where the emphasis should be, and what future activities need to be undertaken. Although the recommendations are not directed to anyone in particular, the fact that they come from an international group of specialists having deep insight in the field has an impact on the planning of future work.

The Technical Committee also discussed other ways of improving co-operation in research, particularly with respect to the possible benefits of a safety research project index, an instrument which has been used for years by OECD/NEA and CEC. Such an index would provide, in brief, information on "who does what" in safety research at national and international institutions. It would give planners and co-ordinators an overview of on-going activities. It would make research workers aware of work done elsewhere, and it would open the possibility of establishing direct contacts between research groups having similar interests.

The Technical Committee concluded that an IAEA index should reflect the interests of the Agency's large membership and agreed with the Secretariat's recommendation that it should begin with a pilot scheme to collect information in a limited field. The Secretariat has since invited Member States and international organizations to submit information on research projects carried out on blowdown and emergency core cooling, a subject on which contributions can be expected from many countries. Depending on the response from Member States, the index will then be gradually expanded to cover all areas of broad interest.

Plans for the future

Discussions by the Technical Committee have already shown various ways in which research co-operation between member countries and organizations can continue to grow.

Topics have been identified in which specialists' meetings would be welcomed by many countries participating in the work of the committee. In addition to the conferences, seminars, and other meetings already planned, there is a clear rôle for other Agency-sponsored research meetings in 1984 and beyond. A second important need is to expand the Safety Research Project Index if the current pilot scheme is successfull.

Presentations by Member countries at meetings of the Technical Committee are also a very important way of exchanging information so as to arrive at a common definition of priorities in various safety areas. An example of this is that at the next committee meeting the balance between measures provided for accident prevention and those for mitigation of accident consequences will be the subject of specific review.

It is important to note the relationship between this Technical Committee and other Agency-sponsored groups and activities. There is common ground, for instance, with the:

- International Working Groups on Control and Instrumentation, on the Reliability of Pressure Vessel Components, and on Fuel Performance and Technology;
- Technical Committees on Airborne Fission Product Release following Extensive Core Damage Accidents and on Operating Procedures for Abnormal Conditions;
- Working Group on Reliability Analysis and Probabilistic Risk Assessment in the Licensing Process.

In the future, input from these groups to the committee will be an important contribution to its discussions, while output from the committee should in turn be helpful to these other groups.

In the somewhat longer term a more ambitious programme of co-operative actions is worthy of consideration. Other organizations have found comparison benchmark exercises to be very beneficial in validating computer codes, especially where comparison with experimental results is possible. There is always a problem of avoiding duplication, but an expansion of activities based on the wider membership of the Agency could be feasible. Co-operative use of research facilities in one Member country by other members is another possibility. Only recently, at the IAEA Symposium on Operational Safety of Nuclear Power Plants held in Marseilles in May 1983, Hungarian participants mentioned that their new PMK* test loop could be made available to the international community. The loop, which is expected to be operational in mid-1984, is specially designed for small-break loss-of-coolant experiments for WWER-440 reactors. Another possibility for expanded co-operative research may develop in Poland where a new test loop at the research reactor MARIA is beeing installed. It will allow investigation of fuel behaviour under accident conditions.

* PMK: Primerköri Modell Kiserlet (Primary circuit model experiment).

Conclusion

The first results of the Agency's efforts in intensifying exchange and co-operation in reactor safety research among its Member States have been fruitful, and the prospect for the future are encouraging. This can be attributed in large part to the following factors:

- The common interests of Member States.
- A step-by-step approach combined with careful preparation and evaluation of accomplishments.
- Close contacts with other organizations active in this field (OECD/NEA, CEC, CMEA).
- A Technical Committee through which interests of Member States and international organizations can be expressed and common ground identified, and which can therefore produce valuable guidance.

The IAEA has succeeded in opening new channels for exchange of information; the specialists' meetings are a good example of these. This is an important first step, but a truly effective exchange can be achieved only if it is continuous, and if it reflects new developments in a given research field. The IAEA and its Technical Committee on Thermal Reactor Safety Research have a keen interest in ensuring that the committee's activities supplement, rather than duplicate, the activities of other organizations. The Agency's broader membership makes this possible. The committee also provides a focal point for activities within the Agency related to reactor safety research. In addition, it can review other international activities outside the IAEA and facilitate the regular exchange of information among the OECD/NEA, CEC, CMEA, and developing countries.