

memorandum

DATE: August 18, 1994

REPLY TO
ATTN OF: ER-16

SUBJECT: Summary of the Recent Developments in Cold Fusion

TO: Walter M. Polansky

Attached is the report that you requested on the above noted subject.

Duane L. Barney
Division of Advanced Energy Projects
Office of Basic Energy Sciences

Attachment

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SUMMARY OF THE RECENT DEVELOPMENTS IN COLD FUSION

by Duane L. Barney

August 18, 1994

EXECUTIVE SUMMARY

The objective of this report is to provide a summary of the developments in cold fusion in the past year. The Department of Energy has continued its policy on cold fusion that evolved from the 1989 Energy Research and Advisory Board (ERAB) report. This policy is that cold fusion proposals are considered for funding within existing budgets and are subjected to normal merit review procedures; one proposal has been received in recent years and this proposal was declined largely because of negative reviews. Despite pressure from cold fusion proponents, this policy appears valid today for a number of reasons. The cold fusion community's technical reports have centered around four international conferences on cold fusion, the most recent, the Fourth International Conference on Cold Fusion (ICCF-4) took place in December, 1993. Overall, the claims for cold fusion at ICCF-4 were scaled back in magnitude from the preceding conference, held in October, 1992. Some researchers who had previously reported excess heat were silent at ICCF-4. At ICCF-4, Steven Jones retracted his claims of detecting neutron bursts in cold fusion experiments. A cold fusion paper by Pons and Fleischmann in a prestigious refereed journal was met by detailed scientific criticisms and failed to convince the general scientific community of the reality of cold fusion. Researchers have continued to come forth with non-nuclear explanations, including hydrogen-oxygen recombination, for the excess heat obtained in Pons-Fleischmann experiments. A comprehensive review article concluded that there was no theory that explains cold fusion. Advocates of cold fusion do not claim reproducible experiments with excess heat and an equivalent amount of fusion products. General Electric paid the University of Utah for information on cold fusion, conducted research and published negative results, and dropped research on cold fusion. A Japanese group, New Hydrogen Energy (NHE), formed by the Ministry of International Trade and Industry (MITI) has started a \$30 million dollar, four year program to develop cold fusion; Pons and Fleischmann are funded by this group at a laboratory in southern France. A private organization, ENECO, has been formed in Salt Lake City to fund cold fusion research; this organization is funding a number of U.S. researchers.

I. OBJECTIVE

This objective of this report is to provide a summary of the developments in cold fusion in the past year, including a review of the material published on cold fusion in this period. Material on this subject is found in a wide range of publications, reports, and communications.

II. INTRODUCTION

Immediately after the announcement of the discovery of cold fusion by the electrolysis of heavy water using a palladium electrode by Pons and Fleischmann at a press conference in March, 1989, scientists all over the world rushed to attempt to duplicate the phenomena. The Secretary of Energy directed 10 DOE laboratories to intensify their research efforts on cold fusion and the Secretary was kept informed on a weekly basis. After several months of repeated negative results the DOE laboratories dropped their efforts.

Also in 1989, the Secretary asked the Energy Research Advisory Board (ERAB) to convene a panel to assess cold fusion. In its final report [1], the Panel stated, "The Panel concludes that the experimental results on excess heat from calorimetric cells reported to date do not present convincing evidence that useful sources of energy will result from the phenomena attributed to cold fusion. In addition, the Panel concludes that experiments reported to date do not present convincing evidence to associate the reported anomalous heat with a nuclear process". Also in their conclusions, the Panel stated that, "The Panel recommends against the establishment of special programs or research centers to develop cold fusion. However, there remain unresolved issues which may have interesting implications. The Panel is, therefore, sympathetic toward modest support for carefully focused and cooperative experiments within the present funding system". The Department of Energy accepted this report and this last statement has been the basis of the Department's policy in receiving proposals on the subject. The Department has repeatedly stated that it will consider substantive proposals on cold fusion and that these proposals will be subjected to the same peer review process as all other research proposals.

The experience of the DOE laboratories - working feverishly to duplicate the announced cold fusion phenomena in 1989 and then dropping the efforts after failing to reproduce the phenomena - was also experienced by most of the rest of the world scientific community.

However, a group of researchers, including Pons and Fleischmann, continued to work on cold fusion and report positive results. This group has become extremely active and well organized and has made its presence felt in the world.

III. SUMMARY OF PUBLICATIONS AND REPORTS IN THE PAST YEAR

The cold fusion community's technical reports have centered around four international conferences on cold fusion - the most recent, the fourth, was held in 1993. The Journal of Electroanalytical Chemistry, which is a refereed journal, published the first paper on cold fusion by M. Fleischmann, S. Pons, and M. Hawkins.[2] This journal is regarded as a special case among refereed journals; the editor is located at the same university (Southampton University) as Fleischmann and apparently this editor performed the review on the Pons and Fleischmann paper. This journal has continued to publish papers on cold fusion. Only a relatively small number of papers on cold fusion appear in prestigious refereed journals. There have been a great many reports on cold fusion, many of them published in Fusion

Technology, which apparently publishes articles on cold fusion without review. Covering all of the reports and publications is beyond the scope of this report. The significant papers will be covered. A computer literature search was used. Also, the Internet has an active cold fusion dialogue and information was obtained from this source.

The Fourth International Conference on Cold Fusion (ICCF-4) was held in Maui, December 6-9, 1994. The Third International Conference on Cold Fusion (ICCF-3) was held in Nagoya, Japan, October 21-25, 1992. The organizers of ICCF-4 were the Electric Power Research Institute (EPRI) and the Stanford Research Institute (SRI). These conferences are sponsored by cold fusion proponents. Almost all of the presentations at these conferences are favorable to cold fusion - the conferences include the essence of a cold fusion workshop. At ICCF-4, there were 20 plenary papers, divided about equally between calorimetry, fusion products, theoretical presentations, and materials. In addition, there were 127 presentations, including poster sessions. Material presented included such subjects as biological fusion, light water calorimetry, cold fusion and nuclear proliferation, transmutation of elements by cold fusion, and cold fusion powered space travel.

Overall, the claims for cold fusion, compared to ICCF-3, were scaled back in magnitude.

There are no publications in which it is claimed that excess heat is reproducibly produced along with an equivalent amount of fusion products. Therefore, this section is divided into three subdivisions - excess heat, fusion products, and theory.

A. Excess Heat

One of the most notable developments regarding the production of excess heat was the silence at ICCF-4 of Yamaguchi of Nippon Telegraph and Telephone Corporation (NTT), who had made major claims of excess heat at ICCF-3.[3] Just before ICCF-3, Yamaguchi gave a press conference which resulted in the NTT stock value increasing by 11 % (about \$ 8 billion).[4] This silence is regarded as significant because all of the active cold fusion proponents make presentations at these conferences. Yamaguchi did not repeat his claims in any other publication medium. NTT is the company that has marketed a \$565,000 "cold fusion kit".[5] After the announcement by Yamaguchi at ICCF-3, the NTT president, Mr. Kojima, stated, in a Wall Street Journal article that, "If another scientist replicates Mr. Yamaguchi's experiment, the result will likely be the Nobel Prize for Mr. Yamaguchi".[6] Kevin Wolfe, a researcher who also reported excess heat in the past did not present a paper at ICCF-4.

In 1993, Pons and Fleischmann published a paper on their work in Physics Letters A, a prestigious, peer reviewed publication.[7] This was a very significant event because these two researchers had been repeatedly challenged to publish such a paper. The paper was entitled "Calorimetry of the Pd-D₂O System: from Simplicity via Complications to Simplicity". They reported that they reproducibly produced excess enthalpy of greater than one kW per cc of palladium in a Pd-D₂O system, a rate which they state, "...is in line with those achieved in fast breeder reactors". As was the case in their original work, the calorimetry is performed in

open-cell systems. They measured the excess enthalpy by measuring the time required to boil to dryness using video camera measurements. The term "nuclear fusion" is not used in the paper, but they conclude that, "...the magnitude of these sources are such that explanation in terms of chemical changes must be excluded." The paper presented by Pons and Fleischmann at ICCF-4 was similar to this paper, except that they used the term "heat after death" to describe their finding that heat remained in the cells after boiling to dryness.[8] No effort was made to measure fusion products.

This paper by Pons and Fleischmann was met by criticism, much of it detailed.

D. Morrison published a paper in Physics Letters A in which he strongly challenged the conclusions of the Pons and Fleischmann paper.[9] Morrison presented a detailed analysis of the Pons and Fleischmann paper and concluded that "Fleischmann and Pons have claimed to have performed a 'simple' experiment and to have observed excess enthalpies larger than 1 kW/cm³ of Palladium. It is shown that in fact the system they use is exceedingly complicated, is under-instrumented and that they have ignored several important factors so that it is unclear whether or not they have observed any excess heat." Morrison stated that, "It is interesting to note that the Fleischmann and Pons paper compares their claimed power production with that from nuclear reactions in a nuclear reactor and this is in line with their first paper where d-d fusion reactions were given and production of neutrons and tritium claimed. It may be noted that the present paper does not mention fusion nor indeed consider a possible nuclear source for the excess heat claimed." Morrison also stated that, "A number of effects have been presented which have not been considered by the authors before they claimed large excess enthalpies."

Pons and Fleischmann, in a paper in Physics Letters A, replied to Morrison's paper. They stated that, "Apart from this general classification of our experiments into stages 1-5, we find that his comments are either irrelevant or inaccurate or both." [10]

In an article in New Scientist, titled, "Frosty reception greets cold fusion figure", Brown criticized the Pons and Fleischmann paper.[11] Brown stated that not enough fusion products are produced. Brown quoted Jean-Pierre Viger, editor of Physics Letters A, "The fusion ashes-neutrons, tritium, and so on - are not there in sufficient amounts...it is not fusion". Brown stated that Viger did not allow the authors to use the word "fusion" in their paper. Brown discussed the paper with David Williams, who led the Harwell UKAEA's experiments, and wrote: "...Williams estimates that this (excess) power can be accounted for by just a small discrepancy in the measured temperature, or estimates of what it should be. Fleischmann and Pons expect the temperature to rise by about 40°C. But Williams says without the extra power the two are claiming, the temperature rise would be only 1 or 2° less - well within the margin of error for the experiment. 'It is very sensitive to experimental error,' he says."

In an article on the Pons and Fleischmann paper in Science, Amato quoted McKubre of SRI, who stated that in the 25 day experiment, the excess power amounted to 6%; in his own experiments, McKubre stated that he has shown a 3% excess.[12] The article also quoted

Nate Lewis of the California Institute of Technology, who said that he found "nothing in it that make me change my views. They never say how reproducible (the claimed phenomenon) is; they lack controls; it's the same old stuff." Dagani wrote an article on the Pons and Fleischmann paper in Chemical and Engineering News, titled, "Latest Cold Fusion Results Fail to Win Over Skeptics".[13] In this article, the following summary is given, "The basic position of the skeptics is that when these electrolytic experiments are performed properly, careful, and with stringent controls, no 'anomalous heat effect' is observed. Most of these experiments haven't been reported, they say, because the experimenters found nothing unusual. Cold fusion proponents, on the other hand, argue that so many groups around the world have reported similar, positive results using different approaches and different types of apparatus that it's unlikely they're all making mistakes."

Wilson, J. Bray, P. Kosky, H. Vakil, and F. Will of General Electric have disputed the early claims of Pons and Fleischmann of excess heat in a 1992 publication.[14] In this publication, it is stated that, "...we present a detailed analysis of calorimetry with heavy-water electrolytic cells, especially of the type described by Pons, Fleischmann and co-workers.... We also summarize our own experiments, which involve calorimetry of electrolytic cells of various designs. None of our experiments has yielded any excess heat or radiation products within the detection limits. We evaluate the data and methods of Pons Fleischmann and co-workers and where sufficient data are available, conclude that they overestimate significantly the excess heat. This is in part because in their calibration they did not include calculation of the change in input electrochemical power to the cell resulting from the calibration heater power. An additional significant overestimate of excess energy occurs when the calibration is made at cell temperatures above 60°C owing to the increased evaporation of heavy water during the calibration." They stated that, "While our analysis shows their claims of continuous excess heat generation to be overstated significantly, we cannot prove that no excess heat has been generated in any experiments." Following the work described in this publication, General Electric dropped research on cold fusion; before doing the research, General Electric paid the University of Utah for information on cold fusion.

Pons and Fleischmann strongly replied to the paper by Wilson and co-workers with a critical paper.[15] They state that the paper is "...a series of misconceptions and misrepresentations..." They stated that, "It is shown that the conclusions reached by the authors lead to gross errors in the prediction of the observed responses of the electrochemical calorimeters described in the original work and that the correct methods of analyses are indeed those we originally described as well as those which have been outlined in subsequent publications. We find that the authors have not validated their own methods and have not provided sufficient information to allow assessment of their work."

In his presentation at ICCF-4, McKubre of SRI reported only a small amount of excess heat, presented no fusion product data and stated that he had not confirmed a nuclear process.[16] The experiment in which a worker was killed in McKubre's laboratory has been evaluated by a team from Lawrence Livermore National Laboratory.[17]

Lee Hansen and co-workers at Brigham Young University are submitting a paper to a refereed journal, Analytical Chemistry, entitled "Recombination of H₂ and O₂ during Electrolysis of Water Can Account for Reported Excess Heat".[18] This BYU team used experimental apparatus similar to Pons and Fleischmann and showed that in the electrolysis of light water, large amounts of excess heat, as reported by those claiming cold fusion, can be accounted for by H₂-O₂ recombination.

In a paper published in 1993, R. Keesing and A. Gadd reported that a combination of the Peltier effect and electromigration may be the main contributors to the "anomalous heat effects" seen in cold fusion experiments.[19]

In another publication, M.Miles, R.Hollins, B. Bush, J. Lagowski, and R. Miles claim excess heat in cold fusion electrolysis experiments.[20] They also claimed to detect the fusion product helium-4, although only in amounts approximately equivalent to the excess heat produced.

There were reports that cold fusion could be initiated by pressurized deuterium gas as well as electrolyzing light water, including electrolysis with nickel electrodes.[21] The cold fusion community continues to be sharply divided as to whether or not cold fusion can be achieved with light water. Most of the advocates who report cold fusion with heavy water discount cold fusion with light water. From early in the history of cold fusion, proponents claimed that one of the proofs of cold fusion was that a null result was obtained with light water.

A number of critics of those who report excess heat in cold fusion electrolyses argue that the researchers do not provide information on excess heat as measured by the total integrated power, rather than in bursts. When the total integrated input is compared to output, the "excess" enthalpy is small and is subject to large errors. One lucid statement on this problem in a 1994 paper [22] by V. Chechin, V. Tsarev, M.Rabinowitz, and Y. Kim, is, "Of all the different kinds of measurements that have been made, one might expect the calorimetric measurements to be the most direct and clear-cut, but this is not the case. The possibility of a small systematic error integrated over a long period of time has not been conclusively eliminated. Transient or steady-state hot spots due to inhomogeneities rather than CF may give rise to erroneous temperature readings. Because of very long charging time in electrolytic CF, it is difficult to prove excess heat generation. A legitimate question may always be raised if the process may be like trickle-charging a battery which after a long period can deliver a lot of power for a short time. If one does not keep track, with high accuracy, of the very small energy input during the long charging period, a high-energy burst may not really exceed the input".

B. Fusion Products

The known fusion reactions of hydrogen isotopes are shown in the Table 1.[23]

From the day that Pons and Fleischmann made their announcement in March, 1989, the lack

TABLE 1. Known fusion reactions of hydrogen isotopes.

The approximate branching ratios for the D+D reaction at low energies are included.

Reaction	Energy Release (MeV)	Reactions sec ⁻¹ per 1 Watt Output	Branching ratio
(1a) D + D → ³ He + n	3.27	1.91 × 10 ¹²	-0.5
(1b) D + D → T + p	4.03	1.55 × 10 ¹²	-0.5
(1c) D + D → ⁴ He + gamma	23.85	2.61 × 10 ¹¹	-10 ⁻⁷
(2) p + D → ³ He + gamma	5.49	1.14 × 10 ¹²	
(3) p + T → ⁴ He + gamma	19.81	3.15 × 10 ¹¹	
(4) D + T → ⁴ He + n	17.59	3.55 × 10 ¹¹	

The numbers in the third column are the reactions per second per watt of output power for each of the reactions considered individually. For example, the D+D reaction branch (1c) requires 2.61 × 10¹¹ reaction events of this type per second to generate 1 watt of power. Based on the branching ratios in the last column of Table 1, 1 watt of power from the D+D reaction produces 8.55 × 10¹¹ neutrons (and helium-3 atoms) per second, 8.55 × 10¹¹ protons (and tritium atoms) per second and approximately 1.7 × 10⁵ atoms of helium-4 (and 23.8-MeV gammas) per second. As evident from these numbers, 1 watt of excess heat (or, more precisely, excess power) from D+D fusion produces copious amounts of fusion products.

of an equivalent amount of fusion products has been a major problem for those claiming to obtain cold fusion in Pd-D₂O systems. The fusion of deuterium produces neutrons, protons, tritium, the helium isotopes of mass three and four, and gamma rays. It has always been recognized that the large amount of excess heat reported would produce large quantities of nuclear "ash", which could be readily detected.

Detection of nuclear fusion products should be much easier to detect than the excess heat reported by cold fusion proponents. Nevertheless, despite much effort, persuasive evidence of commensurate amounts of fusion products have not been found. The fusion products that are reported are at near background levels. A paper by S. Jones contains a detailed graphical summary of the claims of the detection of such levels of fusion products.[24]

The major publication in this area, indeed in all of cold fusion, in the past year is the paper presented by S. Jones at ICCF-4.[25] In this paper, in which Jones reported on the use of a new segmented neutron detector, he retracted his claim of neutron bursts that he had previously reported in cold fusion experiments. Although the levels of neutrons reported by Jones were far less than should be produced for Pons-Fleischmann excess heat, his careful experiments in which he reported neutrons have always greatly encouraged cold fusion advocates. Jones concluded that when state-of-the-art neutron detectors are imposed, "no compelling evidence for neutron production from deuterided materials currently exists in any cold fusion experiment....". Both J. Huizenga and D. Morrison termed this report by Jones as the most significant paper at ICCF-4.[26, 27] Jones will repeat his retraction in a paper to be published.

Other claims of the detection of fusion products have been made in the past year, but the levels have been at very low levels. F. Will has reported detecting very low levels of tritium.[28] B. Liaw, P. Tao, and B. Liebert at the University of Hawaii also reported detecting small amounts of helium in molten salt electrolyses.[29]

The lack of fusion products remains a major problem for the proponents of cold fusion, as they themselves freely acknowledge.

C. Theory

From the very first days after the Pons-Fleischmann announcement of cold fusion, the subject attracted theorists. This was probably because, from the outset, fusion products were not detected and thus imaginative new theories seemed to be needed. An enormous number of theoretical papers have been published in an attempt to explain cold fusion in deuterated metal systems.

A very thorough and penetrating review of cold fusion theory was provided by Chechin, Tsarev, Rabinowitz, and Kim in 1994 entitled "Critical Review of Theoretical Models for Anomalous Effects in Deuterated Metals." [30] The authors succeeded in including all of the theories that have been reported. In this exhaustive work, the review is divided into six main

categories by which different models attempt to overcome the problem of achieving cold fusion. These six categories are : (1) Barrier Circumvention, (2) Barrier Reduction, (3) Barrier Ascent, (4) Narrow Nuclear Resonances, (5) Multibody Fusion, and (6) Exotic Chemistry. The authors place all of the many cold fusion theories into each category and then review and critique each one in detail.

The conclusions of this exhaustive work by Chechin et al are quoted below:

"We conclude that in spite of considerable efforts, no theoretical formulation of CF has succeeded in quantitatively or even qualitatively describing the reported experimental results. Those models claiming to have solved this enigma appear far from having accomplished this goal. Perhaps part of this problem is that not all of the experiments are equally valid, and we do not always know which is which. We think that as the experiments become more reliable, it will be possible to narrow down the contending theories and zero in on a proper theoretical framework, or dismiss CF. There is still a great deal of uncertainty regarding the properties and nature of CF."

"Of course, the hallmark of good theory is consistency with experiment. However, at present, because of the great uncertainty in the experimental results, we have been limited largely in investigating the consistency of the theories with the fundamental laws of nature and their internal self consistency. Unfortunately, a number of the theories do not even meet these basic criteria."

"Some of the models are based on such exotic assumptions that they are almost untestable, even though they may be self-consistent and not violate the known laws of physics. It is imperative that a theory be testable, if it is to be considered a physical theory."

This review concluded with the following statement:

"It is an understatement to say that the theoretical situation is turbid. We conclude that the mechanism for anomalous effects in deuterated models is still unknown. At present there is no consistent theory that explains or predicts CF and its specific features from first principles."

Fusion Technology has published a number of theory papers, including that of Hagelstein.[31]

IV. SUMMARY OF RECENT ACTIONS AND POSITIONS

A. Actions and Positions Taken by the Cold Fusion Community

The cold fusion community has been active, both in the media and in financial areas.

One recent thrust by the community was a cover article in the May/June, 1994 Technology Review, which is "edited by the Massachusetts Institute of Technology".[32] The article,

entitled, "Warming Up to Cold Fusion", was written by MIT alumni Edmund Storms, who is retired from Los Alamos National Laboratory and is a leading cold fusion advocate. Storms has reported excess heat in Pons-Fleischmann type experiments.[33] Storms reviewed various experiments and theories. He did not mention the very significant fact that Steven Jones has retracted his previous neutron detections nor did he cover the repeated failure of cold fusion experimentalists to detect fusion products. He attempted to deal with this problem by stating that, "Maybe our current understanding of the nucleus is wrong, or at least incomplete. An explanation of cold fusion might then invoke new nuclear particles or new types of nuclear interactions". He criticized the Department of Energy and other federal agencies for not funding cold fusion currently and pointed out that two organizations, EPRI and ENECO, both "imaginative" and "courageous" are supporting cold fusion. In the conclusion to his article Storms stated: "Superconducting effects were consistently observed in the lab for decades before physicists were able to explain it. So far, cold fusion falls short on both fronts: experimental evidence is difficult to replicate and a theoretical underpinning is absent". The August/September issue of Technology Review has been published and along with various letters to the editor the column "First Line" deals with the controversy in an article entitled "Don't Blame the Parent".[34] In this column the writer appears to attempt to distance MIT from the publication.

Edmund Storms has also written to various politicians regarding cold fusion. One such letter was to Senator Bob Smith (R., N.H.).[35] He was responding to a letter from Dr. Iran Thomas, Acting Associate Director for Basic Energy Sciences, Office of Energy Research, Department of Energy to Senator Smith regarding a request from a constituent for information on cold fusion.[36] In his letter to Senator Smith, Dr. Thomas gave the DOE position on cold fusion. Storms, in his letter to Senator Smith, disputed Thomas' statement that cold fusion has not been proven to be true. Storms stated that the fusion product tritium has been found, but did not state that the amount of tritium detected was a very small amount and far short of an amount equivalent to the excess heat measured. He mentioned the Japanese and EPRI financial support of cold fusion. He argued that the DOE should reexamine cold fusion. Storms included his May, June 1994 MIT Technology Review article.

Cold fusion is being funded by several organizations.

At ICCF-4, Dr. Matsui announced the creation by the Ministry of International Trade and Industry (MITI), of a new organization, New Hydrogen Energy (NHE), to investigate, confirm and demonstrate the excess heat phenomena. NHE will have a budget of about \$30 million for a 4 year period. In a March 9, 1994 news release it was stated that the work would be done at the "...Sapporo laboratory of the R&D Center for New Hydrogen Energy in northern Japan.[37] Five private Japanese companies, including Mitsubishi Heavy Industries, Ltd., Hitachi Ltd. and Toshiba Corp., have joined the experiments, which also will receive funding from a group of about 20 other companies." The former director-general of MITI's Agency of Natural Resources is quoted as saying, "As long as there is any possibility that unlimited energy will be produced, it is worth a try for resource-scarce Japan". The article further stated that "MITI plans to release the results of all the experiments and a committee chaired

by Hideo Ikegami, professor at the Education Ministry's National Institute for Fusion Science, is expected to assess the project. If his assessment, due around the spring of 1995, determines there is no prospect for success, the project will probably be discontinued". The news release concluded with the following statement, "Former President of the University of Tokyo Akito Arima, who vowed five years ago to quit physics 'if room-temperature nuclear fusion is real' says, 'the scientists who mistakenly announced that they had confirmed room-temperature fusion have yet to report the reason (for their mistake) properly, and a lack of repentance would be another mistake". MITI had previously been funding cold fusion research, including that of Pons and Fleischmann.

EPRI has funded cold fusion for several years. The exact level of this support is difficult to ascertain but it is believed to be several million dollars per year. The current EPRI situation at EPRI on cold fusion seems to be marked by internal disagreements. It is possible that this is related to the recent publications of M. Rabinowitz of EPRI, who is a coauthor of the major paper evaluating cold fusion theory, which also included the quote on the difficulty associated with measuring excess heat. Apparently, the support for McKubre at SRI has been terminated. EPRI has also terminated the work of the Jones group at Brigham Young University.

A new organization in Salt Lake City, called ENECO, Inc. has been formed to support cold fusion. This organization has signed an agreement with the University of Utah acquiring exclusive worldwide licensing rights to the university's cold fusion technology developed by Pons and Fleischmann. In a December, 1993 announcement, the ENECO president, Mr. Fred Jaeger stated that, "Cold fusion is our only business". [38] In this announcement, it is stated that ENECO has sponsored or is currently sponsoring cold fusion research at MIT, Texas A&M, Cal Poly (Pomona), the University of Hawaii, and two institutes in Russia. In the press release, it was stated that ENECO also supports R&D efforts of individual scientists and inventors". ENECO sponsored the attendance of 22 people, including 8 Russians, at ICCF-4.

Cold Fusion Research Advocates is an active group in lobbying for cold fusion. The offices are in Atlanta and the organization is directed by Jed Rothwell and Eugene Mallove.

A new magazine, "Cold Fusion", was started in May, 1994. It is sold at newsstands for \$5.95 and is edited by Eugene Mallove, a leading cold fusion advocate and is published in New Hampshire by Wayne Green (writer of the letter to Senator Smith referred to above).

The next conference, ICCF-5 is scheduled for March or April, 1995. It will be held in southern France, hosted by Pons and Fleischmann.

B. Actions and Positions Taken by Those Outside the Cold Fusion Community

S. Jones, who is no longer considered by the cold fusion community to be a part of the community, is active in attempting to promote cooperative experiments. He is attempting to persuade researchers who have positive results to perform cooperative experiments with the

Brigham Young group. For those who find excess heat, he is attempting to promote cooperative calorimetry experiments with Prof. Hanson of BYU. For those who detect neutrons, he is offering to do cooperative research with his neutron detection equipment.

Prof. John Huizenga, who chaired the ERAB panel and has written a book on cold fusion, continues to monitor cold fusion research. He has attended the ICCF meetings and reported on them. His conclusions can be distilled in one statement from his book: "To this date, not a single, well-controlled and reproducible experiment has been reported where corresponding amounts of excess heat and nuclear reaction products are reliably measured".[39] Huizenga reported on ICCF-4 in the latest edition of his book.[40] He reported that, "The scientific claims of ICCF-4 were repetitive of those at ICCF-3, however, often less spectacular and scaled back in magnitude". He stated that, "In the plenary session on calorimetry, the McKubre (SRI) and Kunitatsu (IMRA JAPAN) groups reported small amounts of excess heat. Although their experiments are often cited as the best evidence for cold fusion, neither group has seen any nuclear reaction products!" He concluded "After 56 months, there is still no persuasive evidence that the reported excess heat is due to a nuclear process. From the point of view of confirmation of cold fusion, the Fourth Conference was a colossal failure, as were previous conferences".

Another observer at ICCF-4, D. Morrison, reported that, "Perhaps the most outstanding feature compared with previous 'annual' conferences was the lack of enthusiasm for Cold Fusion. Even when Dr. Fleischmann spoke, he was not successful in rousing his audience as he had done at the first annual conference."[41] He also commented on the silences of those, such as Yamaguchi and Huggins, who had previously made significant claims.

An article by A. Wright was published in 1993 in Electronics World entitled "Clawing Back - Respectability for Cold Fusion?"[42] In this article, which attempts to be positive, the conclusion is made that "...the results are not repeatable on demand". The article also noted the lack of convincing evidence of fusion products. This article is mentioned because it is typical of a number of such writings - the author appears to want to be positive but sees the key issues of lack of repeatability and lack of fusion products. In this article, the author sums up the Harwell work on cold fusion: "Some of the most painstaking research was carried out at AEA Harwell under Professor Williams. In three months, of seven-days-a-week investigation at a cost of some 320,000 pounds, the Harwell team found that observations attributed to cold fusion could be artefacts arising from several possible errors. Among defects identified were inadequate controls; imprecise material characterisation; insufficiently thorough calorimeter calibration; problems in distinguishing neutron counts from the background; and well known spurious effects with $^{10}\text{BF}_3$ and ^3He proportional counters."

C. Actions and Position Taken by the Department of Energy

This agency has consistently reiterated its policy on cold fusion. This policy, which came from the ERAB panel's assessment, is that cold fusion proposals are considered for funding within existing budgets and are subjected to normal merit review procedures.[43] The agency

has received only one proposal on cold fusion in recent years; it was declined largely because of negative reviews. This proposal was not a cooperative effort as mentioned in the ERAB report; the ERAB report was calling for the teaming of those who found the effect with those who had not. Nor did the proposers offer an experimental program which would measure excess heat along with an equivalent amount of fusion products.

The DOE policy appears to be valid today for a number of reasons. Overall, claims for cold fusion have dwindled. Workers who previously reported positive results have become silent. S. Jones retracted his claim that he detected neutrons in cold fusion experiments. Advocates of cold fusion do not claim reproducible experiments with excess heat and an equivalent amount of fusion products. The Pons and Fleischmann paper on cold fusion in Physics Letters A was met with detailed scientific criticism and did not convince the scientific community that cold fusion was valid. The statement quoted earlier from the May/June, 1994 Technology Review by Edmund Storms, a leading cold fusion experimenter and advocate, on the lack of reproducibility and lack of a theory, is highly significant. General Electric challenged the validity of the Pons and Fleischmann excess heat claims in the publication of Wilson and co-workers. The scientific community is not calling for a change in this policy or for a new DOE ERAB-type panel review. DOE spokesmen have consistently made the cogent point that the claimed results are not complete - one group finds excess heat and another finds fusion products - at a level near background. The BYU group is submitting a paper to a refereed journal claiming evidence that the excess heat is due to hydrogen-oxygen recombination. There is not a demand for a DOE workshop on cold fusion; the cold fusion community has what amounts to a workshop at the ICCF meetings.

The publicity and lobbying efforts, as outlined above, are increasing. Activity by Cold Fusion Advocates is increasing and the magazine Cold Fusion can be expected to provide a vehicle for proponents. In the July/August edition of Cold Fusion, Eugene Mallove authored an article titled "What to do about Uncle Sam".[44] He wrote: "What to do about Uncle Sam? Would it be a good idea to try to entice him, or embarrass him into supporting cold fusion research more generally - much as many of us in cold fusion have tried to do over the last four years? Or should we just ignore the poor fellow and go on with our business?" Significantly, he goes on to state, "What is needed is not a torrent of money thrown at the problem, just the careful attention of interdisciplinary teams of scientists". This remarkable statement resembles the DOE position on funding cold fusion.

It is interesting that many of the U.S. cold fusion researchers are now being funded by ENECO. This may reduce the pressure on the DOE to provide support.

The DOE continues to monitor cold fusion research. Those in the DOE who do this will be watching closely for the results of the cold fusion review by NHE in early 1995. ICCF-5 will be held in the spring of 1995. Another interesting area will be to follow the situation at EPRI, ENECO and the attempts by the Jones BYU group to perform cooperative experiments. It is significant that although the ERAB report was supportive of cooperative experiments, there has been little such activity.

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