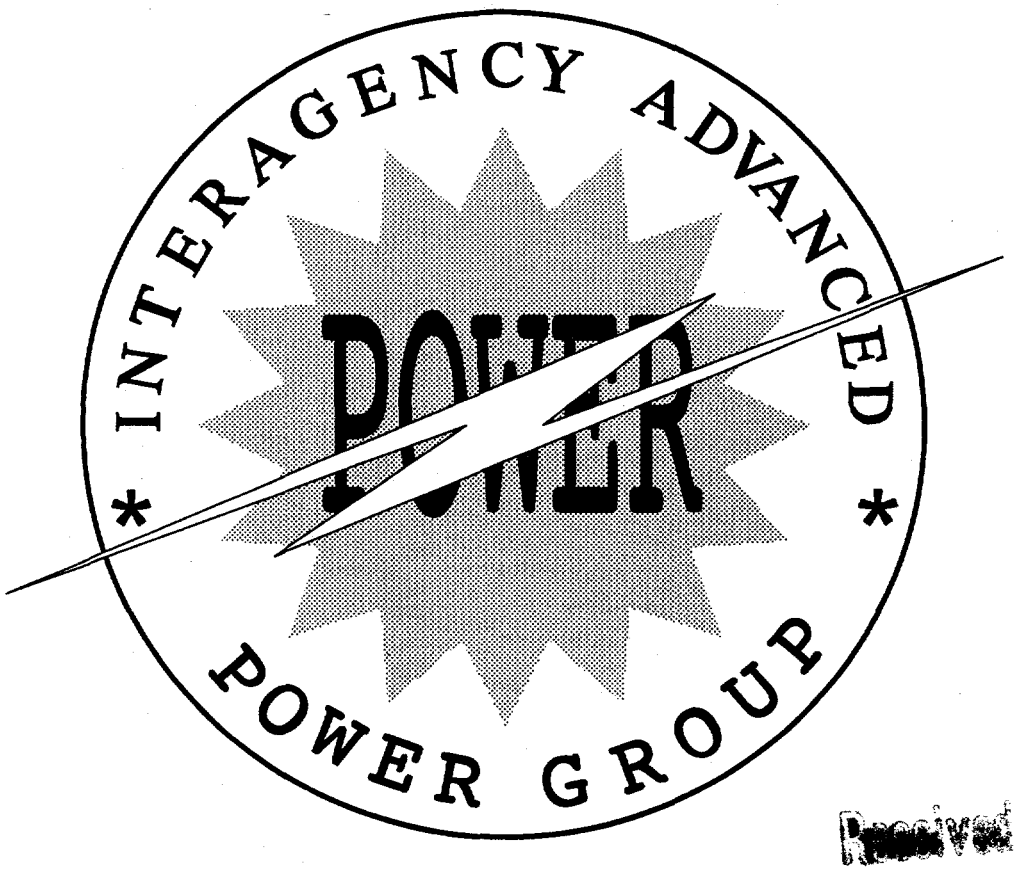
CONF-920384--Summ.

IAPG MEETING COMPENDIUM

OCTOBER 1991 - DECEMBER 1992



JANUARY 1993

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INTRODUCTION

Under the direction of the Interagency Advanced Power Group (IAPG), the Power Information Center (PIC) provides support services for each IAPG information exchange session. IAPG members meet a minimum of once each year to share programmatic and technical information on federally funded research and development (R&D) projects in the area of advanced power. This R&D is directed by one of the five IAPG member agencies—the U.S. Army, U.S. Navy, U.S. Air Force, U.S. Department of Energy, and the National Aeronautics and Space Administration. Affiliated Federal groups and federally funded research and development centers can also participate.

To enhance the exchange of information between Government researchers, this *1992 IAPG Meeting Compendium* has been assembled. This publication is a re-printing of abstracts of each IAPG presentation offered during 1991-1992. The information is arranged chronologically by IAPG meeting. During the 1992 IAPG meeting year, there were presentations restricted to Government audiences only. These "Restricted" minutes have not been included in this compilation. Copies of these restricted materials are available from the PIC to IAPG members who are employed by the U.S. Government.

The Power Information Center provides published meeting minutes to meeting attendees and IAPG requestors following each meeting. If you would like an individual presentation summary, published meeting minutes, or additional IAPG meeting information, please call (703) 758-0531. For further information on the IAPG or PIC, please contract the:

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October 1991 - December 1992 IAPG Meetings

SECTION 1

SOLAR PHOTOVOLATIC PANEL MEETING

HELD IN CONJUNCTION WITH IEEE PVSC CONFERENCE

LAS VEGAS, NV

MINUTES OF IAPG SOLAR PHOTOVOLTAIC PANEL MEETING

Fall Meeting, October 9, 1991
in conjunction with IEEE PVSC Conference (Las Vegas, NV)
notes as taken by Michael Piszczor (Chairman-Elect)

The technical and programmatic information usually discussed at panel meetings was presented at the IEEE PVSC Conference. For this reason, this IAPG Solar Photovoltaic Panel meeting did not have any scheduled formal technical discussions. Rather, the meeting presented an open forum for everyone attending to have the opportunity to further discuss details from the conference or other important information regarding their own particular programs.

Dr. Mort Prince (DOE) discussed a few items with regard to DOE's programs. Dr. Prince distributed copies of a Photovoltaic Energy Contract List, Photovoltaic Energy Program Overview, Photovoltaic Program Plan FY 1991 - FY 1995, and U.S. Department of Energy Program Activities. Xeroxed copies of these brochures may be obtained through the Power Information Center (PIC). Dr. Prince noted that DOE's new Director of the Photovoltaic Technology Division was Mr. Jim Rannels.

Because no meeting minutes were available from the Spring Photovoltaic Panel Meeting, Mr. Piszczor attempted to reiterate a brief summary of those minutes based on the collective memories of those who attended that meeting.

Two significant events were noted from the Spring 1991 meeting:

(1) Michael Piszczor of NASA Lewis was elected as the new chairman of the Solar Photovoltaic Panel, replacing Dr. Mort Prince of DOE, and

(2) That DOE's PMAT Program was discussed briefly.

The 1992 Spring Meeting Symposium was announced and a short discussion followed. In anticipation of agenda discussions at the November 14th Steering Group meeting, suggestions were made regarding topics (specifically for the Solar PV Panel) which might be included at the Spring Symposium.

Some of the suggestions made were:

(1) Have all agencies review their programs,

(2) discuss the future goals of these program,

(3) pick one or two significant technical accomplishments/programs for presentation by each agency,

(4) explore new areas of collaboration between agencies and programs, and

(5) discuss the current Air Force space power program.

These suggestions were to be conveyed to the Steering Group members at their next scheduled meeting.

The meeting was adjourned.

SECTION 2

JOINT MEETING OF THE SYSTEMS, SOLAR AND ELECTRICAL WORKING GROUPS

FT. MONMOUTH, NJ

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OPENING REMARKS

Mr. David Singh opened the Joint Meeting by welcoming all the attendees to the Electronic Technologies and Devices Laboratory (ETDL). He stated that the mission of the laboratory was to develop and transition critical electronic technology into the Army's systems. He added a few remarks regarding the agenda for the day, and turned the meeting over to Mr. Gene Schwarze.

Mr. Gene Schwarze, Chair of the Electrical Working Group, welcomed everyone to the meeting and introduced the speakers for the next two days. He introduced Mr. Ted Mroz, who expressed his excitement over the topics to be shared, and returned the meeting to Mr. Schwarze, who turned it back to Dave Singh.

OVERVIEW OF ETDL

Mr. David Singh introduced ***Dr. Art Ballato***, principle scientist of ETDL, who gave an overview of the ETDL mission. Dr. Ballato welcomed everyone to ETDL, and expressed the regrets of Dr. Thornton, Director of ETDL, who was unable to attend. Dr. Ballato gave a brief overview of Ft. Monmouth and its relationship to the Army Material Command. He described the various laboratories at Ft. Monmouth with a thumbnail sketch of each. He then mentioned some of the specific research being conducted at ETDL, and the development of new electronic technologies and devices for the army. He discussed the need for cooperation in information exchange, and the manner in which ETDL utilized other agencies and conferences to assist in gathering and assimilating various information resources. Dr. Ballato then listed some of the changes in military operations over the past few years, and explained the need for new technologies to be high-impact, high-leverage. He mentioned the possibilities of commercial use for the developing technologies which he described, and considered the factor of affordability. He continued by describing the advantages of "opening laboratories", sharing information and resources between groups, and then touched on the Technology Transfer Act and its benefits to Government research and development.

POWER ENVIRONMENTAL ASSESSMENT

Mr. Walter Taschek, Belvoir Research and Development, began with an overview of his intent to describe the penalty in mobility when electronic equipment is cooled using air conditioning equipment; and that an increase in the operating temperature environment for that electronic equipment would lead to the conclusion that other means of cooling for electronic equipment would result in more mobile systems.

Mr. Taschek described his duties in the System Assessment Team, to determine heating/cooling electric power requirements for standard shelter systems in the Army. Utilizing diagrams and illustrations of assessment modeling, he briefly described the process which is used to make these determinations. He described the problems of mobility and summarized with the key features necessary for mobile electronic systems: electronics capable of operating at greater than 345°K (161°F); development of lightweight APU/ECU's; and heavy variant HMMWV. In conclusion,

he gave a brief overview of the funding for the program, primarily by the Program Manager of Mobile Electric Power, and secondarily through TROSCOM. He invited anyone interested in further information to contact him.

SDIO POWER PROGRAMS

Mr. Bill Baker, Chairperson of the Systems Working Group, introduced ***Dr. Mitch Nikolich***, who spoke on the new SDI program. Dr. Nikolich began with an overview of the development of power technology for the entire range of SDI systems. He described the baseload power, and burst power requirements. He gave an overview of the vision of SDI for the foreseeable future, detailing the segments of CONUS protection, space segment, command and control, and others. He explained the Survivable Power Subsystem (SUPER) and its relationship to the development of the entire system, and survivability against a wide range of threats and the natural environment. He stated the purpose was to build a general purpose capability applicable to a range of users. He described the assemblies which comprise SUPER, and discussed its autonomy. Following this, Dr. Nikolich detailed the array itself with the use of illustrations.

Dr. Nikolich considered the advantages of building survivability into a system "up front" and discussed SUPER's approach to survivability, which is to "ride out the attack". He described advancements in the fields of cells and photovoltaics, developing the next generation of energy storage batteries. In the area of power conditioning, he described the development of components, switches, capacitors, etc., which will be of significant value in the SDI program. He discussed a program with Naval Research Laboratory and the intelligence community to pursue the development of common pressure vessel technology.

He stated that involvement in SD-100, a program to develop an enabling technology for a space nuclear reactor, was continuing. Dr. Nikolich briefly discussed development of the thermionic program, which includes the purchase of an unfueled Soviet nuclear space reactor and, previously, the purchase of Soviet tacitrons.

In pulse power and power conditioning, the focus has shifted toward the development of RF sources. Improvements have especially been made in the size of RF devices. An explanation of the differences between the 1985-technology of the kystron and the 1991 klystrode was given. He discussed the purpose of the Directed Energy Weapon Power Integration (DEWPOINT), which determines the feasibility of providing multi-megawatt power to an accelerator. He concluded his talk with a discussion of several other efforts concurrently undertaken, including the resolution of problems in theater missile defense (TMD).

2 KWE SOLAR DYNAMIC SPACE POWER SYSTEM GROUND TEST

Mr. Ted Mroz, NASA LeRC, Chairperson of the Solar Working Group, presented a discussion of a new program at NASA LeRC, the 2 kWe Solar Dynamic Space Power System Ground Test. Carol Tolbert (Ohio Aerospace Institute), the designated presenter, was unable to attend.

An overview and background of the Solar Dynamic (SD) Closed Brayton Cycle was presented. This included an explanation of the SD schematic, qualitative benefits of this power system (flexibility, long life components, lower mass, lower recurring costs, etc.), description of the SD system module components (concentrator, receiver power conversion unit, radiator, etc.) and prior test history of a 10 kWe Brayton Power System (39,000 hours).

Mr. Mroz then described the 2 kWe Test Program. Unlike the prior 10 kWe Test Program, which did not include a concentrator and receiver, the 2 kWe Test Program will test a complete system with thermal energy storage in a simulated space environment. The discussion included benefits from this test program, such as validation of system and component design codes, early resolution of system integration issues, and verification of solar dynamic technology at a system level. The NASA LeRC test facility, program schedule, and program approach were described.

HYBRID SOLAR DYNAMIC/PHOTOVOLTAIC CONCEPTUAL DESIGN STUDY

Mr. Mike Brown, Naval Research Laboratory, described his efforts to define necessary requirements for putting the solar dynamic power system onto an unmanned spacecraft, as contrasted with placing it on a manned space station. Mr. Brown demonstrated the configuration for the unmanned spacecraft, detailing the relationship of the concentrator, spacecraft, Brayton cycle engine, and radiators, on a 9' diameter satellite. He described the process for assimilating energy from the sun and the necessary axes of motion necessary to track the sun from an unmanned craft.

He compared the solar dynamic power system with a photovoltaic system, in terms of configuration and complexity of parts and joints. He also compared single- and double-axis tracking systems, concluding that the accuracy of the solar reflector required the double-axis concentrator.

Mr. Brown related that there must be some sort of small, photovoltaic array on a craft with a solar dynamic system, since there is no power until the system is deployed and focused toward the sun. He explained that the solar dynamic system was most suitable for larger spacecraft where the power requirements were more stable, rather than for smaller, low-orbit craft for which the power requirements vary more significantly. Mr. Brown then described the system components and their relationship to the spacecraft itself, concluding that the study indicates that the solar dynamic power system should have an autonomous pointing and control system.

IAPG BUSINESS MEETING

Mr. Gene Schwarze conducted a short Working Group business meeting. He pointed out that a Steering Group Meeting was scheduled in the same facility, using the same conference room as the current meeting on November 14. He encouraged everyone present to attend, if possible.

The Group had a short discussion regarding the upcoming Spring IAPG Meeting, noting that the discussion would be continued at the Steering Group Meeting on the 14th.

Mr. Schwarze presented a motion to approve the meeting minutes of the April 1991 Joint Meeting as published. The motion carried and the minutes were approved. The business meeting adjourned.

NAVY OVERVIEW: ELECTRICAL POWER DISTRIBUTION

Mr. Gene Schwarze noted that the next scheduled speaker, Mr. Howard Stevens of the David Taylor Research Center, was unable to attend due to a family emergency. Therefore, the Navy Overview of the Electrical Power Distribution would not be presented.

INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM — POWER MANAGEMENT

Mr. Gene Schwarze introduced ***Dr. Robert Bercaw***, Branch Chief of the Electrical Components and Systems Branch from NASA Lewis, to speak on the Integrated Technology Plan for the Civil Space Program.

Dr. Bercaw described the basic structure of NASA's Power Management Program. Three basic elements of the Program are: Electrical Components & Systems; Power Materials; and Environmental Interactions. The widely varying technologies required for different missions were also mentioned, leading to a discussion of the difficulties developing this type of program: the complexity of the need and the unique and hostile environment in which there is no experience. The additional factor of limited budgets also govern development of the program.

The four elements of the program (Lunar and Mars Bases; Advanced Science Missions; Launch and Orbital Transfer Vehicles; and Environmentally Compatible Power Systems) were then briefly explained. Dr. Bercaw introduced several specific examples of the research being carried out by the Power Management Program, including: power integrated circuits being developed by Westinghouse; Mr. Gene Schwarze's program of reviewing the effects of radiation on all commercial power semi-conductors; and the support of a program on silicon carbide for high-temperature electric switches. Plasma effects on Space Station Freedom, and the decision to put a plasma clamp on the station were also discussed.

Dr. Bercaw introduced the Environment Power System Analysis Tool (EPSAT) and its usefulness as a design tool for vehicles used in a low-earth orbit. In the area of exploration, Dr. Bercaw mentioned that new, complex systems were being developed for Lunar and Mars missions, and new technologies for power conversion and storage are being developed for these new systems.

Finally, the need to integrate Power Management into all missions by addressing the complex issues and multiple technologies, and the tremendous payoff in safety, reliability, and confident system development was stressed.

PULSED POWER TECHNOLOGY OVERVIEW FOR THE US NAVY

Mr. Larry Luessen, Head of the Pulsed Power Technology Branch of the Naval Surface Weapons Center, (NAVSWC) Dahlgren Laboratory, and co-chair of the Pulsed Power Panel, gave a brief overview of the work done at his facility and its relationship to other Naval laboratories. He

mentioned the changes in the Navy laboratories system's missions, and the restructuring of the laboratories.

Mr. Luessen then began his discussion by addressing the main threat to Naval combatants, the anti-ship cruise missile (ASCM), differentiating between conventional and unconventional hard and soft kills, and comparing the French Exocet and French-German Anti-Navire Supersonique (ANS) missiles.

Mr. Luessen detailed some of the pulsed power programs in the Navy, including Plasma Opening Switch and Plasma-Filled Diode research taking place at the Naval Research Laboratory, Washington, DC; Electro-Thermal (ET) Gun Development at David Taylor Research Center in Annapolis, MD; the SDIO Pulsed Power Program at the Office of Naval Research, Arlington, VA; and the High-Power Spark-Gap Switches for Compact Accelerators, and Bulk Optically Controlled Semiconductor Switch (BOSS) being developed and tested at the Naval Surface Warfare Center, Dahlgren, VA.

Mr. Luessen discussed the development at Dahlgren of photoconductive switches, which are based on optically sensitive semiconductor materials, stressing the issues of lifetime, optical source size, and average power capacity in their development. He then gave an overview of the properties of the BOSS, which is closed on-command by one laser frequency and opened on-command by another, and briefly discussed its application in unconventional countermeasures for ASMD wide-band radar for non-cooperative target recognition (NCTR) and optical computing.

Mr. Luessen discussed development and applications of the charged particle beam (CPE), covering some of the difficulties to develop repetitive CPB accelerators. In conjunction with Saudia National Laboratories efforts to develop a compact accelerator design, NAVSWC is developing a 500 kV hydrogen switch that will operate at 10 kHZ and recover in 100 microseconds.

In conclusion, Mr. Luessen discussed the efforts on the part of the Navy to find adequate funding to continue pulsed-power-related work at the laboratories.

PULSED POWER TECHNOLOGY OVERVIEW FOR THE US AIR FORCE

Mr. Fernando Rodriguez, from the Applied Electromagnetics Group, Wright Laboratories, began by mentioning the name change in what had been the Pulsed Power Group and was now Applied Electromagnetics Group, which encompassed a broader range of topics.

Mr. Rodrigruez discussed the work to develop a new type of full-bridge the DC-DC Converter Switch, which would remove some of the complexity and reduce the cost of the present system. So far, they have developed an 8kW, 20 kHz DC-DC converter using the ZVS/ZVS technique. Mr.Rodrigruez described the high current pulse injection (simulated lightning tests) for the F-16 aircraft.

Mr. Rodrigruez mentioned the difficulties in funding the program solely through the Scholars Research Program, adding that alternative funding was being sought.

HIGH VOLTAGE MOS-CONTROLLED THYRISTOR STATUS

Captain Chris Braun, Pulsed Power Center, ETDL, described the MOS Controlled Thyristor (MCT) as a hybrid device consisting of a vertical power thyristor, similar to an SCR, but with the addition of a high-density of MOSFET control gates on the surface. The FET control gates provide the means to turn the thyristor on and off. The blocking voltage and on-state conduction are determined by the power thyristor. The device is at the stage of two major thrusts: epitaxial technology, which is currently supporting Government needs; and higher-voltage devices, which are three years from "useable". Captain Braun mentioned the relevance of these devices for SDIO efforts, as well as its military uses in electric guns, tanks, etc.

Captain Braun detailed the physics of the device and gave a brief overview of the current stage of the program, mentioning the encouraging aspect of commercial interest in the device. Nevertheless, he mentioned that high-voltage, high-power devices would never be "off-the-shelf", but would be procured through contracts.

Captain Braun highlighted the differences between the epitaxial and the high-voltage technologies, and mentioned that the high voltage, diffusion-doped MCTs are needed in systems which handle high powers and have a premium on size/weight (space platforms, tactical and transportable systems, etc.) He also mentioned that there was twice the size and weight reduction over the existing GTO, with performance gain.

AIR FORCE/ARMY ELECTRICAL TANK GENERATOR PROGRAMS

Mr. Guido Guazzoni spoke briefly before introducing ***Mr. Fernando Rodriguez***, who spoke on Air Force/Army Electrical Tank Generator Programs. Mr. Guazzoni mentioned having attended a workshop on Superconducting Magnetic Energy Storage Engineering Test Model. He briefly described the program and the system, and called for greater awareness of the program in order to assist funding efforts for it. He offered further information on the program to anyone interested.

Mr. Rodriguez, from the Applied Eletromagnetics Group, Wright Laboratories, spoke about the Air Force/Army Electrical Tank Generator Program. He began with an overview of the Generator System as proposed to the Army. The belief in the feasibility of a 1 MW HTS Generator was supported by a description of the current progress in its development, including research and development of low-temperature wire metal conductors, a 20 mW generator developed by the Air Force, and the discovery, in 1986, of ceramic superconductors.

Mr. Rodriguez described a 21K AL coil tested in a 1 mW generator, highlighted by a diagram of the interior of the generator. Using diagrams, he gave a brief description, of the conceptual 1 mW turbogenerator. Mr. Rodriguez illustrated the levels of funding necessary to continue the development of the generator, and the proposed plan of development through 1999.

ANL HIGH-TC PROGRAM POWER APPLICATIONS

Mr. Guido Guazzoni introduced ***Dr. John Hull***, from the Materials and Components Technology Division of Argonne National Laboratory, who spoke on the applications of high-temperature superconductors, concentrating on the work being done at Argonne. He mentioned that the annual budget for Argonne Labs was approximately $15 million.

Dr. Hull began his discussion by mentioning the significant progress which has been made in superconductors, showing data for the state-of-the-art high-temperature superconductors (HTSC), and estimates of their application requirements at 77°K. HTSC thin films at 77°K have larger J_c than Low-Temperature superconductors (LTSC) at 4°K. This would indicate that HTSC 77°K wires are physically possible, though not necessarily economically feasible. HTSC wires at 4°K have shown larger J_c than is possible with LTSC wires at magnetic fields greater than 20 T. This performance should hold at least up to 20 K. Future commercial use of HTSC wire at <~20 K appears likely, but the feasibility for their use at 77 K is still unknown.

Dr. Hull also discussed some of the near term applications for the HTSC: Current Leads, Bearings, and Liquid Nitrogen Sensors. On an intermediate basis, applications could be found for Fault Current Limiters and Transmission Lines. In the long term, applications in Superconducting Magnetic Energy Storage, Magnetohydrodynamics, Fusion, Accelerators, and MRI/NMR are likely.

In general, the HTSC material requirements for good superconducting magnetic bearings are different from those used to make good superconducting wires — e.g., transport of current between grains is not necessary for good levitation. Thus, the potential exists for making composite materials that have good mechanical and levitating properties.

NEW RESONANT LINK AIRCRAFT POWER GENERATING SYSTEM

Mr. Gil Garduño, Chair of the Power Conditioning Panel, introduced ***Dr. Tom Jahns***, Corporate R&D, Power Controls Program, General Electric, who spoke on the High Reliability Generator System. He described the efforts to develop the Next Generation of Variable-Speed, Constant Frequency (VSCF) Generating Systems. Dr. Jahns began with an overview of the system itself and the objectives of the program.

Specific components of the new VSCF Generator System for future aircraft needs would include Resonant Link Power Convertors (soft-switched); MOS-Controlled Thyristor (MCT) Power Switches; and DSP-Based Voltage Regulation via Vector Control. Dr. Jahns summarized the advantages of switching under zero-voltage conditions, which would reduce losses and electrical

stress on power devices. In addition, the reduction in EMI generation and improved invertor protection opportunities were also touched upon.

Dr. Jahns then gave a brief synopsis of the basic properties of the Resonant Link circuit, and continued with a synopsis of the High-Reliability Generator System complete Resonant Link Converter Configuration. He then mentioned the progress in developing the MOS-Controlled Thyristor (MCT), referring to the work undertaken by Captain Chris Braun of the Pulsed Power Center, ETDL. He illustrated and explained the 60 KW "breadboard" system which they are in the final stages of testing.

Dr. Jahns summarized by stating that the Resonant Link Convertor would provide a basis for the next generation of VSCF Generating Systems with several advantages, including true utilization of the high generator machine, reduced invertor switch losses and stresses, and reduced EMI generation. He also stated that the next generation of MCTs were demonstrating their value in aerospace applications. This combination of new components and power circuit topologies was necessary in the success of the More-Electric Airplane.

NASA LERC ELECTRICAL ACTUATION PROGRAM FOR AEROSPACE VEHICLES

Mary Ellen Roth, NASA Lewis Research Center, was introduced by Mr. Gil Garduño. She began with an overview of the electrical actuation program for space vehicles. The goal of the National Launch System (NLS, previously ALS) Program was to develop an entire family of launch vehicles with advanced technologies to help reduce the cost per pound to orbit. LeRC's part was to develop electric activator technology. The Electrical Actuator/Power System Technology Bridging Program was discussed, with the goal of transferring the NLS developed electric activator technology to the space shuttle. She also mentioned the Power-by-Wire (PBW) Program, and the ELV/Atlas In-House Program. Ms. Roth showed an overview of the total system approach for technology development, showing milestones of the program from 1990 and projected through 1992.

The first job for the ALS, performed by General Dynamic, San Diego, CA, was to develop a 25-HP EMA System as a "breadboard": Ms. Roth illustrated the EMA system components. From there, the development of a 40-HP System was undertaken, followed by the development of a field-oriented induction motor controller. Ms. Roth detailed some of the specific elements of the advanced induction motor and its performance requirements.

An electromechanical actuator potential design configuration was then discussed with illustrations. A brief discussion of the ELV Atlas in-house program followed, with a block diagram of the ELV system being used to describe the components.

Following this, an overview of the PBW was given. The goal was to develop a technology base for application of integrated Fly-by-Light (FBL) PBW Systems for civil transport aircraft. McDonnell-Douglas began a study in Oct 1990 to look at an all-electric secondary power aircraft and determine any advantages and cost savings. An advanced 300 passenger tri-engine aircraft

was selected as the baseline aircraft for the study. Only conventional 400 Hz technology was studied.

In conclusion, there was a 12,000 lb (2%) weight savings was noted in the final report of the 400 Hz study. Demonstrations of the EMA Technology Bridging Program are scheduled for 1992 and 1993. The ELV Atlas Program should be demonstrated in late 1992. The PBW should be funded by 1993.

INTELLIGENT POWER SUBCOMMITTEE REPORT

Dr. Gil Garduño, speaking for Carl Kellenbenz, updated the status of the Intelligent Power Subcommittee. He began with a brief history of the subcommittee and mentioned the change in name from "Smart Power" to "Intelligent Power". He described the primary mission of the Subcommittee as maintaining an "Intelligent Power Notebook" and Vendor/Product Listing. Currently, it is working only in a data gathering/disseminating mode at IAPG meetings, and has only a few active members. He highlighted the market trends of the intelligence power arena and activities of foreign companies as Fuji Electric, Hitachi, Mitsubishi, and others working in this area. He mentioned that this activity was largely concentrated on automotive and functional module business, and products were primarily sold to high-volume OEM users.

Dr. Garduño then mentioned the formation of the Power Semiconductor Research Center (SPRC) at North Carolina University, under the direction of Dr. J. Baliga. He continued with a brief discussion of the Governmental activity, largely taking place at NASA/JPL. He concluded with a listing of future activities, including the continuing update of the Intelligent Power Notebook.

HIGH TEMPERATURE ELECTRONIC SUBCOMMITTEE REPORT

Mr. Gene Schwarze, opened with a history of the subcommittee, which began in Albuquerque, and its approval by the Steering Committee a week before. He synopsized the meeting from the week before which brought Air Force personnel up to date on what is happening in high-temperature electronics in the Government. He mentioned the main participants in high-temperature electronics today, including Wright-Patterson (Air Force) and NASA Lewis. He concluded with an overview of future conferences, and an invitation to call him for any further information.

LIST OF APPENDICES

SECTION 3

STEERING GROUP MEETING

FT. MONMOUTH, NJ

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STEERING GROUP MEETING

WELCOMING/ OPENING REMARKS

The Steering Group met on November 14, 1991 at Ft. Monmouth, NJ, in the ETDL Myers Center, Room 4D121. Richard Belt opened the meeting at 8:30 am, and asked everyone in the room to introduce him/herself.

IAPG/PIC CONTRACT DISCUSSION

The discussion regarding the IAPG/PIC Contract took place in a closed session. No meeting notes are available.

PIC STATUS REPORT

Judy Hanst, Project Manager for the Power Information Center (PIC), was introduced by Dick Belt. She spoke on the status of the PIC and asked for direction from the Steering Committee on where, from their perspective, the PIC should be going, and a clearer definition of what kinds of support should be coming from the PIC. She explained Horizon's role in the PIC, her background with Horizon, and briefly touched upon her own hopes and expectations for the IAPG, broadening its exposure within the Government. She mentioned new projects as possibilities for the PIC (e.g. newsletters) which she felt would more fully utilize the resources Horizon can offer the IAPG. She also mentioned that she would like more interface with the Panel Chairs and Vice-Chairs.

NEW BUSINESS — 1992 SYMPOSIUM

Discussion of the 1992 Symposium was moved forward for the convenience of those who had to leave early. A lengthy discussion regarding the format of the April Symposium and the number and placement of speakers resulted. The following conclusions were reached:

- A three-day presentation will be held with concurrent (parallel) meetings.
- There would be a Keynote Speaker the first morning.
- There will be a banquet with speaker the second night.
- Active promotional campaigns will be undertaken within Government agencies, but not within commercial organizations.
- The main purpose of the Symposium will be to facilitate interaction among the various groups.

At the conclusion of the discussion, Dick Belt directed each Working Group Chairperson to provide the PIC with a preliminary agenda outline for the Symposium before close of business Tuesday, November 19.*

CHEMICAL WORKING GROUP REPORT

Loyd Doering, Chemical Working Group Chair, presented the Chemical Working Group overview. Mr. Doering noted that program funding would probably not be available for most programs. One contract has been awarded, and one project (the Interceptor Battery Program [A1503]) has been funded.

Mr. Doering noted that the Chemical Working Group's last meeting, held in the Spring at Sandia National Labs, was very successful. Approximately 42 persons attended that function.

Dr. Carl Mueller asked Mr. Doering to explain how the Chemical Working Group structured its meetings, and whether Mr. Doering believed that structure contributed to the success of the meetings. Mr. Doering explained that the Working Groups' meeting structure was primarily programmatic, but there was a forum for current/relevant presentations to be offered from the private sector. He also noted that the Chemical Working Group always had two full days of meetings, and that these were well attended.

NUCLEAR WORKING GROUP REPORT

Lt.Col. Chip Martin, Nuclear Working Group Chair, presented that Group's overview.

Lt.Col. Martin noted that membership for the group stood at 49 (up from 31 in August, 1989), and 30 Nuclear Briefs are on-line at the PIC. A review of the last SNP Symposium proceedings for candidate briefs is being undertaken, and Tom Lamp is reviewing the last IECEC proceedings for candidate briefs. This information will be passed to the PIC for development of new briefs and follow-up by letter.

The fall meeting was canceled due to problems with travel money and conflicts with other meetings. The spring meeting will be held in conjunction with the April IAPG Symposium.

The agenda for the Spring Meeting (30 March - 2 April, 1992) includes:

- Nuclear Working Group Theme: "Materials and Modeling"
- MHD Working Group invited to submit topics.

Tom Lamp, Vice-Chair for the Nuclear Working Group, presented a proposal for a new Nuclear Working Group Newsletter to be produced with the assistance of the PIC. The first issue is

* Action Item

planned for release in January, 1992, and will consist of 4 pages and 5 sections. He expects this newsletter to encourage involvement and interest in the Group.

MECHANICAL WORKING GROUP REPORT

Dick Shaltens, Mechanical Working Group Chair, presented the report.

Mr. Shaltens reviewed organizational changes in the Group that had been proposed during the Fall 1990 Working Group Session. He noted the appointments of a new Chair and Vice-Chair, as well as the restructuring of the Group into three new panels.

Mr. Shaltens reviewed the Steering Group Meeting at Ft. Belvoir, at which a reorganization was proposed, and recommendations for Chairs and Vice-Chairs were made. A new test for the panel descriptions was proposed and accepted.

Mr. Shaltens then reviewed the May 2, 1991 meeting in Cleveland:

- The minutes of Summer 1990 meeting were ratified.
- Steering Group approval of reorganization narrative was reviewed
- Planned fall meeting to be determined
- 1992 Symposium was discussed
- Mechanical Working Group and Panels decided not to go ahead with Fall meeting because of the work involved for the Spring Symposium.
- Overview of the power programs at NASA Lewis was given.
- Aerospace Power Panel presented several papers.
- Speaker at the dinner reviewed NASA research over the years.
- More papers were presented the following day.
- Meeting was well-attended and highly interactive.
- Terrestrial Panel presentations focused largely on applications of components rather than R&D.
- Rotation of meeting locations discussed to encourage attendance.

Mr. Shaltens noted that the Chair for the Aerospace Power Panel has not been filled and continues to be an open action item.**

ELECTRICAL WORKING GROUP REPORT

Gene Schwarze, Electrical Working Group Chair, presented the report. He thanked the groups and panels that were involved in the meeting over the past days. He noted that the Solar and Systems working Groups joined the Electrical Working Group for their meeting on Tuesday. Mr. Schwarze mentioned the absence of Mr. Howard Stevens, originally scheduled to present the

** Action Item

Navy Overview for Electrical Power Distribution: Mr. Stevens was unable to attend due to a family emergency. Following a brief review of the Business Meeting and Plan for the Spring Meeting, he went over topics from the Working Group Meeting, mentioning the Navy, Army, and Air Force overviews, and the NASA Lewis Overview presented by Dr. Bercaw.

Pulsed Power Panel Overview

Mr. Singh made note of the excellent presentations that had been given over the past two dates of meetings. Mr. Singh hoped that, in the future, he would be able to secure relevant program overviews from each program branch.

Superconductivity Panel Overview

Dr. Guido Guazzoni, Co-Chairperson of the Superconductivity Panel commented on the excellent presentations that had been made over the past two days of joint meetings.

Dr. Guazzoni noted that during the past fiscal year he had many opportunities to interface with other agencies, especially DARPA. He encouraged the membership to participate more when such interagency opportunities were presented.

Dr. Guazzoni solicited assistance from the meeting participants concerning identification of potential users of "bulk" materials. He noted that DARPA was finding it difficult to justify support for its superconductivity "bulk" materials programs when it cannot identify users. DARPA supports superconductivity programs with approximately $25 million ($8-9 million for High Temperature Building Materials). A short discussion ensued regarding various users within Navy programs.

Power Conditioning Panel

Dr. Gil Garduño noted that the Power Conditioning Panel plans to continue to maintain an active status, as was exemplified by the excellent speaker at the meetings over the past two days. Dr. Carl Kellenbenz remains the Intelligent Power Subcommittee's Chairperson. Dr. Garduño pointed out that the Intelligent Power Subcommittee continued to maintain its Power Notebook, and a current vendor product list. He also mentioned that they had given a demonstration program to show technology and intelligent power at the Spring Meeting. PIC briefs have been added to the database, and a dialogue interchange with the Power Semiconductor Research Center in North Carolina has been set up.

High Temperature Subcommittee

Dr. Gil Garduño noted that the High Temperature Electronics Subcommittee still does not have a Chairperson: that remains an open action item.***

Dr. Garduño briefly identified three high-temperature programs: Compassitors at Wright Patterson; Magnets at NASA Lewis; and a Switch Program at both Wright Patterson and NASA Lewis. He stated that efforts to identify applications for these programs outside NASA continue, but few have surfaced to date.

SOLAR WORKING GROUP REPORT

Mr. Ted Mroz, Solar Working Group Chair, presented the Solar Working Group's overview. He noted that there were no minutes available from the Spring meeting, which was held in May in conjunction with the SPRAT conference. Mr. Mroz mentioned that Mr. Michael Piszczor had been nominated as Chairperson for the Solar Photovoltaic Panel, replacing retiring Dr. Mort Prince. Mr. Piszczor chaired a successful Fall meeting this past October, held in conjunction with the IEEE PVSC Conference in Las Vegas, NV.

Mr. Mroz commented that Dovie Lacy was no longer Chairperson of the Solar Thermal Panel and that he will continue to identify a candidate.****

SYSTEMS WORKING GROUP REPORT

Mr. William Baker presented a general overview of the Systems Working Group, noting that the membership continued to be active and interested in the programmatic exchanges presented at the meetings. Mr. Baker believes the Systems Working Group is of interest and fairly applicable to each Working Group.

BUSINESS MEETING

Mr. Richard Belt conducted a short business meeting. He noted that Mr. Ted Mroz had been selected to Chair the Solar Thermal Panel. Mr. Belt proposed Mr. Michael Piszczor for Chairperson of the Solar Photovoltaic Panel, replacing Dr. Mort Prince who retired as of May 9, 1991. The proposal was brought to the floor for a vote and a motion was made and carried to select Mr. Piszczor as Chair of the Solar Photovoltaic Panel.

Mr. Belt reminded the Working Group Chairpersons that their Groups' plans and recommendations concerning the April meeting need to be into the PIC by close of business

*** Action Item

**** Action Item

Tuesday, November 20, 1991. Mr. Belt also reminded the PIC that the Chairpersons had requested that copies of the presentation materials collected from individual speaker be mailed to the meeting participants as soon as possible after the conclusion of the meeting.*****

The Meeting adjourned at 3:25 pm.

***** Action Item

ACTION ITEMS	RESPONSIBLE PERSON(S)
FAX Presentation to PIC Center by COB Tuesday, Nov. 20, for forwarding to Dick Belt	Group/Panel Chairs Judy Hanst, PIC
Search for Chair of the Aerospace Power Panel	Dale Houser
Search for High Temperature Electronics Subcommittee Chairperson	Gil Garduño
Search for Solar Thermal Panel Chairperson	Ted Mroz

LIST OF APPENDICES

SECTION 4

1992 SPRING SYMPOSIUM

ALEXANDRIA, VA

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WELCOME AND INTRODUCTION

Mr. Richard N. Belt of the U.S. Army, Belvoir RD&E Center who is also the IAPG Steering Group Chairman, welcomed everyone to the meeting. Mr. Belt gave a short outline of how the meetings were to be conducted over the next two days, noting that parallel meetings would be in session in two separate meeting rooms. He said he was encouraged at the number of participants and was certain everyone would benefit from the various speakers slated to do presentations.

Mr. Belt introduced the Power Information Center's Program Manager Ms. Judy Hanst and commended her on the efforts put forth in bringing the details of the Symposium together.

Mr. Belt asked the audience if there were any questions relative to the Symposium. When no questions were asked, he introduced the keynote speaker, Dr. John B. Mock who is currently Director of the U.S. Department of Energy's Geothermal Division.

KEYNOTE ADDRESS

Dr. John E Mock, Director of the U.S. Department of Energy's Geothermal Division presentation on "Geothermal Power-Tapping the Heat of the Earth" which addressed the energy needs and potential energy resolutions of the future. The National Energy Strategy estimates that approximately 200,000 MWe of additional capacity may be needed by the year 2010 to meet projected demand. This is in addition to replacing existing power plants that will be retired over the next two decades. Only about 25,000 MWe of this new capacity are under construction or committed in the form of large thermal power plants. This means that over 175,000 MWe of new generating capacity are open for employing "non-conventional", advanced, or alternate energy technology.

Geothermal technology can play an important role in satisfying this projected capacity shortfall, especially in the West and Northwest where the best geothermal resources lie. Geothermal energy technology, which uses the heat of the earth to "fuel" stem turbines, is already supplying about 3000 MWe commercially in the U.S. and twice that worldwide. Geothermal power already supplies approximately 7% of California's annual demand. The Energy Information Administration estimates that geothermal power can supply about 23,000 MWe by the year 2030 with high levels of R&D ---

46,000 MWe with even more aggressive R&D programs. Even partial realization of these estimates can go a long way towards meeting our national goal of a secure, stable, and economically competitive energy mix. In addition, geothermal technology offers significant environmental benefits over conventional fossil-fueled power generation since it results in minimal or zero releases of gases that contribute to such phenomena as global warming and acid rain.

The Geothermal Division of the U.S. Department of Energy (DOE/GD) is the lead agency charged with sponsoring research to eliminate critical technical impediments to the accelerated and expanded use of this valuable renewable energy resource. its portfolio covers R&D in four major types of geothermal resources for power production, namely: hydrothermal, geopressured-geothermal, hot dry rock, and magma energy. In addition, an important new initiative focuses on the direct use of geothermal heat pumps for residential, commercial, and industrial uses. DOE/GD R&D projects address key problems in resource identification, definition, and management; energy extraction; conversion; and transmission and distribution. The range of research initiatives and the multi-disciplinary approach required to successfully meet program objectives create an interesting potential for interagency information exchange, R&D collaboration, and technology transfer.

Solar Working Group
Solar Thermal Panel
Session 1A, Morning
March 31, 1992

SOLAR WORKING GROUP OVERVIEW

Mr. Ted Mroz, of NASA Lewis Research Center, who is the Solar Working Group Chair, presented the "Working Group Overview." He gave a short overview of the general purpose of the Interagency Advance Power Group and the Solar Working Group in particular. Mr. Mroz referenced the various aspects of solar energy noting the renewed emphasis on solar thermal terrestrial power and advance solar thermal power in space. He presented a visual outline of the Panel's schedule for that morning, pointing to the subject matter of the two guest speakers and calling attention to the fact that the main thrust in Solar Thermal Energy research and development were primarily supported by DOE and NASA.

Mr. Mroz introduced the group's first speaker, Mr. Miles Dustin.

ADVANCED SPACE SOLAR THERMAL POWER

Mr. Miles O. Dustin, of Sverdup Technologies, began his discussion by noting that the presentation subject matter would specifically address the "Advanced Space Solar Thermal Power" project of the solar dynamic space power system under development at NASA Lewis Research Center. This system's primary application appears two fold: (1) use in small communication and observation satellites and (2) Earth orbiting platforms. Mr. Dustin critique the qualitative benefits of each application. In support of the systems applications overview, Mr. Dustin stepped through design configuration of the thermal dynamic module including the solar concentrator. He reviewed the extensive test methods used to establish system viability, including the fact that components testing included underwater assembly. A short summary of the programs major accomplishments over the past seven years was given with references to what accomplishments were expected to result in the future. Mr. Dustin concluded his review with a description of a 2kW Ground Demonstration that is being managed out of NASA Lewis Research Center. This test, which will consist of a concentrator, receiver, radiator, Brayton heat engine and necessary controls, will be carried out in a 25 foot diameter vacuum tank at Lewis. Mr. Dustin noted that this development program had just come under contract as of the week of March 23rd and the its duration was 4 years.

DOE TERRESTRIAL SOLAR THERMAL PROGRAMS

Mr. Gary D. Burch, Director of the Solar Thermal and Biomass Power Division at DOE, presented an overview of the "DOE Terrestrial Solar Thermal Programs." Mr. Burch spoke of DOE's mandate to identify sources of energy to support the need for alternative/renewable energy. He reviewed future projections of power use and noted projected forecasts for supporting those needs. Mr. Burch's bottom line prognosis was that the U.S. does not currently have the resources to meet the energy needs of its population without utilizing alternative energy sources. He cited various trends nationally, including the energy incentives incorporated by some states to encourage conservation. He also stated DOE's prospective of encouraging the commercial sector to partner with Government in commercially addressing the solutions to our energy problems. Mr. Burch noted a report DOE had recently released, SOLAR 2000, which outlined that kind of collaborative strategy via technology development and validation, market condition and joint-venture project activities. Mr. Burch reiterated DOE's commitment to identify an energy "nitch" and to support that "nitch."

Mr. Burch also took this opportunity to present an overview of DOE's Biomass Program. DOE's summation of the last decade was that the '80's was the age of Technological Progress. DOE's commitment for the next decade is to make the '90's a Decade of Commercialization. Mr. Burch noted that DOE is encouraging a shift from CO_2 energy w/emission to Biomass Power. He reviewed DOE strategy, near term goals and mid to long term goals set to accomplish such commercialization. Mr. Burch reiterated that DOE views the Biomass Power potential as the most plausible solution to our long term energy needs which offers the least negative environmental impact and the most positive employment opportunities.

SOLAR THERMAL PANEL'S BUSINESS MEETING

The Solar Working Group's Chairman, ***Mr. Ted Mroz*** brought the business portion of the agenda to order. He briefly reviewed an IAPG organizational chart, giving a short summary of each working group and specifically referencing the Solar Working Group.

Mr. Mroz noted that the IAPG's secretarial/administrative support was given by the Power Information Center (PIC) and asked Ms. Judy Hanst, Project for PIC to give a short overview of the kinds of support the PIC offers its IAPG members both administratively and technically. Ms Hanst spoke for a short time and briefly outlined the PIC's responsibilities.

Mr. Mroz introduced the group's vice chair Mr. Chris Garner of the Naval Research Lab. Mr. Mroz noted that no candidate has been identified to chair the Solar Thermal Panel and therefore remains as a committee action item* He mentioned that he was hoping to fill this position with a representative from the Department of Energy. Mr. Mroz pointed to the fact that the technical area relative to Solar Thermal concerned both Space and Terrestrial and that the Solar Working Group needed more interaction with regard to terrestrial programs. He would continue to endeavor to identify a candidate with DOE with technical emphasis on solar terrestrial programs.

Mr. Mroz asked the membership for comments and ideas concerning how to increase working group participation. Chris Gartner was tasked with an action to solicit suggestions on how to increase meeting participation and more clearly define the term "Solar" as it applies to various program and applications.* Mr. Mroz added that he would like to have the membership offer their perspective and gave everyone his telephone number.

* action item

Mr. Mroz discussed the regular scheduled Solar meeting which are held semi-annually. He asked that the memebership consider potential locations for the next Solar Thermal Panel Meeting and to let him know their suggestions. With no further discussion needed, the meeting was adjourned.

Solar Working Group
Solar Photovoltaic Panel
Session 1A, Afternoon
March 31, 1992

SOLAR PHOTOVOLTAIC PANEL OVERVIEW

Mr. Michael Piszczor, of NASA Lewis Research Center, presented the "Solar Photovoltaic Panel Overview." Mr. Piszczor introduced himself as the chairman of the Solar Photovoltaic Panel. He then briefly reviewed the agenda. Mr. Piszczor mentioned that he had requested from the PIC send him copies of some historical meeting minutes from previous years. He showed a viewgraph of the cover sheet of meeting minutes from February, 1962, from the Solar Working Group Conference, along with a Table of Contents from that meeting. Mr. Piszczor noted that some things has not changed much in 30 years of photovoltaics research and concluded by acknowledging that most of the testing procedures discussed in that 1962 Solar Working Group conference are still being used today.

Mr Piszczor introduced the panel's first speaker Dr Gary Bennett.

NASA SPACE POWER PROGRAMS

"NASA's Space Power Programs" were discussed by ***Dr. Gary Bennett, NASA Headquarters***. Dr. Bennett addressed the space power research and technology program sponsored by NASA's Office of Aeronautics and Space Technology (OAST). The objective of the OAST space power research and technology program is to provide a technology base to meet system requirements for future space missions, including growth space stations Earth orbiting spacecraft, lunar and planetary bases, and solar system exploration. The NASA space power research and technology program encompasses photovoltaics, chemical energy, thermal-to-electric energy, conversion, power management and focused programs such as space nuclear power (SP-100 space nuclear reactor power system), solar dynamics, and high-capacity power.

FUTURE DIRECTIONS FOR SPACE PHOTOVOLTAICS IN NASA

In his discussions on the "Future Directions for Space Photovoltaics in NASA," ***Dr. Dennis Flood, of NASA's Lewis Research Center***, outlined the future directions for the advanced space photovoltaic research and development in the Agency. He stated that there were at present two distinct technology paths being pursued. One is toward high power per unit mass array technology, and the other is toward high power unit area array technology. The former will use either thin single crystal cells mounted on lightweight substrates, or thin film cells on flexible substrates. The latter approach incorporates high efficiency multiple bandgap cells operating under concentrated sunlight. NASA has plans for a ground test demonstration of a concentrator array in 1998. Dr Flood also stated that one of NASA's major concerns for near earth applications is solar cell survivability in the natural environment, especially in those regions of near earth space with a high population of trapped electrons and protons. Concentrator arrays can offer advantages in that regard by providing more protection to the cell without adding significant weight to the satellite.

Dr. Flood indicated that NASA has not been interested in thin film cells because of the efficiencies are lower than single crystals cells. Studies have indicated that 10% efficiencies (at AMO) are needed before they become competitive for most orbital space applications. He noted that when the possibility of going to the moon or the Mars arose, the Agency became interested in flexible thin film cell technology. The primary reasons are 1) the fact that thin film cells can be stowed in small volumes during transit, and 2) lunar or Martian surface applications are not limited by area considerations, so lower efficiencies are acceptable, provided the mass is sufficiently low

THE PHOTOVOLTAIC POWER PROGRAM IN THE MILITARY

Dr. Inara Kuck, US Air Force, spoke on "The Photovoltaics Power Program in the Military." She mentioned that there have been a lot of changes in the military requirements and that the trend is toward lighter weight, lower cost, proliferated systems. She explained that the technical approach will be to consider the total system design, adopt flexibility, use innovative methods, components, and materials, and think in terms of overall "life cycle" of the technology. Dr. Kuck also emphasized the importance of flights for technology transition.

THE DEPARTMENT OF ENERGY'S PHOTOVOLTAIC ENERGY PROGRAM

"The Department of Energy's Photovoltaic Energy Program" was discussed by ***Dr. Morton Prince of DOE***. He illustrated the program by using slides. Dr. Prince began by describing the major reorganization of the Photovoltaic Division of DOE. He then introduced the changes that were made to the division. Dr. Prince outlined the Core Program to include: Crystalline Silicon, Amorphous Silicon, Polycrystalline thin cells, III-V cells, Concentrator Cells and Modules, Characterization and Testing, Insulation Research, and Environment, Safety, and Health (ES&H). Dr. Prince then described the three phases of Photovoltaic Manufacturing Technologies. These phases are: (A) 22 contracts, $50,000 each; opportunity for manufacturers to review their production lines and recommend both proprietary and non-proprietary ideas for improving the quality of the products and reducing the cost; (B) Approximately 6 contracts for 3 years on a cost sharing basis (up to 50%); (C) 2 or 3 contracts for generic research in areas of interest to more than one manufacturer. Dr. Prince also reviewed the Market Stimulators. The first of these stimulators is Photovoltaics for Utility Scale Application (PVUSA). Phase I includes 8 emerging technology installations and 3 utility sized installations. Phase II has a 20 KW installation being considered, and a 500 KW installation being considered for utility validation experiment. Additional Market Stimulators include CORECT and Finesse activities, and photovoltaics in building activities. Lastly, Dr. Prince briefly discussed the U.S. Photovoltaics budget for years 1990 through 1993.

RECENT ADVANCEMENTS IN TERRESTRIAL PHOTOVOLTAICS

The National Renewable Energy Laboratory's (NREL) Mr. John Benner presented "Recent Advancements in Terrestrial Photovoltaics." Mr. Benner began by stating that the funding history for NREL's Photovoltaics peaked at $120 million in the early '80's. He went on to say that approximately 50% of money goes to industry and university subcontractors. Mr. Benner stated that commercial Photovoltaic module cell efficiencies have risen from 6% to 7% in the late '70's, to 10% in the mid '80's, and now 12% to 13% efficiency. In the same period, research has improved the efficiency of advanced solar cells from about 20% efficiency to more than 30% efficiency. A new thrust of the Photovoltaic Program, as described by Mr. Benner, is to establish multi-year, cost-shared government/industry partnerships to improve on manufacturing technology through competitive procurements. This project called PVMat includes supporting company specific R&D on industry-selected manufacturing technology issues, and the support to teamed R&D on industry-identified common manufacturing problem areas.

PHOTOVOLTAIC APPLICATIONS FOR THE 1990

Mr. Rick Sellers, of Solar Energy Industries Associates, reviewed the "Photovoltaic Applications for the 1990's." Mr. Sellers expressed that Photovoltaic research performed by the government has been more than twice matched by the U.S. industry. The industry share, according to Mr. Sellers, is about 2.25 billion dollars since the mid 1970's. He explained that this has resulted in tremendous pricing improvements, quality improvements, and quantity improvements. Photovoltaic Power progress has improved in efficiency and decreased in price. Mr. Sellers noted that the life expectancy of a module deployed in the field now averages about 24 years. The hopes of the Photovoltaic industry rests in 2 places; one in the international market, and the other is in the U.S. utility industry. Mr. Sellers reiterated that the forces that are now driving Photovoltaic commercialization are the national programs around the world, and the changing parameters of the U.S. utility industry.

THE PHOTOVOLTAIC ARRAY SPACE POWER PLUS DIAGNOSTICS (PASP PLUS)

Capt. Brian Maxwell, of the U.S. Air Force, presented "The Photovoltaic Array Space Power Plus Diagnostics (PASP Plus) Flight Experiment." Capt. Maxwell began by stating that Photovoltaic Power is now, and will remain, the main source of power for the Air Force and DoD Space Missions. He outlined the PASP Plus objectives as: characterizing the electrical performance of advanced technology solar arrays, to include the investigation of array arcing and current leakage effects during high voltage biasing; the determination of long term radiation degradation on the solar arrays; and the flight qualification of new array designs. The solar array technologies to be tested on the PASP Plus mission includes standard and advanced Silicon Based designs, next generation Gallium-Arsenide arrays, new material compositions, and survivable concentrator designs.

SOLAR PHOTOVOLTAIC PANEL BUSINESS MEETING

Mr. Piszczor brought the business portion of the agenda to order. He presented a motion to ratify the minutes of the last Solar PV meeting, which was held October 9, 1991 at the Photovoltaic Specialist Conference (PVSC) Las Vegas, Nevada. A discrepancy was noted in the draft minutes: PMAT should have been PVMat. With this correction recorded the motion was seconded and carried.

Mr. Piszczor noted that the next Solar PV meeting will be held on Thursday, October 22, 1992 in conjunction with the Space Photovoltaic Research and Technology

(SPRAT) Conference held at the NASA Lewis Research Center in Cleveland, Ohio. He said that he would send the membership a meeting notice prior to that date as a format and content for the October meeting.

There was a short discussion regarding the general impressions on how the Symposium was going. Ms. Kathy Mould of the IPAG Power Information Center's secretariet staff informed Mr. Piszczor that a survey would be sent out soliciting comments from the Symposium participants at its conclusion. Mr. Piszczor asked that the membership please be consciencous in resonding the survey. With no further business to pursue, the meeting was adjourned.

Systems Working Group
Session 1B, Morning
March 31, 1992

WELCOME AND PROGRAM OVERVIEW

Mr. William Baker, of the Naval Research Laboratory, who is the Systems Working Group Chair, conveniened the meeting and welcomed the participants. Mr. Baker summarized the IAPG's purpose pointing out that it is primarily a vehicle for information exchange of research and development information between member agencies and that as such strives to avoid duplication of efforts and expense and to enhance the development of projects and programs.

Mr. Baker introduced the groups's first speaker, Mr Patricia Tiernan.

DARPA POWER SYSTEMS PROGRAM

The "DARPA Power Systems Program" was the first topic of discussion and was presented by ***Ms. Patricia M. Tiernan of Space Applications Corporation*** for DARPA, and ***Dr. Frank Jankowski of Phillips Laboratory.*** Ms. Tiernan addressed the Space Applications Corporation for DARPA sponsored project: Photovoltaic Space Power Generation Using Holographic Wavelength Separating Concentrators. As stated by Ms. Tiernan, the objective of this project is to reduce the weight and increase the power density by 30% and 43% respectively through the use of flexible thin-film concentrators. She explained that there will be several phases to the Holographic Concentrator, and Phase I was just completed in August, 1991. Phase I demonstrated the feasibility of fabricating thin-film holographic solar energy concentrators for integration with Photovoltaic Arrays for satellites. Ms. Tiernan went on to introduce Phase II, which began in March, 1992, and will fabricate 1m^2 concentrator system.

Dr. Jankowski of Phillips Laboratory spoke regarding the Inflatable Torus Solar Array Technology Demo (ITSAT Demo). He noted that Phase I of this DARPA sponsored project was completed and the inflatable rigidized structure demonstrated ITSAT superior mass/volume characteristics however amorphous silicon cells was found inadequate. Dr. Jankowski went on to state that Phase II will be starting in April, 1992, and plans to fabricate and space qualify a Crystalline Silicon APSA-type Array by June, 1993. Phase III plans to integrate the ITSAT (Demo) with spacecraft in 1994, with a one to three year test in space. Dr. Jankowski expressed that, for small power needs, the ITSAT has promise to provide more power per kg mass and will be far superior to those small satellite used today.

SDIO POWER SYSTEMS PROGRAM

Dr. Mitch Nikolich, of W.J. Schafer & Associates, discussed the "SDIO Power Systems Program." He began by saying that it is the objective of the SDIO Power Systems Program to generate baseload power requirements for multi-year operation and burst power requirement for 100's - 1000's of seconds of operation. He explained that the way to improve power system specific mass is to move to higher frequency power conditioning and power management for space. Dr. Nikolich stated that they are seeking a low-cost method and program to develop a power system hardened for nuclear and chemical threats as well as natural environments. He added that power requirements for space systems have grown tremendously. Not only has the need to develop technology grown for the civil sector, but defense wide as well. Dr. Nikolich recounted that the SP100 has been the national Space Reactor program since 1983. However, we have learned alot from the Soviets regarding the Topaz Reactor and believe we can reduce our cost and improve our schedule, concept, technology and knowledge, if we purchase the Soviet Topaz Reactor. SDIO's current strategy is to not invent new technology, but to integrate already existing technology.

USAF PHILLIPS LABORATORY POWER PROGRAMS

The "USAF Phillips Laboratory Power Programs" were presented by ***Lt. Col. E. Herrera, U.S. Air Force.*** Lt. Col Herrera gave a basic overview of Phillips Laboratory. He recounted that Phillips Laboratory was first presented to the IAPG in November, 1991. The laboratory was established as recently as the fall of 1990 as an organization responsible for space power and thermal management in DoD. Lt. Col. Herrera explained that the philosophy of the organization is to take high risk/high payoff with

full technology life cycle development and deliver technology for flight in three to five years. He outline the three systems currently being developed as: (1) Convention Power (develop technologies to triple power efficiencies and halve cost of SOA); (2) Thermal Management (develop lightweight, long-life, affordable thermal control system); and (3) Space Nuclear Power (develop and flight test space nuclear power systems).

NASA LeRC POWER SYSTEMS PROGRAMS

Mr. J. Nainiger, of NASA Lewis Research Center, addressed the "NASA LeRC Power System Programs." He began by expressing that LeRC is NASA's lead center for space power which is responsible for Technology - Office of Aeronautics and Space Technology (Code R), Development - Space Station Freedom Power System and Space Exploration Initiative. Mr. Nainiger explained that, at present, the fuel cell,lunar base and environmental interactions (EPSAT) are getting alot of attention. LeRC is currently involved in many national power technology programs in conjunction with DOD, DOE, SDIO, and NASA. Mr. Nainiger recounted that they are responsible for developing the power system for the Space Station Freedom Restructured Program through the year 2000. He noted that testing will be done at the Lewis facility. Mr. Nainiger addressed that there are many LeRC SEI Power Systems Studies on-going at this time, along with cooperative studies with DOE. Conclusions and applications for Solar and Nuclear Power Systems for lunar base application, Solar Photovoltaic Power Systems Designs, Nuclear Power Systems Designs, and Rover Power System and Beamed Power System Evaluations, as well as Antarctic Space Analog Remote Power System Application were also discussed.

NSWC CRANE POWER SYSTEMS PROGRAM

The topic of discussion given by ***Mr. Harry Brown, of the Naval Surface Warfare Center*** was "NSWC Crane Power System Programs." Mr. Brown explained that the Naval Surface Warfare Center (NSWC), Crane Division, performs mostly test and evaluation of batteries, but also provides to DoD battery engineering and material analysis. Mr. Brown discussed the battery involvement from development to disposal. He expressed that the complete support throughout the lifecycle of the battery would include development/standardization, qualification, production, in-service support, surveillance, and disposal. Mr. Brown gave examples of a vast array of weapon, shipboard and miscellaneous systems supported by the Crane Division. The specific

projects discussed were limited to the testing at Crane sponsored by the Navy, NASA, and the Air Force Aerospace programs. The mission, sponsors, cell compositions, testing and development, and future efforts of the Aerospace Power Systems Programs were discussed. The emphasis was placed on their mission to provide an unbiased test and evaluation of electrochemical power sources used in satellite and other electronic devices with emphasis on certification and long term cycling performance.

DOE SOLAR POWER PROGRAMS

Dr. Robert A. Stokes, of the National Renewable Energy Laboratory, introduced the "DOE Solar Power Programs." Dr. Stokes presented information regarding the generation of electricity from Photovoltaic, Solar Thermal, and wind. He recounted statistics on the energy flows and distribution to industry, buildings and transportation. According to Dr. Stokes, the program mix has shown redirection to sectors from technologies, market conditioning, and research and development. A strong position has been taken to be more industry-driven than government-led. Dr. Stokes presented graphs to show the cost of electricity from wind, Solar Thermal, and Photovoltaic technologies. He also referenced statistics regarding availability, capacity, efficiency, and industry investment. There has been tremendous progress in the Photovoltaic area with a substantial drop in price and increase in lifetime. The efficiency of sunlight to electricity, as Dr. Stokes stated, is improving immensely, especially since Photovoltaics works even on a cloudy day.

SYSTEMS WORKING GROUP BUSINESS MEETING

Mr. William Baker, Systems Working Group Chair, conducted a brief business meeting. He asked that the membership, upon conclusion of the Symposium, send him comments regarding their individual impressions of the Symposium. Ms. Kathy Mould of the PIC secretariat informed Mr. Baker that a survey would be sent participants soliciting comments would be mailed subsequent to the conclusion of the Symposium. The meeting was then adjourned.

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Mechanical Working Group
Terrestrial Power Panel and Thermal Management Power Panel
Session 2A, Morning
April 1, 1992

WELCOME & INTRODUCTION

Mr. Phil Colegrove, Wright Patterson and Mechanical Working Group Vice-Chair conveniened the meeting and welcomed the attendees. In the interest of keeping to the agenda schedule Mr. Colegrove kept his remarks brief and introduced the first speaker in the Terrestrial Power Panel, Mr. Scott Coombe.

ARMY'S TACTICAL QUIET GENERATOR PROGRAM

Mr. Scott Coombe, Project Engineer, of the Power Generation Division at ***US Army Belvoir Research, Development and Engineering Center*** presented an overview of the "Army's Tactical Quiet Generator Program (5-60 kilowatt)." Mr. Coombe reviewed five (5) specific generator units and briefly outlined each units development stage. He noted that the program's aim was to replace currently fielded units which do not meet new Army requirements for reliability, noise, and nuclear survivability.

Mr. Coombe reiterated that the government is extremely conscious of the constricting requirements of these generators. The general aim is to replace each field unit with a generator of the same dimensions with lower weight, less noise and easier to maintain. He also said in addition to attempting to accomplish these goals another aspect was to try to use the same trailers and towing vehicles for field interchangeability. He called attention to the fact that more than 16 months of reliability testing has been done on 30 generators sets. Mr. Coombe concluded his presentation by reviewing extensive fact sheets in the specific hardware configurations and production status regarding the generator program. These fact sheets are included in the presentation index of these minutes.

DIESEL ENGINE ADVANCEMENTS

Detroit Diesel's Government Sales Program Manager, Mr. Walter R. Ward gave an extensive overview of his company's "Diesel Engine Advancements." Mr. Ward was accompanied by Mr. Roman Gawlowski, Senior Applications Engineer, also of Detroit Diesel. Mr. Ward gave a short review of the company; where it is physically located, its' current involvement is in the market place and where its expertise lies in the diesel engine manufacturing arena.

Mr. Ward concluded his portion of the presentation and introduced Mr. Gawlowski who then presented a detailed overview of Detroit Diesel's "state of the art" electronic engine control and monitoring system, "DDEC". Mr. Gawlowski overview included engine's from 5-2340 hp. He presented a concise analysis of current diesel control technology.

COMPOSITES FOR GENERATORS

Dr. John W. Gillespie, Jr., Senior Scientist and Associate Director at the University of Delaware Center for Composite Materials, began his presentation on "Composites for Generators" with a brief background on the Center for Composite Materials (CCM). The Center was established at the University of Delaware in 1974 in response to industrial interest in solving applications problems. CCM began its current interaction with the Army in 1986, upon award of a five-year ARO/URI grant to establish a Center of Excellence for Composites Manufacturing Science, Reliability, and Maintainability Technology; in 1992, the Center was awarded a second five-year grant under the same program. CCM has also had extensive interaction with individual Army labs and other organizations. It was through such collaboration that the generator project, managed by Dave Vaughn at the Fort Belvoir RD&E Center, was initiated.

The goal of the project was to design a generator housing that would be both lighter in weight and quieter than the current aluminum-frame version. The work was conducted according to a concurrent engineering approach, in which the manufacturing process, the materials, and the design of the structure itself were addressed simultaneously. Undertaken by a group of senior design students co-advised by Gillespie and Vistasp M. Karbhari, Associate Scientist at CCM, the project resulted in a generator that exceeded the initial goals, with the sound level reduced by 10 decibels and the weight by 12 pounds over its non-composite predecessor. Weight reduction was only partly attributable to the new housing — the researchers also replaced the flywheel of the generator itself with composites.

"This significant reduction of noise and weight could be brought about only through the use of composites," said Gillespie. "Our work in this area is indicative of the multifunctionality of composites. The project was an excellent example of the effective collaboration that we have developed with the Army. The Center plans to continue to transfer this technology to industry for use in the manufacture of products for Army use — in effect, completing the technology transfer loop."

SUBSYSTEM INTEGRATION TECHNOLOGY (SUIT) PROGRAM

Mr. Bill Haskin, Wright Patterson Air Force Base, presented an overview of the "Subsystem Integration Technology (SUIT) Program" sponsored by Wright Laboratory. Mr. Haskin stated that the objective of this program is to significantly improve the performance and affordability of future military aircraft through physical, functional, energy, and control integration of the utility subsystems. He explained that three parallel study contracts are in progress and will be completed by September, 1992. A Program Research and Development Announcement (PRDA) is to be issued in the summer of 1992 for one or more new contracts to begin to develop selected subsystem suites. Mr. Haskin noted that a validation and demonstration program is planned to start in 1996.

SPACE STATION THERMAL CONTROL TECHNOLOGY

Mr. John Thornborrow of Johnson Space Center, presentation detailed "Space Station Thermal Control Technology". Mr. Thornborrow noted that The Space Station Freedom (SSF) External Active Thermal Control System (EATCS) consists of 3 two-phase isothermal ammonia loops which provided low temperature (33 to 39°F) or moderate temperature (55 to 62°F) cooling to all section of SSF. He reiterated that these loops accommodate multiple loads and varying heat flux densities at various temperature levels and locations. Electrical, metabolic, chemical, and environmental loads are acquired from heat acquisition devices and heat exchangers throughout the station. As heat is absorbed, liquid ammonia is vaporized thus utilizing the high heat of vaporization of the fluid. Mr. Thornborrow pointed out that the heart of the transport system is the Rotary Fluid Management Device which is able to separate two-phase mixtures into liquid and vapor phases. The vapor is then pumped to the flow - through condensing radiators where the heat is rejected to deep space. the EATCS is capable of acquiring 246.7 kW of heat from various locations. The baseline heat rejection level for the SSF is 82.5 kW since all heat loads will not be applied simultaneously.

ANALYTICAL MODELING FOR TWO-PHASE THERMAL SYSTEMS

Dr. Jentung Ku of NASA Goddard Space Center, presentation detailed NASA's program of "Analytical Modeling for Two-Phase Thermal Systems."

Dr. Ku presented an extensive review the computer programs currently used at tools in modeling and analyzing the CPL system outlining both the CPL modeler limitations and capabilities. Dr. Ku outlined aspects of various computer support programs available and gave a short analysis of his conclusions regarding existing software support.

EFFECTS OF HYDROGEN RECOVERY ON SYSTEM WEIGHT FOR SPACE BASED WEAPONS PLATFORM

The "Effects of Hydrogen Recovery on System Weight for Space Based Weapons Platform" was discussed by ***Mr. Eugene P. Hoffman, Wright Patterson Air Force Base.*** Mr. Hoffman presented that Space Based Weapons systems typically use large amount of stored liquid hydrogen for cooling purposes. He explained that, normally, this large amount of hydrogen far exceeds that hydrogen required to produce power. The materials Mr. Hoffman presented depicts a scheme for reducing the overall quantity of hydrogen required by the platform by recovering/recirculating some fraction of the hydrogen flowing out of the main cryo maintained load. As Mr. Hoffman emphasized, results show that, based on the NPB-FSD hydrogen usage configuration, on-board hydrogen could be reduced by as much as 50%.

Mechanical Working Group
Aerospace Panel
Session 2A, Afternoon
April 1, 1992

CSTI HIGH-CAPACITY POWER PROGRAM
CSTI HIGH CAPACITY POWER - THERMAL MANAGEMENT PROJECT ELEMENTS

Mr. Joe Sovie, NASA Lewis Research Center, was scheduled to discuss "CSTI High-Capacity Power Program." Mr. Sovie was unable to attend, therefore Mr. Al Juhasz also from NASA Lewis combined elements of Mr. Sovie's presentation with his own presentation. Mr. Juhasz discussed the CSTI High Capacity Power - Thermal Management Project Elements, with most concentration on Radiator Design and integration. He explained that the overall goal of the radiator system, which is now in Phase IV, is to have a 10 year life with higher mass, but lower cost. Mr. Juhasz compared sheet radiator with heat pipe radiator concepts. He expressed that the Stirling Power System is very well suited for integration with the liquid sheet radiator. The closed brayton power system cannot be readily integrated with the liquid sheet radiator, but is more compatible with the heat pipe radiator concept.

AIR FORCE PHILLIPS LABORATORY SPACE POWER PROGRAM

The "Air Force Phillips Laboratory Space Power System Thermal Management Program" was presented by ***Mr. Robert Vacek, Chief, Thermal Management Division, Phillips Laboratory.*** Mr. Vacek gave an overview of the business status for the personnel and facilities of Phillips Laboratory. He began by explaining that there have been a number of changes in the past 12 months, since the Air Force has had a major reorganization. Mr. Vacek expressed that the philosophy over the past 12 months focused on high risk/high payoff for a broad range of activities. He stated that Phillips is becoming more market driven to determine the user requirements and cover the full technology life cycle development. Mr. Vacek gave some background information for cryogenic cooling and the developments that must be met. His discussion noted that the biggest issue and main objective at this point is reliability since they want to produce sustained performance over the required operating life. He also expressed that one of the main goals of the Laboratory is the system trends that require new thermal control technologies. Heat transfer and dissipation with regard to radiator and heat pipes was discussed as well.

NUCLEAR ELECTRIC PROPULSION (NEP) SPACE POWER REQUIREMENTS

Mr. Michael P. Doherty of the Nuclear Propulsion Office (NPO), ***NASA Lewis Research Center***, outlined "Nuclear Electric Propulsion (NEP) Space Power Requirements." Mr. Doherty stated that the responsibility of the NPO is to identify, develop, and demonstrate NEP technologies to meet NASA advanced propulsion requirements. NEP can be justified for science missions by

its capability for outer planet rendezvous, reduced trip time, increased on-board power, and reduced sensitivity to launch date and mission opportunity. NEP's justification for exploration missions is reduced trip time and sensitivity to launch date for piloted planetary missions and reduced vehicle mass for both cargo and piloted missions. Mr. Doherty mentioned that the proposed budget may be increased over the next 5 years to allow major milestones to be met. There are a number of system development options, according to Mr. Doherty, including; a 5 MWe NEP module which would be the building block for SEI cargo and piloted missions, a lower power "fast track" system comprised of the 2.5 MWt SP-100 reactor and dynamic power conversion, and a "near term" system comprised of ion electric thrusters integrated with the SP-100 reactor with conductively-coupled thermoelectric power conversion. He stated that new policy at NASA Headquarters is leading the project to be focused on the near term system development option in response to user requirements from NASA's Office of Space Science and Applications.

Li/NaK PUMPED LOOP SPACE HEAT REJECTION SUBSYSTEM

Dr. Kent Koester of SPI was to give a presentation on the "Li/NaK Pumped Loop Space Heat Rejection Subsystem." Dr. Koester was unable to attend the meeting so Mr. Al Juhasz, of NASA Lewis Research Center gave a brief overview on the subject from Dr. Koester's notes. Mr. Juhasz spoke of the two radiator subsystems conceptually designed which would reject heat from future space nuclear power systems. He also covered the Phase IV Loop Design Features. Mr. Juhasz explained that an evaluation of what can be achieved is in process.

MECHANICAL WORKING GROUP BUSINESS MEETING

Mr. Phil Colegrove, Vice-Chairman of the Mechanical Working Group chaired the business meeting for Mr. Richard Shaltens who was not available able to attend the Symposium. Mr. Gene Hoffman was nominated along with Lt. Col. E. Herrera to co-chair the Aerospace Power Panel. Their nomination will be presented at the next Steering Group Meeting. Phil Colegrove volunteered to host the next Mechanical meeting at Wright-Patterson AFB around the first week of November. Mr. Colegrove also asked the meeting attendees for their thoughts concerning the Symposium and its format. A short discussion followed and the meeting was then adjourned.

Electrical Working Group
Program Overview and Power Conditioning Panel
Session 2B, Morning
April 1, 1992

ELECTRICAL WORKING GROUP OVERVIEW

The Chairman of the Electrical Working Group, ***Mr. Gene Schwarze, NASA Lewis Research Center***, introduced himself and the vice-chairpersons of the Electrical Working Group and their panels. Mr. Schwarze stated he believed the Working Group's agenda was going to be very

informative and was looking forward to the up coming presentations. He then introduced the first speaker.

NAVY OVERVIEW, ELECTRICAL POWER DISTRIBUTION

Mr. Howard Stevens of the Naval Surface Warfare Center presented a "Navy Overview, Electrical Power Distribution." He recounted how things have changed a great deal in the past couple of years. Mr. Stevens stated that the driver for a great deal of present effort is affordability. He expressed that the Navy is looking for ways to reduce the ship construction cost of the Electrical system. Mr. Stevens outlined what is proposed for the DDV: port and starboard architecture with zonal distribution, and, elimination of multiple cable penetrations to zones. He explained that the Advanced Electrical Distribution System will save money on the DDV by removing 19,826 ft. of 60 Hz power cables (-48%), removing 7,375 ft. of 400 Hz power cables (-78%) for a total of 27,201 ft. of cable reduction. It will also reduce the weight 40.4lt and reduce ship acquisition cost. To conclude, Mr. Stevens stated that the cost to introduce the Advanced Electrical Distribution System into the DDV is $5M detailed design (non-recurring) and acquisition cost savings recurring per ship is -$2M to -$.25M.

OVERVIEW OF INDIVIDUAL SOLDIER POWER

Dr. Larry Amstutz, Ft. Belvoir, presented an "Overview of Individual Soldier Power." He began with the problem; a soldier in MOPP IV in warm/hot environment will succumb to heat stress in about 60-90 minutes at a moderate level of activity. Dr. Amstutz explained that the Tech Base Executive Steering Committee (TBESC) has a wide representation with NATICK being the chair. He listed the candidate solutions for power as primary batteries, secondary batteries, internal combustion engines, Stirling Engines, Vapor cycle engines, PEM Fuel Cells and radioactive isotopes. Dr. Amstutz emphasized that the cost, of course, is the driver in the Army. He expressed that the system of choice is the battery driven system for low energy use and near term application. The least expensive is the internal combustion engine driver power system. Dr. Amstutz explained that the Army has presently funded the primary battery capability. He also stated that the Army has fully funded the reduced cost rechargeable battery option.

THE STATUS OF THE POWER APPLICATIONS CENTER

Mr. Stephen Levy, EPRI-PEAC introduced the "The Status of the Power Applications Center and Its Programs." Mr. Levy began by explaining the PEAC is an ERPI Center operated by the Tennessee Center for Research and Development (TCRD). He went on to explain that it is jointly operated by the State of Tennessee, Martin Marietta Energy Division, Tennessee Valley Authority, and the University of Tennessee. He expressed that the main thrust of power electronics at PEAC is to demonstrate advanced power electronic technologies for improved efficiency, higher productivity, and improved system compatibility. Mr. Levy added that another main thrust of power electronics at PEAC is to characterize advanced devices and components, and technology transfer. He described some of the power electronics activities as high frequency

welding power supply, advanced power semiconductor device characterization, and high frequency electronic ballast. There are may technologies that impact both government and EPRI. Mr. Levy recounted that IAPG coordinates information on government electric power technology, EPRI is a potential co-investor and user of electric power related technology. He also stated that PEAC offers its assistance in working with IAPG to establish a coupling between government and EPRI in electric power related technology. Mr. Levy concluded by emphasizing that EPRI would like to join with IAPG.

OVERVIEW OF VIRGINIA POWER ELECTRONICS CENTER

In his "Overview of Virginia Power Electronics Center," ***Dr. Fred Lee, of VPEC***, discussed the centers activities. He began by stating that VPEC is also under CIT, and that CIT funding is essential in promoting advertizing and attracting industry partners and research. The Government funding is about $700,000. Dr. Lee recounted that VPEC growth has risen highly over the years, and they now have about 60 members. He explained that VPEC has 6 different facilities, and is affiliated with Hybrid Microelectric Lab. VPEC partnership members are about 40, according to Dr. Lee.

OVERVIEW OF NASA LEWIS RESEARCH CENTER SILICON-CARBIDE PROGRAM

Dr. Lawrence Matus, NASA Lewis Research Center, presented an "Overview of NASA Lewis Research Center Silicon-Carbide Program." Dr. Matus talked about the technology development of the Silicon-Carbide at NASA Lewis Research Center. He recounted that the program got a restart in 1982. Dr. Matus explained that they are interested in SiC because of high temperature applications. Dr. Matus expressed that SiC is also a viable semi-conductor material for high power applications, high frequency applications, and radiation environments. He described Silicon Carbide as a crystalline material with unique properties; abrasive, structural, refractory. According to Dr. Matus, the high temperature of the SiC material is what NASA LeRC is interested in. He explained that it has a wide energy bandgap which gives the high temperature capability. Dr. Matus emphasized that the high breakdown voltage capabilities of SiC is important from a power point of view. He noted that a SiC silicon carbide diode was reported to have tested its (600°C) temperature. He stated that a SiC diode demonstrates high quality 6H-SiC epitaxial film growth processes. Dr. Matus described some of the benefits of silicon carbide diodes (p-n junctions) as the basic building block from which future silicon carbide electronic devices will be developed. He also noted that a silicon carbide depletion-mode MOSFET that has been developed and successfully demonstrated; at an operational temperature of 500°C. The benefits of this, according to Dr. Matus, are that the switches provide the most basic active electronic device from which integrated circuits can be developed.

INTELLIGENT POWER UPDATE

The last presentation of this session was given by ***Mr. Carl Kellenbenz of NASA Goddard Space Center***. The topic of discussion was the "Intelligent Power Update." Once a year, Mr.

Kellenbenz comes before the Power Condition Panel and gives a summary of what is happening in the industry and the commercial field on intelligent power. This is not a look at what the Government is doing with intelligent power. Mr. Kellenbenz describes the definition of Intelligent Power as a highly integrated power circuit that contains a combination of high current output, logic and/or decision making capability, self-protective features, and diagnostic capability to allow the power circuit to perform/communicate intelligently with regard to its primary function. The Intelligent Power Subcommittee has a Notebook kept by Mr. Kellenbenz. He stated that some of the contents of this notebook are IAPG Subcommittee notes, Smart Power Workshops, Conference Information, Descriptive Articles, Applications Notes, Power Supply ICs, Intelligent Motor Control, Smart Interface Circuits/Sensors, and so on. Mr. Kellenbenz explained that some of the major trends are integration of higher level of intelligences and grouping by Quad and Bridge Topologies. He recounted that some of the new products are International Rectifier second sourcing national Quad High Side Driver - National LMD18400 and International Rectifier IR8400; Harris MOSFET and IGBT Driver HV400 - Source 6 amp, sink 30 amp, drives 100,000 pf, maximum frequency of 300 KHz. Mr. Kellenbenz mentioned that plans of the future activities of the subcommittee include contacting the Power Semi-Conducting Research Center (PSRC) for possible presentation/meeting with IAPG, complete much needed comprehensive update of vendor/product listing and to continue periodic updates at IAPG meetings.

Electrical Working Group
Superconductivity Panel and Pulse Power Panel
Session 2B, Afternoon
April 1, 1992

OVERVIEW OF SUPERCONDUCTIVITY AT WRIGHT LABORATORIES

Mr. Schwarze introduced the first speaker of the afternoon session, Mr. Fernando Rodriguez. ***Mr. Fernando Rodriguez, of Wright Laboratories***, gave an "Overview of Superconductivity at Wright Laboratories." He described their in-house efforts and the objectives and approaches for both conductor development and downlead development. In reviewing their personnel, Mr. Rodriguez stated that 6.6 years of man hours have been spent to date in their effort relating to superconductivity. Mr. Rodriguez discussed how contractual efforts are being undertaken in the areas of conductor development, diffusion barrier development, thermal characterization, computer modelling of normal zone propagation/quench analysis, coil development, and dielectrics. He also discussed the stages of development for the various projects currently being

conducted. In conclusion, Mr. Rodriguez listed other areas of interest, including SMES applications and 1MW generator concept.

OVERVIEW OF SUPERCONDUCTIVITY TECHNOLOGY PROGRAM FOR ELECTRIC ENERGY PROGRAM

The "Overview of Superconductivity Technology Program for Electric Energy Systems" was given by ***Mr. Robert Hawsey, of Oak Ridge National Lab.*** Mr. Hawsey gave an overview of the DOE program in general, stating that this program is devoted primarily toward development of HTS wire and to applications that would use the wire. The program is funded by 22 million per year, with an expectation of growth in 1994. He explained that there are 3 primary labs located at Oak Ridge, Los Alamos, and Argonne. The projects at Oak Ridge include cooperative effort among 22 companies and universities. Mr. Hawsey reviewed the mission of developing technology base needed for U.S industry to proceed to commercial development of electric power applications of high temperature superconductivity. He emphasized that their efforts are driven by the needs as defined by industry. Significant progress has been made in demonstrating high current density wires in relatively long lengths (viz., 1.5 x 10^4 A/cm^2 @ 30K in a 2 Tesla field, 30 meter lengths). Mr. Hawsey outlined the FY 1992 planned areas of emphasis: industrial programs to include conductor development, applications development, and applications support. Mr. Hawsey described a major new industry initiative in FY 1992 with a five year goal to develop a pre-commercial prototype of an electric power application of high temperature superconductivity.

OVERVIEW OF SUPERCONDUCTIVITY AT ARGONNE NATIONAL LABORATORIES

Dr. Kenneth Uherka of Argonne National Laboratories presented a discussion on the "Overview of Superconductivity at Argonne National Laboratories." Dr. Uherka introduced the three areas being pursued at Argonne in superconductivity: fundamental superconductor research, development of bulk high-T_c SC materials, and superconductor applications. Argonne/industry collaborative projects were outlined. Dr. Uherka explained that most projects are cooperative efforts with private industries, and involves development of high-T_c superconducting wire and tape. He also discussed the features and status of research on magnetic bearings, high-T_c current, maglev vehicles, and MHD propulsion. Program objectives for the MHD propulsion program were outlined and the technical approach was also explained.

SMEPS SUPERCONDUCTING INVERTOR SWITCH ANALYSIS

In his discussion on "Superconducting Invertor Switch Analysis," ***Dr. Rod Petr, the Principal Engineer for W.J. Schafer, Associates***, presented an overview of the program which is critical

for future Army mobile electronics packages. Mr. Petr emphasized that superconducting inverter switches are the key technology needed to make Superconducting Magnetic Energy Power Supply (SMEPS) practical. He explained that the program is focused on SC inverter switch analysis and development for Army SMEPS applications. Dr. Petr described the SMEPS power system approach and the principal system components. In discussing the energy density ratings of inductors, he stressed the need for superconductivity wire. Dr. Petr went on to outline the areas being investigated, which include: SC invertor switch approaches, B-field trigger requirements, B-field distribution, serpentine invertor switch model, effect of output lead inductance on switch dissipation, SC switch R, L, and volume scaling, spice code analysis, and SC switch thermal analysis.

A SURVEY OF THE CRITICAL CURRENT PROPERTIES FOUND IN HTS MATERIAL

Dr Soulen, of Naval Research Laboratories, topic of discussion was "A Survey of the Critical Current Properties Found in HTS Materials." Dr. Soulen summarized the status of critical current in high T_c superconducting (HTS) materials. He indicated that this parameter was sufficiently high in thin films that several electronic applications, especially in communications, would be possible. On the other hand, in bulk HTS materials, this parameter is yet too small, thus hampering such navy applications such as ship propulsion.

ARMY PULSED POWER OVERVIEW

The "Army Pulsed Power Overview" was recounted by ***Mr. Dave Singh, Army ETDL***, Ft. Monmouth. Mr. Singh described the cooperative effort for weapons pulsers. He addressed the Army needs, which include: Electric Guns, High Power Microwave, Lasers, and Accelerators. In describing the energy pulse width curve for various applications, he explained that each system needs switches, energy storage, etc., but each are different. The role of the Pulse Power Center was explained along with its capabilities. Mr. Singh described their objectives, approaches, and status for gun pulsers and high power microwaves. His conclusions included pulse power systems must be reduced in size and weight, components must be adapted to withstand the rigors of the battlefield environment, systems must function independently of cumbersome auxiliaries, and recognize the difference in characteristics of components required from one system to another.

U. S. NAVY ARMAMENTS OVERVIEW

Mr. Guy Grater, of the Naval Surface Warfare Center, Annapolis Detachment, presented an overview on "Naval Pulsed Power." Mr. Grater reviewed the Navy's plans for pulsed power. He stated that a key element of shipboard electric armament compatibility is the capability to supply large amounts of prime power to a variety of ship electric gun systems. The prime power requirements, according to Mr. Grater, will influence the design of the charging system architecture and each shipboard user system will require defining and quantifying. He concluded

by stating that existing programs include Electromagnetic Aircraft Launching System, Electromagnetic Torpedo Launcher, Electro-Thermal Gun Demonstration Program, and Advanced Gun Weapon Systems Technology Program.

DOE PULSED POWER OVERVIEW

The "DOE Pulsed Power Overview" was discussed by ***Dr. Malcolm Buttram of Sandia National Laboratories***. Dr. Buttram addressed trends in pulsed power at the DOE Labs, stating that peak power requirements are trending down, average power requirements are rising, and size, weight and robustness are becoming major issues. He reviewed the DOE laboratories' presentations at the 1991 Pulsed Power Conference. Dr. Buttram then covered proposed designs; including a linear inductor accelerator at Los Alamos, and linear induction adder at Sandia and several RF and component technologies. His conclusions are that pulsed power is alive and well at the DOE laboratories, simulator/ICF technology is metamorphosing, growth areas of RF/Microwaves and electrical armaments, average powers are rising rapidly and pulsed power size and weight are becoming smaller than source size and weight.

ELECTRICAL WORKING GROUP BUSINESS MEETING

Mr. Gene Schwarze, Electrical Working Group Chairman, reviewed the requirements for membership in the IAPG stating that if anyone was not a member, a membership application was provided for them in their meeting packets. The membership approved the Electrical Working Group and its panels Fall 1991 Meeting Minutes from 12-13 November 1991, meeting held at U.S. Army ETDL, Fort Monmouth, NJ. Mr. Frank Thome was nominated for the High Temperature Subcommittee to be approved by the Steering Group. The Superconductivity Panel Vice Chairmanship opened due to the retirement of Major Tom Gist. Mr. Fernando Rodriguez was nominated to replace Major Gist. This nomination will be submitted for approval by the Steering Group. The date and location of the next meeting of the Electrical Working Group and its panels will be at ERPI in Palo Alto, California some time in November.

BANQUET SPEAKER

Mr. Antonio F. Tavares, Chief of Staff, Superconducting Super Collider Project, ***Department of Energy***, presented a comprehensive overview of the current status of the Superconducting Super Collider (SSC) Project.

Mr. Tavares thanked his superior, Mr. Joe Cipriano for making it possible for his to allot the time to attend the Symposium and speak. He noted that he was certain that everyone in attendance was aware, from press and television coverage, that the SSC project was going through a number of complex and delicate developmental changes.

Mr Tavares reiterated that, to date, the program had attracted more attention as a political issue during the days of site selection than it did as a technological/scientific endeavor. In reviewing the site selection process, Mr. Tavares noted that there had been intense competition between various states vying for site approval. Even though he was not associated with the project at that time, Mr. Tavares believed the lengthy site selection process was necessary. The physical construction program alone involves dollar amounts as much as 8 billion dollars; enough money to get everyone's attention.

Every aspect of development in the SSC project is not only competitive but complicated. The project represents the largest piece of laboratory equipment ever built and the most complicated assembling of a scientific research team ever attempted. The aim is to bring together the finest technical and professional minds in our nation. Because of the size of this endeavor, one end result will be the birth of a new community.

In brief, Mr. Tavares, stated the SSC project is in business to conduct research involving fusion. The challenge involves new development breakthroughs in superconducting materials, magnet designs, in detection capabilities for capturing proton collision and in the use of high-speed super computers for large scale data analysis, to mention a few.

Mr. Tavares noted that this effort is not exclusively a Department of Energy project but that DOE is the leading agency. The wider view involves not only the U.S. Government and the State of Texas but potentially sources outside the United States.

He gave a short summary of the potential physical size and complexity of the facility, related the following:

- a tunnel 200 feet below ground that is 54 miles long is being created
- construction contract for the first 2.7 miles has been awarded
- two major contractors are General Dynamics and Westinghouse
- over 1800 staff are currently in place with all key positions keyed to be filled by the end of this year.
- Babcock and Wilcox designing and building the first quadruple magnet

- a contract to design, build and install the first cryogenic refrigeration systems has been awarded
- at least 7,000 have been created across the country in direct support of the project

At this point, Mr. Tavares presented a 10 minute video presentation depicting the efforts put forth to bring the SSC project into being and what the project's facilities look like, to date, as it is being constructed. The video also presented projections and graphs on growth and funding pertinent to the SSC project's development.

It is hoped, Mr. Tavares stated, that this effort will open the door to a new world of energy production, transmission and use. It has the potential to solidify America's leadership role in a vast international scientific effort which could form a building block for the world's future.

Mr. Tavares concluded his presentation by observing that he believes everyone is aware of the cost of relevant scientific and technological research and development and that if America is to lead the World in this most basic of research efforts, the support and contributions of the community, of the nation and of the World are necessary.

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Chemical Working Group
Session 1B, Afternoon
March 31, 1992

WELCOME AND INTRODUCTION

Mr. Loyd Doering, U.S. Army Strategic Defense Command and Chemical Working Group Chair, welcomed attendees and introduced himself. He stated that he expected the Symposium to be profitable for everyone and encouraged participants to "sit in" on other Working Group meetings.

Mr. Doering introduced his first speaker, Mr. Charles Pax.

DOE FOSSIL ENERGY ACTIVITIES IN FUEL CELLS

In his discussion of "DOE Fossil Energy Activities in Fuel Cells", ***Mr. Charles Pax, Department of Energy***, discussed the national energy strategy goals of securing future energy supplies while respecting the environment through development of clean, high-efficiency technologies which produce economic and environmental benefits.

The strategy, Mr. Pax explained, is to develop and demonstrate fuel cell technology for commercial applications. Fuel Cell RD&D history and plans were described from the phosphoric acid field tests of the late-1970s, through the phosphoric acid, molten carbonate and solid oxide test plans by the year 2000. The program is completing it's development initiatives in phosphoric acid, and planning a three-year cost-shared effort on solid oxide monolithic concept.

Mr. Pax concluded by describing the interaction that is taking place within the fuel cells program, between EPRI, the Fuel Cell Association, NASA/DoD, various consortia, GRI, and DOE.

DOE TRANSPORTATION FUEL CELL PROGRAM

Mr. Bob Kost, Department of Energy, presented the "DOE Transportation Fuel Cell Program", beginning with an overview of efforts being made to develop and evaluate fuel cell systems in the nation's transportation sector. This effort will eventually provide data and information for industry decisions regarding the merits of developing fuel cell systems and future commercial products for use as a power source in transportation applications. Mr. Kost explained that benefits would include high fuel efficiency very low emissions and noise; fuel flexibility; low maintenance costs; modularity; and packaging flexibility.

Mr. Kost addressed several issues of using fuel cells for transportation systems, among them: rapid response to load changes; ability to withstand shock and vibration; range of environmental temperatures; shorter start-up time; acceptable initial cost; low maintenance cost; and long service life.

Mr. Kost also presented program objectives for the (PEM) phosphoric acid fuel cell/ battery-powered bus system: those objectives include fabrication of three 27- to 30-foot urban buses, and design of a 40-foot urban bus. The PEM fuel cell system R&D program objectives include a two-year feasibility study and demonstration of a 10-kW PEM system. Efforts are also underway to develop advanced fuel processing systems for methanol, ethanol, compressed and liquified natural gas, and other fuels for use in stand-alone and hybrid fuel cell/ battery propulsion systems.

MONOLITHIC SOLID OXIDE FUEL CELLS (MSOFC)

Mr. Gorik Hossepian, Allied Signal Corps, discussed the "Monolithic Solid Oxide Fuel Cells (MSOFC)", beginning with a technology status update of the monolithic solid oxide fuel cells (MSOFC). Mr. Hossepian explained the revolutionary nature of the MSOFC technology. Its properties include direct efficient conversion of fuel to electricity, clean exhaust products, multi-fuel capability, high-power density, and low manufacturing costs. Through graphic presentations, Mr. Hossepian demonstrated the make-up of the MSOFC, the materials, and a description of the low manufacturing costs. Mr. Hossepian described several of the developmental successes, which included performance of single-cell stacks approaching that of tri-layer cells; two-cell stack performance within a factor of five of single-cell stacks; the development of analytical design tools; and the demonstration of long-life cathode stability and anode sulfur resistance. Additionally, he discussed other progress, including the invention of a co-fired interconnect; the demonstration of MSOFC operation on diesel fuel; and the demonstration of its self-reforming advantages.

Mr. Hossepian discussed the technical challenges ahead, including the fabrication and demonstration of high-performance, multi-cell stacks with equivalent performance to single-cell stack; increasing stack footprints to a minimum of 3"x 3"; improving the test manifold and stack stress model, and developing improved MSOFC materials.

ELECTROCHEMICAL POWER SOURCES PROGRAM

Dr. Richard T. Loda, Material Sciences Division, DARPA, gave an "Electrochemical Power Sources Program", beginning with the general characteristics of batteries and fuels cells. He outlined the schedule for development for demonstration of solid state batteries and the cooperative venture between DARPA, the University of Pennsylvania, RPI, Uppsala (Sweden), and Innovision (Denmark). In discussing the development of the Lithium Polymer Battery Program, he emphasized the breakthrough of Li Polymer Electrolytes and the potential impact on private sector industry and military applications.

Dr. Loda also described DARPA's direct fuel cell program, concluding with a discussion of the potential applications of direct oxidation fuel cells: Unmanned Undersea Vehicles, Subtech (Auxiliary Power), Silent Watch (APU) for Tanks, and HVAC Power for Individual Soldiers (SIPE).

FUEL CELL PROGRAM FOR UNMANNED UNDERSEA VEHICLE (UUV)

Dr. Bob Rosenfeld, Program Manager, Undersea Warfare Office, DARPA, described the "Fuel Cell Program for Unmanned Undersea Vehicles (UUV)" by defining the program as unique in its specific goal: to assist the UUV program. He described the fuel cell program basis and background, and explained that since the fuel cell must fit current vehicles, specifications have built-in restraints. Other considerations which he examined were safety, reliability, sand performance.

Dr. Rosenfeld followed with a technical description of the UWO Fuel Cell Program, utilizing a series of overhead drawings and photographs which detailed the progress of the design of the IFC PEM fuel cell and the aluminum-oxygen semi-cell.

FUEL CELL CORE TECHNOLOGY PROGRAM SUPPORTED BY DOE/OTT

The "Fuel Cell Core Technology Program Supported by DOE/OTT" was presented by ***Dr. Shimshon Gottesfeld, Los Alamos National Laboratory.*** After explaining the background of investigating a power source for future electric vehicles, he described the attributes and characteristics of such a fuel cell power source. While relying on US domestic fuel sources, it should have high power and energy density, and produce minimal air and noise pollution.

An outline of the PEM fuel cell research program, and the advantages of polymer electrolyte fuel cells included an overview of achievements to date. Fundamental investigations of electrocatalysis at the Platinum/recast Ionomer interface; cell testing; membrane characterization, and modeling of PEM fuel cells have all been accomplished.

Future plans, as Dr. Gottesfeld explained, include studies of the membrane/electrode assembly; fundamental investigations of electrocatalysis; fabrication and testing of advanced fuel cell structure; membrane characterization; and modeling.

FUEL CELL MATERIAL RESEARCH

Dr. Albert Landgrebe, Program Manager, Department of Energy, recounted "Fuel Cell Material Research" beginning with a description of the solid polymer electrolyte fuel cells and explanation of the cell's construction. He continued by stating that the proposed PEM power plant's good weight, volume, and cost features result partially from the characteristics inherent in PEM fuel cells, and partly from the novel system design approaches. For ancillary reasons, the PEM fuel cell would be a good match for vehicle applications.

Dr. Landgrebe reviewed the special requirements for fuel cell power plants in vehicle applications, include frequent start-up and turn-off, continual load cycling , and shock and vibration. Both advantages and disadvantages are currently being studied. The engineering and

development needs are: to increase cell performance; to reduce the total catalyst loading; to develop a low-cost PEM alternative to Nafion; and to develop a cell that can undergo freeze-thaw cycling without incurring damage.

FUEL CELLS PROGRAM OVERVIEW

Mr. Donald McVay, of International Fuel Cells spoke of his company's commercial 200kW power plant and described projects at the megawatt level. He present an overview of two EPA sponsored programs utilizing fuel cells running on waste methane from a landfill and a proposed program using anaerobic digester gas is given. Mr. McVay also gave a review of the state-of-the-art of IFC alkaline technology and a brief overview of IFC's DARPA program.

CHEMICAL WORKING GROUP BUSINESS MEETING

A short business meeting was convened by ***Mr. Loyd Doering, Chemical Working Group Chair.*** A short discussion was held regarding the conduct of the Symposium to date. It was decided that another meeting should be held at the close of the groups last meeting, April 2nd which would coincide with the conclusion of the Symposium. The meeting was then adjourned and rescheduled to reconvene at 4:00 p.m., April 2nd.

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Session 3A, Morning
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ARMY STRATEGIC DEFENSE COMMAND (ASDC) POWER PROGRAM

Mr. Loyd Doering, Chemical Working Group Chairman, Army Strategic Defense Command, presented the "Army Strategic Defense Command (ASDC) Power Program." His explanation of the A1503 Power Program FY92 Technology Program included the Interceptor Battery Program. His discussion included the funding of the program after it went to SDI, which was 350M for the Interceptor Battery Program and 450M for the Advanced Alternator for High Power Programs. All the money for the power program at SDI is being spent for near term deployment options that congress has mandated for 1996 or when technology permits.

SDIO PRODUCIBLE TECHNOLOGY WORK GROUPS

The "SDIO Producible Technology Work Groups" topic was discussed by ***Mr. Joe Andrews, of Technology Assessment and Transfer, Inc.*** He explained that technology programs, including power, are being cut by SDI management in view of early deployment. Mr. Andrews discussed the Producible Technology Working Group's (PTWG) goals, the first of which is to assist in assuring that the manufacturing capabilities and the industrial capabilities are sufficient to meet the SDI element production schedules and target costs. Another goal for the PTWG is to establish support contracts with other laboratories and to identify common problems. The

guidelines for the PTWG, Mr. Andrews explained, are to assist, not direct, and listen to issues and problems of the SDIO element contractors.

ZINC AIR BATTERIES TECHNOLOGY

Mr. Ron Putt, of MATSI, Inc. discussed "Zinc Air Batteries Technology." He explained that NASA Johnson Space Center has funded MATSI to develop the next generation of primary zinc-air batteries. These are based on the use of plastic cell trays in a prismatic, stackable configuration, which overcomes the capacity limitations of zinc-air button cells and the rate limitations of currently-available industrial zinc-air batteries. He presented the results of testing individual cells and five-cell batteries of both 30 Ah and 200 Ah designs, which demonstrated specific energies in excess of the 440 Wh/kg goal for the program.

LABCOM BATTERY PROGRAM

The "LabCom Battery Program" was reviewed by ***Dr. Sol Gilman, U.S. Army, ETDL.*** Dr. Gilman began by explaining that the Electronics Technology and Devices Laboratory (ETDL) is part of U.S. Army Laboratory Command and serves as the Army's corporate R&D laboratory in the fields of microelectronic and power sources. He stated that Army needs lightweight (1 kg or less) ambient temperature primary batteries to provide power for hundreds of manportable circuits for communications, sensors, target acquisition, etc. Li/SO_2 batteries are now standard battlefield/training power sources for such applications. $Li/SOCl_2$ would provide better electrochemical performance, but that chemistry is being introduced cautiously (due mainly to cost and safety considerations) for critical applications. Two such applications are laser equipment and "soldier systems". The former application requires minimum voltage delay during pulse discharge. The latter application requires the highest possible energy density. The Li/SO_2Cl_2 battery chemistry will be explored next for "soldier systems" with the expectation that energy densities twice that of Li/SO_2 may be achieved.

The Li/MnO_2 primary battery system is also being explored as an alternative to Li/SO_2 for communications applications. It is of interest because such batteries might be commercialized and might become more readily available than non-commercial Li/SO_2. Low temperature performance must be improved significantly for wide-spread Army use.

Improvements in aqueous Mg/MnO_2 batteries are being sought. That battery chemistry could provide cost savings for relatively low current, moderate temperature applications. So far, improvements in performance have been obtained mainly through mechanical design.

The Army needs lightweight ambient temperature rechargeable lithium batteries for manportable circuits (training and special, operations), soldier systems and future robotics/vehicle applications. Batteries utilizing liquid organic electrolytes and intercalation cathodes are now close to realization with prototypes presently under development for energy densities upwards of 150 watt-hrs/kg. The Army is now looking to Li/polymer battery technology for the next factor of two improvement in energy density. The Li/Polymer program includes the development of cells

based on polyacrylonitrile gel electrolyte and the exploration of other polymer/electrode interfaces.

Dr. Gilman noted that the Army needs rechargeable batteries capable of full discharge in one minute for electric weapons applications. The battery chemistries which presently have that capability are those utilizing molten alkali halide electrolyte and the $LiAl/FeS_2$ or $LiAl/CoS_2$ couples. Development of reliable batteries prototype in sizes up to 100 megajoules is now underway for delivery in 1-2 years. Development of reliable bipolar seals is a major problem. Alternatives to molten salt cells are also being sought. This includes battery chemistries using solid inorganic and organic polymer electrolytes operating at elevated temperatures.

NASA'S BATTERY PROGRAMS

Mr. John Smithrick, NASA Research Center (NASA/LeRC) provided an overview of "NASA's Battery Programs." Information on the battery R&D being conducted at NASA's Lewis, Goddard, Marshall, and Johnson Centers was included in this briefing.

The goals of the NASA/LeRC nickel-hydrogen (Ni/H_2) cell/battery R&D program is to improve cycle life and performance of the Ni/H_2 battery. The program activities include the individual pressure vessel (IPV) battery cell, bipolar battery, and component development. Funding increased from $1,235,000 in FY91 to $1.307,000 for FY92.

With support from the Naval Weapons Support Center (NWSC) in Crane, IN, NASA, LeRC is attempting to demonstrate advanced IPV Ni/H_2 battery cell technology through LEO real-time cycle life tests of advanced flight cells. Mr. Smithrick highlighted a number of program accomplishments that included a breakthrough in cycle life, validations test of boiler plate results, and validation test of NASA advanced design IPV Ni/H_2 flight cells.

In addition to the IPV work being conducted at NASA/LeRC, bipolar batteries are being studied. Actively cooled bipolar battery systems are fully assembled and supplied as a completely integrated battery system by the manufacturer. Two 10 cell, 40 Ah actively cooled bipolar Ni/H_2 batteries have been built. The No. 1 battery ran for 10,000, 40% DOD LEO cycle. The No. 2 battery is presently on test and has run for more than 14,000, 40% DOD LEO cycles to date. A 75 Ah, 10 cell, actively cooled bipolar Ni/H_2 battery is being tested by Loral. To date 14,000 DOD LEO cycles have been observed. Passively cooled designs are being investigated. A flight-weight passively cooled bipolar Ni/H_2 battery is being designed.

NASA/LeRC's component development includes the development and demonstration of an optimized nickel electrode for an Ni/H_2 cell with improved specific energy and specific volume, and the evaluation of new separators to replace the asbestos in boiler plate Ni/H_2.

The goal of the NASA Marshall Space Center (NASA/MSFC) Battery program is to (1) perform battery and cell tests for the Hubble Space Telescope (HST), (2) perform cell characterization and life tests for the Advanced X-ray Astrophysics program (AXAF) and (3) provide small scale test support for other programs.

The goal of the NASA Goddard Space Flight Center (NASA/GSFC) Batter program is to provide reliable Ni-Cd batteries for flight programs. A number of cell packs are being tested at NWCS at the present time. Advanced and Super Ni/cd cells are undergoing testing and could be used to replace the standard Ni/cd battery for certain missions. The Ni/cd handbook is being updated and a Ni/H_2 battery handbook is being written.

Mr. Smithrick concluded with the work being conducted at NASA Johnson Space Center (NASA/JSC). The JSC battery program goal is to improve safety and performance of batteries for manned spacecraft. Program activities range from off the shelf Ag/Zn, Ag/cd and Ni/H_2 to developing a large capacity $Li/SOCl_2$ battery for ARCV. A secondary Zn-air battery is being developed for crew equipment. A thermovoltaic battery is being developed under an advanced program.

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NAVY BATTERY, 6.2, 6.3 PROGRAM

Mr. Maurice Murphy, NSWC, White Oak, gave an overview of the "Navy Battery, 6.2, 6.3 Program." He described the reorganization of the Naval Surface Warfare Center into five divisions which include the Dahlgren Division and the White Oak Detachment of the Dahlgren Division. Other major Navy laboratories have been organized under the Naval Air Warfare Center , the Naval Undersea Warfare Center, and the Naval Command, Control, and Ocean Surveillance Center. Mr. Murphy stated that the major Navy battery development thrusts are in the areas of lithium rechargeable batteries, primary ambient temperature lithium batteries, a non-aqueous electrolyte for a magnesium battery, high pulse power batteries, thermal battery technology advancement, lithium battery safety, and a high power/energy density aluminum/silver oxide seawater battery. An investigation of techniques of reinforcing nickel electrodes for nickel cadmium batteries is in progress, according to Mr. Murphy. He noted that there were significant accomplishments in rechargeable lithium battery development, lithium/thionyl chloride cell performance, approval of lithium batteries for fleet use, and in a silver oxide/iron propulsion battery nearing in-water testing. Technology and engineering barriers/issues being addressed in ongoing investigations were described.

6.1 ELECTROCHEMICAL SCIENCES PROGRAM

An overview of the "6.1 Electrochemical Sciences Program" was presented by ***Dr. Robert Nowak, Office of Naval Research (ONR).*** Dr. Nowak introduced the objective of the ONR Chemistry Division Program ($16.1M in PY91) to develop, characterize, and understand materials and chemical processes and to extend mission capability of the Navy and Marine Corps. He explained that there are five program areas within the ONR Chemistry Division and that he is responsible for Electrochemical Sciences. Dr. Nowak briefly touched on the Chemistry Division programs and accomplishments for 1991 and the division plans. Dr. Nowak explained that the core program objective of the Electrochemical Sciences Program is to provide the basic research that underlies the electrochemical power source and device needs of the Navy and Marine Corps. He spoke about accomplishments (electrified microheterogeneous catalysis, the electrochemical synthesis of thin films and nanostructures), plans in the area of biocorrosion and a transition involving electrical microengineering of redox enzymes.

DOE WEAPONS BATTERY PROGRAM

Dr. Robert P. Clark of Sandia National Laboratories addressed the "DOE Weapons Battery Program." He gave a brief summary of Sandia National Laboratories' weapon-related battery program. The mission of the program, as outlined by Dr. Clark, is to exercise their expertise in the battery design and development activities. He recounted that the materials and new technologies are designed for specific battery applications and support the production. Customers include Sandia systems organizations and related DOD programs, as well as DOE and the private sector. Dr. Clark explained that there are five types of technologies that support weapons: thermally activated, lithium ambient temperature, zinc/silver oxide, nickel/cadmium, double layer capacitors. Dr. Clark gave a brief summary of the Sandia thermal battery history which includes activities related to the Patriot S&A battery and the small ICBM APS battery. He presented a range of typical thermal battery output and activities, as well as weapon applications. He also stated that there has been alot of attention given to thermal battery research. Dr. Clark explained that major concerns at this point are to maintain technical competency and weapon systems interaction.

SANDIA STORAGE BATTERY PROGRAM

The "Sandia Storage Battery Program" was presented by ***Mr. P.C. Butler, Supervisor, Storage Batteries Division, Sandia National Laboratories (SNL).*** Mr. Butler gave an overview of the history of the storage battery program at Sandia. The goal of the program is to develop improved batteries with industry for commercial applications. The objectives, according to Mr. Butler, are to analyze energy storage benefits and requirements, contract for development of prototypes with high performance and reliability, long life and low cost, and perform supporting evaluation and applied research. Mr. Butler presented battery technologies that were developed by Sandia, along with the application and developer. Load leveling, a benefit to electric utilities of charging during off-peak and discharging during peak times, was discussed. If load-leveling and other use modes of utility battery systems can be combined it becomes much more beneficial. Mr. Butler

stated that this is the direction the program has been taking. Sandia's electric vehicle battery program was also reviewed. He displayed contract and project information for several battery technologies.

DOE ELECTRIC AND HYBRID PROPULSION SYSTEMS PROGRAM

In his discussion on the "DOE Electric and Hybrid Propulsion Systems Program," ***Dr. Kenneth Heitner, of the Department of Energy***, outlined the research and development program for Battery Systems, Advanced AC Propulsion Systems, Fuel Cell Systems, and Test and Evaluation. According to Dr. Heitner, there was significant growth in all areas of the budget for FY 1993. Mr. Heitner spoke of the battery systems for electrical vehicles and the difficult goals and challenges that need to be met as well as the need to keep competitive with gas-powered vehicles. Several battery technologies were discussed and the relevant technical issues presented. Dr. Heitner explained that the U.S. Advanced Battery Consortium was formed to focus a collective effort and quickly identify the best options for commercialization.

ACTIVITIES OF THE NAVY/PSMA BATTERY R&D COMMITTEE

Mr. Albert Himy from Westinghouse Electric Corp., presented an overview of the "Activities of the Navy/PSMA Battery R&D Committee." Mr. Himy noted that the Battery R&D Committee was formed under the sponsorship of the Navy and the Power Sources Manufacturers Association (PSMA) and consisted of representatives from government, national laboratories, universities, and industry. The objective of the committee is to develop a document on all batteries, regarding the state-of-the-art, the R&D needs, the Environmental and Safety issues, the locations where research is done and the degree of maturity for each system.

Mr. Himy stated that the batteries have been divided in the following groups: lead-acid system, silver systems, nickel systems, air systems, lithium systems, and others (sodium/sulfur, lithium/iron sulfides and zinc/bromine). Each of these group is covered in a subcommittee headed by a group leader.

To date, Mr. Himy concluded, several meetings have taken place and drafts from each group are currently being reviewed. The entire document requires editing and is expected to be issued by the end of this year.

CHEMICAL WORKING GROUP BUSINESS MEETING

Mr. Loyd Doering, Working Group Chair reconvened the business meeting which had adjourned March 31st. Mr. Doering solicited comments from the group regarding their impressions and opinions of the Symposium in view that the majority of meetings had concluded. There was much discussion from the membership concerning the length of time the Chemical Working Group had for presentations. A general consensus was drawn that one and a half days did not allow sufficient time. All other comments relevant to the Symposium; presentation content, speakers, personal networking were all positive. Mr. Doering reminded the group that the PIC

would be sending them a letter asking for personal comments on the Symposium and he encouraged them to respond promptly and honestly.

After a short discussion is was decided that the Chemical Working Group would not hold a fall meeting but plan for an extended Spring meeting. At the conclusion of this discussion, the meeting was adjourned.

Nuclear & MHD Working Group
Session 3B, Morning
April 2, 1992

WELCOME AND INTRODUCTION

Lt. Col Chip Martin, USAF Secretariat and Working Group Chair welcomed everyone to the Nuclear/MHD session of the Symposium. He felt certain each of the speakers scheduled would bring informative and relevant presentations. Lt. Col. Martin then introduced his first speaker, Mr. Kenneth Chidester.

SP-100 PROTOTYPIC UN FUEL PERFORMANCE TESTING

Mr. Kenneth Chidester, Los Alamos National Laboratory, presentation elaborated on the "SP-100 Prototypic UN Fuel Performance Testing," specifically discussing the Uranium Nitrate fuel. Mr. Chidester outlined the reactor power assembly in general, emphasizing the SP-100 NAT Fuel Pin Assembly. He reviewed, in detail, the types of testing that had been done, and the technical issues relative to the fuels and materials. Nearly 100 UN fuel pins have been successfully irradiated with no failures. Fission gas release, fuel swelling, and material interactions are with the SP-100 design envelope.

Mr. Chidester's focus was on the development of the Uranium Nitrate fuel and the Uranium Nitride Phase Relationship, pointing to the successful fabrication of the fuel in UN1.00 form. He believes that there are "no show stoppers" or major concerns with the SP-100 UN fuel design. Mr. Chidester also noted that 80% of the high density UN fuel is fabricated for the SP-100 reactor and resides at Los Alamos.

PROMISING NEW THERMOELECTRIC MATERIAL: RU_2SiA_3

Regarding the subject of advanced thermoelectric material development, ***Dr. Cronin B. Vining of the Jet Propulsion Laboratory***, gave an indepth presentation entitled, "Promising New Thermoelectric Material: RU_2SiA_3." Dr. Vining reviewed the types of testing that had been done, why certain materials were chosen and reiterated what appears to be very promising results regarding Ruthenium Silicide.

He noted that the program did not address a typical device but attempted to optimize the active materials. In reviewing the status of Ruthenium Silicide development, he noted that it is not known if Ruthenium Silicide will work out and, while results to date are quite promising, the program continues to look at other materials.

Although much is unknown about related materials under research, or how they will react in the kind of testing being done, there was no reason to believe these materials would not be used in the future. Dr. Vining concluded offering an overview of doping methods currently used and offered that it is believed that the key to development of advanced thermal-to-electric materials is to develop better doping methods.

INVESTIGATION OF TFE COLLECTOR SURFACES

Dr. Paul R. Davis, a Surface Physicist from the Linfield Research Institute, discussed the research activities involved in the "Investigation of TFE Collector Surfaces." Dr. Davis' primary emphasis was on surface interactions occurring at electrodes in thermionic converter cells used for in-core reactor power systems. Dr. Davis offered that the thermionic cell is a building block for in-core power systems at all power levels. He noted that his overhead slide showed a generic cell design while the ATI cell he is actually working on is a longer single cell unit type. Dr. Davis reviewed the particulars of types of surface phenomena, depending upon the types of materials used and the various surfaces involved. Dr. Davis offered pictorial examples of such surface involvement showing slides taken from a thermionic projection microscope. Unfortunately, the actual multi-color representation visible through the microscope was not reproducible for the purpose of this presentation. In conclusion, Dr. Davis offered a summary of the programs' work efforts and graphically charted surface testing results.

THERMIONIC REACTOR DESIGN CODE

The "Thermionic Reactor Design Code" was presented by ***Mr. Andrew C. Klein, Associate Professor, Oregon State University***. Mr. Klein discussed the systems design analysis code developed at Oregon State University with funding from Universal Energy Systems, Inc. and the Wright Research and Development Laboratory. He explained that the modules and capabilities of the code include reactor sizing, criticality calculations, power profile generation, coupled thermalhydraulic and thermionic analysis, shield calculations, heat rejection system analysis, and system performance parametric studies. Mr. Klein mentioned that the code uses object oriented programming to set up FORTRAN program input files, then run a variety of codes on PCs, and has the capability to retrieve data/results from the output files.

Mr. Klein also noted that Neutronics analysis can be accomplished using a three dimensional MCNP model to determine the critical reactor core dimensions and power distributions, using both driven and driverless cores. With this method calculations can be set up and completed quickly using an MCNP input/output processor to handle the tedious/complicated task of

modeling the full core system. Mr. Klein explained some of the features of the MCNP input processor includes setup and run MCNP on PC from within the SMALTALK processor, allows rapid and easy changes to complex MCNP inp files, analyzes a complete 3-D, heterogeneous, 1/4 core model which contains typically over 300 cells. He stated that this processor allows anyone to build and run complicated MCNP problems after receiving about 1/2 an hour of instruction. Some examples of possible variations which can be analyzed include changes in pitch to diameter ratios, changes in fuel element dimensions, changes in materials, changes in individual rod characteristics, changes in core height and diameter, and changes in reflector thickness.

Mr. Klein concluded his presentation with a discussion of the coupled thermionic performance with thermalhydraulic analysis to obtain self-consistent analysis of thermionic fuel pins. This discussion included the methodology used, some sample results, and a comparison of the code to data obtained from the Russian TOPAZ-2 electrically heated ground tests. He noted that the problems analyzed to date as benchmarks appear to show that the code can be used to reliably predict the performance of single cell thermionic fuel elements. The results presented show that this code can be readily modified and adapted to analyze a wide variety of thermionic fuel element applications from single cell TFEs to multicell TFEs.

MODELING OF THE PLASMA AND SHEATH IN THERMIONIC CONVERTERS

Mr. J.B. McVey, of Rasor Associates, Inc., introduced "Modeling of the Plasma and Sheath in Thermionic Converters." A new method for computer modeling of thermionic energy converters was described. Mr. McVey explained that this method seeks to replace the often inaccurate "regional" method, in which the bulk plasma is modeled with fluid equations and the electrostatic sheaths with a collisionless description, with a self-consistent kinetic description of the entire interlectrode plasma. He stated that the solution is implemented by the "convective scheme" (CS), which tracks the motions of a plasma represented by cells in phase space. The extreme range in characteristic time scales (10^{-12} to 10^{-5} seconds) found in thermionic converters has necessitated the development of methods to accelerate the process of achieving a steady state solution, according to Mr. McVey. He also mentioned that additional work is being carried on to model the population and distribution of excited states of cesium, necessary to the ionization-recombination process in ignited-mode thermionic converters.

Research activities are under UES, Inc. contract F33615-89-C-2950 sponsored by the Aero Propulsion and Power Directorate, Wright Laboratory, Aeronautical Systems Division (AFSC), United States Air Force, Wright Patterson AFB, OH 45433-6563.

THE NATIONAL THERMIONIC SPACE NUCLEAR POWER PROGRAM

Lt. Col. E. H. Herrera, USAF Phillips Laboratory presentation reviewed the National Thermionics Space Nuclear Power Program. Lt. Col. Herrera gave a brief overview of the programs management structure. SDIO, the Air Force, and DOE aim is to develop qualify, and

fly a thermionic space nuclear power system. The military's interest in thermionics is because of its potential to deliver a flight qualified reactor this decade at a modest cost compared to SP-100. One of the strategy of this program is concurrent technology development which will insure that space nuclear power investment is relevant to military needs. If space nuclear power is to be viable as a technology option, it should demonstrate capability simultaneously with the technologies with which it will be integrated. Lt. Col. Herrera concluded his presentation noting that it is a goal is to have a pathfinder flight by 1996, leading to a demonstration flight around the turn of the century

ANTIPROTON SCIENCE AND TECHNOLOGY

Lt. Col. Chip Martin, USAF Secretariat, presented "Antiproton Science and Technology." Lt. Col. Martin briefed on the recently initiated program at the Phillips Laboratory on Plasma and Nuclear Physics with Antiprotons. He noted that this program is part of a larger proposed effort to advance antiproton science and technology. The Air Force has been interested in this area since 1986 as a result of Project Forecast II, according to Lt. Col. Martin. There is growing interest in this science and technology area throughout the government and the academic community as a result of recent findings at CERN. The briefing covered some results of those experiments, a review of the prospects for improvements in production of antiprotons, a review of prospects for improving storage capability with emphasis on portable Penning traps (electromagnetic bottles), and an overview of the applications of this technology both in the near term and the potential in the long run.

Lt. Col. Martin's briefing ended with a sketch of the program plan and an open request for broad support by the agencies which will likely benefit to include the USAF, SDIO, DARPA, DNA, DOE, NASA, NIH and NIST. In general, the USAF is seeking to expand the current $3.5 million effort to include medical experiments at Fermilab ($2M), facility upgrades to improve collection at low energy at either Fermilab or BNL ($20M-50M), development and testing of a portable Penning trap at Los Alamos National Lab ($850K), and basic science and related safety studies at Los Alamos ($5M).

MAGNETIZED TARGET FUSION

"Magnetized Target Fusion" was also discussed by ***Lt. Col. Martin***. Lt. Col. Martin gave a presentation on a new initiative (not yet approved or funded) to study the effects of premagnetizing the fuel of Inertially Confined Fusion (ICF) target capsules as a means of lowering the ignition driver requirements to a point where currently available drivers might be sufficient to ignite these fuel capsules. According to Lt. Col. Martin, by passing a current through the fuel prior to compression, the electron thermal conduction is greatly reduced, allowing slower compression of the fuel and less total PdV work to achieve ignition conditions. In addition, the alpha particles will be retained in the fuel to a larger degree further reducing requirements for external compression. The USAF is seeking permission to collaborate with the

Russians who have been experimenting in a related area for nearly 20 years. Lt. Col. Martin emphasized that the possibility exists to take advantage of advanced technology developed by the Russians to accelerate our efforts in this area.

THE ADVANCED THERMIONIC TECHNOLOGY INITIATIVE PROGRAM

"The Advanced Thermionic Technology Initiative Program" was discussed by ***Dr. M. L. Ramalingam, UES, Inc.*** Dr. Ramalingam noted that non-destructive failure analysis was performed to evaluate the causes of an inoperable thermionic energy converter. Thermionic energy conversion is a method for the direct conversion of heat into electrical energy through thermionic electron emission. He pointed out that the output power characteristics were experimentally obtained for converters utilizing both a rhenium and a molybdenum-rhenium electrode pair. The Re-Re converter obtained a maximum output current density of 10.1 amps per square centimeter whereas the output from the Mo-Re converter suggests a short-circuit between the electrodes.

To determine the failure mode of the Mo-Re converter, Dr Ramalingam said, non-destructive evaluation was chosen as the preliminary form of failure analysis to precede the destructive evaluation by cutting the converter casing open. Thermodynamic calculations revealed that the chances of cutting the converter casing open. Thermodynamic calculations revealed that the chances of failure by evaporation or thermal expansion of the electrodes were negligible. The cesium reservoir was heated to vaporize cesium, located between the electrodes of the colc converter, that may have shorted the electrodes. Both X-ray computed tomography and microfocus radiography were utilized to image the electrode region. Dr. Ramalingam concluded that the information gathered non-destructively from the converter can be correlated with future destructive investigations. Detailed interior images were limited by X-ray source energy or special resolution.

MATERIALS FOR SPACE NUCLEAR PROPULSION SYSTEMS

Mr. Roy H. Cooper, Oak Ridge National Laboratory gave an overview of the current programs on Materials for Space Nuclear Propulsion Systems. Mr. Cooper noted that two concepts are being considered: electrical and thermal. He believes that if we are to get into space exploration, Mars, etc., both of these types of power should be considered. Nuclear propulsion systems hold the potential for shorter trip times to the outer planets. Mr. Cooper briefly discussed the materials information available to support the design of space nuclear propulsion systems and the diverse materials challenges which exist in nuclear electric subsystems. He reviewed a number of refractory allows being considered for space nuclear power applications and what successful development of such alloys would mean to implementation of space power systems.

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Lt. Col. Martin reconviened the afternoon session and introduced Mr. Thome.

TESET

Mr. Frank Thome, of Sandia National Laboratories, presented "TESET." Mr. Thome discussed the background information on the U.S. purchase from Russia of the unfueled Topaz II reactor and key components. He described TESET as a turnkey project that is an electric test only. Mr. Thome noted that the purchase included the hardware and the services to assemble and train. He outlined the TESET goals as follows: to learn from the Soviets, evaluate within the design limits of TOPAZ, get it done quickly, stay within budget, conduct safe operations, and train cadre of U.S. experts on SNP system. Mr. Thome expressed that TESET is part of a larger joint program to satisfy DoD power needs by the year 2000. Using overhead photos, he described the activities leading up to delivery of the TOPAZ, including the design and construction of the building facilities. Mr. Thome stated that the objectives of the TESET program are to learn from the Soviets, stay on schedule, "Don't break it," conduct safe operations, and fold the experience into SDIO/AF TI design.

INSULATOR MATERIALS FOR THERMIONICS APPLICATIONS - THE NEXT GENERATION

"Insulator Materials for Thermionics Applications - the Next Generation" was the topic of discussion presented by ***Dr. Vish Sabramanian of Ohio State University, Department of Mechanical Engineering***. Please reference Table of Contents. Dr. Sabramanian has provided detailed abstract of his presentation which has been published along with his presentation materials.

MATERIALS RESEARCH FOR THERMIONIC SYSTEMS

Dr. Ralph Zee, of Auburn University, addressed "Materials Research for Thermionic Systems." Dr. Zee described the efforts being undertaken by Air Force Phillips Laboratory relating to investigating the ceramic insulator. The task, as stated by Dr. Zee, includes: (1) internal stress buildup due to irradiation, (2) factors influencing the above, (3) radiation effect, and (4) electrotransport. With the help of overhead graphs and photos, he described the results of stress generation under irradiation and creep and the lifetime limitation due to pre-existing crack. Dr. Zee's conclusions are: finite element program developed to analyze intergranular stress generation, temperature and flux dependence of stress examined, effect of trilayer geometry on

stress determined, and lifetime predicted. The second task Dr. Zee described was the dispersion strengthened advanced emitter.

IST'S ADVANCED THERMIONICS INITIATIVE PROGRAM

The "IST's Advanced Thermionics Initiative Program" was introduced by ***Mr. Tom Lamp of Wright Laboratories***. Mr. Lamp explained the development of the ATI program from the Strategic Defense Initiative's Office of Innovative Science and Technology. The ATI technology roadmap, as stated by Mr. Lamp, includes programs through the year 2000 and include SNP System Code, TI Design Code, Tacitron-Dual Vapor converter, Advanced Refractory materials, in-core & ex-core tests of prototypic single cell TFE's. He explained that ATI's program goals include leveraging of "high science" to increase performance and to create advanced design analysis tools. He also noted that ATI is the only dedicated advanced thermionics technology program in the U.S.. Mr. Lamp emphasized that ATI has access to the only DoD thermionics test facility in the U.S. including: electrically heated testing of core-length TFE's, electrically heated testing of out-of-core thermionic converters, diamond film research and evaluation, advanced refractor alloy evaluation, and thermionic SNP analysis capability.

NUCLEAR & WORKING GROUP BUSINESS MEETING

Lt. Col Chip Martin, Nuclear Working Group Chair called the meeting to order. A short discussion was held relative to the fact that so few members were in attendance that quorum would now be possible for conduct of business. The meeting was adjourned.

SECTION 5

NUCLEAR WORKING GROUP

SAN DIEGO, CA

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WELCOMING/OPENING REMARKS

Lt Col Martin convened the meeting at 5:45 p.m. and thanked everyone in attendance for setting aside their time during the IECEC convention to attend. Lt Col Martin noted that the Nuclear Working Group had not had an opportunity to hold a business meeting for quite some time and that this particular meeting was specifically for that purpose.

NEW BUSINESS

Accuracy of PIC database

The first item of business Lt Col Martin addressed was the current state of the information contained on the PIC database. He told the membership that he had personally reviewed the database and found current program information to be poorly represented. He requested that individual members review their own agency's contracts by project and to make certain the current program information was placed on the PIC database.[1]

This request resulted in a short discussion by the membership who made inquiries as to how detailed the information should be. Lt Col Martin noted some of the names of the programs he had found missing from the database. Examples were: SP100, TFE, RTGs, Oak Ridge Materials Research, Advanced Thermonics, TSET and TOPAZ. He felt that the more detailed the information the better, but he emphasized the necessity of noting the Contract number and project manager.

Dr. Landgrebe mentioned that he thought that the Navy had a MHD program at Argonne Labs. he wasn't certain and offered to verify that information. If the MHD program did indeed exist, Dr. Landgrebe would supply an abstract for the PIC database. Ed Coomes asked if Lt Col Martin also wanted balance of plant programs in the database. Lt Col Martin responded that if the program was nuclear related to should be added.

Future Newsletters

Lt Col Martin offered a copy of the IAPG Newsletter, noting that it had been mailed to members of the Nuclear Working Group. He explained that this copy represented the first issue and that he planned to publish the newsletter twice a year; once in July and again in September. Lt Col Martin shared that one of his motivations was to span the summer and winter periods where there were no meetings, hoping to keep the membership informed.

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* Action Item

Awards Program

Lt Col Martin announced that the Nuclear Working Group would be establishing an awards program. He solicited nominations from the membership.[2] The criteria for the award would be either to acknowledge a member's contribution to the IAPG or for an individual's technical merit. He used Dr. Gary Bennet as an example of a member who had been a ling time IAPG member and whose contributions to the organization had been extensive. Lt Col Martin asked for recommendations for each of the attendees which would reflect an "agency" recommendation. Specifically, if the attendee represented DOE that their recommendation would be for someone within that agency. He asked that along with the recommendation, the person would send a short explanation of why that person was being recommended. Lt Col Martin explained that once the recommendations were received that he would contact the nominee and ask for a resume or something in order to solicit more information.

Spring Symposium Discussion

Mr. Frank Thome asked how the Spring Symposium was received. A short discussion ensued regarding the various pros and cons on IAPG sponsoring a symposium. One general conclusion was expressed by Mr. Richard Shaltens that the agenda for any IAPG symposium should be more programmatic than it had been.

Travel Concerns

Mr. Shaltens also expressed his concern regarding the problem of lack of agency funding for travel relating to meetings. He stated that was fairly certain his own ability to attend IAPG meetings would be greatly curtailed in this coming fiscal year. There was general agreement that travel funding would be a problem in this upcoming fiscal year.

Upcoming Spring Meeting

Lt Col Martin offered to host the Spring Nuclear Working Group Meeting. The tentative dates were set for March 23-24 timeframe. The meeting would be held in the Washington, D.C., metropolitan area, probably Crystal City. He would finalize dates and location and the PIC would notify the membership.[3]

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[2]Action Item

[3]Action Item

IAPG Membership Roster

Lt Col Martin asked each attendee to review their copy of the IAPG membership roster and to send any corrections or changes to the PIC.[4]

Accomplishments of IAPG Members

Lt Col Martin asked each attendee to send him the names of at least one star or SES level person within their respective organizations.[5] Lt Col Martin explained that the names were being requested so that he could direct kudo letters to the appropriate persons within agencies regarding activities of individual IAPG members. A lengthy discussion followed. Each attendee cautioned Lt Col Martin that is might be difficult if not impossible to make certain the correct senior level person was the one being contacted. Their concern was that with so much re-organization going on within each government agency the senior persons of today would not be the same persons tomorrow. There was general agreement that the members would let Lt Col Martin know who to contact.

Requested STIG Charter

Lt Col Martin asked if anyone there could secure a copy of the JDL or STIG charters for him.[6] Mr. Ed Coomes offered to get a copy of the STIG charter. Lt Col Martin told the group his need for each of these charters were tied to a Steering Group Action item that he had responsibility for completing.

IAPG Database Update by PIC

At this point in the meeting Lt Col Martin introduced Ms. Judy Hanst, the PIC Project Manager noting that she would be addressing the issue of the IAPG database.

Ms. Hanst thanked Lt Col Martin for giving the PIC the opportunity to address the database problem at the Nuclear Working Group Meeting. She then reviewed the fact that the Steering Group, at its May 14th meeting, had assigned an action item to the PIC for completion by the following Steering Group Meeting in November. That action item was to present the IAPG with a "White Paper" outlining potentially how the PIC database could be expanded so that it would network with other relevant databases. Ms. Hanst explained that two HDC associates were with her and that they would be presenting a database prototype for the group to review. She noted that her purpose in presenting these materials was to solicit their opinions of the material and questions regarding the prototype's structure. She felt that in this way the PIC would be more responsive to the membership's requirements regarding the use of the database.

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[4]Action Item

[5]Action Item

[6]Action Item

Conclusions Regarding PIC Database

Mr. Dick Shaltens interjected that he did not understand why the PIC was perusing this objective. A lengthy discussion followed wherein each participant expressed their personal opinions, views, and perceptions of databases and database value to the IAPG. The discussion encompassed such things as: (1) the attributes of libraries within each agency, (2) the efficiency of libraries within each agency, (3) the sufficiency of libraries within each agency, (4) the lack of or interest in networking interagency libraries, (5) volumes of printed materials containing program information of interest, and (6) whether or not the PIC should get these volumes of printed materials and put the information into the PIC database. Conclusions reached during these discussions: (1) the PIC database does not contain enough current and complete information, (2) the membership is not interested in information 10 years old or older, (3) the membership needs information on current funded energy contracts, (4) it would be best if the membership had one point of contact to get contract information, (5) the PIC needs to expand the database in some way to get this information and (6) that it would be far better to have the PIC to go and get the contract information, put it into brief/abstract form and to have that information confirmed by a member RATHER than have a member be responsible for getting the information and transferring it to the PIC. The discussion concluded with the general consensus that something should be done, but no agreement on what. The prototype was never completely demonstrated.

Lt Col Martin thanked everyone for their time and for their comments. The meeting was then adjourned.

ACTION ITEMS	PERSON RESPONSIBLE
Get current program information to PIC for database.	Members
Lt Col Martin is seeking nominations for the awards program.	Members
Notify membership of Spring Meeting.	PIC
Send corrections or changes to the IAPG Membership Roster to the PIC.	Members
Send Lt Col Martin the names of star or SES level personnel from each organization as point of contact.	Members
Get a copy of the STIG charter to Lt Col Martin.	Ed Coomes

SECTION 6

SOLAR PHOTOVOLTAIC PANEL

NASA LEWIS RESEARCH CENTER, CLEVELAND, OH

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Solar Working Group
Solar Photovoltaic Panel
October 22, 1992

SOLAR PHOTOVOLTAIC PANEL

WELCOME AND INTRODUCTION

Mr. Mike Piszczor, NASA Lewis Research Center, Chairman of the Photovoltaic Panel, welcomed the attendees to the semi-annual Photovoltaic Panel meeting. Mr. Piszczor mentioned that he had sought to center the meeting around reports from the panel members on the various photovoltaic testing, measurement and fabrication facilities that were available to member organizations, however some attendees did not get the word and other key organizations were not represented. While speakers from JPL and NASA Lewis could not make this meeting, presentation material from these organizations will be added to the minutes. Mr. Piszczor then asked the audience to introduce themselves and their facilities. Mr. Piszczor then introduced the first speaker, Dr. Dean Marvin.

Dr. Dean Marvin from the Aerospace Corporation, discussed three unique testing facilities that are available at Aerospace Corporation in Los Angeles. Dr. Marvin emphasized that Aerospace is quite willing to discuss collaborative research with other agencies in the use of these facilities, especially if there is benefit to current Air Force programs. The three facilities discussed were (1) ***Low Energy Accelerator Facility (LEAF):*** This facility is basically an ion implanter which has been somewhat modified for use in proton irradiation effects studies. The energy range for protons is 10 keV to 400 keV. It is capable of producing proton fluxes from 1E9 to approximately 1E13/cm^2/sec over a 10 x 10 cm target. Thus, realistic total mission fluences can be achieved in a few hours at most. There are several advantages in the use of this machine over conventional accelerators for solar cell proton studies. One is that the proton energy can be changed rapidly, simply by changing the accelerator voltage. Conventional accelerators require breaking vacuum and changing target foils to obtain a new energy. Hence it is realistic with LEAF to irradiate samples with a proton spectrum, rather than a single energy. Another advantage is the sharp proton energy distribution. At 50 keV the energy spread at LEAF is less than 100 eV, whereas a high energy accelerator that passes the protons through a foil to reduce proton energy and expand the beam to cover a wide area may have a 5-10 keV spread. This difference can be important for study of thin layered structures such as solar cells. The Energy

Technical Department at Aerospace utilizes LEAF primarily for investigation of proton effects on Si and advanced solar cells. Collaborative efforts are welcomed.

(2) ***Transient Photo-Luminescence Facility (TPL):*** TPL is a standard technique for minority carrier lifetime measurement. It is not widely available, however, with NREL and Aerospace being the two facilities in the US. The latter facility is focusing on measurement of radiation effects in a variety of III-V materials (utilizing LEAF) and on extension of the method to obtain information on defects. (NREL uses their facility to assist the contractor community in optimizing semiconductor growth conditions.) Aerospace is especially interested in collaborative work to obtain radiation degradation information on new III-V material systems for solar cells.

(3) ***^{60}Co gamma source:*** A 7000 Curie source is available for radiation effects studies. Investigations include comparison of gamma induced degradation as a model of uniform damage mechanisms with 1 MeV electron effects. Studies of radiation damage to optical fibers, optoelectronic components, and general electronic components have also been conducted.

Lt. Kristen Gledhill, Phillips Laboratory, spoke on the Phillips Laboratory ***In-House Photovoltaic Research Effort.*** The Conventional Space Power Branch of Phillips Laboratory is in the process of setting up a laboratory for the testing and evaluation of solar cells. The laboratory, expected to be operational in April, will provide the capability to measure light and dark I-V and spectral response curves. These will be accomplished by the use of a Hewlett Packard 145B Parametric Analyzer, a Spectrolab X25 Solar Simulator, and a monochrometer/light source set-up. The monochrometer/light source set-up will also allow for the examination of individual layers of multi-bandgap cells. Expansion of the lab beyond these capabilities is expected and will be guided by the desire to provide research capabilities not available at other photovoltaic laboratory facilities.

Mr. Guido Guazzoni, ARL Electronics and Power Sources Division, spoke on the ***U.S. Army's interest Developing small thermophotovoltaic power source for a variety of missions.*** The Army had conducted considerable research in the area of thermophotovolatics about 20 years ago, but that work was terminated. Today, the interest in thermophotovolatics has resurfaced with applications toward small, lightweight power systems. Currently small, portable arrays of PV solar panels are used by the Special Operations Forces (SOF) as a source of power in many of their missions. These solar panels are intended to be used in direct sunlight to provide low power (30-50 watts) for communication equipment and battery charging. The ARL-

Electronics & Power Sources Directorate is evaluating approaches that allow the utilization of thermophotovolatics to supply these same electrical power needs at night. For example, a small lightweight artificial light source (a selective emitter mantle heated by a hydrocarbon flame) could illuminate current (or specifically designed) PV cells to produce this power. The Study of ytterbium oxide emitters and the design of panel array practical configurations will be conducted by the Alternative Power Sources Branch of the ARL-APSD during FY-93.

Mr. Vaidevutis Alminauskas, Naval Surface Warfare Center, Crane Division presented ***Charging Lead Acid Batteries with Unregulated Photovoltaic Panels***. Mr. Alminauskas discussed the preliminary results of a long term evaluation of the charging of sealed lead acid batteries with unregulated solar panels. The U.S. Coast Guard (USCG) uses unregulated solar panels to recharge batteries that power night navigational aides. The USCG is examining the benefit of replacing the current maintenance free lead acid batteries with sealed batteries. The tests conducted at the Naval Surface Warfare Center will determine the useful life and failure mode of batteries exposed to unprotected outdoor environments. Preliminary results of the tests found that the batteries were being exposed to charge voltages of between 12.5 and 16.0 volts, which are well outside the designed charging voltages for sealed lead acid batteries of 13.5 to 14.2 volts. Charging at these voltages (both overcharging and undercharging) accelerates the decay of sealed lead acid battery positive plates and greatly reduces the expected service life. Preliminary results of fielded batteries found that the maintenance free batteries lasted approximately 60% longer than sealed lead acid batteries. Mr. Alminauskas also discussed the type of photovoltaic arrays used in his testing.

Mr. Doug Willowby, NASA's Marshall Space Flight Center, spoke on the ***Testing of Solar Array Panels for space applications.*** Mr. Willowby mentioned that prior to a center reorganization, Marshall did do some work on solar cell and solar cell contact development. This work involved growing contacts directly on the cell. Mr. Willowby then discussed Marshall's current involvement in photovoltaic. This involves the testing and qualification of various solar arrays and panels for various NASA missions. NASA Marshall has a variety of solar simulators and thermal chambers used to conduct this life cycle testing. In addition to the panel testing, radiation damage effects on various photovoltaic devices can also be investigated.

Mr. Neelkanth Dhere, Florida Solar Energy Center, spoke briefly on the ***polycrystalline $CuInSe_2$ & CdTe PV solar cells.*** The major thrust areas of the project are to develop scalable processes for the fabrication of $CuInSe_2$ and CdTe solar cells.

A multichamber vacuum coating unit was fabricated and installed. It has a 6" six-way cross chamber pumped by a corrosion-resistant, hybrid turbomolecular pump with a molecular drag stage; and another 18" diameter chamber pumped with a cryopump having a large argon-pumping capacity for sputtering applications. A third six-way cross has been provided for post-deposition annealing in the presence of plasma. The six-way crosses with ultra-high vacuum type oxygen-free high-conductivity copper gaskets were chosen for obtaining clean hydrocarbon-vapor-free conditions and easy access from all sides for installation of sputter-guns, gas lines, pumps, gauges, substrate heating and biasing. The larger 18" diameter chamber has been provided with three sputtering targets of Mo, Cu, and In, and an evaporation source. Investigations were carried out for DC magnetron-sputter-deposition of individual Mo, Cu, and In thin films for $CuInSe_2$ solar cells, and RF magnetron-sputter-deposition of Te and DC magnetron-sputter-deposition of Cd thin films for CdTe solar cells. Solution growth of CdS was investigated for use as a heterojunction partner in $CuInSe_2$ and CdTe polycrystalline thin film solar cells. Recently a new setup has been installed for the heat recrystallization, and the fabrication of complete cells. The deposited thin films were analyzed by various material characterization techniques such as profilmoetry, x-ray diffraction, scanning electron microscopy, optical absorption spectroscopy, Rutherford backscattering, Auger electron spectroscopy at UCF, X-ray photoelectron spectroscopy, and electrical conductivities in the dark and under illumination. Solar cells are being prepared based on the following structures: $CdS/CuInSe_2$/Mo/Glass, ZnO/thin $CdS/CuInSe_2$/Mo/Glass, and Glass/SnO_2/CdS/CdTe/Graphite:Cu. The group has plans to undertake projects on the development of ultra-lightweight, polycrystalline $CuInSe_2$ and CdTe PV solar cells.

Mr. Lloyd Herwig, U.S. Department of Energy, presented ***Current Activities in the U.S. Photovoltaic Program.*** Mr. Herwig mentioned that through the 1980's, the U.S. federal photovoltaic program placed heavy emphasis on research and development to improve photovoltaic devices, cell and module efficiencies, and the fabrication of laboratory module structures based upon a large number of different photovoltaic materials. Building on the very important R&D and technology advances obtained during the 1980's, the program balance during the early 1990's has been shifting toward increasing efforts in technology validation, manufacturing processes development, market analysis and conditioning, and joint-venture applications, all in close cooperation with the U.S. photovoltaic industry. Thus, in the 1990's, there is a firm foundation for increased emphasis on market development, market aggregation, and application analysis followed by joint venture demonstration activities. These market-oriented activities are involving not only the U.S. photovoltaic and large-power industries (utility and commercial) but also a broad cross-section of state energy and

regulatory bodies, user associations, and trade and consumer groups concerned with energy supply decision making. (The material and ideas appearing in this paper are selected and presented by the author but are not necessarily the official position of the U.S. Department of Energy.)

Business Meeting

Mr. Piszczor conducted the business portion of the meeting by ratifying the Spring meeting minutes after various changes, mostly typographical, have been made. Mr. Piszczor then talked about the next meeting of the Photovoltaic Panel at the PVSC meeting in Louisville, May, 1993. Mr. Piszczor asked the members for their comments on the programmatics of the next meeting. He mentioned that there is a lot of current interest in the solar electric airplane. Mr. Piszczor said that NASA and DOD have initiated a number of small projects in this area. He will investigate the possibility of setting up a number of presentations on this area for the next meeting. Mr. Severns (NRL) expressed an interest in specifically discussing space flight experiment opportunities that come up. He said that formally exchanging this information would greatly assist further PV technology development. Mr. Piszczor then suggested that a specific time be set aside at panel meetings to discuss flight experiment opportunities and share this information among panel members. Mr. Piszczor will look into incorporating this suggestion into future meetings.

Mr. Piszczor asked the individual attendees how they respond to their individual organization about the IAPG. Did they get a positive response from the meetings. Mr. Piszczor then asked if the IAPG was helpful in controlling duplication. The response was varied. One comment suggesting that IAPG meetings have been too technical in some instances was also made. Mr. Piszczor then asked if the membership would be interested in knowing what the other panels and working groups were reporting on and if there would be an interest in possibly having joint meetings with other working groups. It was suggested that a meeting be scheduled away from the photovoltaic conferences, possibly teaming with another working group. It was also mention that some could not attend an IAPG meeting if it was not in conjunction with the photovoltaic conferences. Mr. Piszczor then said that he would be discussing these issues at future meetings and will get in touch with other IAPG members not in attendance at this meeting. With no further discussion, the meeting was adjourned.

SECTION 7

MECHANICAL WORKING GROUP

WRIGHT-PATTERSON AFB, OH

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WELCOME AND INTRODUCTION

Mr. Richard Shaltens, NASA Lewis Research Center, Chairman of the Mechanical Working Group welcomed the attendees and opened the meeting by introducing the host of the Fall 1992 meeting, Mr. Phil Colegrove of Wright-Patterson AFB meeting. Mr. Colegrove also represents the IAPG as Vice Chair of the Mechanical Working Group.

Mr. Colegrove welcomed the attendees to Wright-Patterson Air Force Base, and noted as a point of general information that this was the first meeting of the Mechanical Working Group held at Wright-Patterson AFB. He then introduced Dr. William Borger.

AIR FORCE OVERVIEW

Dr. William Borger, Division Chief, of the Aero Propulsion and Power Directory at Wright Patterson AFB thanked the attendees for coming and he then reiterated the new and changing aspects happening in the Air Force, stating that other agencies and branches of the military seem to be experiencing changes. He said that the Presidential candidates are talking about down sizing the Department of Defense. They also say that strong Research and Development programs are needed. Dr. Borger mentioned that the Aero Propulsion and Power Division are big in the R&D business, but at the same time plans are being made to down size the Aeronautical System Center. The intended change will be to keep the old airplanes flying. The Power Division's budget is lower than it has been in the past so there is a push to fix the old airplanes with the new technologies. The environmental concerns are also part of the new administration's agenda. There is an opportunity to fix some of the environmental problems using new technology and possibly implementing some of the Power Division ideas. The F-16 flies with hydrazine for its emergency power unit. The use of hydrazine is somewhat frowned upon because it is proported to be a carcinogenic. Technology is now available to alleviate this problem by replacing the Hydrazine off with stored Hydrogen/oxygen. Dr. Borger noted, however, that the deployment of this technology would be expensive.

The last change Dr. Borger addressed was a mandate for commercialization of defense technology. The Air Force is an enthusiastic proponent of efforts for getting technology into the commercial sector and have been moderately successful. The major thrust in the Power Division's organization is the more Electric airplane. Although this is not a new concept, it has been resurrected because of technology advances. The process removes the use of hydraulics from airplanes and performs those functions electrically.

Dr. Borger then mentioned that he would be taking a more active role in the IAPG as he will be replacing Mr. Dick Belt, U.S. Army's representative, as Chairman of the Steering Group. Dr.

Borger then turned the meeting over to Mr. Dick Shaltens.

Mr. Shaltens then reviewed the IAPG Organization structure and reviewed the order of the meeting agenda.

THERMAL MANAGEMENT PANEL

Mr. Shaltens then introduced ***Dr. Jerry Beam, Chairman of the Thermal Management Panel.*** Dr. Beam thanked Mr. Shaltens and acknowledged Mr. Ted Swanson's efforts in organizing the presentations of the Thermal Management Panel. He reviewed the individual panel reports and then introduced the first speaker.

Capillary Pump Loop Test Facility

Ms. Laura Ottenstein, NASA Goddard Space Flight Center, acknowledged that Mr. Matthew Buchko from Goddard Spaceflight Center had been scheduled to speak, but regrets that he was unable to attend the meeting, and that she would be presenting his information on "CPL Materials Life Cycle Facility (MALTF)".

The facility is basicly composed of a life test unit for a capillary pump loop. The Materials Life Cycle Test Facility was built with in-house R&D funding. The project was managed by Matt Buchko with the prime contractor being NSI. The hardware pieces were built by various subcontractors. NSI did all of the instrumentation design and fabrication. The purpose of the program was to perform a five year life test of a capillary pumped loop (CPL), identify parameters controlling long-term performance of a CPL, and to investigate chemical compatibility of CPL materials with Anhydrous Ammonia.

An analysis for the presence of dissolved non-condensible gases (NCG) in liquid ammonia samples is currently being conducted. The CPL is scheduled to fly on the space shuttle next year. Some of the features are capillary cold plate, six 1/2" diameter capillary pumps welded to ISOGRID and individual control of heat load to each pump. A two-phase reservoir provides operating pressure and temperature control used in fluid management and fluid storage for excess fluid in the loop. It utilizes capillary wick for fluid management. Two heat pipe heat exchangers (HPHX) act as a condenser in the capillary pump loop. The status of the CPL MALTF experiment is that the hardware is complete and on site at Goddard Spaceflight Center. The harness installation has been completed and the instrumentation verification will be performed in November. The RGA procurement is in process - RGA delivery is expected in December of '92. The system will be cleaned with ammonia and then charged with a permanent ammonia charge. The expected time frame for the beginning of operation is early CY 1993.

Thermal Control Systems and Compressors

Professor K. Sridhar, University of Arizona, spoke on "Heat Pump Assisted Thermal Control Systems for Space Applications" and "Solid State Compressor Without Moving Parts". One of the important issues in the design of a lunar base is the thermal control system (TCS) used to reject low-temperature heat from the base. The TCS ensures that the base and the components inside are maintained within an acceptable temperature range. The temperature of the lunar surface peaks at 400 K during the 336-hour lunar day. Under these circumstances, direct dissipation of waste heat from the lunar base using passive radiators would be impractical. Thermal control systems based on thermal storage, shaded radiators, and heat pumps have been proposed. Based on proven technology, innovation, realistic complexity, reliability, and near-term applicability, a heat pump-based TCS was selected as a candidate for early missions.

In this report, Rankine-cycle heat pumps and absorption heat pumps (ammonia-water and lithium bromide-water) have been analyzed and optimized for lunar base cooling load of 100 kW. For the Rankine cycle, a search of several commonly used commercial refrigerants provided R11 and R717 as possible working fluids. Hence, the Rankine-cycle analysis has been performed for both R11 and R717. Two different configurations were considered for the system--one in which the heat pump is directly connected to the rejection loop. For a marginal increase in mass, the decoupling of the rejection loop and the radiator from the heat pump provides greater reliability of the system and better control. Hence, the decoupled system is the configuration of choice. the optimal TCS mass for a 100 kW cooling load at 270 K was 5940 kg at a radiator temperature of 362 K. R11 was the working fluid in the heat pump, and R717 was the transport fluid in the rejection loop.

Two TCSs based on an absorption-cycle heat pump were considered, one with an ammonia-water mixture and the other with a lithium bromide-water mixture as the working fluid. A complete cycle analysis was performed for these systems. The system components were approximated as heat exchangers with no internal pressure drop for the mass estimate. This simple approach under-predicts the mass of the systems, but is a good "optimistic" first approximation to the TCS mass in the absence of reliable component mass data. The mass estimates of the two systems reveal that, in spite of this optimistic estimate, the absorption heat pumps are not competitive with the Rankine-cycle heat pumps.

Future work at the systems level will involve similar analyses for the Brayton- and Stirling-cycle heat pumps. The analyses will also consider the operation of the pump under partial-load conditions. On the component level, a capillary evaporator will be design, built, and tested in order to investigate its suitability in lunar base TCS and microgravity two-phase applications.

Oxygen Heat Pipe Flight Experiment

Mr. Mike Morgan, Wright Patterson AFB, presented the "Oxygen Heat Pipe Flight Experiment". Mr. Morgan noted that the Cryogenic Heat Pipe (CRYOHP) Experiment has been designed to test two axially grooved oxygen heat pipes independently in a micro-gravity environment. The CRYOHP experiment is manifested for flight aboard the space shuttle Discovery (STS-53) which is scheduled for launch on 2 December 1992, he said. Specific experiment objectives include:

- Measuring 0-g cryogenic heat pipe transport capability and thermal conductances;
- Demonstrating 0-g heat pipe start-up from a supercritical condition;
- Correlating 0-g and 1-g data with existing analytical models; and
- Establishing a micro-gravity cryogenic thermal test bed.

Oxygen was selected as the working fluid, according to Mr. Morgan, because it has the best transport and wicking properties in the 60 - 100K cryogenic range. Safety is an important concern for shuttle missions, and the relatively small amount of oxygen required for each heat pipe does not present a safety issue. Axially grooved heat pipes were selected because their performance with ambient fluids such as ammonia is well understood and has been correlated with existing analytical models. In addition, several of the axially grooved designs which are commonplace in ambient temperature flight systems have sufficient performance with oxygen or nitrogen for most cryogenic applications. Mr. Morgan noted that applications of cryogenic heat pipes include: transport from a heat source (IR sensor) to a passive radiator, passive two-stage radiators with heat pipes used to isothermalize the radiator surface and heat pipe switches used to thermally switch between the IR sensor and two redundant cryogenic coolers.

At the conclusion of Mr. Morgan's presentation, Mr. Shaltens adjourned and reminded attendees that the meeting would begin the next day at 8:30 in the same location.

AEROSPACE POWER PANEL

The second day of the Mechanical Working Group meeting reconvened as Mr. Shaltens introduced ***Mr. Al Juhasz, NASA Lewis Research Center, Vice-Chairman of the Aerospace Power Panel.*** Mr. Juhasz gave an overview of the presentations for the day and then introduced the panel's first speaker, Mr. Gene Hoffman.

Integrated Power Unit For The More Electric Airplane

Mr. Gene Hoffman, Wright Patterson AFB, spoke on the "Integrated Power Unit for the MORE Electric Airplane" (Restricted presentation - Government only attended. Abstract to be sent under

separate cover to these individuals only).

Solar Dynamic Power System

Mr. Richard Shaltens, NASA Lewis Research Center, presented an overview of NASA LeRC "2 kW_e Solar Dynamic (SD) Ground Test Demonstration (GTD) System Program". He noted that the program is a congressionally mandated program initiated after Space Station Freedom dropped Solar Dynamics as a growth option. Space Station Freedom baseline power is a Photovoltaic/battery system only, it currently has no plans for Solar Dynamics or other growth options. An Aerospace Industry Team headed by Allied-Signal advocated a follow-on program and demonstration. It is believed that solar dynamic technology exists and the next logical step is an integrated system demonstration. The proposed demonstration is to be performed at the NASA Lewis Research Center in an existing large vacuum facility. It will be an opportunity to resolve both system and component issues raised during the SSF SD effort. This demonstration will be the first time that an integrated solar dynamic system will provide performance data in a relevant environment. Proponents believe that most of the technology for this program has already been developed.

In April 1992 NASA Lewis Research Center contracted with an industry team led by Allied-Signal Aerospace Company, Garrett Fluid Systems Division, Tempe, Arizona, for the 2 kW_e Solar Dynamic (SD) Space Power Ground Test Demonstrator (GTD) Program. The aerospace contractor team includes Harris Corporation, Melbourne, Florida, for the solar concentrator; Allied-Signal Aerospace Company, Airesearch Los Angeles Division, Torrance, California, for the heat receiver and gas cooler; Allied-Signal Aerospace Company, Garrett Fluid Systems Division, Tempe Arizona, for the turbine/alternator/compressor assembly; LORAL Vought Systems (formerly LTV Aerospace and Defense Company), Dallas, Texas, for the radiator; and Rockwell International Corporation, Rocketdyne Division, Canoga Park, California, for system integration. The goal of this program is to conduct a ground-based test in a simulated space environment of a 2 kW_e SD system that is flight configured, incorporates relevant features of the SSF solar dynamic power module design, and is scalable to the 20 to 25 kW_e range. The intent of the program is to complete component technology development effort begun under the SSF SD power option and to demonstrate the technology readiness of dynamic space power systems.

Although many of the key technologies needed for the successful application of SD power to platforms in near-earth orbit have been demonstrated by previous NASA programs, several technical challenges were identified during the SSF program which can be resolved in a ground based test. These issues are as follows:

- Flux tailoring-integration of the concentrator and receiver such that adequate solar

flux is transferred into the cycle without excessive flux deposition in any one area of the receiver,

- Concentrator facet fabrication and manufacturing techniques,
- Thermal energy storage (TES) fabrication and manufacturing techniques,
- Control methodology-whether to use speed or mass flow for control,
- Transient mode performance—evaluation of startup and shutdown transients, load following capabilities, and multiple orbit operations, including radiator thermal lag effects, and
- Scalability to the 20 kW_e to 25 kW_e range

The approach selected for the SD GTD program is to use the existing TAC and recuperator from the BIPS program of the mid-70s couples with a solar concentrator, heat receiver and radiator based on SSF designs to provide a complete solar dynamic power system for testing in a large vacuum tank at the NASA Lewis Research Center. The control system for the SD system will be PC-based using concepts developed on the BIPS program as well as concepts from the SSF SD efforts.

The BIPS program, concluded under joint NASA/DOE sponsorship, resulted in the design, fabrication and endurance testing of a 1300-watt, space-configured, isotope power system. The system consisted of a TAC, recuperator, controls, ducting, and structure and simulated isotope heat source exchangers integrated into a workhorse loop.

The solar concentrator, heat receiver and radiator for the GTD will be based on the design of the 25 kW_e SSF SD power system. The concentrator will use the honeycomb facet design and manufacturing technology developed for NASA by Solar Kinetics, Inc. The honeycomb facets will be assembled onto a test structure that will use beams and latches from the Solar Concentrator Advanced Development (SCAD) project which was conducted as part of the SSF Program.

The receiver, which is used to both transfer the solar energy to the cycle working fluid and to store solar energy for use during eclipse, will be essentially a 1/20th scale of the receiver design for the SSF. The receiver will use the same thermal energy storage (TES) canister as was designed, built, and tested during the SSF program. The TES consists of a Haynes 188 canister, or hollow doughnut, filled with a LiF-CaF_2 eutectic salt. The TES canister will be placed in the

scaled down receiver, which will have 23 tubes with 24 canisters per tube rather than the 82 tubes with 96 canisters per tube on the full-scale SSF receiver. The radiator will be out of closed pumped loop design, just as on SSF, integrated to the CBC loop by means of a gas-to-liquid heat exchanger, or cooler.

Although the SD GTD conversion system will use space-configured components, the integrated system will be configured in breadboard fashion to facilitate its use as a component evaluation tool by NASA. Mounting the major components as discrete pieces rather than an integrated assembly will allow individual subsystems to be readily removed and modified. It will also allow the substitution of alternative subsystems to allow evaluation of other technologies or design solutions. The completed SD GTD system will be installed and tested in the Tank 6 Space Environment Facility at NASA Lewis Research Center. Tank 6 has a liquid-nitrogen-cooled cold wall which simulates the heat sink provided by the space environment to an actual orbital system. This cold wall will remove the waste heat radiated by the radiator subsystem, allowing evaluation of the system under realistic conditions. In addition, the NASA facility is being modified to incorporate a solar simulator which is being designed and fabricated by NASA for installation into Tank 6. This solar simulator will supply the equivalent of one "sun" to the surface of the concentrator.

The status of the solar dynamic ground test demonstration is that the RFP was released in December 1991 and a letter contract with NASA/Allied-Signal was executed April 1992. Solar Dynamic GTD system requirements review (SRR) was completed in July 1992. Solar Dynamic GTD critical design review (CDR) is planned for April 1993. The subsystem/component delivery is scheduled for August/September 1994, and the turnover of "turnkey" SD GTD system is scheduled for May 1995. Mr. Shaltens concluded his presentation and yielded the podium to Mr. J. C. Conklin.

Modular High Temperature Gas Cooled Reactor-Gas Turbine Program

Dr. J. C. Conklin, Oak Ridge National Laboratory, presented the "Modular High Temperature Gas Cooled Reactor-Gas Turbine Program at Oak Ridge National Laboratory". Oak Ridge National Laboratory (ORNL) has been involved in gas-cooled reactor research for many years, dating back to the ORNL Graphite Reactor of the 1940s. Recently, a Modular High-Temperature Gas-Cooled Reactor (MHTGR) has been designed with ceramic fuel at a low power density and high-pressure helium as a coolant. This design is passively safe with no active engineered safety systems or human operator action necessary to insure retention of fission products. The MHTGR concept studied at ORNL is designed for the generation of electricity.

A relatively small nuclear core, having a thermal power of 200 to 450 MW with an annular ring

of ceramic fuel surrounding a graphite moderator, is encased in a steel pressure vessel. This pressure vessel is placed in a cavity such that the nuclear decay heat can be transferred to a reactor cavity cooling system that uses natural convention to keep the fuel below a temperature limit for fission product release. Hence the term "passively safe."

The initial application of the heat from the MHTGR was to provide steam for a conventional Rankine cycle. After an independent study at the Massachusetts Institute of Technology (MIT), a closed Brayton cycle using helium was examined for generation of electricity instead of Rankine cycle using steam. A closed Brayton cycle had been studied earlier and rejected because of cost and safety concerns - primarily due to the cost of large recuperators and deblading of the turbomachinery under accident conditions. The MIT study claimed that recent developments in heat exchanger and turbomachinery technologies obviated those concerns, making the concept viable. An independent study began at ORNL in 1991, funded internally, to verify the MIT results and identify additional research and development needs.

This independent study at ORNL has four elements: technical review of gas turbine design options (both direct and indirect versions), identify key design parameters and unresolved technical issues, select a baseline design and evaluate performance, and prepare plans for advancement of a recommended design.

Presently, the status of the heat exchanger and turbomachinery technology is such that a viable MHTGR gas turbine operating on the closed Brayton cycle is within the envelope of existing technology. The choice between the direct and indirect version requires further evaluation of licensing and cost considerations.

Further evaluation is recommended for: space nuclear core power and temperature distributions; fission product transport and deposition; hardware configuration and plant layout; accident modes and safety analysis, economics, and system control and dynamics.

Dr. Conklin ended his presentation by noting that the program identifies a cost of both direct and indirect cycles, relative to other electrical power generation concepts. Either MHTGR gas turbine designs present a cost advantage relative to the other concepts.

Multi-Megawatt CBC Power System

Mr. Al Juhasz, NASA Lewis Research Center, presented an overview of Multi-Megawatt Closed Brayton Cycle (CBC) Space Power Systems for Nuclear Electric or Lunar/Mars Surface Power applications.

This work is being performed in house under the High Capacity Power Thermal Management program which consists of the following project elements: Advanced Radiator Concepts (ARC) Development (performed under contracts with SPI and RI/Rocketdyne); Heat Pipe Code Development (performed under university contracts and grants); and complementary in-house efforts on radiator surface emissivity enhancement, light weight composite materials identification and development (also supplemented by the ARC work), and space radiator design/power system integration. Although the presentation focused on study results generated under the latter project element, the results included key information supplied from the other project elements of this program, focussed on achieving a radiator specific mass of 5 kg/sq. meter at an emissivity of 0.85 or greater, with a 0.99 reliability over a 10 year life.

To illustrate the importance of space radiator and heat rejection system on the overall power system at multi-megawatt power levels, Mr. Juhasz presented bar charts on nuclear space power system mass distribution, showing that whereas the radiator represents only about 20 percent of the overall system mass for a 1 MWe system, the radiator mass fraction increase to over 50 percent for a 10 MWe power system, and to near 90 percent for a 100 MWe power system. Hence efforts to reduce radiator and overall system mass are directed at not only radiator subsystem materials technology, but also on the integrated power system and its thermodynamic cycle, in order to achieve optimum conversion efficiency consistent with reasonably high effective heat rejection temperatures. In this regard the importance of providing the closed gas turbine cycle with a high (near 2000 K) peak cycle temperature (i.e. turbine inlet temperature), preferably by using a directly coupled high temperature gas reactor (HTGR), was discussed. Such HTGR heat sources, as represented by pellet bed reactor, PEBR, technology minimize system mass by enabling a high cycle temperature ratio while still preserving reasonable heat rejection temperatures to avoid excessive radiator heat rejection area requirements at multi-megawatt power levels.

Development of these high temperature helium gas cooled reactors could be based on work already under way overseas, exemplified by the AVR (Arbeitsversuchsreaktor) technology in Germany and the MHTGR-GT (Modular High Temperature Gas Reactor-Gas Turbine) program being conducted by Oak Ridge National Laboratory in this country, as presented by Dr. J. Conklin of ORNL in a preceding presentation at the same meeting.

The use of graphite-carbon composite materials will play a key role in making such power systems a reality in the not too distant future. Not only would such composites provide high temperature strength and low density for the highly stressed turbine components, but their high potential thermal conductivity in a woven fiber matrix configuration would make them ideal candidate materials for the fabrication of light weight space radiator heat pipes and heat pipe radiator panels. The technology for successful demonstration of carbon-carbon composites in

space radiator applications is being addressed by the ARC contracts and the composite materials and radiator surface emissivity enhancement project elements of the program. Using T-300 graphite-carbon fibers integral in woven heat pipes with thin (75 micron wall thickness) niobium-zirconium liners have been fabricated and will be tested with potassium working fluid during the next three months.

In closing remarks Mr. Juhasz emphasized that the synergistic efforts under the various project elements of the NASA Lewis Thermal Management program should pave the way for light weight space radiators and heat rejection sub-system utilizing carbon-carbon heat pipes with a variety of working fluids to cover a broad spectrum of heat rejection temperatures. Such light weight space radiators, in turn, would lead to viable multi-megawatt space power systems as required for nuclear electric propulsion and lunar/Mars surface power applications in the next century.

Lastly, Mr. Juhasz added that the final speaker of the panel, Professor Amir Faghri, would be offering an example of the work on theoretical modeling of heat pipes, both under steady state and transient operating conditions and stated that the work is being jointly funded by NASA Lewis and the Air Force WRDC and Phillips Laboratory.

Analytical Modeling For Heat Pipe Performance

Professor Amir Faghri, Wright State University spoke on "Analytical Modeling for Heat Pipe Performance for Space Radiator Applications". The Professor reiterated that significant research has been performed during the last decade with the advancement of computers on numerical modeling of heat and mass transfer and fluid flow in heat pipes. The purpose of this research information is to give a summary of these efforts for 1-, 2-, or 3-dimensional modeling of wall, wick, and vapor regions. He noted that the program review deals with three main theoretical modelings related to the steady state analysis, continuum transient analysis with pulsed heat input and output, and startup from the frozen state. In each section a complete review of previous work with complete governing equations, boundary conditions, and thermodynamic conditions are given. Comparison of numerical results along with existing experimental results achieved under various boundary, initial, and operating conditions to determine the effectiveness of these efforts to predict the real physical model were discussed. Finally, Professor Faghri pointed out that recommendations for further research needed in complete numerical simulation are given have been presented.

TERRESTRIAL POWER PANEL

Free Piston Stirling Engine Power Generation System

Dr. S. A. Nasar, University of Kentucky, although unable to present his information, generously provided an abstract of his presentation on the "Stability Analysis of Free Piston Stirling Engine Power Generation System" which can be found in the index.

Fuel Cell Vehicles

Mr. Jeff Bentley, Arthur D. Little, Inc., opened the Terrestrial Power Panel presentations with a discussion on "Fuel Cell Vehicles". His presentation covered three topics: an overview of Fuel Cells for transportation, a review of Arthur D. Little Fuel Cell Vehicle program, and hydrogen IC engines. Mr. Bentley first described ADL's many years of experience in tracking fuel cell technology and battery technology on a worldwide basis. They have multi-disciplinary, experienced project teams with expertise in fuel cells, system engineering, and automotive engineering. ADL also has an ongoing major project for DOE to develop hydrogen supply systems for fuel cell buses and cars, which involves, on-board hydrogen storage technologies and fuel flexible reformers. ADL also conducted a recent study for DOE comparing the energy efficiency, emissions and global warming potential of fuel cell vehicles, electric vehicles, and alternative fuel vehicles. Mr. Bentley noted that there is a fuel cell plan by DOE that documents proposed strategy for the next 10 years. The program's aim is to have fuel cell cars on the road in commercial numbers by the year 2000.

California, as well as Massachusetts, New York, and a number of other states, have legislation mandating that by 1998 2% of the vehicles sold will be required to have zero emissions. Today zero emission vehicles are electric vehicles, but, in the future, could be fuel cell vehicles.

Fuel cell vehicles are an alternative to the electric vehicle. Three technologies that are appropriate for terrestrial vehicular activities are Phosphoric Acid (PAFC), Proton Exchange Membrane (PEM) and Solid Oxide (SOFC). Some of the major hardware programs of initial prototypes will help resolve a number of configuration issues which includes battery requirements, reformer technology and integration, and durability. The system integration issues are the pressurization parasitics, heat recovery, and water management. These issues will greatly influence system efficiency and cost. The ADL hydrogen supply program will fill a major gap in DOE's fuel cell vehicle program. Both major DOE FCV programs (PEM Car/PAFC Bus) use on-board methanol reformation to supply hydrogen to the fuel cell. The uncertainties that exist are: Will a methanol infrastructure develop or will alternative fuels such as methane or ethanol dominate? and Can a reformer be successfully integrated and packaged in an on-board system? To provide more flexibility, the Arthur D. Little program will demonstrate several alternatives for supplying hydrogen to a fuel cell vehicle. One of the alternatives is to have the capability for on-board reforming of methanol and ethanol, and the other alternative is to have on-board hydrogen storage for direct H_2 supply. Mr. Bentley ended his presentation by stating that the

main objective of the hydrogen storage program is to develop and demonstrate technology options for FCV hydrogen supply.

Advanced Gas Turbine Project

Mr. Paul Kerwin, NASA Lewis Research Center, presented material that covered the "Advanced Gas Turbine Project for NASA/DOE". He spoke on the current phase of the automotive gas turbine project conducted through DOE conservation. Mr. Kerwin is the NASA contract manager for the Allison General Motors contract. Mr. Kerwin mentioned that Mr. Tom Strom is NASA's project manager for the Garrett project.

The current phase of the project has been going on at NASA since 1987. That phase focuses on ceramic technology development and has a five year cost share contract with Allison and Garret. The program goal is to develop and demonstrate structural ceramic components in an automotive turbine engine environment up to 2500 °F peak temperature conditions. The government's objectives are: to develop and improve ceramic component processing methods in the U.S.; to develop ceramic component design methodology; and to fabricate reliable ceramic components. The ATTAP major participants include Garrett Auxiliary Power Division, the prime contractor, and the Allison Gas Turbine Division. The ceramics suppliers are Norton/TRW Ceramics, Garrett Ceramic Components Division, Carborundum, Corning, and Ceramic Process Systems. The main objective was to develop a ceramic component technology base for an automotive application. Multi-facet consideration is given to design, fabrication, component evaluation and technology evaluation. NASA/DOE is currently in the component evaluation phase with the milestone focused on ceramic development. A major milestone was successfully reached in late 1991, which was the operation of the all ceramic gas fire stage for 100 hours cycling up to 2500 °F. A 300 hour cyclic engine test of components to 2500 °F is upcoming. Some of the test goals successfully achieved were the steady-state emissions data taken at 70, 80, 85, and 90 krpm, performance data taken at 70, 80, 85, and 90 krpm and maximum TIT = 2354F at 85 krpm. All hardware survived the testing. Some of the teardown results were FOD to turbine (small chips on inducers), small chip on baffle foot, and small chip on FSH (located at regenerator shield flange). All chip damage was reparable by hand finishing. Mr. Kerwin concluded his presentation by responding to questions from the attendees. At the conclusion of the Working Group presentations, the Business portion of the meeting commenced.

BUSINESS MEETING

Old Business

Aerospace Power Panel Chairmanship

Mr. Richard Shaltens opened the business meeting by stating that there was an action item concerning the open chairmanship for the Aerospace Power Panel and that there were two nominations for the Chairmanship. Mr. Shaltens stated that these nominations were sent to the Steering Group and their response was that it would have to be up to the Mechanical Working Group as to which nomination would be accepted. Mr. Shaltens then reviewed the nominations for this position which were Mr. Gene Hoffman of Wright-Patterson AFB who was nominated by Mr. Phil Colegrove and Lt Col Ernie Herrera from Phillips Laboratory who was nominated by Mr. Al Juhasz. Lt Col Herrera designated that Mr. Bob Vacek should be nominated for the position instead of himself. After discussions between Mr. Shaltens, Mr. Colegrove, Mr. Juhasz, and Mr. Vacek, it was declared that this was an inappropriate nomination on Mr. Vacek's behalf. Mr. Juhasz then withdrew his nomination of Lt Col Ernie Herrera. There was further discussion that the working group wanted Phillips Laboratory to be more involved in the Aerospace Power Panel. Mr. Vacek recommended that he would ask someone at Phillips Laboratory to be a representative. Mr. Juhasz volunteered to step down as Vice Chairman as soon as a representative from Phillips Lab was available to take his place. Discussion ensued on the possibility of breaking the panel into Air and Space panels. No resolution was found for this portion of the discussion. Mr. Gene Hoffman's nomination was accepted as Chairman of the Aerospace Power Panel.

New Business

Terrestrial Power Panel Chairmanship

The first item on the new business agenda was to fill the Chairmanship of the Terrestrial Power Panel of the Mechanical Working Group, as Mr. Dave Vaughn has resigned. A nomination of Mr. Tom Sebestyen from DOE was accepted.

Next Mechanical Working Group Meeting

The next item of business was the 1993 Spring Mechanical Working Group meeting. Mr. Ted Swanson has accepted the responsibility to host the Spring Meeting at Goddard Space Flight Center, Greenbelt Maryland in April/May. Mr. Shaltens then stated that he would like to encourage more participation from the Army and Navy at this meeting.

Proprietary Presentations

It was also discussed that when a presentation is known to be proprietary, after the preliminary

agenda has been issued, that the participants be notified.

Action Items

Mr. Jeff Schreiber of NASA Lewis requested that the Mechanical Working Group consider a panel on space based Refrigerator/Freezer Systems. Mr. Jerry Beam has accepted an action item to investigate including the Space Based Refrigerator and Freezer units in the Thermal Management Panel.[1]

[1] Action Item

ACTION ITEMS

TASK TO COMPLETE	RESPONSIBLE FOR COMPLETION
Investigate including the Space Based Refrigerator and Freezer units in the Thermal Management Panel.	Jerry Beam

SECTION 8

STEERING GROUP

FT. BELVOIR, VA

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Steering Group Meeting

DATE: November 18, 1992

LOCATION: Ft. Belvoir, Virginia

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WELCOME AND INTRODUCTION

Mr. Richard Belt, Ft. Belvoir RD&E Center, as host and Chairman of the Fall 1992 Steering Group meeting welcomed all the attendees. He stated that a few items would be covered and then Dr. Borger would be stepping in as the new Steering Group Chairperson. Mr. Belt announced that the first item on the agenda would be a presentation by Horizon Data Corporation (HDC), but first gave each attendee an opportunity to introduce themselves. After the introductions were complete, Mr. Belt recognized Mr. Loyd Doering and graciously thanked him for his many years of service to the IAPG and presented him with a Certificate of Appreciation. At this time, Mr. Belt reviewed the agenda for the day, pointed out the location of pertinent necessities, and invited everyone to enjoy lunch in the base cafeteria before turning the meeting over to Horizon Data Corporation.

PRESENTATION

Mr. Rogelio Sullivan, COTR, offered a brief explanation for the purpose of HDC's presentation stating that it was to determine the feasibility of enhancing the PIC database.

Ms. Charlie Smart, Horizon Data Corporation, gave an animated slide presentation outlining a programming enhancement for the PIC database which would expand the database capabilities to better serve the membership. Her presentation summarized the recent history of the PIC database which in recent years was truly automated into a relational database system.

The purpose of the PIC is to collect & disseminate information. The PIC contains information on executed contracts on energy within the five agencies comprising the IAPG and research sources that can be utilized by members. In the process of seeking relevant and significant data for their work, the IAPG understands that the volume of data available has increased beyond what an individual can track or process productively. Considering limited funding and increased oversight, the ability to avoid duplication and access broader resources is a goal that can be accomplished. Ms. Smart then explained that Horizon Data Corporation was asked, by the Steering Group, to analyze the information access problem, determine a solution, and give a presentation to the Steering Group.

The solution, to solve the information collection problem, identified as PRISM (**PR**ogram **I**nformation **S**earch **M**echanism), allows the PIC to reach out to other established databases and retrieve information needed by IAPG members. Three representative types of databases were investigated: governmental, academic, and commercial. The three examples: DOE in Oak Ridge, TN, VPI in Blacksburg, VA, and EPRINET in Palo Alto, CA were briefly summarized and elements such as the accessibility to each database were explained and compared to the PIC database in Reston, VA. Ms. Smart identified three main steps involved in the process. First, the PIC would receive a request for information from the membership. Then, the PIC would search all available databases for the needed information. Lastly, the output would be generated and forwarded to the requesting member. Responses could be in various formats such as fax,

hard copy via mail, diskette, or computer dial in. PRISM, a knowledge based system, would contain all information to access every database approved for use by the IAPG.

Ms. Smart concluded her presentation by stating that the IAPG would have a broader base of resources available and to further pursue this, Horizon Data Corporation needed direction from the IAPG in the form of tasking. The first phase would consist of establishing a requirements definition. Direction for the Steering Group would be to review, quantify and agree on IAPG requirements for advanced database applications.

The meeting was then opened for questions which then expanded into lengthy discussions. Issues that surfaced were:

> How long will it take to get a response? It depends on the complexity of the inquiry.
> What are the user fees? They would be varied.
> Can it be expanded into other databases? Yes, and each one would be analyzed separately to determine costs.

More discussion ensued. Mr. Belt expressed his viewpoint that the action item assigned to the PIC addressing the question of databases had not been addressed. Mr. Belt believed the action item requested the PIC to identify all databases available to the IAPG and not just three. Ms. Hanst, PIC Program Manager, interjected that in the history of the database that every other year the Steering Group brings up the question of the usefulness of the database and she asked if the consensus was to make it more useful. Mr. Sullivan, COTR, stated that he felt that Horizon Data Corporation had answered the action item and that what was done is useful and shows an alternative to what was currently being done. Mr. Belt continued to say that the mission is to promote information interchange using the database as the tool. He wanted to see a summary of all possible databases where access is a possibility. Ms. Smart added that HDC was proposing a unified way to get to various sources and emphasized that HDC was not proposing to build a new database.

Dr. Borger summarized the concerns of the Steering Group, stating that two problems had surfaced: the PIC database is incomplete and that there is other information out there that the members would like to access. Since there were many viewpoints and issues to address it was decided that further discussion of the issue would take place in New Business and then the attendees enjoyed a coffee break and a chance to talk with other participants.

WORKING GROUP AND PANEL REPORTS

Dr. William Borger, Wright Patterson AFB, addressed the attendees after the break and introduced himself as the new Chairman since the Air Force was next in rotation for the Steering Group Chairmanship. Dr. Borger offered a brief background of his experience.

Dr. Borger stated that his background was primarily in power systems and he had a Management degree from MIT. He has headed the Air Force Power Division since 1988 when Jim Reams retired and he has been involved in the IAPG since that time. He stated that he has watched this group struggle with fundamental issues. What is the purpose of the IAPG, he asked. The mission is to communicate better and eliminate redundancy.

Dr. Borger reiterated his opinion that the global perspective is that people think they are better off than they actually have been. When thinking about the world in the future, and considering decreasing budgets, Dr. Borger personally feels that from the DOD perspective we are living in more dangerous times than ever before. Who is controlling the missiles? We should not let our guard down. The Country, to survive, has to be an economic power in order to sustain military power. It is equally important, in these times, for the Army Navy, and Air Force to join forces with the private sector to translate Government technologies into commercial endeavors. Dr. Borger hopes that is also the wish of President-Elect Clinton.

Dr. Borger let the participants know that in his mind the most driving issue concerning the IAPG is clarification of direction. Where has it been, and where is it going in order to accomplish the global issues of the future? Also, another important element to the operation of the IAPG is the flow of information.

The next highlight of the meeting before the Working Group Chairmen began speaking was the honoring of Mr. Richard Belt for his dedication to the IAPG. Dr. Borger expressed that Mr. Belt was a "gentleman" and presented him with a Certificate of Appreciation while thanking him for his service and expressed his hope of continued support on the Steering Group.

In order to hold to a schedule, Dr. Borger emphasized that the speakers adhere to the time allotted on the agenda and with that he began introducing the Chemical Working Group Chairman.

Chemical Working Group

Mr. Loyd Doering, Chairman, gave an overview of the Chemical Working Group program. The last meeting, the Symposium, was very successful. The only problem was that people wanted to be in two places at one time. The Chemical Working Group feels that the Symposium should not take place every year, but rather every two or three years. The next meeting is scheduled for March 23-25, 1993 at NSWC, White Oak.

Mr. Doering reviewed the Army power source programs; the interceptor battery and the power generator. The Army needs $250,000 to complete Phase I of the interceptor battery program because SDI has zeroed it out of the budget. Mr. Doering also stated that $1.1M was needed to complete the power generator program. He then reviewed the increase in Chemical membership. Mr. Doering concluded by stating that he wanted to continue Chairing the group, but would be stepping down after the Spring meeting when he retires.

Mechanical Working Group

Dr. Jerry Beam, Chairman Thermal Management Panel, presented the status of the Mechanical Working Group as Mr. Richard Shaltens and Mr. Phillip Colegrove were unable to attend the meeting. Dr. Beam addressed the open action item of Navy participation and the action item was then closed. He also reviewed the outcome of the Fall meeting showing the new nominations for the three panels. Although it falls under New Business, Dr. Borger prompted the attendees to vote, at this time, on the nominations for the Mechanical Working Group panels while Dr. Beam was present because he would be unable to attend the Business Meeting. A motion was brought forward to accept Mr. Gene Hoffman as the Aerospace Panel Chairman and the motion carried. A Vice Chair for this panel is forthcoming. A motion was brought to the floor to approve Mr. Tom Sebestyen's nomination for the Chairman of the Terrestrial Panel. This motion was also approved and a replacement for Mr. Sullivan, Vice Chair, will be found by the Spring meeting.[1] The Thermal Management Panel remained unchanged, therefore, voting was unnecessary.

Dr. Beam continued discussion of the Mechanical Working Group's activities by announcing that the upcoming spring meeting would take place at the NASA Goddard Space Flight Center. Dr. Beam also gave a brief summary of the agency participation as far as where new participation exists and where participation has been lost because of retirements. Even though Navy participation was brought up in an action item from the last meeting, it was determined that Army participation was really needed after Dr. Beam revealed a chart on the overhead projector showing the membership of the respective agencies.

Dr. Beam addressed the issue that a request for a data exchange on space refrigerator/freezers had been made at the fall meeting and that he and Mr. Ted Swanson would make this the central focus of their spring review at NASA Goddard Space Flight Center. Dr. Beam then yielded the floor to Mr. Garduno for the next discussion.

Electrical Working Group

Mr. Gil Garduno, Chairman Power Conditioning Panel, gave the highlights of the Electrical Working Group for Mr. Gene Schwarze, who could not attend. Mr. Garduno was pleased to point out that the Electrical Working Group was properly staffed with actively working and agency diversified personnel.

Mr. Garduno addressed the future activities by saying that the next meeting, which had been scheduled for December, was rescheduled for February 8-12, 1993 at the EPRI Conference Center, Palo Alto, California. This meeting would be a joint meeting of the Electrical Working Group, panels, subcommittees, and EPRI. Mr. Garduno stated that EPRI would host the meeting

[1] Action Item

and other invitees included the Power Semiconductor Coordination Committee (PSCC), the IAPG Electrical and Systems Working Groups, along with industry and university participants. Mr. Garduno concluded the presentation with the tentative agenda for the joint meeting and then Lt. Col. Chip Martin took the floor.

Nuclear Working Group

Lt. Col. Chip Martin, Nuclear Working Group Chair, gave an overview of the status stating that the Working Group has increased to 79 members. He also noted that the total number of PIC briefs have increased. Lt. Col. Martin said the increase was directly related to the PIC's review of the IECEC Symposia proceedings and the Space Nuclear Power proceedings, identifying projects by contract and sending letters soliciting information. He expressed that the participation at the last Nuclear meeting in San Diego was unexpectedly low, with only six members present. He attributed the low turnout to conflict of activities. He announced that the next meeting, which is the Nuclear Working Group only, will be held in Washington D.C., March 30-31, 1993.

Lt. Col. Martin next addressed the action item from the last Steering Group meeting stating that his action item was complete and offered explanation for the purpose of the request, which asked for the STIG (Space Technology Interdependency Group) Charter. He stated that last year a decision that other groups similar to the IAPG existed and he had been tasked to get the Charter of one of the groups, the STIG.

Lt. Col. Martin then handed out a copy of the Nuclear Working Group newsletter to all the attendees and asked for feedback. Dr. Grobstein provided her viewpoint stating that it is not clear that the newsletter covers only Nuclear information. She stated that it's confusing because it looks like an IAPG newsletter and that the IAPG only deals with Nuclear programs. Many other responses were elicited, especially those regarding who was absorbing the cost and distribution of the newsletter. Ms. Hanst replied that the PIC did pay for the production and distribution of the newsletter. The question was raised regarding the use of the PIC to produce newsletters for the use of other Working Groups. A similar question regarding the Steering Group's right to produce an IAPG newsletter was also asked. The consensus of the attendees was that a general newsletter was not necessary. Ms. Hanst, PIC Program Manager, stated that at this point the SOW in the contract, which governs the PIC's tasking, is very loose in its direction and up to this point the PIC has completed every request it has been given, but this is an area that needs to be redefined.

Dr. Borger initiated conversation regarding nuclear power and Lt. Col. Martin's perspective of the new administration's viewpoint. Lt. Col. Martin replied by saying that problems did exist for certain programs and that cut-backs were foreseen. Space nuclear power in general is in trouble. The only robust funding out of SDI will be for ground based interceptor programs and long-term R&D will go forward with SDI. The space exploration initiative programs will be focussed on mission to planet earth, focussing on what's wrong at home and not getting to Mars.

It is also possible that the terrestrial nuclear program that just made it through Congress may be halted by the new administration, Clinton/Gore.

Solar Working Group

Mr. Joe Sovie, NASA Lewis Research Center, presented three Solar reports. The first report was the Solar Photovoltaic Panel report presented for Mr. Michael Piszczor. Mr. Sovie reviewed the attendance at the Fall 1992 meeting held in Cleveland, Ohio, where 13 individuals participated. The next meeting is scheduled for the week of May 10-14, 1993 in Louisville, Kentucky. It will be held in conjunction with the 22nd IEEE Photovoltaic Specialists Conference (PVSC) and the topic is the "Photovoltaic Powered Aircraft". Mr. Sovie pointed out that a concern of the panel, brought up at the Fall meeting, was how to increase interest in and the usefulness of the panel. A continued effort to do this is strengthened by having meetings in conjunction with PVSC and SPRAT conferences. Another element to make meetings more interesting was implementing the use of discussion topics, which was well received. A discussion was held regarding increasing the number of meetings held a year, but the concern of travel funding was discussed. Before transitioning into the Solar Thermal report, Mr. Sovie mentioned that Mr. Piszczor would be investigating the travel funding issue.

Mr. Sovie then presented the Solar Thermal Panel report for Mr. Ted Mroz, who is the acting panel Chairperson. He stated that the panel only plans one meeting per year because past attendance proved to be poor with more than one meeting, partly because of limited travel funds. The last meeting was the spring meeting which was held in conjunction with the Spring Symposium. The plan for future meetings is to focus on DOE terrestrial applications. The next meeting will be a joint meeting planned for spring 1993. Mr. Sovie discussed the Chairmanship of the Solar Thermal Panel and explained that Dr. Gary Burch (DOE) had been asked to fill this position. Dr. Burch feels that the scope of the panel should be expanded to include bio-mass, wind and solar detox. There was much discussion regarding whether these proposed expanded areas should be included in the Solar Thermal Panel. Dr. Grobstein had some concern that the Solar Thermal Panel was not the appropriate area and maybe it should be included in the Terrestrial Power Panel. Mr. Sovie directed Dr. Grobstein by way of an action item to work with Mr. Mroz to determine where the new areas would reside.[2] Before transgressing into the Solar Working Group report, Mr. Sovie stated that the name of the Chairperson will be provided by December 30, 1992.

Lastly, Mr. Sovie presented the Solar Working Group report, again for Mr. Mroz who was unable to attend. Mr. Sovie began this section of the report explaining that Mr. Mroz and Mr. Piszczor were excluded from the meeting because of travel funding limitations. Mr. Sovie also pointed out that Mr. Mroz would soon be retiring and plans for a replacement should be considered. He recommended that Mr. James Garner move up from the Vice Chair position and that Mr. Piszczor

[2] Action Item

would move into the Vice Chair position. A motion was brought forward for these two nominations and they were seconded. A vote followed to accept the nominations and the vote carried. Dr. Borger suggested that the Air Force should find a candidate from their branch of service to fill the currently opened Chairmanship of the Solar Photovoltaic Panel and he assigned that action item to Mr. Koop.[3] Mr. Sovie concluded his reports by announcing that Mr. Mroz completed an action item to write an article on how NASA coordinates with the Navy and it will be ready for publication by November 30, 1992.

Systems Working Group

Ms. Hanst, PIC Program Manager, was scheduled to give the Systems Working Group report for Mr. Nainiger, but she never received the information. Dr. Borger asked that when the PIC does get his information to send it out to the Steering Group. A brief discussion as to the necessity of the Panel ensued. Dr. Borger stated that he would like to see the Working Group remain until Clinton/Gore enter office to see what impact that would have on the growth of the Systems Working Group.

At the conclusion of the Working Group reports some discussion evolved regarding the status of the MHD Working Group and then Dr. Borger recessed the meeting for lunch.

BUSINESS MEETING

PIC Status Report

Ms. Hanst, PIC Program Manager, reconvened the meeting with an IAPG status report offering that at the conclusion she would be giving each Steering Group member a copy of the *Year to Date Summary Report* which includes membership status, promotional strategy, meeting support synopsis, and the PIC brief status along with financial information which she would briefly address. Ms. Hanst began by reviewing past membership records and stated that there had been an increase in IAPG membership since 1990 and this was because of the follow-up with non-members by the PIC after the meetings, the active participation of the Working Group Chairs, and the PIC participation at the IECEC Conference to promote the IAPG. Responses from the Conference were very well received, as Ms. Hanst pointed out a new technique the PIC recently implemented to track where new members were receiving IAPG information. This effort will help guide the PIC in using avenues that will provide the greatest benefits.

To further promote membership in the IAPG, the PIC proposed attendance at three upcoming promotional events for the year: the 10th Symposium of Space and Nuclear Power in January, the 22nd IEEE Photovoltaic Specialists Conference in May, and the IECEC Conference in August. Ms. Hanst announced that she had contacted the University of New Mexico and

[3] Action Item

received a verbal commitment for exhibit space and that the fee for the space would be waived. Ms. Hanst also brought up the fact that an exhibit exists, or did exist, that could also help in recruiting members, but the location of the exhibit is unknown. There are several references to its use in the past and Ms. Hanst showed the attendees a photograph of the exhibit. She brought up the topic to let the Steering Group know that at one time they did own and use an exhibit and she wanted to see if there was any interest in using one at this time.

Another item referenced which could help the IAPG function more effectively is a Policy and Procedures manual which has also been referenced numerous times in various IAPG documentation. A Policy and Procedures Manual would eliminate the confusion over many issues and would eliminate depending on the groups collective memory to govern the meetings. Differences in opinion exist over the tenure of Steering Group and Working Group Chairs. There is conflict of instruction from Working Group Chairs. There is also confusion over the contract rotation of the member agencies. These issues are examples that the PIC often struggles with when determining the appropriate procedures.

Discussion evolved regarding the retrieval of various pieces of information and forwarding this to the PIC. Dr. Borger stated that Jim Reams may have records (from 1985 forward) and that he would go back through the files to find what he could. Mr. Sullivan said he would check with Pat Sutton about getting information from CSR. The manual was stated to be the most important element that the PIC needs. Dr. Borger asked that any individuals who could get this documentation to retrieve it and send to the PIC. Dr. Borger directed Ms. Hanst with an action item to prompt everyone by fax, giving two weeks to respond, for the information needed.[4]

Ms. Hanst continued her report with an update of the PIC Project Brief status. The total number of briefs currently on file are 1,084 and they continue to be routinely updated every 30, 60, and 90 days. The number of briefs on file have increased since last year from 741, thus showing the increase in membership and more active involvement by the Working Group Chairs with follow up.

The Spring meeting schedule was the next item Ms. Hanst reviewed. As it stands now, the events are scheduled as follows: the Electrical and Systems Working Group meeting is in Palo Alto, California, February 8-12; the Chemical Working Group is at the Naval Surface Warfare Center, White Oak, Maryland, March 23-25; the Nuclear and MHD Working Group is in Crystal City, Virginia, March 30-31; the Mechanical Working Group meeting is tentatively planned for May at the NASA Goddard Space Flight Center; and the Steering Group meeting is tentatively planned for Washington D.C., April 21, 1993. Ms. Hanst asked all the attendees if there were other activities they wanted to see listed on the Calendar of Events to contact her with the information. The Spring Calendar will be published in December 1992 and will include the meeting schedule as well as promotional events scheduled.

[4] Action Item

In concluding the PIC status report, Ms. Hanst stated that the last two contract funding modifications came in September and that the PIC had been providing contract support without funding since the second week of October. Ms. Hanst explained that this was the last option year of the contract and there was some discussion as to the contract continuing or being re-bid. Also, the question was raised as to whether or not the contract was rolling over to NASA and would the next contract by a three-year or a five-year contract. Another recommendation to consider that would benefit the contract would be to change the date the contract begins. The time of year the contract currently commences is disadvantageous to the government agencies because of funding budgets. Ms. Hanst also strongly recommended implementing a procedure to connect the next agency's contract people into the administration aspects of the contract during this last option year to provide assistance and eliminate any possible down time and to ensure a smooth transition. Further discussion of these issues were tabled until New Business.

Old Business

The first item scheduled for Old Business was reviewing the Action Items. Much discussion evolved from the first action item which requested obtaining the STIG Charter. Dr. Grobstein asked why this was requested and what can the IAPG do with it. Mr. Sovie offered explanation regarding the STIG's purpose and stated that they mirror the IAPG in many ways. The STIG meets twice a year and concentrates on space programs with NASA and the Air Force in a cooperative effort. There was some discussion of identifying their candidate programs and possibly combining some panels depending on the overlap. Dr. Borger suggested soliciting information from a NASA representative and an Air Force representative and assigned Mr. Koop with an action item to get information regarding STIG from the Air Force.[5] Ms. Hanst was assigned an action item to send a copy of the STIG Charter to all the Steering Group Members.[6]

The second action item was for each Working Group Chair to make changes to their section of the Membership Roster (which each Working Group Chair received at the spring Steering Group meeting) and forward the changes to the PIC. Ms. Hanst handed out copies of the specific sections of the Roster to each Working Group Chair in attendance so they could easily mark up the information and return it to her.

The third action item dealt with Mr. Mroz's article on "Coordination of an Interagency Hybrid Solar Dynamic Flight System" which is to be released by November 30, 1992.

The next action item was for Mr. Houser to identify a Navy point of contact, as a representative, for the Mechanical Working Group. Mr. Houser was not present to comment, but Mr. Mueller thought that this action item was complete. Mr. Mueller said he would talk with Mr. Houser the following day. This action item is considered closed.

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[5] Action Item

[6] Action Item

The fifth action item was for Dr. Guazzoni to approach Mr. Rodriquez about rotating the Superconductivity Panel Chairmanship every year. Even though Dr. Guazzoni was not present, Ms. Hanst stated that Dr. Guazzoni had told her that he had talked with Mr. Rodriquez and that Mr. Rodriquez would take the Chair in a few months.

The sixth action item dealt with the clarification on the nominations for the Aerospace Power Panel. Mr. Sovie had completed this action item in his presentation earlier.

The next action item for Mr. Mroz was also complete as a Solar Thermal Panel Chairperson will be identified by December 30, 1992.

The eighth action item is the only incomplete task. Mr. Houser was to contact Mr. Phil Selwin, head of the Office of Navy Technology, to speak at this Steering Group meeting. Since this opportunity was missed, it was suggested to possibly have him speak at the spring meeting.

The ninth action item was a task for the PIC to ascertain what databases were currently available with all of the agencies and observer IAPG groups and to determine what the requirements are for access. This item had been expanded by DOE and HDC's earlier presentation today had completed this action item.

The tenth action item was to identify a candidate for the Chemical Working Group Vice Chairman. Mr. Doering expressed his willingness to remain the Working Group Chairman until after the spring meeting, thus the need for a Vice Chairman is postponed until a later date.

The last action item was already complete since the Certificates of Appreciation were presented earlier in the meeting.

The next item in Old Business was led by ***Mr. Rogelio Sullivan*** who gave the report of the ***Contract Status Review*** from DOE. Mr. Sullivan prefaced his report by stating that he would be addressing membership, lack of policy and procedures, and limited funding. First, he stated that it was time for the contract to roll over and that he thought the Navy was the next agency in line to administer the contract. Mr. Sullivan also recommended that the contract should become a five year contract, not a three year contract. He believes three years is too short a time. It seems just when everything is working smoothly, it's time to let another agency start all over from scratch trying to figure out how to administer this contract. Mr. Sullivan suggested that DOE could extend the current contract for two more years. Dr. Borger asked Mr. Sullivan if he had talked with his contracting department to make sure the extension of the contract is possible.[7]

[7] Action Item

Mr. Sullivan showed a view graph of the funding over the life of the contract stating that the cost had varied in every direction throughout the life of the contract. Dr. Grobstein brought up a valid point that since the SOW basicly asks for meeting support that the PIC is currently doing much more than necessary. At this time HDC was asked to leave the room because contract sensitive funding information was going to be discussed.

At the conclusion of the discussion the attendees enjoyed another break and a chance to talk with other participants before the New Business began.

New Business

Dr. Borger opened the New Business section of the meeting by reviewing the topics to cover. There were no new action items to assign, but a previously tabled discussion of PRISM needed to be addressed along with establishing requirements for membership eligibility, and deciding on the next meeting location and time.

Membership eligibility was the first item discussed. In clarifying this issue, it was pointed out, from Ms. Hanst's PIC report, that there was no clear distinction between observer and liaison membership. It had also been pointed out previously that in the prior contract years a fee schedule had been established to supplement the reproduction costs of mailings to observer members. Much discussion ensued as to whether this was legal and did the IAPG want to do this now. The subject of the Government collecting money is a very delicate situation. Suggestions were made to send observers to NTIS for copies of information. The question was raised as to how much was being spent on observer mailings. Another question was asked regarding observer's rights to Chair Working Groups. The answer to the latter question was yes, as documentation can be found where this happened in previous years. Discussion then ensued regarding observer's rights to participate on the Steering Group. All the discussion led to the obvious, that some form of rules and procedures needed to be established.

Dr. Borger queried the group to see if they felt a decision needed to be reached that day. Mr. Mueller responded that if it wasn't done that day, that it definitely needed to be done by the next meeting. With that, Dr. Borger defined the problem by stating that the Steering Group needed to find or re-construct a set of rules and asked if Dr. Grobstein would take the responsibility for this task as an action item.[8] He asked that she submit a "strawman" Policy and Procedures Manual to the Steering Group, prior to the next meeting. The task was outlined into defining the membership, defining the term of office, voting rights, definition of duties, and clarifying the SOW. Several people at this point offered assistance. Mr. Doering is going to contact Ms. Judy Decker, a past PIC employee, and try to ascertain the whereabouts of the exhibit. Mr. Sullivan offered to forward a copy of the SOW to Dr. Grobstein and will find out if there is any pertinent

[8] Action Item

information left in the archival contract files. Mr. Sullivan would also contact the previous contractor, CSR, to inquire about the PIC equipment the IAPG had purchased.[9]

Dr. Borger began reviewing the next item of New Business which was to discuss PRISM. Dr. Borger said he was impressed with the PRISM idea and the Steering Group was interested, but they are not ready to jump into implementing this idea. It was discussed that the group needed to get away from the PRISM idea and figure out how they can more efficiently get data into and out of the PIC system. Lt. Col. Martin added that the PIC database is being by-passed and the alternative of going straight to the other sources was being done because people have said that the PIC database is incomplete. Mr. Sullivan asked do we need the PIC database? Discussion continued regarding the incomplete project briefs and how to ensure they are being kept current. Mr. Sovie suggested that maybe the IAPG needs the service of the PIC database broadened. Mr. Mueller spoke in favor of keeping the PIC database because it is unique and useful. Mr. Sullivan asked Ms. Mould, the Information Specialist, how many inquiries does the PIC get and she responded that there have been approximately 25 requests for briefs since Sep/Oct. Ms. Mould was then asked how the search was done. Did she query the database? She responded that *queries* are not possible, that specific items must be identified and *requested.* A member has to look through the compilation and request a specific PIC brief and then it is forwarded to the individual. Further discussion evolved as Mr. Sebestyen spoke in favor of PRISM in lieu of the PIC database.

Dr. Borger concluded the section of the PRISM discussion by reviewing all options given. Lt. Col. Martin gave three options: PRISM, no database, and an interface (single point of contact). Mr. Mueller endorses the PIC database. Another viewpoint was to let the PIC keep the briefs current anyway they see fit and the final option was to make one individual at each agency responsible for getting all information to the PIC in a timely fashion. Dr. Borger boiled all that down to say that the purpose was to make the PIC database better. In order to achieve this purpose, Dr. Borger assigned every Steering Group member an action item to formulate a means for better information to flow into and out of the PIC, specifically from their agency, and to design a view graph to present at the next Steering Group meeting which would present the solution.[10]

The Steering Group was also interested in knowing the cost to maintain the PIC database and directed Ms. Hanst with an action item to prepare a viewgraph for the next meeting.[11]

Dr. Borger then asked the attendees where they would like to see the next meeting take place. After all the input from the participants, it was determined that the meeting would be held in

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[9] Action Item

[10] Action Item

[11] Action Item

Rosslyn, Virginia at the W. J. Schafer facility on April 21, 1993. This location is tentative and depends on availability.

Mr. Belt was graciously thanked for the donuts and hospitality and the meeting was adjourned.

ACTION ITEMS

	Task to Complete	Responsible for Completion	Status
*	Contact Mr. Phil Selwin to speak at a future Steering Group meeting.	Dale Houser	
*	Get a commitment from Dr. Burch about chairing the Solar Thermal Panel.	Ted Mroz	
1	Find a replacement by the spring meeting for Mr. Sullivan as the Vice Chair for the Terrestrial Power Panel.	Dick Belt	
2	Get a response from Dr. Burch concerning the additional areas of bio-mass, wind and solar detox; in regard to their appropriate panel location (solar vs. terrestrial).	Ted Mroz	
3	Seek an Air Force representative for Chairmanship of the Solar Photovoltaic Panel.	Bill Koop	
4	Prompt all Steering Group members, by fax, giving them 2 weeks to respond with various information (as identified on the fax).	PIC, Program Manager	Complete 12/7/92
5	Contact someone (Dr. Shell was named) in the Air Force to get more information regarding their involvement with and purpose of the STIG.	Bill Koop	
6	Send a copy of the STIG Charter to all of the Steering Group members.	PIC	Complete 12/7/92
7	Talk with DOE's contracting department to determine if the extension of the contract is possible.	Rogelio Sullivan	12/16/92
8	Regarding membership eligibility, spearhead the re-construction of a set of rules for the IAPG to follow; specifically addressing: rights, privileges, duties of members; term of office; and a complete SOW.	Toni Grobstein & PIC, Program Manager	

	Task to Complete	Responsible for Completion	Status
9	Contact the previous contractor, CSR, to inquire about the PIC equipment the IAPG had purchased.	Rogelio Sullivan	In progress 12/16/92
10	Design and present at the next Steering Group meeting a view graph depicting how each agency could get their project information into and out of the PIC database more efficiently.	Each Steering Group member	
11	Determine what portion of the IAPG budget is dedicated to maintaining the PIC database and prepare a viewgraph for the next meeting.	PIC, Program Manager	