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Interim Report of the Cold Fusion Panel of the Energy Research Advisory Board

August 1989

A Report of the
Energy Research Advisory Board
to the
United States Department of Energy
Washington, DC 20585

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Energy Research Advisory Board
to the
United States Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585
(202) 586-5444

August 17, 1989

Admiral James D. Watkins
The Secretary of Energy
US Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Admiral Watkins:

It is my pleasure to send you the interim report of the Cold Fusion Panel of the Energy Research Advisory Board. The report has been approved by the full Board by letter ballot.

The Panel has worked diligently to respond to your charge and the members deserve a great deal of credit for the dedication and expertise they have brought to this assignment.

The Board concurs with the Panel's overall finding that cold fusion does not merit any special program or major expenditures at this time, although a modest level of funding would be appropriate to resolve outstanding issues as identified in the report.

The Panel consists of 22 distinguished scientists, including chemists, physicists and metallurgists. In reviewing the research on cold fusion, the members visited a number of laboratories involved in this effort, including the University of Utah, Brigham Young University, Texas A&M, Stanford, and the California Institute of Technology. The Panel has also been in contact with prominent independent scientists in the United States and abroad who are engaged in this or related research.

We hope this interim report will be useful to you. We plan to submit a final report in November.

Sincerely,

John Landis
Vice Chairman

Attachment

UNIVERSITY OF
ROCHESTER

COLLEGE OF ARTS AND SCIENCE
DEPARTMENT OF CHEMISTRY

John R. Huizenga
Tracy H. Harris Professor

July 20, 1989

Mr. John Schoettler
1580 Lincoln Street, Suite 1200
Denver, CO 80202

Dear John:

I am pleased to forward to you the Interim Report of the Cold Fusion Panel. This report reviews the current status of cold fusion and makes some preliminary conclusions and recommendations, as requested by the Secretary of Energy.

The Panel or subgroups thereof have participated in the Workshop on Cold Fusion in Sante Fe, have visited several laboratories, have studied the open literature and numerous privately distributed reports and have participated in many discussions. In addition, the Panel held three public meetings where its findings were discussed and drafts of the Interim Report were formulated.

I wish to thank the members of the Panel and its staff for their cooperation and their diligent work during these weeks. The Panel anticipates that their final report will be completed in November, 1989.

Sincerely,

John R. Huizenga
Co-Chairman,
Panel on Cold Fusion

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University of Rochester
Rochester, New York 14627
(716) 275-4217

INTERIM REPORT OF THE COLD FUSION PANEL OF

THE ENERGY RESEARCH ADVISORY BOARD

INTRODUCTION

As a result of the startling announcements in March 1989 by Utah scientists claiming the attainment of cold fusion, the Secretary of Energy requested (see Appendix A) that the Energy Research Advisory Board (ERAB) convene a panel (see Appendix B) to assess the possibility of cold fusion. The panel meetings and schedule of laboratory visits are summarized in Appendix C.

Since the above announcement, many laboratories worldwide have initiated research in cold fusion. In the United States, a major effort has been undertaken to search for cold fusion by a large number of research groups at industry, university, and national laboratories. Unfortunately, at the present time, the reports from different laboratories are quite divergent. Some laboratories claim excess power production attributed to cold fusion, usually for intermittent periods and for various periods of time, but with no supporting evidence for the production of commensurate quantities of fusion products. Other laboratories find no measurable excess power production and no measurable high levels of fusion products. Some laboratories attribute the discrepancies to inaccuracies in measurements, others to non-reproducibility of a new and not understood process. Tritium levels above normal have been reported in some cells following electrolysis, but not in others. Neutrons near background levels have been reported in some D_2O electrolysis and pressurized D_2 gas experiments, but at levels 10^{12} below the amounts required to explain the experiments claiming excess power.

Since early May 1989, the Panel or subgroups thereof have participated in the Workshop on Cold Fusion in Santa Fe, have visited the laboratories listed in Appendix C, have studied the open literature and numerous privately distributed reports, and have participated in many discussions. This report is not concerned with the well established process of muon catalysis, which has sometimes also been called cold fusion.

GENERAL CONCLUSIONS

Although the Panel's task is not yet completed, the Panel finds that the experiments reported to date do not present convincing evidence that useful sources of energy will result from the phenomena attributed to cold fusion. Indeed, evidence for the discovery of a new nuclear process termed cold fusion is not persuasive. Hence, no special programs to establish cold fusion research centers or special programs to support new efforts to find cold fusion are justified at the present time.

However, there remain unresolved issues and scientifically interesting questions stemming from reported cold fusion efforts. Some of these are relevant to the mission of DOE and should be handled by carefully focused and cooperative efforts within current programs by normal mechanisms for project selection.

The reports of excess heat and fusion products are assessed in separate sections. Preliminary recommendations are summarized in the final section.

CALORIMETRY AND EXCESS HEAT

The claim for electrochemically charged palladium cells as prospective energy sources rests on reports of "excess heat" (or, more precisely, excess power) that cannot be accounted for in the thermal balance normally applied to water electrolysis. Among the issues the Panel addressed in site visits were whether the power levels themselves are being accurately measured and whether the reactions being considered in these cells are, in fact, satisfying the chemical assumptions made. These heat measurements have been done with calorimetry that varied as to technique and to levels of precision and accuracy. In most cases, calorimetric effects attributable to excess heat are very small. The calorimetric measurements are difficult to make and are subject to subtle errors arising from various experimental problems.

For the purposes of this report, the calorimetry is usefully differentiated as to whether the D_2 and O_2 gases are allowed to exit the cell completely unreacted or are intentionally catalytically recombined to regenerate D_2O and to recover the corresponding heat. In the case of open cells, where the gases are assumed to be vented without reaction, any output power (as heat) greater than the electrical input power minus the power equivalent of the D_2O formation enthalpy [1.527 V(volts) x I (cell current)] is considered excess, a result reported by several groups. In closed cells with total recombination (and with a deuterium-charged Pd electrode), the total electrical power in and total heat power out would normally balance (as for Pt and Pd electrodes in light water). At present no experimenters who have performed calorimetry with closed cells under strict recombination conditions have reported any excess heat. Another important point is that most of the reported measurements with open cells are actually power measurements, and the data have not conclusively demonstrated that the total amount of energy produced (as heat and chemical energy) exceeds the total electrical energy input.

Since the claimed excess heats have, in most cases, been of a magnitude significantly less than the 1.527 V x I factor itself, issues of calibration, reliability, and support of the assumptions of zero recombination are especially critical. The Panel's site visits have identified experimental uncertainties, e.g., nonlinearities of the calibration in power output vs. temperature, time dependence of calibration, and doubtful accuracy of data acquisition relative to the magnitude of the effects asserted. Even in laboratories that

report excess heat, this effect, under apparently identical conditions, is not reproducible. In none of our visits to the different sites did we see an operating cell that was actually producing excess heat. So far, we have seen no experimental results that are sufficiently free of ambiguities and calibration problems to make us confident that the steady production of excess heat has been observed. However, there are reports of sporadic temperature "excursions" or "bursts" that apparently represent power outputs significantly larger than the input power. These events cannot be attributed to problems with accuracy or calibration alone and are presently not understood. In general, the calorimetry to date does not persuasively demonstrate the production of excess heat, but the bursts will require evaluation in the Panel's final report.

FUSION PRODUCTS

Since deuterium fusion necessarily yields fusion products (neutrons, protons, tritium, ^{3}He, ^{4}He, gamma rays), it is essential to establish the presence of such products in any claim of fusion. Each watt of power must be accompanied by about 10^{12} particles per second. This makes product detection by far the most sensitive method to search for fusion. Results to date on fusion products are summarized in the following paragraphs.

Neutrons are an established signature of the well studied d+d fusion reaction. Although many experimenters report no neutrons, some report as many as 0.1 neutron per second. If confirmed, this rate would be of scientific interest (even if not indicative of cold fusion). This rate is so far below the 10^{12} neutrons per second required for 1 watt of power generation that it is of no interest as a practical energy source.

Numerous experimenters have sought tritium production in electrochemical cells and have found no excess tritium. One group reports finding up to 10^{14} tritium atoms (neglecting losses to the gas phase) in each of several cells with Pd cathodes and Ni anodes. Some of the same experimenters report neutrons produced from similar electrochemical cells, but at a rate of only about 0.1 neutron per second. If the tritium were a result of deuterium fusion, the rate of neutron production should be comparable, and thus some 10^{11} times greater than reported.

Another important fusion signature is ^{3}He, which should be detectable within a cathode after operation at fusion power levels of watts. It has been postulated that the cold fusion reaction might conceivably proceed predominantly by the production of ^{4}He and thermal energy. None of the researchers to date, including those reporting the production of heat, have reported ^{3}He or ^{4}He above the detectable level of 10^9 atoms. One watt-hour of energy corresponds to more than 10^{15} He atoms.

Low level cold fusion in geologic processes has been proposed to cause high $^{3}He/^{4}He$ ratios and tritium abundances associated with volcanoes. Several laboratories are currently attempting to detect volcanic tritium.

INTERIM RECOMMENDATIONS

1. The Panel recommends that the cold fusion research efforts in the area of heat production focus primarily on confirming or disproving reports of excess heat. Emphasis should be placed on calorimetry with closed systems and total gas recombination, use of alternative calorimetric methods, use of reasonably well characterized materials, exchange of "promising" electrodes between groups, and careful estimation of systematic and random errors. Cooperative experiments are encouraged to resolve some of the claims and counterclaims in calorimetry. Such experiments should be pursued at a limited number of laboratories and supported at a modest level on the basis of competitive proposals. At the present time, the panel recommends against any significant expenditures to establish cold fusion research centers or to support new efforts to find cold fusion.

2. A shortcoming of most experiments reporting excess heat is that they are not accompanied in the same cell by simultaneous monitoring for the equivalent production of fusion products. If the excess heat is to be attributed to fusion, such a claim should be supported by measurements of fusion products at commensurate levels.

3. Experiments designed to check the reported production of excess tritium in electrolytic cells are desirable.

4. Experiments reporting fusion products (e.g., neutrons) at a very low level, if confirmed, are of scientific interest but have no apparent current application to the production of useful energy. Continued support of such experiments at modest levels is justified, provided the proposals for such research are evaluated in comparison with other DOE research proposals. In view of the difficulty of these experiments, collaborative efforts are encouraged to maximize the detection efficiencies and to minimize the background.

The Secretary of Energy
Washington, DC 20585

April 24, 1989

Mr. John H. Schoettler
Chairman
Energy Research Advisory Board
US Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Mr. Schoettler:

In recent weeks, there has been a great deal of interest in the prospects for "cold fusion", based on experiments at universities in Utah and subsequent experiments performed elsewhere. At present, the apparent observations of cold fusion and significant quantities of energy from this phenomena are being investigated extensively. Because of the potential benefits from practical fusion energy, I request that the Energy Research Advisory Board (ERAB) assess this new area of research. Specifically, I would like the Board to:

1. Review the experiments and theory of the recent work on cold fusion.

2. Identify research that should be undertaken to determine, if possible, what physical, chemical, or other processes may be involved.

3. Finally, identify what R&D direction the DOE should pursue to fully understand these phenomena and develop the information that could lead to their practical application.

I request that the Board provide an interim report on the first item by July 31 and a final report on all items by November 15, 1989.

Sincerely,

James D. Watkins
Admiral, U.S. Navy (Retired)

ENERGY RESEARCH ADVISORY BOARD
COLD FUSION PANEL

6/02/89

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PANEL MEETINGS AND SCHEDULE OF LABORATORY VISITS

PANEL MEETINGS

Washington, DC	June 22, 1989
Washington, DC	July 11-12, 1989

SCHEDULE OF LABORATORY VISITS

University of Utah	June 2, 1989
Brigham Young University	June 13, 1989
Texas A&M University	June 19, 1989
California Institute of Technology	June 20, 1989
Stanford University	July 6, 1989
SRI International	July 6, 1989

OTHER

Workshop on Cold Fusion, Santa Fe, NM	May 23-25, 1989