H. Comment on ^{252}Cf issues

(EVALUATION DOES NOT BELONG IN THE CHARGE OF THE 2008 INVESTIGATION COMMITTEE REPORT IN THE ALTERNATIVE, CLARIFICATIONS ARE PROVIDED FOR THE RECORD)

Although the Inquiry Committee received allegations of intentional data fabrication through the use of ^{252}Cf, those allegations were not forwarded to our committee. Nonetheless, given the published debate instigated by Dr. Brian Naranjo on this issue, we wish to preserve some observations here.

Dr. Taleyarkhan's prior work at Oak Ridge is beyond the C-22 jurisdiction.

There is no report that a ^{252}Cf source was present during the PRL**96** experiment. Dr. Xu's NED paper does expressly acknowledge that "… the 1 Ci Pu-Be isotope neutron source could not be relocated. Instead, a 0.5 mCi Cf-252 isotope neutron source was available for use" to seed bubble growth for the neutron-emission measurement part of the experiment. Available information indicates that Dr. Xu is the only person who carried out that experiment. As a result, any improper use of a ^{252}Cf source would be his responsibility.

Of course Dr. Xu does not attribute the sonofusion signal reported in the NED paper to any improper use of ^{252}Cf. Dr. Naranjo, who has published a model simulating ^{252}Cf as a generator of reported sonofusion signals, was asked by the Inquiry Committee if his simulation would preclude the truthfulness of an eyewitness affirmation regarding the lack of data fabrication via ^{252}Cf. Dr. Naranjo would not claim that his simulation had such power. The potential proof value of Dr. Naranjo's analysis would be as corroboration of the credibility of an eyewitness to data fabrication via ^{252}Cf. The record is devoid of an eyewitness to such data fabrication.

As part of our effort to familiarize ourselves with the research papers before us, we chose to delve further into the neutron spectrum in measurements reported by Dr. Taleyarkhan and/or Dr. Xu. In particular, there is still the issue of the "ice pack" between the cavitation chamber and the liquid-scintillator (LS) detector in the PRL 96 paper. This is the explanation cited for the "anomalous" shape of the neutron spectrum in ~~all~~ some of these measurements of neutron spectra from the LS detector as shown in Fig. 4 (Exh.H.1) of the PRL 96 paper by Taleyarkhan et al. and in Fig.5 (Exh.H-2) of the 2005 NED paper by Xu et al. but NOT for the original discovery work published in Fig. 8 (Exh. H-3) of the 2004 PRE paper by Taleyarkhan et al. where a distinct hump occurs at the 2.45 MeV Proton-Recoil-Edge as would be anticipated for a situation where there were no ice-packs in between the detector and the test cell. Also, the confirmatory work published by Prof. Forringer et al. shows a neutron spectrum shape as that would be anticipated for a case where ice-packs were not present -as shown in the group's Fig. 2 (Exh. H-4) of their manuscript published in the archives of the Proceedings of the Winter Annual American Nuclear Society Conference, Albuquerque,NM, Nov. 2006. Therefore, the results are indeed self-consistent and there is no outstanding "issue." Where there was no ice-pack, the spectrum shape was as would be expected; where there was indeed several cm of intervening ice the spectrum shape became skewed towards the lower energy channels.

The 4.18.08 Inv.C Report members have mistakenly cited that this very important detail involving intervening ice-packing is never indicated on any of the schematic diagrams of these experiments by Dr. Taleyarkhan and/or Dr. Xu, which always appear to show an uninterrupted path between the chamber and the LS detector. but this is NOT SO when one examines the situation more closely. There are several instances where this fact has been directly identified and Dr. Taleyarkhan and colleagues have privately shared this information even with detractors and competitors such as Dr. Putterman et al. of UCLA. Specifically, the presence of ice-pack surrounding the test cell enclosure has been shown in Fig.11 (Exh.H-5) of Dr. Taleyarkhan's paper published in the Journal of Power and Engineering, as also depicted in Ref.32 of 2002 Science paper (Exh. H-6); as Figure 2 (Exh.H-7) in the 2004 PRE paper 2004. Furthermore, the effect of the intervening ice-packs has been mentioned in these papers as reducing the down-scattered neutrons in terms of efficiency as recently again in the 2006 PRL Response paper to Lipson. With regard to the Dr. Xu et al. confirmatory study, the presence of intervening ice should be apparent to anyone who has utilized ice-box freezers as can be directly seen in Fig. 1 (Exh. H-8) of the Dr. Xu et al. 2005 NED paper.

The 4.18.08 Inv.C Report states "Furthermore, the effect of this ice pack on the expected neutron detection energy and efficiency was not discussed in any of the papers" This is INCORRECT – See 2006 PRL Response of Taleyarkhan et al, to Lipson; Science Ref. 32, and the draft of the 2008 manuscript prepared and submitted to PRL for consideration for reviews and publication. It is to be stated categorically that the key results of this new Monte-Carlo based study has already been provided to the 2007 Inq.C which considered this work to be a credible response (see page 32, para.4 of the August 27, 2007 C-22 Inq.C Report to ONR).

The 3.17.08 draft Inv.C report states "In his testimony to us, Dr. Xu seemed to indicate that the LS detector had an unobstructed view of the cavitation chamber despite the fact that his neutron spectrum looks very much like that obtained in the other experiments where an ice pack or other intervening material was supposedly present. Perhaps this was due to the fact that he either did not understand the question or we did not understand his answer. Correct. This is indeed a vivid example of the communication problems one faces when talking with Dr. Xu; an issue which also was faced in 2005 by Mr. E. Venere (Purdue's Press writer) who then had to personally request Dr. Taleyarkhan's assistance to help. As has been noted earlier, Fig. 1 (Exh. H-8) of the Dr. Xu et al. NED paper indeed shows an ice-box enclosure between the test cell and the LS detector. In his verbal testimony Dr. Xu made it clear that despite the fact that he did not "need" to put in any ice-packing, the ice box system itself inside incorporated about ~3 to 5 cm of ice buildup as that happens in most common store-bought freezers.

Also, Dr. Taleyarkhan claimed in his testimony that the ice packs were indicated on the figures in his papers. This is not the case (incorrect – See Exhibits H-5 to H-7). The 2007 Inq.C report itself admitted that Dr. Taleyarkhan's team knew of this effect. Exhibit H-9 is reproduced from the Taleyarkhan et al. newly prepared (yet undergoing revisions per comments) manuscript detailing the specific experimental modeling and simulations, respectively. Ice packs were shown, but there was no clear indication of any ice or other obstructions between the LS detector and the chamber.

The 4.18.08 Inv.C Report states "As Dr. Naranjo has shown in his Monte-Carlo simulations, the presence of ice packs surrounding the chamber will not result in a spectrum like that displayed in Dr. Taleyarkhan's papers unless the ice is directly between the chamber and the detector." This is incorrect. Dr. Naranjo's simulations do NOT include any case that includes ice-packs between the detector and test cell; this is despite telling his supervisor Dr. Putterman on 3.1.2006 to include the same. The clarification of the effect of intervening ice-packs was actually provided by the extensive efforts (conducted at Purdue in consort with Profs. Block, Lahey and Nigmatulin, once again, without DARPA or any other external sponsor support but with our own scientific freedom of choice to engage in this effort). The key results of the effort for the clearly-identified geometry for the PRL 96 study (Exh.H-9) are reproduced in Exh. H-10 which now reveal what happens to 2.45 MeV neutrons with and without intervening ice-shielding. The predictions from the Purdue-RPI effort shed crucial light into the enormously wasteful controversy generated from the deliberately and improperly modeled (despite giving caution to include icepacks) computational studies of UCLA (via. B. Naranjo and S. Putterman).

The 4.18.08 Inv.C report improperly states "Dr. Taleyarkhan was most probably unaware of the effect of the ice packs on his experiment until this was brought to his attention by Dr. Naranjo's simulations." This is incorrect as has already been pointed out independently by other referees in the Aug.27, 2007 Inq.C Report to ONR (page 32, para. 4)– the relative effect of downscattering of neutron energy was already estimated experimentally and accounted for in the 2002 Science paper itself which was also modeled using the well-known MCNP code to estimate the extent of downscattering of 2.45 MeV neutrons (but this was not deemed important at the time to delve into since in the 2002-2004 Taleyarkhan et al, studies of Science and PRE the group's own LS detector was directly in front of the test cell without intervening ice-packs). Fig. 8 of the group's PRE paper is clear testimony to this fact that the as-expected spectral shape could be obtained. When the Fig. 4 results for our PRL 96 (2006) paper were realized the group knew why.

Finally, the 3.17.08 draft Inv.C report states "Dr. Block's testimony to us made clear that the PRL**96** authors were not concerned with understanding the response of the neutron detectors and relied entirely on the differences between the spectra taken with deuterated and non-deuterated liquids. This ~~is evidence of poor scholarship, but~~ not fraud. Unfortunately, it also left them open to the charges of fraud that were ultimately made." The charges of fraud emanated from Dr. Naranjo's ill-conceived computations "despite" being admonished to include intervening ice-packs. Despite this admonishment provided on 3.1.06 itself to Dr. Putterman, Dr. Naranjo only included shielding on the sides of the test cell but left the path between the test cell and the LS detector open. The UCLA conclusions were drawn and published in Nature right thereafter on 3.8.06, a bygone decision of the competitor group to cast their charges. Dr. Block's statement is accurate in that, while the group understood that downscattering would result in a smeared spectrum the PRL 96 paper was the report of an experimental study in which 5 independent detector types were used to affirm production of 2.45 MeV neutrons from self-nucleated acoustic cavitation. The results came out with over 20 SD statistical significance including high (8+ SD) significance from use of passive neutron track detectors. Upon faced with direct questions on spectral shapes for the first time, the group embarked on several month-long activity (personal time funded largely) to develop and exercise a comprehensive Monte-Carlo based 3-D simulation of the entire experiment including the response of the LS detector with and without ice-packs. How can this be cast as lacking in scholarship? Dr. Block was merely echoing the sentiment that at the time of the PRL 96 paper the group was focused on the experimental aspects and challenges, not that the details of spectral shapes did not matter.

Additional Exhibits for Section H	
Exhibit Number	Description / Source
H.1	Fig. 4 of PRL 96 paper (LS neutron spectrum from self-nucleated acoustic cavitation) by Taleyarkhan et al. (2006)
H.2	Fig. 5 of 2005 NED paper by Xu et al. (2005)
H.3	Fig. 8 of PRE paper by Taleyarkhan et al. (2004)
H.4	Figs. 1 and 2 from Forringer et al. (2006)
H.5	Fig. 11 of Nigmatulin et al. (2004).
H.6	Ref. 32 of Science paper Taleyarkhan et al. (2002)
H.7	Fig. 2 of PRE paper by Taleyarkhan et al. (2004)
H.8	Fig. 1 of 2005 NED paper by Xu et al. (2005)
H.9	Fig. 1 of the new paper of the Taleyarkhan et al. group on modeling and simulation of self-nucleated experiments for their neutron spectra
H.10	Fig. 3 of the new paper of the Taleyarkhan et al. group on modeling and simulation of self-nucleated experiments for their neutron spectra with intervening ice-pack shielding

References cited for Section H – source for exhibits H-1 to H-8

E. Forringer et al., "Confirmation of Neutron Production During Self-Nucleated Acoustic Cavitation," Proc. American Nuclear Soc. Conference, pp. 736, 737, Albuquerque, NM, November, 2006.

Nigmatulin, R. I. , R. P. Taleyarkhan and R. T. Lahey,Jr.," The evidence for nuclear emissions during acoustic cavitation revisited," Int. J. Power Energy Syst. 218-A, 345 (2004).

Taleyarkhan, R.P., et al., PRL 97, 149402 (2006).

Taleyarkhan, R.P. C. D. West, R. T. Lahey,Jr., R. I. Nigmatulin, R. C. Block, and Y. Xu, Phys.Rev.Lett. 96, 034301 (Jan. 2006).

Taleyarkhan, R.P., J. S. Cho, C. D. West, R. T. Lahey,Jr., R. I. Nigmatulin and R. C. Block, "Additional evidence of nuclear emissions during acoustic cavitation," Physical Review E 69, 036109 (2004).

Taleyarkhan, R.P., J. S. Cho, C. D. West, R. T. Lahey,Jr., R. I. Nigmatulin and R. C. Block, "Evidence of nuclear emissions during acoustic cavitation," Science 295, 1868, March, 2002.

Taleyarkhan, R. P., J. Lapinskas, Y.Xu, J.S.Cho, R. C. Block, R. T. Lahey,Jr. and R. I. Nigmatulin, "Modeling and analysis of neutron emission spectra from self-nucleated acoustic cavitation experiments," Prepared for journal publication – In review.

Xu, Y. and A. Butt, "Confirmatory experiments for nuclear emissions during acoustic cavitation," Nuclear Engineering and Design, 235 (2005) 1317-1324.

EXHIBIT H.1 (fig. 4 from PRL 96 paper)

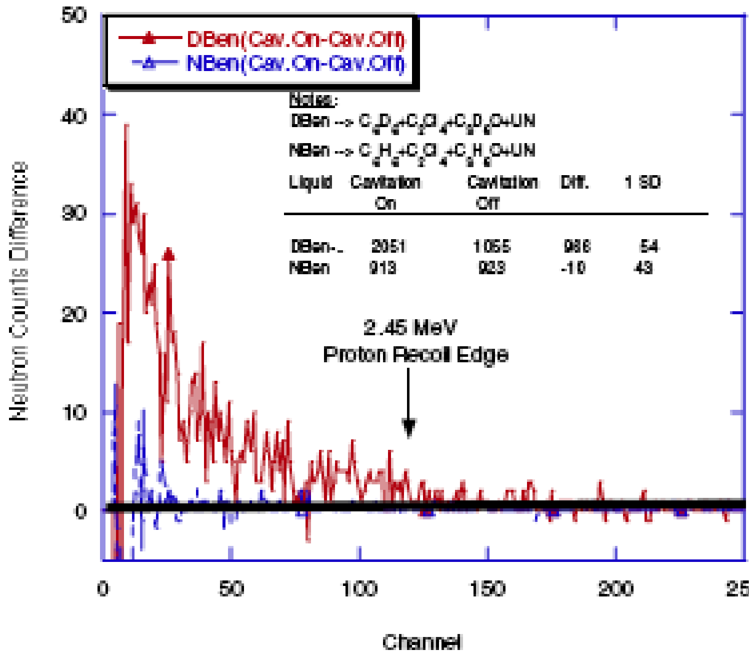

FIG. 4 (color online). Change in counts from pulse height spectra for C_6D_6-C_2Cl_4-C_3D_6O-UN and C_6H_6-C_2Cl_4-C_3H_6O-mixtures with self (alpha recoil nucleation) and LS detector (data taken over 300 seconds).

EXHIBIT H.2 (fig. 5 from 2005 NED paper)

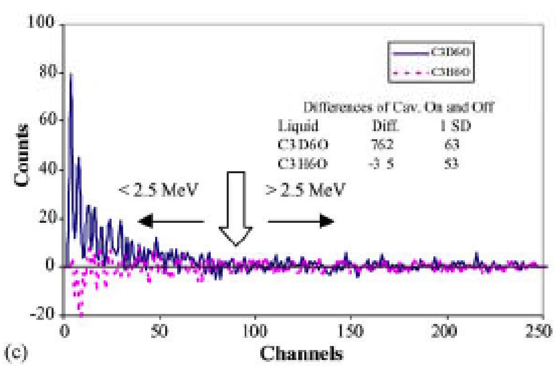

Fig. 5. (a) Representative neutron gated counts below and above 2.5 MeV proton recoil edge for tests with C_3D_6O at ~0 °C with and without cavitation; (b) representative neutron gated counts below and above 2.5 MeV proton recoil edge for tests with C_3H_6O at ~0 °C with and without cavitation; (c) representative neutron gated counts below and above 2.5 MeV proton recoil edge for tests with C_3D_6O and C_3H_6O at ~0 °C with and without cavitation.

EXHIBIT H.3(fig. 8 of 2004 PRE Paper by Taleyarkhan et al.)

Notes:

(1)In this configuration there were no ice packs between LS detector and Test Cell);

(2) The distinct (expected) bump around the 2.45 MeV edge is distinct for- Cavitation On)

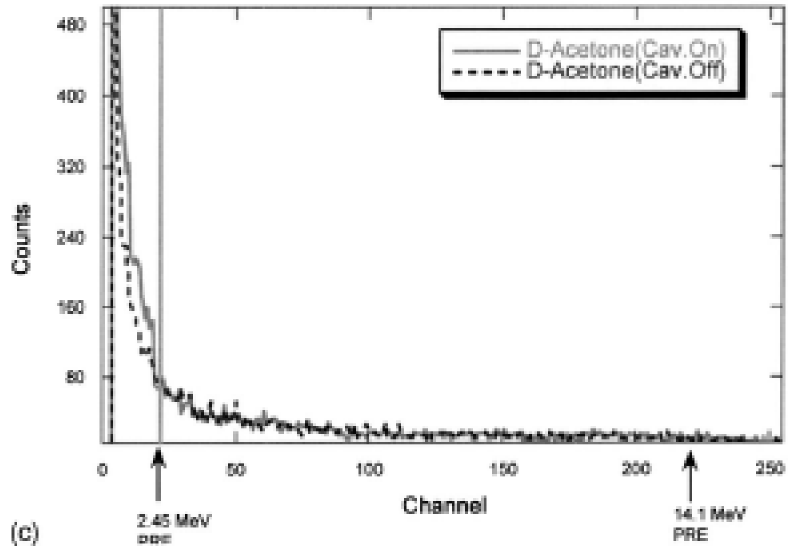

FIG. 8. (a) Changes in neutron counts below and above 2.5 MeV for tests with C_3D_6O and C_3H_6O at ~0 °C with and without cavitation. (PNG drive frequency=200 Hz. Acoustic drive frequencies=~19.3 kHz and =~20.3 kHz for C_3D_6O and C_3H_6O; error bars are 1 SD.) (b) Representative neutron gated counts below and above 2.5 MeV proton recoil edge (PRE) for tests with C_3H_6O at ~0 °C with and without cavitation. (PNG drive frequency =200 Hz. Acoustic drive frequencies=~20.3 kHz.) (c) Representative neutron gated counts below and above 2.5 MeV proton recoil edge (PRE) for tests with C_3D_6O at ~0 °C with and without cavitation. (PNG drive frequency=200 Hz. Acoustic drive frequencies =~19.3 kHz.)

EXHIBIT H.4 (Figs. 1 and 2 from 2006 Paper by Forringer et al.-No Ice Packs)

736 Reactor Physics Design, Validation, and Operating Experience

Confirmation of Neutron Production During Self-Nucleated Acoustic Cavitation

Edward R. Forringer, David Robbins, Jonathan Martin

LeTourneau University, 2100 S. Mobberly Ave., Longview, TX 75602. tedforringer@letu.edu

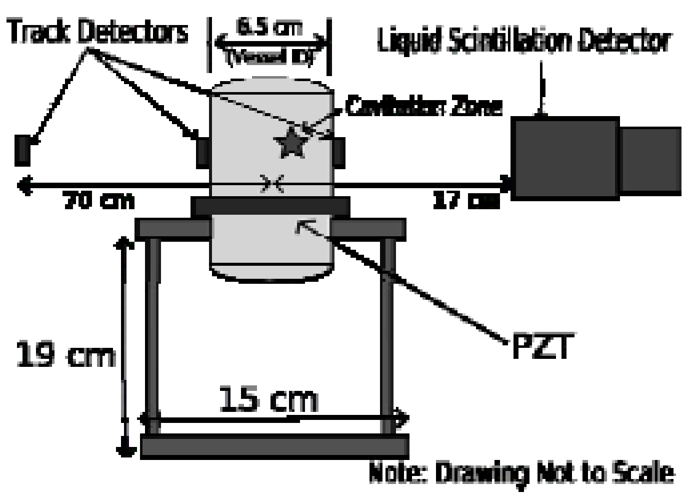

Fig. 1. Schematic representation of experimental setup

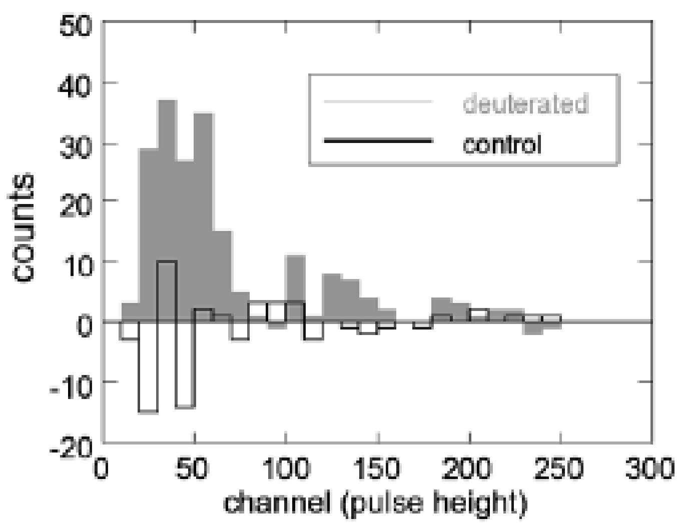

Fig. 2. LS detector pulse height spectrum for cavitation on minus cavitation off for deuterated and non-deuterated (control) liquids.

EXHIBIT H.5 & H.6 (Fig. 11 from 2004 J. Power and Energy paper by Nigmatulin et al.)
(The presence of ice-packs on enclosure walls is shown and come into importance for detectors located outside of the test enclosure)

SPECIAL ISSUE PAPER 345

Evidence for nuclear emissions during acoustic cavitation revisited

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[2]Department of Mechanical Engineering, Purdue University, West Lafayette, Indiana, USA
[3]Center for Multiphase Research, Rensselelaer Polytechnic Institute, Troy, New York, USA

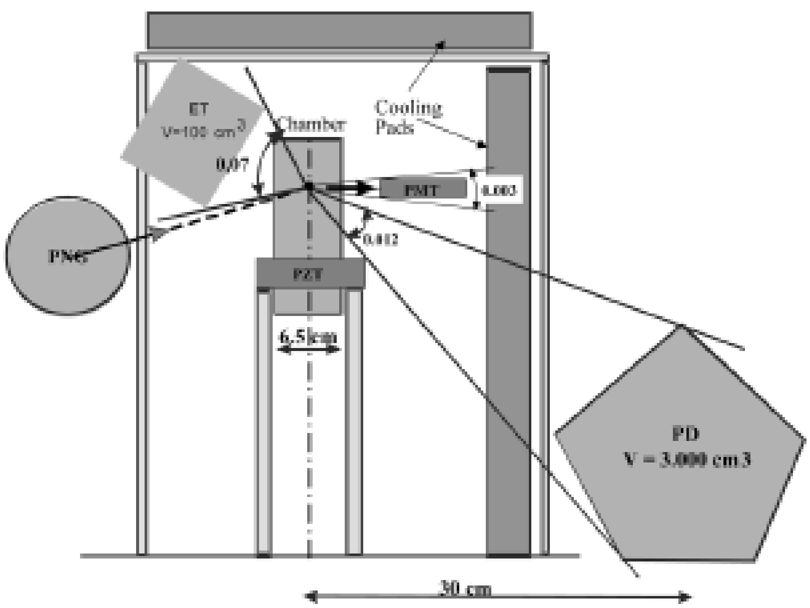

Fig. 11 Comparison of detection systems for D–D neutrons using ET [1] and PD detectors [36]

Proc. Instn Mech. Engrs Vol. 218 Part A: J. Power and Energy

EXHIBIT H.7 (Fig. 2 of 2004 PRE Paper by Taleyarkhan et. al)
(Ice-packs are clearly shown at wall locations of test cell enclosure)

PHYSICAL REVIEW E **69**, 036109 (2004)

Additional evidence of nuclear emissions during acoustic cavitation

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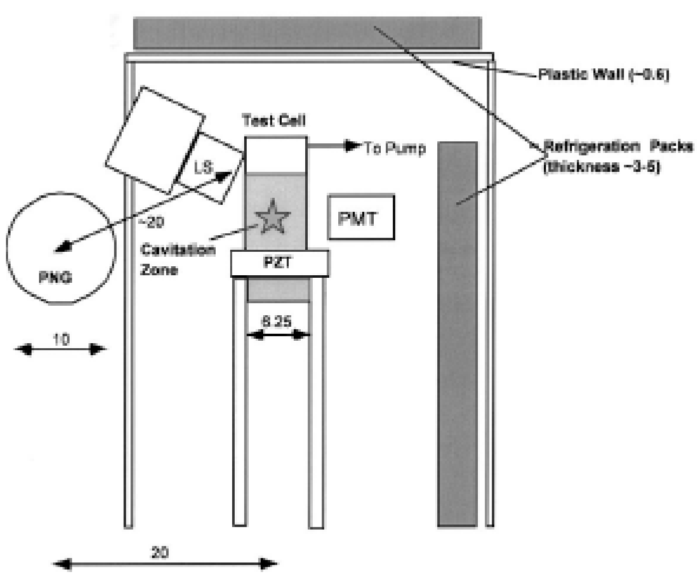
(Received 13 May 2003; published 22 March 2004)

Time spectra of neutron and sonoluminescence emissions were measured in cavitation experiments with chilled deuterated acetone. Statistically significant neutron and gamma ray emissions were measured with a calibrated liquid-scintillation detector, and sonoluminescence emissions were measured with a photomultiplier tube. The neutron and sonoluminescence emissions were found to be time correlated over the time of significant bubble cluster dynamics. The neutron emission energy was less than 2.5 MeV and the neutron emission rate was up to $\sim 4 \times 10^5$ n/s. Measurements of tritium production were also performed and these data implied a neutron emission rate due to D-D fusion which agreed with what was measured. In contrast, control experiments using normal acetone did not result in statistically significant tritium activity, or neutron or gamma ray emissions.

DOI: 10.1103/PhysRevE.69.036109 PACS number(s): 89.90.+n

ADDITIONAL EVIDENCE OF NUCLEAR EMISSIONS . . .



(a)

EXHIBIT H.8 (Fig. 1 of 2005 NED Paper by Dr. Xu et al.)

(The separation of 56.6cm between LS and Chamber includes per Y. Xu testimony of 1.30.08 the presence of the Ice-box wall and coating of about 3 to 5cm of ice; this should be obvious to most individuals familiar with conventional store ice-freezers)

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Nuclear Engineering and Design xxx (2005) xxx–xxx

Nuclear Engineering and Design

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Confirmatory experiments for nuclear emissions during acoustic cavitation

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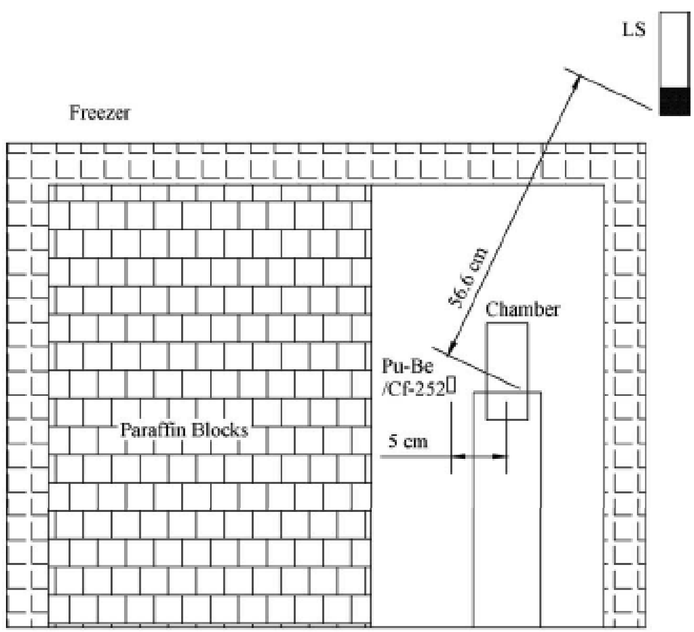
Y. Xu, A. Butt / Nuclear Engineering and Design xxx (2005) xxx–xxx



(a) Layout of experimental apparatus

EXHIBIT H.9 (Fig. 1 of the new paper of the Taleyarkhan et al. group on modeling and simulation of self-nucleated experiments for their neutron spectra

DRAFT Confidential For Review Only–"Bubble Fusion Neutron Transport Simulations" R. P.Taleyarkhan et al., 2008.

Modeling and Analysis of Neutron Emission Spectra from Self-Nucleated Acoustic Cavitation Experiments

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[2] *FNC Technology Co., Seoul National University, S. Korea*
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Abstract

Self-nucleated acoustic (bubble fusion) cavitation experiments have been modeled and analyzed using two independent techniques for neutron spectral characteristics at the detector locations for the published experimental studies of Taleyarkhan et al. (2006) and Forringer et al. (2006). The impact of neutron pulse-pileup during bubble fusion was verified and estimated with pulsed neutron generator based experiments and analysis. Results of modeling-cum-experimentation were found to be consistent with published experimentally-observed neutron spectra for 2.45 MeV neutron emissions during self-nucleated acoustic cavitation (bubble) fusion experimental conditions with and without ice-pack (thermal) shielding. Calculated neutron spectra with inclusion of ice-pack shielding are consistent with the published spectra from experiments of Taleyarkhan et al. (2006) where ice-pack shielding was present, whereas without ice-pack shielding the calculated neutron spectrum is consistent with the experimentally observed neutron spectrum of Forringer et al. (2006) and another independent prediction (Naranjo, 2006) for the case where ice-pack shielding was absent.

DRAFT Confidential For Review Only–"Bubble Fusion Neutron Transport Simulations" R. P.Taleyarkhan et al., 2008.

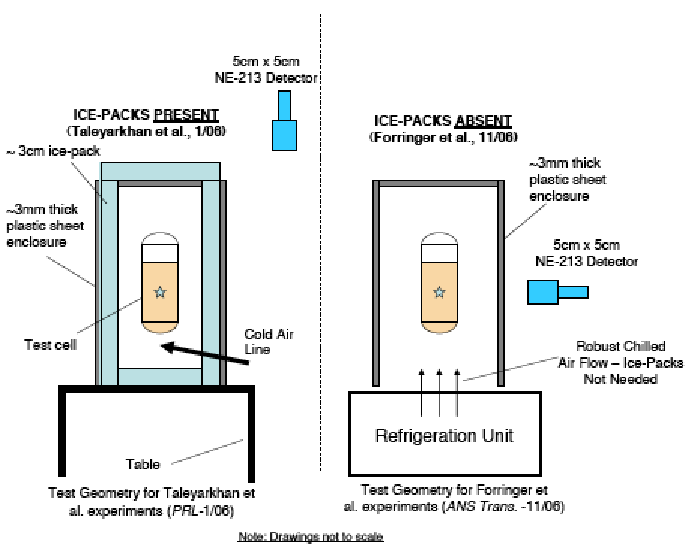

Fig. 1. Exptl. configurations of Taleyarkhan et al. (2006) & Forringer et al. (2006)
(Further details provided in Supplement)

EXHIBIT H.10 (Fig. 3 of the new paper by Taleyarkhan et al. showing good agreement of computed down scattered neutron spectrum with the measured value of PRL 96)

DRAFT Confidential For Review Only–"Bubble Fusion Neutron Transport Simulations" R. P.Taleyarkhan et al., 2008.

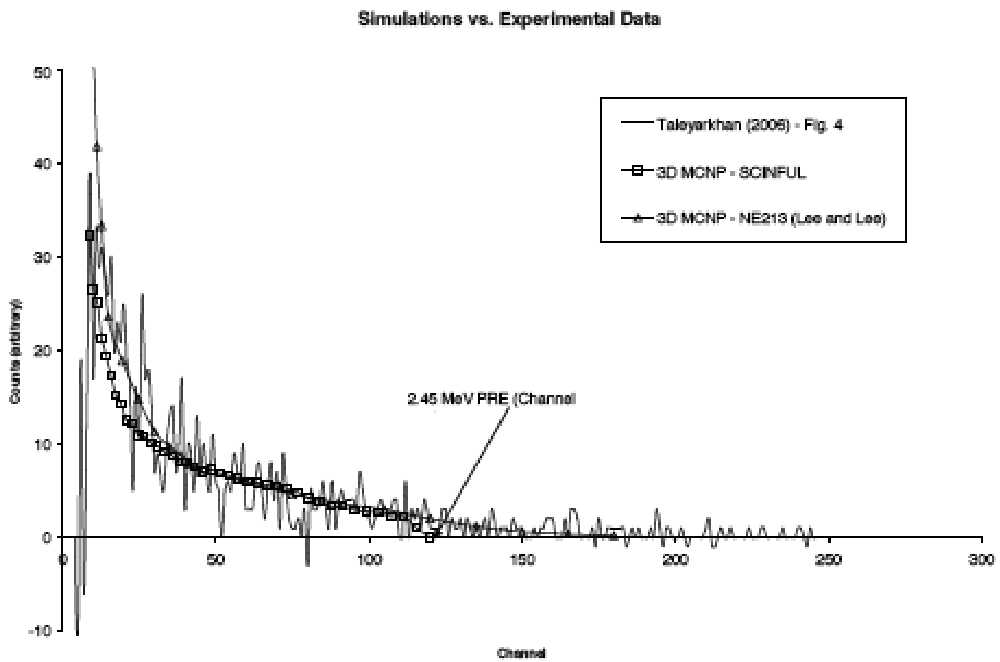

Fig. 3. Predictions of MCNP5-SCINFUL and MCNP5-NE213 (Lee/Lee) Methods vs Measured Neutron Response Spectrum of Taleyarkhan et al. (2006); With Ice-Pack Shielding.