Academy of Sciences won't tone down fusion power report

by Charles B. Stevens

The National Academy of Sciences has submitted an interim report on inertial confinement fusion (ICF) research, which criticizes the Reagan administration's 50% cut in the 1986 budget, and warns that ICF research is being unnecessarily hampered by "top secret" classifications.

The report was produced by a review committee set up last year, at the administration's request. Although the detailed conclusions of the study have not been released to the public, it praises the technical accomplishments, progress, and prospects for success of the inertial confinement fusion program, according to *Fusion Power Associates Executive Newsletter*.

The Academy study means that it is just a matter of investment, whether or not we can have fusion power on schedule as an industrial source of energy.

The report further determines that, contrary to prevalent opinion, the ICF program has made important contributions to the nation's defense. During the Carter administration, inertial confinement fusion was reclassified as a pure weapons-research program. The Reagan administration later concluded that inertial confinement fusion was not making a significant contribution to the Department of Energy (DOE) nuclear weapons program, and could therefore be cut back. The administration's current recommendation for 1986; the House Appropriations Committee is calling for $155 million.

The Office of Science and Technology Policy (OSTP) received the Academy evaluation with an angry demand that the panel "tone down" its report. The DOE's Division of Classification, reviewing an earlier draft of the ularly objected to the panel's view that overclassification is impeding progress in ICF.

At first it appeared that the panel would agree to tone down the report; but according to *Fusion Power Associates Executive Newsletter*, a member of the National Academy Committee then declared: "The Committee has not and will not change a word in its interim report. . . . We listened the Office of Classification's views for two hours and, when the session ended, we were more convinced than ever that we were right in criticizing their policies."

Miffed by what a source called "nitpicking by an OSTP staff member," the Academy requested that OSTP "put its criticisms in writing. After receiving and discussing the written OSTP criticisms, the panel decided not to change its interim

Super Nova: the next step?

The Academy's review of inertial confinement fusion, sometimes known as laser fusion, has sparked efforts by fusion scientists and laser Lawrence Livermore National Laboratory in California, to show that the quickest and most economical path to the full scientific demonstration of laser fusion is by building a massive glass laser, which some have called Super Nova.

Livermore is currently carrying out successful experiments with its Nova glass laser system. The Nova is a 100-kilojoule, 100-trillion-watt glass laser, 1.06 microns. KDP crystals are utilized to decrease this wavelength to .35 microns with a 70-kilojoule, 70-trillion-watt output. The shorter wavelength has been found to be most effective for inertial confinement fusion. But Nova does not have sufficient energy to attain high-gain fusion. The Nova is being utilized to experimentally explore crucial scientific questions, such as laser-matter interaction at high power irradiation and fundamental hydrodynamic processes.

While many scientists believe that a significant net fusion energy output can be attained with 20 to 30 times the energy output of Nova—about 2 to 3 megajoule output—many have suggested that an energy level of 5 to 10 megajoules would provide a margin of certainty. Livermore laser specialists, who have led the world in the development of high-power lasers, have, to the surprise of many, found ways of making such a massive system economical. It that such a large glass laser would cost more than $1 billion. But leading fusion authorities now report that Livermore has been able to show that it could be built for less than half a billion dollars.

Laser fusion energy

In laser fusion, intense pulses of light are focused onto minute pellets of hydrogen fusion fuel. The incident light is absorbed on the surface of the spherical pellets and thereby generates intense convergent shockwaves. The shock compression of the fusion fuel drives it to both high temperatures and densities at which nuclear fusion is ignited.

For net energy generation, the total energy invested in running the laser, the laser pulse, etc., must be more than matched by the total fusion energy output. Generally this output is measured as laser fusion gain. That gain is the ratio of the fusion energy output to the laser energy input. Given the relatively low efficiency of high-energy lasers, it is thought that the gain must approach 100-fold, or more. This is referred to as high-gain fusion.

Research on President's Reagan's Strategic Defense Initiative has led to major advances in high-power lasers, particularly gas lasers. Gas lasers have been generally more efficient than solid state (glass) lasers. They can also operate with a much higher firing rate. Both of these are essential characteristics in determining the economics of a laser fusion plant. But the extremely high power levels needed for laser fusion are not needed for intercepting missiles. As a result, while the technological base for realizing high-power gas lasers for inertial confinement fusion is being developed, the actual prototypes needed for high-gain laser fusion are not.

Gas versus glass

The National Academy of Sciences conducted a full review of the status of lasers for fusion, and found that while gas lasers could be immediately built for laser fusion, the quickest path to realizing the energy levels needed for experimentally demonstrating high gain would use glass.

Glass lasers have hitherto been very inefficient; as the technology now stands, they are not capable of achieving the high firing rates needed for actual electric power reactors. But the experience with construction of high-power and accurate glass lasers apparently makes them the best candidates for near-term demonstration of high gain. As one source noted: "An advanced gas laser might be able to obtain the required energy and power level at the correct frequency, but lasers are complicated beasts and we could be faced with years of teething problems. With glass, we can certainly do it."

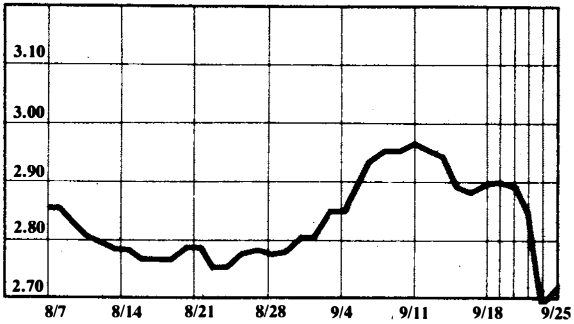
One complication noted by many researchers involves short wavelength optics. It is generally accepted that short wavelengths are essential for high-gain ICF. In the glass lasers, this is achieved by transforming the infrared laser output of 1.06 microns into .35 micron ultraviolet light by means of KDP crystals. As a result, most of the optics in the laser operate on only infrared light. Optics for the shorter wavelength .35 micron light involve great technical difficulties and many breakdowns and burnouts. In the case of gas lasers, the entire system would have to operate with short wavelength optics. While substantial progress in short wavelength optics is currently being made, the existing technology is not sufficient to assure reliable operation with extremely large and high-power lasers needed for ICF in the immediate future. From this operational standpoint for a successful experimental program, glass makes the most sense.

While existing glass laser technology is not capable of attaining high efficiencies or firing rates, research is ongoing into solid-state lasers that will.

Currency Rates

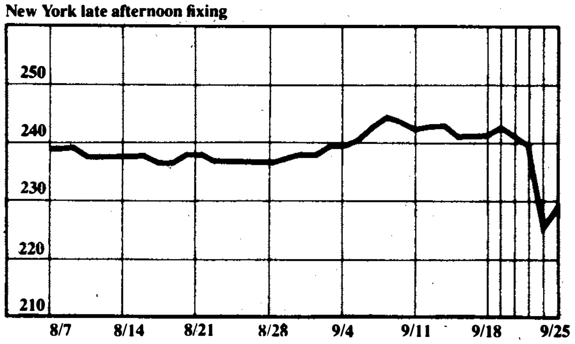
The dollar in deutschemarks

New York late afternoon fixing



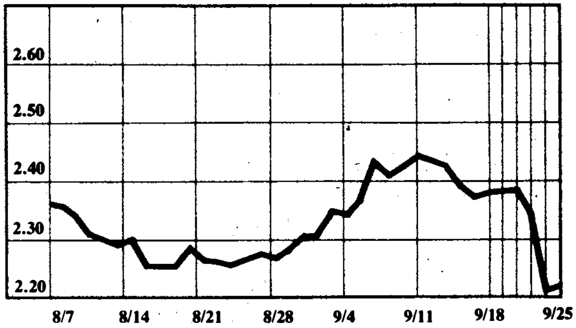
The dollar in yen

New York late afternoon fixing



The dollar in Swiss francs

New York late afternoon fixing



The British pound in dollars

New York late afternoon fixing