INFO MEMO

U-429-09/DWO 30 October 2009

FOR: DIRECTOR, DEFENSE INTELLIGENCE AGENCY

FROM: 1843(a)(3) for Analysis, Defense Intelligence Agency

SUBJECT: (U) Review of Advanced Aerospace Contract Deliverables

(U) This info memo responds to your request for the Defense Warning Office (DWO) 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 DWO-3 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 at Sandia National Laboratories. The DWO program manager, AAP Person 1 AAP Person 1 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. DWO intends to 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 DWO-3 will ensure that they receive copies.

(U) Based on draft budget guidance, Congress apparently will fund the contract's option year one at $12 million. In FY 2010, DWO 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.

2 enclosures as stated

(U) Prepared by: AAP Person 1 Defense Warning Office AAP Person 1 a

(U) FY 2009 Technical Reports

UNCLASSIFIED

Title	Author	Affiliation
Inertial Electrostatic Confinement Fusion	AAP Person 70	U Illinois
Pulse-Power-Based Weaponry	AAP Person 6	Northrup
Space-Time Modifications for Spaceflight Applications	AAP Person 57	EarthTech
Novel MEMS-Based Biosensors	AAP Person 65	Arizona St U
Theory and Experiments of Invisibility Cloaking	AAP Person 68	U St. Andrews
Wormholes in Space Time	AAP Person 58	EarthTech
Gravity Wave Communication	AAP Person 77	Gravwave
Superconductors in Gravity Research	AAP Person 75	
Antigravity for Aerospace Applications	AAP Person 58	EarthTech
Field Effects on Biological Tissues	AAP Person 81	Wayne State
Positron Aerospace Propulsion	AAP Person 69	Positronics
Vacuum Energy Applications	AAP Person 58	EarthTech
Improved Statistical Approach to Drake Equation	AAP Person 80	Acad Astro
Maverick vs. Corporate Research Cultures	AAP Person 75	
Biosensors and BioMEMS	AAP Person 65	Arizona St U
Metamaterials for Aerospace Applications	AAP Person 78	U Texas
Warp Drives	AAP Person 74	
Controlling Devices Without Limb-Operated Interfaces	AAP Person 73	Wayne State
Materials for Advanced Aerospace Platforms	AAP Person 66	Ohio State U
Metallic Glasses	AAP Person 63	Johns Hopkins U
Programmable Matter	AAP Person 90	Prog Matter
Metallic Spintronics	AAP Person 71	U Texas
High-Energy Laser Weapons	AAP Person 79	Priv Consultant
Quantum Entanglement Communications	AAP Person 76	Washington
Space Access: Where Been, Where Go	AAP Person 67	Hypertech
Advanced Nuclear Propulsion for Deep Space	AAP Person 72	Nevada

Red – Independent review.
Green – Sandia National Laboratories review.

(U) Excerpts From Reviews

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

Antigravity for Aerospace Applications in 2050

AAP Person 58

EarthTech International, Inc.

AAP Person 58 *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.*

- AAP Person 75 Consulting Services

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

AAP Person 73

Wayne State University School of Medicine

The paper by AAP Person 73 *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* AAP Person 73 *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.*

- AAP Person 65

On The Role of Superconductors in Gravity Research

AAP Person 75

AAP Person 75 Consulting Services

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

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, AAP Person 75 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.

- AAP Person 74 Consulting, LLC

Metallic Glasses: Status and Prospects for Aerospace Applications

AAP Person 63

John Hopkins University

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.

- AAP Person 129 The Society for Experimental Mechanics AAP Person 129

Theory and Experiments of Invisibility Cloaking

AAP Person 68

University of St. Andrews

The report by AAP Person 68 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. AAP Person 68 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. AAP Person 68 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.

- AAP Person 78, University of Texas at Austin

Positron Aerospace Propulsion

AAP Person 69

Positronics Research, LLC

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.

- AAP Person 70 University of Illinois

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

AAP Person 78

University of Texas at Austin

Metamaterials are "materials beyond materials" with unusual electromagnetic or optical properties. The report by AAP Person 78 *describes several possibilities how such materials can be used for advanced aerospace applications. As examples, he often uses his own experiments.* AAP Person 78 *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.*

- AAP Person 68 University of St Andrews

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Biosensors and BioMEMS: A Survey of the Present Field

AAP Person 65

Arizona State University

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

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 [redacted] 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.

AAP Person 65

- [redacted] Wayne State University School of Medicine

Metallic Spintronics

[redacted]

University of Texas at Austin

[redacted] *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.* [redacted] *at the University of Texas at Austin, 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,* [redacted] *is giving an overview of the entire field rather than just supplying an incremental addition to it.*

AAP Person 71

AAP Person 71

- [redacted] Ravenbrick, LLC

Materials for Advanced Aerospace Platforms

[redacted]

Ohio State University

The position [redacted] *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.* [redacted] *at the beginning of the study subtly suggests that observed performance…or even claimed performance…may be a better starting point.*

AAP Person 66

AAP Person 66

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

- AAP Person 81 Wayne State University School of Medicine

Metallic Glasses: Status and Prospects for Aerospace Applications

AAP Person 63
John Hopkins University

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.

- AAP Person 130 Sandia National Laboratories

Theory and Experiments of Invisibility Cloaking

AAP Person 68
University of St. Andrews

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.

- AAP Person 131 Sandia National Laboratories

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

AAP Person 79
Independent Consultant

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.

- AAP Person 132 Sandia National Laboratories