To: **Charles O. Rutledge, Ph.D.**
Vice President for Research

From: **Examination Committee**
R. Byron Pipes, Ph.D. Chair
W. Dale Compton, Ph.D.
R. Reifenberger, Ph.D.

Re: **Sonofusion Research**

Date: **June 5, 2006**

Examination Committee Report

Examination Committee Charge

The Examination Committee was charged to "(i) discover and examine facts and circumstances surrounding concerns described in recent articles on sonofusion research at Purdue University that have appeared in Nature (March 8, 2006) and elsewhere, by reference to published articles, conducting interviews with relevant individuals, and review of materials that may become available; (ii) from your understanding of the facts, to define questions (issues) that must be addressed to resolve these questions (issues); and (iii) to recommend approaches to resolve the questions."

The committee met on campus during April 17, April 26, April 28, May 4, May 17, May 25, May 30, May 31, June 2 and June 5, 2006. The following individuals were interviewed: May 17: Professor Lefteri Tsoukalas and June 2: Professor R. P. Taleyarkhan. The Examination Committee acknowledges the support provided by Peter Dunn, in the Office of the Vice President for Research.

Background

The research efforts in bubble fusion by Taleyarkhan et al [1-4] have been both pioneering and strategic and his work has received extraordinary attention in the scientific and public presses. While seminal advances cannot be assured, a convincing demonstration of sonofusion and its promise for the benefit to society is a truly worthwhile endeavor for a major research university.

However, reports available to the Examination Committee by investigators without an association with Professor Taleyarkhan appear to have failed to reproduce the data reported in the original claim for nuclear emissions during acoustic cavitation.[5] It is also noteworthy that there are few if any published positive results in this field that were not directly or indirectly influenced by Professor Taleyarkhan. Based on the published record, sonofusion experiments, like other new areas of discovery, seem difficult to control and significant advances will likely occur only when the conditions under which they are conducted can be carefully specified and verified. It is possible that once these requirements have been met by multiple independent scholars, sonofusion may be proven a reality and its benefit to society exploited. However, there is considerable debate in the scientific community as to the reproducibility of the sonofusion published results and therefore, the existence of sonofusion.

Examination Committee Findings

After study of the issues under consideration, the Examination Committee has found the discussions to be both complex, convoluted and apparently contradictory so that the determination of probable cause for investigation of academic misconduct by Purdue personnel requires more in depth study by consideration of specific questions. Further, the Examination Committee believes that it is in the interest of the Purdue community to further investigate the details of the disputes and behavior of all those involved. We recommend that several important questions, that remain unanswered, be considered.

Question I: Are the data presented in the papers in References [6-10] supported by laboratory records and appropriate experimental methods?

The rationale for Question I is that a number of scientists/engineers have stated in the literature or been quoted publicly that they have been unable to duplicate the test results wherein Professor Taleyarkhan *et al* claim detection of nuclear emissions during acoustic cavitation. There would appear to be four possible explanations for this discrepancy between the work by Taleyarkhan *et al* and that of other investigators. In the first, the early published data are valid, but their duplication is extremely difficult to achieve. Second, the data are valid, but have been improperly interpreted. Third, the data are invalid because of experimental difficulty of observing small differences in experimental results with the necessary sensitivity. Finally, the data are invalid because of practices that seriously deviate from those that are commonly accepted within the scientific community, by one or more of the authors.

One way to eliminate the latter possibility of academic misconduct would be a careful and independent examination of the original laboratory records and experimental methods that were the basis for the five referenced papers.[6-10] Several questions should be examined in the study of the actual laboratory results: Do the published data accurately reproduce the raw data contained in the laboratory records? Were valid statistical analyses performed? Was the background radiation properly measured and analyzed? Was an appropriate level of reproducibility of the experimental results demonstrated?

Question II: Were attempts made to restrict the publication of information critical of the successful realization of sonofusion?

Why was the presentation and publication of a paper by Professor Tsoukalas *et al*, reported to contain negative test results for sonofusion,[10], apparently withdrawn from NURETH-11 in early 2005? What role, if any, did Associate Dean Gore play in this action?[11] Interviews with Professors Tsoukalas, Taleyarkhan and Gore may be needed to clarify the exchanges between the three that may have led to the withdrawal of the manuscript.

Question III: Did certain members of Nuclear Engineering faculty engage in non-professional actions?

There are many apparent irregularities that have surfaced in the Committee's examination and they must be resolved:

- Did any faculty provide misleading information to the public press outside the University Office of University Relations regarding disputes on the subject of sonofusion?
- As discussed in Question II, efforts to prevent the publication of negative results of fellow Purdue faculty members by Professor Taleyarkhan have been claimed. [12]
- In the interest of fairness, why did the initial committee, formed by Head Tsoukalas to investigate the circumstances surrounding the publication of references [6] and [7] in January 2005, write a report critical of Professor Taleyarkhan without interviewing him?
- In reference [8], it is clearly stated that independent confirmation of sonofusion had been achieved. Is this claim misleading? A clear definition of independent confirmation is needed. For example, there may be more than one path to independent confirmation: the independence of the investigators or different approaches that lead to the same conclusions. Taleyarkhan appears to claim the former.
- Are the authorships of references [6] and [7] misleading, not properly reflecting the extent of participation of Professor Taleyarkhan? Why would Professor Taleyarkhan assume responsibility for naming A. Butt as an author of reference [6] (as reported by A. Butt)[13] if the work was truly independent of Professor Taleyarkhan?

Concluding Remarks:

While the Examination Committee has not found proof of academic misconduct on the part of the faculty involved, it recommends further study of the above three questions with the goal of resolving this controversy, assigning appropriate responsibility and developing improved procedures.

In order to remove any doubt about the nature of the experiments described in the publications, a committee or committees, following published Purdue University guidelines, should investigate the above stated questions by conducting interviews with the principals involved to better establish what procedures and processes were actually followed. With further interviews and a detailed examination of data notebooks, the potential for development of credible answers to the above questions will be greatly enhanced. During the course of these further investigations, additional relevant issues

may surface and the committee or committees should have the freedom to pursue these issues as well.

Professor Taleyarkhan's claim of the discovery of sonofusion requires further proof when viewed under the premise that "extraordinary claims require extraordinary proof." The details of the experiments must be sufficient to eliminate doubt in interpretation of the findings by independent scholars. However, the present situation is far from the realization of this goal.

Purdue should seek to take advantage of its investment in sonofusion and the global attention to further establish its leadership in the fields of engineering and science. Among many possible actions would be to invite the scientific community to join Purdue in a conference to establish the standards of evidence for sonofusion and that this knowledge be widely shared with the global scientific community.

Submitted on June 5, 2006 by

R. Byron Pipes, Examination Committee Chair

W. Dale Compton, Examination Committee Member

R. Reifenberger

R. Reifenberger, Examination Committee Member

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10. L. Tsoukalas, F. Clikeman, M. Bertodano, T. Jevremovic, J. Wlater, A. Bougaev, and E. Merritt, "Tritium Measurements in Neutron Induced Cavitation of Deuterated Acetone, submitted to Nuc. Techn. (in press).

11. Email from L. Tsoukalas to J.P. Gore dated November 18, 2005; Subject: Stanford GCEP Meeting.

12. see for example, "Is bubble fusion simply hot air" by E.S. Reich published online at www.nature.com/news/2006/060306/pf/060306-2_pf.html on March 8, 2006.

13. Report to Prof. L.H. Tsoukalas from the Nuclear Engineering Fact-finding Committee dated February 23, 2006.