Will America Take Up The Fusion Challenge?

The Soviets and Japanese are pushing the U.S. to say yes

As of this writing, momentous proposals for the development of fusion energy are reportedly under consideration at the highest levels of the Carter Administration. What has prompted the Administration to reevaluate its consistent policy of slighting this most advanced form of nuclear energy is a series of public offers from the Soviet Union and Japan to collaborate on bringing fusion "on line" as quickly as possible.

This is the "energy core" of the international Grand Design pattern of development deals and proposals. It is clearly intended to create a political climate in which the vacillating Carter Administration will be forced to dump its "less is more" antinuclear wing, most particularly Energy Secretary James Schlesinger, and put U.S. resources fully behind the international fusion effort.

The Soviet and Japanese offers came one after the other over the past month.

On May 3, Japanese Prime Minister Takeo Fukuda announced before the Foreign Policy Association and Japan Society in New York City that he had proposed to President Carter a joint fusion energy development fund of up to $1 billion.

Fukuda's announcement occurred just three days prior to the signing of the momentous Soviet-West German agreement for industrial and technological cooperation over a 25-year period. It is no coincidence that in mid-May Mexican President Jose Lopez Portillo was in the Soviet Union, completing economic and scientific accords focused on transfer of Soviet oil and nuclear technology to Mexico. Portillo's visit to the Kurchatov Institute, site of advanced fission and fusion research facilities, underscores his country's commitment to world peace founded on international scientific and technological collaboration geared to industrial development.

Finally on May 31, the Soviets culminated a long series of proposals to the United States with the most open and far reaching one yet. On that day *Pravda* printed a full page proposal "On Practical Ways to Stop the Arms Race," the Soviets' official policy proposal to the United Nations disarmament talks. It said in part, "The Soviet Union is ready to cooperate on a constructive basis with other states in research on new sources and forms of energy. We declared only recently our readiness to participate, together with the United States, the European countries, Japan and other countries, on an international project on the 'tokamak' thermonuclear (fusion) reactor."

The State of the Art

Fundamental research breakthroughs in recent years have forced the construction of a prototype test reactor, the next step prior to a commercial reactor, onto the agenda. The implications of this turn of events are world historical. For the first time in history, we are on the threshhold of an era of energy abundance on a world scale.

But Schlesinger is calling for moving back fusion research into the next century. His program of cuts to the already under-funded U.S. fusion budget will mean that America will lose out on what the Soviets and the Japanese are proposing now.

Controlled thermonuclear fusion is the process by which the conditions in the interior of the sun are replicated in miniature on earth in order to generate energy. The fusion of hydrogen atoms to create helium, which occurs in the sun's core and has been achieved under controlled conditions on a laboratory scale as well as in the hydrogen bomb, releases tremendous amounts of energy. It has, in fact, been estimated that the supply of deuterium (heavy hydrogen, the primary fuel for first generation fusion reactors) available on the planet is sufficient to supply the world population with energy at current North American consumption levels for from 1 to 10 billion years.

Of greater importance even than the sheer quantity of energy that will become available in a fusion-based economy is the implications of the quality of that energy. The temperature of the solar core, 50 to 100 million degrees centigrade, provides unique and now unavailable energy sources for large-scale materials transformations, both in primary material extraction and in recycling. A device known as the fusion torch could carry out this processing by heating raw materials in a fusion plasma (the extremely hot gas which makes the fusion reaction possible) to temperatures where the individual atoms are ionized (that is, stripped of their electrons). Different elements can then be separated by electric and magnetic forces.

Bulk delivery of high-energy radiation, such as x-rays and gamma radiation, now available only in relatively small quantities from fission reactors, will facilitate photochemical processing, thus transforming large sections of the chemicals industries.

At this still early stage, prior to the development of a fusion-based economy, only a few of the revolutionary technological, industrial, and social implications of

fusion can be envisioned. We can be sure, though, that the rapid development of this technology, with the concomitant boosting of living standards and skill levels in the population as a whole, cannot but be a boon to all men.

Recent Breakthroughs

Among the breakthroughs that have made it feasible to begin design of a test reactor is that announced at the Fusion Energy Foundation's January 24 Conference on Middle East Peace and Economic Development in New York City by Dr. Stephen O. Dean, Assistant Director for Confinement Systems of the U.S. Energy Department's Division of Magnetic Fusion Energy. Dr. Dean told the conference that the Princeton Large Torus (PLT) had reached the highest temperature ever achieved in experimental work using a neutral beam heating device. The PLT, like other magnetic confinement fusion devices, uses the principle of magnetic fields acting on the hot, ionized plasma to confine it while the fusion reaction takes place. Plasma temperatures are too high for any material container to hold them. The development of this heating method has facilitated the design of more compact, more economical-to-operate reactors than had previously been thought possible.

The PLT is a prelude to a much larger device now under construction at Princeton, the Tokamak Fusion Test Reactor, which will be completed in 1981. This larger device, using the same principle as the PLT, is expected to produce as much energy through fusion as it consumes in achieving the right conditions, a regime researchers call "energy breakeven." Once this criterion is attained, the next step will be to scale up and modify the design to maximize net energy production. Then, commercial feasibility is in sight.

Soviet fusion researcher Academician B. Kadomtsev recently announced that the Tokamak-7 successfully completed its first test in Moscow last April. This device uses powerful superconducting magnets, rather than the conventional magnets of earlier designs. As a result the Tokamak-7 can be run continuously. Its predecessor, the Tokamak-10, could only run for periods less than a second; otherwise the magnetic coils would melt. Furthermore, the Tokamak-7's superconducting magnets require thousands of times less energy than conventional ones.

In addition to these examples of advances in magnetic confinement fusion research, the concensus of the American Physical Society's annual meeting of the Plasma Physics Division last November 7-11 is that laser and electron beam fusion research are making similar progress. In these two research areas, a small pellet of fuel is bombarded with energy, either in the form of coherent light from a laser or as high energy electrons. The pellets implode, creating high temperature and pressure regimes in which fusion is possible. The technical problem is to design systems in which the period of pellet "burning" is maximized, so that the greatest amount of energy can be produced. Experiments in both the U.S. and the Soviet Union have confirmed earlier theoretical predictions; indicating that fuel pellets can now be designed which have a high enough energy gain that existing low-efficiency lasers can be used not only for breakeven experiments, but even for commercial power plants based on laser fusion designs. These new conceptions will be tested on the world's largest laser fusion device, Shiva at the Lawrence Livermore Laboratory, which began operation in May.

Among other recent achievements:

*Three additional tokamak experiments will come on line within the next few months — the Poloidal Divertor at Princeton, the Doublet III at General Atomic, and the Alcator C at the Massachusetts Institute of Technology. These experiments will conclusively prove the feasibility of tokamak power plants.

*There are strong indications from a number of experiments that so-called classical confinement of plasmas is being achieved. This means that plasmas can now be created to order, rather simply, instead of being subject to the unpredictability associated with the instabilities found in earlier work.

*Impurity control, necessary due to the migration of elements other than hydrogen into the plasma, is rapidly approaching the level of definitive tests.

*Theoretical work is progressing well in the area of plasma betas ("beta" is the ratio of the plasma gas pressure to the pressure exerted by the magnetic field). Power reactors need betas of at least 4 percent, although 10 percent would be required for really economical units. Present test reactors have betas of less than 1 percent.

As these achievements indicate, the time is definitely ripe to move on to the design and construction of precommercial test facilities, if we are to achieve commercial fusion power in the last decade of this century.

The Soviet Offers

The latest Soviet offer of cooperation in the pages of Pravda *has a long history, punctuated by attempts by Schlesinger and the British to halt any collaboration between the two countries.*

The Rudakov Affair

Under a U.S.-Soviet protocol signed in 1973, several hundred Soviet and American fusion scientists exchange visits each year. During the week of July 4, 1976, one such Soviet scientist, Leonid Rudakov, head of the Soviet electron beam fusion research effort, visited several major U.S. laboratories involved in fusion research. On these visits, Rudakov detailed recent Soviet breakthroughs in the area of electron beam fusion. He also proposed that these new Soviet results be connected with the U.S. capability to rapidly fabricate electron beam sources to build, with Manhattan Project-style "brute force" methods, an electron fusion prototype plant by 1981.

The reaction of the U.S. energy bureaucracy was a panicked attempt to keep the whole affair secret. The information that Rudakov revealed might, they argued, be used for construction of atomic weapons by "nonweapons states"!

Under a little-known 1958 treaty between the U.S. and Britain, the British have access to top-level U.S. research, and can unilaterally force the imposition of

security classification, ostensibly to prevent the undermining of Britain's nuclear capability by the proliferation of "secrets" — particularly in the form of collaboration with the Soviets. U.S. Defense Secretary Harold Brown admitted the effects of this arrangement when he was asked by a NATO official why the Rudakov results had been classified, why the Soviet scientist's offer of collaboration had been turned down. Brown's reply was, "Because our British allies won't let us."

The Velikov Offer

In July 1977, another high-ranking Soviet fusion scientist, E. P. Velikhov, a vice-president of the Soviet Academy, visited the Los Alamos Scientific Laboratory. He made a proposal quite similar to Rudakov's in an area of fusion research which the Soviets have pioneered — imploding liners. The Soviet Union was at the time (and still is) several years ahead of the U.S. in this very promising line of research. Just prior to Velikhov's arrival, final notice had been given to Los Alamos concerning a funding cut off for another one of their experiments.

Why not couple the considerably advanced Soviet experimental and theoretical program in liners with the power source from the discontinued U.S. Linus experiment? Velikhov proposed. By the fall of 1977, a five-man U.S. delegation was visiting the Soviet Union to set up details for collaborative experiment. and proposals for U.S. funding had been submitted to the Department of Energy.

Late in 1977, the policy ruling came down from the Energy Department. The liner experiment would not be funded. This meant that the only way the experiment could continue would be through a large Soviet input.

The Basov Visit

The Soviets then escalated their push for collaboration by sending Nobel laureate Nikolai Basov, head of the Soviet fusion effort, to the U.S. in November 1977 with an unofficial plea for expanded U.S.-Soviet collaboration in laser fusion. Basov made a point of documenting his offer with two pieces of scientific information. First, the Soviets had achieved a new milestone — beyond energy breakeven — in their laser program. Second, they had done so on the basis of the results Rudakov had announced a year and a half earlier.

Schlesinger's official response to the Basov offer, during a press conference a number of weeks after it was made, was: "No, a flat no." The Energy Secretary then claimed that laser fusion is classified in the U.S.

The Recent Soviet Initiatives

Subsequently, in March Velikhov made a further private proposal to U.S. fusion research officials to develop a commercial fusion reactor jointly with the United States. He made this proposal formal in late May at the U.S.-USSR
Committee in Moscow. The proposal calls for the United States and the Soviet Union to make major contributions to such a project, but that it must be officially conducted under the auspices of the United Nations International Atomic Energy Agency.

It is in the context of the above proposals and of the considered opinion of experts in the field that a major push for commercial fusion development is now necessary that the *Pravda* article appeared.

The U.S. Program: Progress or Perish?

The humanist intent of both the Soviet and Japanese proposals was summed up by Prime Minister Fukuda's remarks when he announced the Japanese offer:

"Science can provide impetus to new productive activities, and serve as a prime mover in the future expansion of the world economy, or can waste our resources and threaten our survival. Exactly because of this dual character of science and technology, I believe it is the duty of Japan, a nation dedicated to peace to participate vigorously in cooperative international efforts to utilize science and technology solely for improving the standard of living of the world's peoples."

Japanese Foreign Minister Sunao Sonoda announced in a press conference May 30 that the Fukuda proposal is under discussion at the cabinet level in the White House. And Undersecretary in the Energy Department John F. O'Leary announced May 17 that his staff was preparing responses to both the Soviet and Japanese offers. To date, however, there has been no U.S. response to either.

At the same time, both O'Leary and Schlesinger have been pushing for a transfer of Energy Department funds out of the fusion effort and into the solar energy boondoggle. This sabotage has been at least temporarily turned back through the efforts of the Fusion Energy Foundation, the U.S. Labor Party, and a spectrum of progrowth industrialists, scientists, and working people, as well as through the effect of the Japanese and Soviet proposals.

Earlier Schlesinger gave official Department support to the May 2 Sun Day celebration of technological regression and deindustrialization, and urged Congress to do the same. In addition, O'Leary's oft-expressed opinion is that nuclear energy in general is "fading from the horizon." He was recently heard to say in a press conference that he did not know if researchers could even use a $1 billion fusion research budget. Furthermore, he has proposed wildly incompetent "cost-effectiveness" criteria as the basis for making fusion research funding decisions. On that basis, any large scale prototype reactor would a priori be ruled out as too expensive, since its immediate (as opposed to long-term) "economic return" would be "too small." Now, with both Japan and the Soviets offering to help foot the bill, whatever credibility this argument may have had for the misguided has been swept away.

Researchers have repeatedly expressed the conviction that the achievement of commercial fusion could be dramatically accelerated if greater funding were available. For example, the as yet unreleased report of the ad hoc experts group on fusion, the so-called Foster Committee, assessing the current U.S. fusion program has recommended a full-speed-ahead approach. The committee recommended an expansion in the number of reactor designs under investigation, as well as the continuation of existing programs. There are some indications in the May 25 issue of *Nucleonics Week*, however, that the committee has compromised its program in light of Administration efforts to gut the fusion budget.

Outrageously, the proposed Fiscal Year 1979 budget will, by the Energy Department's own estimates, postpone the commercial development of fusion indefinitely if it is pursued at the pace determined by the present level of funding. Compounding the cutbacks in this budget, O'Leary has requested from John Deutsch, Energy Department Research Director, an assessment of the effect of a cut of $50 million to $100 million in the magnetic confinement fusion budget for FY-1980 from the present level of $334 million. Informed sources indicate that such a cutback would not be well received in Congress; both House and Senate committees have been adding sums to fusion research above Administration requests in the FY-1979 budget.

While Schlesingerians hack at the U.S. fusion funding, the Japanese and Soviets have been moving ahead. Prior to Fukuda's offer of a collaborative program, the Japanese government has been committing funds to fusion research at such a rate that they will surpass U.S. funding levels within two years. Their timetable is geared to producing a commercial demonstration plant in 1995.

Best estimates of the Soviet program indicate that they plan to have an experimental power reactor in the 1980s, followed by a commercial demonstration plant some time in the 1990s.

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The Bonn-Moscow accord is part of a global shift both politically and economically, which could be the basis for an unprecedented period of growth for the whole world, including the rapid industrialization of the underdeveloped sector. The resulting potential for multilateral economic cooperation could provide the firm basis for world peace. Similarly, the opportunities opening up for fundamental scientific and technological cooperation among nations can accelerate the rates of economic development that can be achieved. In fact, rapid industrial growth, which necessarily depletes existing energy resources, must have the benefits offered by the early implementation of large-scale fusion power.

In sum, America has been made an offer it cannot — in the national or in the world's interest — refuse.

—John Schoonover