reactor calculations: the state of the art

More than 100 specialists in numerical reactor calculations gathered in Vienna in January for a seminar during which they assessed the development of techniques used in their work — and heard a thoughtful discussion of factors which underlie it.

At the opening ceremony Dr. Yuri F. Chernilin, Deputy Director General, Department of Technical Operations, commented that the number of participants in the seminar exceeded the Agency's original expectations; this confirmed the wide interest which existed in the development of numerical methods of reactor calculation. The Agency had received many more applications for the inclusion of papers in the programme than could be accepted without losing the essence of the seminar [as distinct from the usual form of meeting of this size organized by the Agency, the symposium], namely, that it should take the form of some review lectures and papers, interspersed with plenty of discussion.

Dr. Chernilin recalled that a seminar on the numerical solution of multi-dimensional diffusion equations had been held in Warsaw in March 1969 within the framework of the NPY agreement for collaboration in reactor physics between Norway, Poland and Yugoslavia and the IAEA. At this seminar it was felt desirable, in view of the rapid development which was also taking place in other branches of this field, to have an additional seminar of broader scope, covering not only the newest of computer techniques but also methods appropriate to the smaller computers which were available in developing countries.

Since then, however, many developing countries had installed or had plans to instal large, modern computers, so that the interest of specialists in those countries can be expected to be primarily in computer codes pertinent to the newest machines. The idea for the current seminar was proposed accordingly by the committee co-ordinating activities within the framework of the NPY agreement. Dr. Chernilin expressed the Agency's appreciation to that committee for its "worthwhile initiative".

He said the purpose of the current seminar was to review certain classes of computer calculation techniques for the solution of the Boltzmann neutron transport equation, and other work. Of special interest were numerical methods which allowed systems of high complexity

to be solved with much greater accuracy and shorter machine running times than had been thought possible only a few years ago. The seminar might also identify outstanding problems.

The chairman of the seminar was Professor A.F. Henry, of the Department of Nuclear Engineering, Massachusetts Institute of Technology, United States, who examined in introductory remarks the meanings of the words used in the title of the meeting: seminar on numerical reactor calculations.

"The fact that we are discussing reactor calculations implies that they are possible", he said. "This is obvious to us, but it is not too common a thing in applied technology to have a descriptive equation which really is the foundation of the technology. If we know the nuclear data we can in principle design, and we now know for certain that we can design, systems of considerable complexity, and we can in effect predict what will happen to those systems. This is not only something which we can do, it is something that we must do. Ultimately, our justification for studying this branch of applied physics, or applied mathematics, is that people build reactors, and those who build reactors must be able to predict how they will behave".

The widespread introduction of the computer, and of computer methods of calculation, had forced a change in patterns of mathematical thinking inherited from the last century, said Prof. Henry. Applied mathematicians were thinking more of sequences than series, and so on. Methods which had been developed for numerical reactor calculations were now being refined.

"This can be a dangerous period, for two reasons", said Dr. Henry. "One is that we who are concerned more or less with developing ways of predicting the behaviour of a reactor can fall into the trap of feeling that we understand the situation completely, and of stopping our development efforts. We should always keep in mind that the ultimate goal of the calculations – even if there are many other reasons for doing the calculations – is the useful one of predicting the behaviour of some multiplying reactor system. Until we have reached that goal the job is not finished...

"It seems to me that we are in a second danger now: that the users of our calculations who design reactors feel that the job is done, that there is nothing more needed in the way of reactor theory. That, I think, is a mistake also. As we all know, we sometimes mistake the familiarity that we have with a scheme for its accuracy; the more we use a particular calculational method the more we believe, somehow, that it is true. But all that has happened is that we have become familiar with it. That is a danger to be avoided.

"It happens both ways. Those who apply the methods also become familiar with them and tend to feel that they must be true – particularly if the application of the method to one reactor predicted things correctly. That is almost a dangerous thing to have happen, because when it does people tend to stop worrying!