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possible in the ERDA weapons laboratories before we have achieved high pellet gain implosions.

Other research efforts are directed toward meeting the long-term energy technology goals of inertial confinement fusion. These latter efforts are relatively small because the energy goals are more distant ones.

Based on the pertinence of the background experience of the ERDA weapons laboratories to inertial confinement fusion, the relevance of the early phases of this research to weapons technology design questions, and the relative ease of carrying out single pulse (one firing per day) experiments, the following program objectives have been established:

Near-Term

** demonstrate single-pulse inertial confinement fusion
** assist nuclear weapon development and testing

Long-Term

** develop the technology for energy and power plant (multiple pulse) applications

The Outlook for Inertial Confinement Fusion

The pursuit of major phases of this program towards significant civilian applications can be modular in that the task of scientific feasibility demonstration (that is, achieving high energy gain from pellets in single pulse experiments), can be addressed separately from the applications engineering tasks. These would follow upon a decision to proceed toward an experimental power reactor, for example. While there is as yet no discernible critical path to this major decision point, we believe that the program, as now structured, represents an orderly, low risk approach to feasibility demonstration.

Testimony Of KMS Fusion, Inc. On Laser Fusion

The following are excerpts from the testimony of KMS Fusion, Inc., on laser fusion by Dr. Robert Hofstadter and Dr. Henry J. Gomberg before the House Science and Technology Committee Subcommittee on Fossil and Nuclear Energy Research, Development and Demonstration on March 4.

Dr. Robert Hofstadter

For many years, I have been a consultant for the Harshaw Chemical Co. I cite this record to show experience in scientific matters and in industrial work. This background is appropriate since what I am going to say may be at variance with other testimony you may have heard or will hear. I want to assure this Committee that I have given much thought to how civil energy needs may be advanced in the shortest possible time.

I regard the future of laser fusion energy as much closer than most others — but only if the program of development in this field is given adequate financial support and scientific freedom of investigation. I want to see laser fusion energy production in my life time and I am 62 years old. If I felt otherwise I would work on other subjects.

On the whole, however, a civil energy laser fusion program is nonexistent. I think our national policy needs a severe prod in order to reverse its direction. I should point out that our national program is essentially oriented towards weapons development, weapons simulation and weapons design. But civil energy needs, I submit, are very different from weapon needs, and there are innumerable deviations in the two approaches. My interest and KMS Fusion's interests are in the civil energy department.

In the case of fission energy, which was developed in war time, alternate methods of separating uranium isotopes were investigated simultaneously and alternate designs of the ultimate bomb were also developed. One of the successful designs was based on the implosion phenomenon, an invention of Dr. Seth Neddermeyer, a close friend of mine.

It is essential, in my opinion, to have several different groups working on the development of laser fusion energy and not to have the work directed exclusively from a single masterminding center.

It is to be noted that Russion competition has been a driving force in this field. In fact, the Russian scientist, Basov, is the inventor of the laser fusion concept.

The laser itself was developed in a private laboratory, namely the Bell Telephone Labs. by C. H. Townes, and Arthur Chawlow, who is now a colleague of mine at Stanford. Furthermore, the first laser, a ruby laser, was made by Theodore Maiman, a former Stanford gratuate student who did his epoch-making work in an industrial laboratory.

Forty years of experience as a physicist have convinced me that several investigators, pursuing their own lines of thought, can make discoveries that no one can anticipate. Thus a single undirected weapons approach, such as the one now in effect in the United States, should be changed in my opinion. We need variety, freshness, and freedom of investigation.

Dr. Henry J. Gomberg

KMS Fusion appears before this Subcommittee because we believe that there is much to be done through science and technology in solving vital social and economic problems that should be addressed more aggressively.

In doing so we tread on dangerous ground. The existence of our company and our program in laser fusion is now dependent on government-funded programs. Yet we come to present views which differ from those prepared for presentation before this Subcommittee by the Division of Laser Fusion (DFL) which administers our contract.

We raise no questions as to the merit of the government-funded programs for the stated purposes. The weapons laboratroies in which the vast bulk of the proposed DLF program is placed, are organizations of proven performance. But, in the past, individual groups have seen matters differently on problems of more limited scope than we address today. Difference, there-

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fore, should be expected on the broad questions of new energy sources and their applications, and the priorities with which they are pursued.

The DLF program has been presented as one in which "accomplishment of the major program milestones will provide immediate benefits in weapons technology development, near-term future benefits in weapons effects simulation, and lay the groundwork for potential long-term benefits in civilian power technology development.

The program is structured so that the majority of the *base* program is in the weapons laboratories where weapons technology can be applied to fusion research while nuclear weapons concepts are protected...Within that program structure, the major role for industry will occur after success in the core program demonstrates the feasibility of Inertial Confinement Fusion.

The DLF program has been characterized as an "orderly low-risk approach to feasibility demonstration." We agree, and we believe that this program structure in the Division of Laser Fusion, under the Assistant Administrator for National Security, is ideally suited for the objectives as outlined.

KMS Fusion, has from its inception had a broader view of the short-, mid-, and long-term goals of laser fusion, and the resources that should be brought to bear on solving the problems. We feel that the current energy crisis, the potential of laser fusion for providing a viable solution for that crisis within our life time, as well as possible short-term benefits from applications other than weapons-related, all call for a more-aggressive, vigorous, higher-risk approach than is proposed.

And because we believe the national program should be broader, with adequate emphasis on civilian applications, we believe the program should have an administrative base that reflects civilian interests. We suggest this without rancor. We raise the issue, however, because it is inevitable that the primary interests of the responsible administrative group will have great influence on the goals selected and priorities established.

The justification for the administration of the national laser fusion program as part of the weapons complex is the potential for early military application. There is, however, equally valid potential for early civilian application.

We foresee, in addition, other civilian uses arising from the exploration of new physical, chemical and biological phenomena that can be observed as neutron output rises. And finally, and more important, is the potential for production of inexpensive chemical fuels by conversion techniques using the laser-fusion driven sources.

We recognize the need for security, but this is hardly a new situation. There is ample experience. A strong collaborative and competitive effort is needed so that information can be transferred in ways that the whole effort benefits and moves forward.

KMS Industries has in the past brought industrial resources and financing into the laser-fusion field far in excess of any other private group in the country. We firmly believe that *if* the national laser-fusion program had a more clearly defined mission for the development of civil energy resources, along with the early development of other applications suitable for the civil economy, and *if* this civil mission had the firm support of the government, industry will join with the government to develop and commercialize laser fusion.

U.S. E-Beam Research In Breakthrough

While details are still being withheld under top secret classification wraps, testimony by officials of the federal Energy Research and Development Administration (ERDA) indicates that U.S. electron-beam pellet fusion researchers at Sandia Weapons Lab in New Mexico have duplicated what Soviet researchers, led by L.I. Rudakov accomplished one year ago: experimentally producing controlled thermonuclear fusion reactions, utilizing the electron-beam pellet approach.

Preliminary analysis, based on what scanty information has been released, points to the fact that the Sandia researchers utilized the same method which Rudakov revealed to U.S. scientists last year. With this new experimental breakthrough, U.S. electron-beam pellet fusion scientists can demonstrate the feasibility of this approach to harnessing the vast energies of nuclear fusion reactions with the completion of the construction of their next planned experimental facility by 1980.

In his testimony today before the House Science and Technology subcommittee on energy, Dr. C. Martin Stickley, the director of the ERDA Laser Fusion Division, reported that researchers at the Sandia Laboratories "produce measurable numbers of thermonuclear neutrons...on Proto I." Furthermore, he went on, "the most important achievement has been the experimental and theoretical observation of enhanced electron beam energy deposition in thin shells over what had been predicted from simple models. This order-of-magnitude enhancement reduces the requirements on the design of targets and generators for electron beam fusion. New target designs are yielding evidence of thermonuclear neutron production." The success in enhancing the energy deposition in electron beam targets was also reported in an article in the Feb. 21 *Physical Review Letters* by the Sandia group.

Researchers at Sandia have also developed a new method of getting around the chief technological roadblock to realizing economic and reliable power reactors based on e-beam pellet fusion. Under normal conditions the diode which generates the electron beam must be within a few feet of the pellet. This would lead to its rapid deterioration in a power reactor in which up to 10 microexplosions per second must be obtained if significant power output is to be reached.