INDIA'S FUTURE

The potential for a nuclear fusion effort

by Uma Zykofsky

Indian nuclear scientist Homi Bhabha predicted in 1955 that "a method will be found for liberating fusion energy in a controlled manner within the next two decades." With this prediction vindicated by research in fusion energy during the past few years, the Indian government in its Sixth Five-Year Plan, released in early 1981, has committed itself to the "development of the capability to move into fusion technology." The first concrete step will be establishing of a high-energy plasma physics research center in the western city of Ahmedabad, while fusion-related research will be stepped up at several institutions throughout the country.

India's growing attention to fusion-related research is also reflected in the inclusion of that area as a new sphere for possible cooperation between India and the United States at the latest Joint Scientific Commission meeting held in New Delhi in early December.

A few days earlier, two U.S. fusion scientists, Dr. Stephen Dean, President of Fusion Power Associates and former director of the magnetic fusion program in the Department of Energy, and Uwe Parpart, Research Director of the Fusion Energy Foundation and an *EIR* contributing editor, visited the institutions in India at which fusion-related research is proceeding. The tour, organized by the Council of Scientific and Industrial Research, included visits to, and meetings with scientists at, the Physical Research Laboratory in Ahmedabad; the Tata Institute of Fundamental Research and the Bhabha Atomic Research Center in Bombay; the Indian Institute of Science in Bangalore; the Saha Institute of Nuclear Physics in Calcutta; and Delhi University and the Indian Institute of Technology in Delhi.

Dean and Parpart briefed scientists on fusion research in the United States, Europe, and Japan and emphasized the need for India to intensify its own efforts in this field. Without having to spend large amounts of money, they added, India could build up the necessary small-scale experiments to train manpower and keep abreast of fast-breaking international work in fusion. Fusion research today, they noted, is at a stage very similar to that of fission energy research in the 1950s, when India set up its atomic-energy program under Bhabha.

Given that India has the largest thorium reserves in the world, Dean and Parpart also emphasized the importance of the proposed fission-fusion hybrid reactors. The hybrids, once developed, would be able to breed large amounts of fissile fuel from thorium—much larger amounts than the conventional fast breeder reactors—for India's conventional fission reactors, even before pure fusion energy reactors come on line.

For India to undertake fusion research, they said, would be consistent with its efforts since independence in 1947 to apply science and technology for rapid economic development. Because of this approach, India today has the third largest number of scientists and engineers in the world—the most vital input for speeding up fusion research. Dr. Dean further pointed out that India's space program and its tested and self-reliant capabilities in nuclear energy give it a head start in entering the fusion-engineering field in the next decades.

At the conclusion of their tour, Dean and Parpart met with Prime Minister Indira Gandhi as well as some of the directors of the Council of Scientific and Industrial Research, the Department of Science and Technology, and the Department of Atomic Energy.

Fusion scientists talk about India

Dr. Stephen Dean, who is presently head of Fusion Power Associates in Gaithersburg, Maryland, was interviewed in the Dec. 6, 1981 issue of the Indian newspaper New Wave. *Excerpts follow.*

New Wave: You have been in India for 10 days and have toured some of our main cities. What are your general impressions?

Dean: The country has a large number of very qualified and competent and able scientists in all areas, including plasma physics and fusion. They suffer from the fact that there tend to be a relatively few number of fusion and plasma physics people that are spread out among many centers, so that in each center they only have a few people, and therefore they don't get the benefit of interaction among themselves as much as they might.

They also understandably suffer from lack of equipment in fusion research. Experimental groups are working with very little equipment. That limits the kinds of research they can do to very fundamental studies. It also makes it difficult for them to compete on a world scale with some of the research that is going on elsewhere. The kind of research that can be done on the kind of equipment that is available here—the easy research—has already been done in such facilities several years ago. So it

makes it especially difficult for Indian fusion scientists to do research that would gain them the kind of recognition that their abilities warrant.

This is not true in the theoretical areas as theoreticians do not require this kind of equipment, except to the extent that much of the theory today is also done using the computer, and access to some larger kinds of computers and sophisticated software is not yet available here.

New Wave: In India there has been considerable debate on what energy option we should be following. How would you compare fusion with some of the other energy options?

Dean: Fusion is clearly not something that can be used today to solve the energy needs of the next few years, but beyond that time, it is the energy source of preference. . . .

In traveling through your country, I was struck by comments that there were great, undeveloped hydro resources in the country, quite a bit of coal, and also quite a bit of thorium that can be used in nuclear fission reactors. So you do have a variety of options to choose from in the near term to supply your needs. Unfortunately, not all that energy is economically and rapidly developable. Some of it has major drawbacks.

I think one of the major problems that struck me in the short time I was in this country is that you are creating tremendous environmental and biological hazards in your cities from burning so much fossil material. If you have more coal-fired plants, you are certainly not going to do yourself any great good. . . .

New Wave: As far as I know, India is the only country in the developing sector that is thinking seriously about this option. I would like your comments on how you think one should proceed with a fusion program in India. Wouldn't fusion require a very large financial outlay to get it going?

Dean: I think that the country should not feel that it has to construct all of the large facilities that are being built around the world by the countries that are developing fusion now. One can have access to and take advantage of these technologies that have been developed elsewhere by having trained personnel who are knowledgeable in science and engineering go and work at facilities that exist in other countries. These people would gain the knowledge and technical base to be able to build these facilities.

By building up a scientific and engineering base, I think that can be done with relatively modest experimental equipment and a strong theoretical program with extensive coordination, cooperation, and exchange programs and working relations with some of the larger facilities abroad. I think that that way you can postpone the date at which you feel the necessity to build expensive experimental hardware.

Excerpts follow from a New Wave *interview with Fusion Energy Foundation Research Director Uwe Parpart published in the Dec. 20, 1981 issue of* New Wave. *Parpart toured India in May and June 1980, heading up a 1980 FEF team which prepared a 40-year industrialization program for the Indian subcontinent, in collaboration with specialists there.*

New Wave: In your view what would be the prerequisite to get a fusion program going in India?

Parpart: Today what is needed is a government decision and a number of individuals in the field of fusion to say we have to pull together our scientists and our resources and develop a concentrated program in fusion energy development. There are many people who will say that this is not possible for India because the country does not have the resources, too much money is involved, look at the large machines that would have to be built, look at the enormous expenses, and so on.

I would like to point out that first of all, the initial expenses in this development effort are not very large. They might run into the order of a few million dollars a year, which India is certainly capable of spending on research and development of a high technology field. In the past, India has demonstrated that it is capable of spending that much and utilizing it fruitfully.

The money is not so much the problem. I think what is at the moment the problem is to find a solution for how one can concentrate the manpower of those 50 or so experienced plasma physicists in the field immediately related to fusion energy development. Some of these people are in the country and others are abroad and undoubtedly they could be convinced to come back if such an effort were put forward.

It is a management problem, not just a technology or financial problem. It is a management problem that has to be resolved with some dispatch. It cannot be allowed to drag on for months and years, because under those circumstances the people who otherwise will be enthusiastic about such a program quickly find that they are using a lot of their talents and energies in bureaucratic exercises rather than the solution of the problems they were trained to solve.

So I think, and I believe Dr. Dean concurs with me on this, that financially as well as from the manpower standpoint, India is capable of engaging in the problem. The question is one of the national determination of a sovereign nation to develop this program.

The reason I stress this notion of the determination of a sovereign nation is because being able to participate in the international fusion program in the next 30 years on the level with other nations which are now engaged in this work is going to be a very important element of exercising the sovereignty of the nation. This is going to

be the most advanced technological field which will determine the course of development in the next century, and to have an independent capability of participating in this kind of development and to exercise that capability is a major contribution to the exercise of national sovereignty.

On the other hand, to have such a potential as India has with regard to scientific manpower and to fail to make a decision to pull together such a program would be a very serious lapse which would have important negative consequences in the time to come.

It has also been pointed out that, not just in the countries of North America or Western Europe, but also in India's history—from Prime Minister Jawaharlal Nehru to Prime Minister Indira Gandhi—technological and scientific independence, the development of indigenous capabilities at the highest level, are a very essential ingredient of national independence. With regard to fusion we can say today that developing a capability in this field is going to be of the utmost significance.

New Wave: Could you say something about the work you saw on fusion energy on your tour? What do you see as the strong and weak points of the work going on?
Parpart: At the moment, experimental work in plasma physics in the country goes on at the Physical Research Laboratory in Ahmedabad. I think they have a small but excellent program. There is work going on at an experimental center at the Bhabha Atomic Research Center in Bombay and on a small but significant scale at the Saha Institute of Nuclear Physics in Calcutta. There is also a certain amount of work planned more for the purpose of graduate education at the Indian Institute of Technology, New Delhi.

There is no question that the groups at Ahmedabad and Calcutta, with whom Dr. Dean and I had the most extensive discussions, are doing excellent work and that they are enthusiastic about the prospects for development of their work. But as I have said earlier, I think the effort is too diffused and dispersed. I would think that the first order of business is to somehow make a decision to pool some of these scientists and resources in one or two locations which themselves are backed up by sufficient infrastructure in terms of machine shops, engineering capabilities for the support of significant experimental work, and so forth.

I think the time in which a decision will be needed on the building of larger machines in India is about three to five years away. At this point, the appointment perhaps of a coordinator for the fusion program, a selection of individuals who for a certain period of time may be sent abroad—be that to the United States, Western Europe, the Soviet Union, or Japan—to get their hands dirty with functioning experiments in the fusion energy area will be important.

Manpower, I think, has never been a problem in India. I think the problem is in the area of management and administration and in the availability of experimental facilities and the costs involved in these facilities. But I believe that the initial cost involved here, let's say in the first three years or so of a scaled-up fusion effort, will not be large. When we look beyond that, of course, larger expenditures have to be taken into account and when the discussion of expenditures for the next Five-Year Plan begins, there should already be some sense of the direction that this program will take.

New Wave: Everyone is talking about a big fusion effort by Japan. What exactly are the Japanese doing?
Parpart: India in the early 1960s had a very similar opportunity [to Japan] to become one of the leading nations in semiconductor applications. The scientific manpower existed in the form of Indian scientists who had done exceptional work in this field in the United States as well as in other countries. Indeed, certain steps were taken in that direction but the total amount of expenditures that were at that time allocated by India were not sufficient to define critical mass either to get the program off the ground in India or to convince some of these leading scientists that their research would indeed be supported at an adequate level.

I think not having made this commitment in the 1960s in India is something that has hurt the country significantly, and if India is today number ten in the world with regard to production of semiconductor-related technology items and not number two or three, this is directly the outcome of not making the decisions that should have been made at that time.

There is another example with regard to making such a decision in which case India made the proper decisions at the right moment. In the late 1940s and early 1950s, it became clear that nuclear energy was going to be developed as a source for peaceful energy production. Many of India's leading scientists at that time under the leadership of Homi Bhabha made the decision that even though India had many problems to deal with, it was necessary to develop the manpower and the infrastructure so that some 25 years later when the technology would actually come on line, India would not have to import these technologies and patents but would itself be capable of producing nuclear reactors indigenously.

This program was successful, and to the extent it was successful there is a reasonable expectation that a significant share of the energy problem India faces can be relieved through the utilization of nuclear power on the basis of technologies produced in India.

With regard to fusion, we stand today roughly at the same point as Bhabha did in the early 1950s. We know that by the year 2000—a few years earlier or later—these technologies will become available commercially.