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INFO MEMO

U-429-09/[redacted] (b)(3):10 USC 424

30 October 2009

FOR: [redacted] (b)(3):10 USC 424 DEFENSE INTELLIGENCE AGENCY

FROM: [redacted] (b)(3):10 USC 424;(b)(6) Defense Intelligence Agency

SUBJECT: (U) Review of Advanced Aerospace Contract Deliverables

(U) This info memo responds to your request for the [redacted] (b)(3):10 USC 424 [redacted] (b)(3):10 USC 424 to review the quality and value of the first-year technical reports delivered under the Advanced Aerospace Weapon System Applications contract with Bigelow Aerospace Advanced Space Studies (BAASS), LLC. As a reminder, you made this request to [redacted] (b)(3):10 USC 424 personnel during a 15 May 2009 meeting with you after your meeting with Senator Harry Reid. The goal of the contract is to identify key technologies and physics concepts that would support revolutionary aerospace vehicle research and development. Contracted studies were designed to provide a prioritized list of technologies/concepts that then would drive detailed, focused searches into foreign aerospace research and development. Each research report (in the areas of lift, propulsion, control, power generation, spatial/temporal translation, materials, structural configuration, signature reduction, human interface, human effects, and armament) was written by world-class technical experts in industry and/or academia.

(U) The table in Enclosure 1 lists the 26 extensive technical reports delivered to DIA in FY 2009. The report titles highlighted in red and green are the ones that were reviewed. Eight reviews were performed by other authors listed in the table; five were performed by outside reviewers, including three research staff members [redacted] (b)(3):10 USC 424 at Sandia National Laboratories. The [redacted] program manager, [redacted] (b)(3):10 USC 424;(b)(6) [redacted] (b)(3):10 USC 424;(b)(6) has reviewed all of the papers and concurs with the reviews. As the excerpts indicate, all of the reviews were positive, some exceptionally so. Even within the limitation of being able to conduct only unclassified research in the first contract year, the quality hoped for in the reports was achieved. [redacted] (b)(3):10 USC 424 intends to [redacted] (b)(3):10 USC 424 publish them in coming weeks as Defense Intelligence Studies. Some or all of these studies may be of interest to Defense Department agencies, national laboratories, and/or defense industries focused on blue-force capability development, and [redacted] will ensure that they receive copies.

[redacted] (b)(3):10 USC 424

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(U) Based on draft budget guidance, Congress apparently will fund the contract's option year one at \$12 million. In FY 2010, [redacted] will use the 26 FY 2009 technical reports in having BAASS evaluate potential adversary exploitation worldwide, select studies amenable to classified experimental verification by BAASS, and have BAASS conduct new classified and unclassified studies with select academic and industry partners. Deliverables are expected in late summer 2010.

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2 enclosures as stated

(U) Prepared by: [redacted (b)(3):10 USC 424;(b)(6)]

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**(U) FY 2009 Technical Reports**

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<b>Title</b>	<b>Author</b>	<b>Affiliation</b>
Inertial Electrostatic Confinement Fusion	(b)(6)	
Pulse-Power-Based Weaponry		
Space-Time Modifications for Spaceflight Applications		
Novel MEMS-Based Biosensors		
Theory and Experiments of Invisibility Cloaking		
Wormholes in Space Time		
Gravity Wave Communication		
Superconductors in Gravity Research		
Antigravity for Aerospace Applications		
Field Effects on Biological Tissues		
Positron Aerospace Propulsion		
Vacuum Energy Applications		
Improved Statistical Approach to Drake Equation		
Maverick vs. Corporate Research Cultures		
Biosensors and BioMEMS		
Metamaterials for Aerospace Applications		
Warp Drives		
Controlling Devices Without Limb-Operated Interfaces		
Materials for Advanced Aerospace Platforms		
Metallic Glasses		
Programmable Matter		
Metallic Spintronics		
High-Energy Laser Weapons		
Quantum Entanglement Communications		
Space Access: Where Been, Where Go		
Advanced Nuclear Propulsion for Deep Space		

Red – Independent review.

Green – Sandia National Laboratories review.

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**(U) Excerpts From Reviews**

(U) All of the following review information and comments are UNCLASSIFIED.

**Antigravity for Aerospace Applications in 2050**

(b)(6)

(b)(6) has provided an excellent overview of conventional approaches to gravity manipulation within the confines of Newtonian, relativistic and quantum physics. With his typical lucid style, he takes the time to add useful explanatory notes which are especially enlightening for those for whom Relativity is not their first language. In addition, his extensive technical appendix concerning such exotica as squeezed vacuum states, zero-point fluctuations and negative energy is of great benefit.

(b)(6)

**Technological Approaches to Controlling External Devices in the Absence of Limb Operated Interfaces**

(b)(6)

The paper by (b)(6) looks at the present and future prospects for the human thought control of robotics and machines by way of high technology neural interfaces. The ultimate aim of such research is to allow an individual to control the function of a prosthetic or robot as an extension of his own body and mind or to exercise thought-based control over a mechanized environment. We find from (b)(6) current review that the state of the art is still quite far away from achieving such control but strong efforts are being made on a number of approaches.

(b)(6)

**On The Role of Superconductors in Gravity Research**

(b)(6)

Because of the author's involvement and activity in the field, it seems natural that he chose to write on this subject, and he is able to demonstrate not only a solid

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*understanding of the research area, but is also able to provide his personal accounts of meetings with the prominent researchers. In addition, he describes his own experimental results, or lack thereof. Because of his own personal attachment to the field, I found the report to be somewhat captivating, as I felt a strong sense of being close to the research and hearing from the 'horse's mouth,' so to speak. Despite his involvement, Hathaway's point of view seems to be that of an impartial observer and he does not appear to take sides, or seem to be trying to promote or 'sell' the research field. He does an excellent job of relaying a candid and informative survey of what, to me, seems to be a tantalizing yet controversial field of study.*

(b)(6)

**Metallic Glasses: Status and Prospects for Aerospace Applications**

(b)(6)

*This is an excellent and highly readable Survey report that defines Metallic glasses, the advantages and disadvantages to other composite materials, and how their mechanical properties are both alike and different from those of pure metals. These properties include strength, stiffness, and toughness. The author makes a case that the processing capability meets and sometimes exceeds those of thermoplastic polymers, and traditional metals. Glass hybrid composites are found to excel in almost all cases to current materials in widespread use.*

(b)(6)

**Theory and Experiments of Invisibility Cloaking**

(b)(6)

*The report by (b)(6) describes the background and recent advances in the field of invisibility cloaking. This field recently emerged as one of the most exciting applications of metamaterials – artificially structured media possessing unusual refractive properties. (b)(6) ...is a pioneer in this field, having published one of the first theoretical papers describing the possibility of cloaking. This topic still evokes misunderstandings and confusion. That is not surprising: the concept of invisibility (although not its technical implementation) has been preoccupying people for centuries if not millennia. (b)(6) report does an excellent job of clearing some of this confusion and providing clear definitions of what constitutes true cloaking/invisibility. It also honestly discusses technological challenges to making a practical invisibility cloak.*

(b)(6)

**Positron Aerospace Propulsion**

(b)(6)

*This status paper is very exciting and provides new important information about the present status and prospects for positron energy production and storage, especially for space applications. It is recommended reading for both researchers in the area and aerospace scientists. In addition, others interested in national policy for both future energy and future space exploration should consider this status paper to gain further insight into positron energy and propulsion.*

(b)(6)

**Metamaterials for Aerospace Applications: Energy Harvesting, Sub-Wavelength Imaging, Optical-Device Miniaturization, and Non-Reciprocal Optical Devices**

(b)(6)

*Metamaterials are "materials beyond materials" with unusual electromagnetic or optical properties. The report by (b)(6) describes several possibilities how such materials can be used for advanced aerospace applications. As examples, he often uses his own experiments. (b)(6) is one of the research leaders in the field of metamaterials and has built up a highly credible reputation in this area. Although the research area of metamaterials is still rather new and mostly confined to proof-of-principle academic research at present, it will undoubtedly revolutionize photonics and lead to commercial applications that are interesting for the aerospace industry.*

(b)(6)

**Biosensors and BioMEMS: A Survey of the Present Field**

(b)(6)

*This paper reaches toward and achieves a laudable goal: making BioMEMS understandable and relevant. The author's contribution is important, because the number of current programs and projects in the US Government that are either touting the importance of, or making responses to research requests in 2009*

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numbers in the thousands. As many recent US Academy of Sciences and other scholarly studies have shown, few persons in the decision-making areas of the government have sufficient background in BioMEMS from which to make intelligent decisions. As key customers of this study, the sponsors are well-served with (b)(6) survey. Throughout the Survey, the author often introduces ancillary technologies that will enable further BioMEMS development, solve problems, or lead to alternative technologies. The survey is made more useful to the reader and the sponsor because of this.

(b)(6)

### **Metallic Spintronics**

(b)(6)

(b)(6) paper is concerned with an emerging technology known as spintronics ("spin-based electronics"). In this technology information is carried by moving or altering the spin of electrons, rather than by moving the charged particles themselves. (b)(6)

(b)(6) has at least a dozen publications in the field of study in top-tier journals, and has won NSF grants to pursue the topic. As a result one must regard him as an expert in the subject and take his opinions seriously. In addition, the paper cites 97 references, which is quite a lot for a 10,000 word paper. Clearly, Tsoi is giving an overview of the entire field rather than just supplying an incremental addition to it.

(b)(6)

### **Materials for Advanced Aerospace Platforms**

(b)(6)

The position (b)(6) takes at the first instant is that previous design methodologies have largely failed, because of a lack of appreciation of material property life cycles, which are clearly now known to be very different. If one is to examine, for example, in an attempt to reverse engineer materials and components possibly of interest, one might want to approach the "reverse" paradigm from first principles of materials in contexts of observed performance. (b)(6) at the beginning of the study subtly suggests that observed performance...or even claimed performance...may be a better starting point.



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*The author elegantly describes how this “commonly encountered inconsistency between technical innovation and commercial progress” has become [in the West] a current deterrent to the development and the deployment (adoption) of “literally all classes...of polymers, metals, and ceramics.”*

(b)(6)

**Metallic Glasses: Status and Prospects for Aerospace Applications**

(b)(6)

*I found it to be a clear and even-handed evaluation of the pros and cons of bulk metallic glasses (BMG) and composites employing them. The author clearly points out possible advantages in processing while he equally clearly points out the difficulties associated with inherent unstable shear band formation and consequent lack of general ductility.*

(b)(6)

**Theory and Experiments of Invisibility Cloaking**

(b)(6)

*Overall, this is a nice qualitative description of the rapidly moving field of invisibility and cloaking and can serve as a good starting point for someone interested in diving into the details of this new technology.*

(b)(6)

**State-of-the-Art & Evolution of High Energy Laser Weapons**

(b)(6)

*The technical discussions and history review are generally correct to the extent they address the topics and this paper is a good general introduction for those unfamiliar with high energy lasers.*

(b)(6)