



# NASA M&P UPDATE (NMPU)

October 1997

NASA M&P Update

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<http://nasa-mp.jpl.nasa.gov/jpl-mp/homepage.htm>

## ABOUT THE 1<sup>st</sup> NMPU ISSUE

We are pleased to publish the first issue of the NASA MATERIALS & PROCESSES UPDATE (NMPU). We are initiating this Update on a trial basis as a forum of information communication and technical interchange among the space M&P scientist and engineers. Our goal for NMPU is to serve as an information platform of the NASA M&P Working Group (NMPWG). NMPU covers M&P space related activity and technical news from the various NASA Centers, the aerospace industry, standardization technical societies and other Non-NASA Organizations (NGS). The reported information has the format of short paragraphs with a point of contact for inquiries of further details. The distribution of NMPU will be done mostly through the Internet, i.e., e-mail and WWW. As the technology evolves, efforts will be made to employ the latest tools of electronic communication.

## NASA HQ MESSAGE

*Richard Weinstein, [rweinste@hq.nasa.gov](mailto:rweinste@hq.nasa.gov)*

One of the basic assumptions of the NASA Strategic Plan is that NASA programs will be driven by mission and function rather than by Field Center geography. We have the information technology tools to do it, but it will take work. JPL proposed this "Update" concept for the NASA M&P community to share information and, hopefully, help us work together more seamlessly. It's worth a try. The orientation of the "Update" will be standardization than research and technology, which is the responsibility of the Enterprises. Also, at least initially, circulation will be

<u>CONTENTS</u>	<u>Page No.</u>
<b>ABOUT THE 1<sup>ST</sup> NMPU ISSUE</b> .....	<b>1</b>
<b>NASA HQ MESSAGE</b> .....	<b>1</b>
<b>NMPWG</b> .....	<b>2</b>
<b>NASA STANDARDS NEWS</b> .....	<b>3</b>
<b>NASA CENTERS ACTIVITY</b> .....	<b>3</b>
GSFC .....	3
JPL .....	4
JSC .....	5
KSC .....	5
LERC.....	5
MSFC.....	6
SSC .....	8
<b>TECHNICAL SOCIETIES</b> .....	<b>8</b>
ASTM .....	8
SAMPE .....	8
SPACE M&P, MANUFACTURING COMMUNITY .....	8
<b>SPACE INDUSTRY</b> .....	<b>8</b>
AEROSPACE CORPORATION .....	8
DIGIRAY .....	9
GENERAL ELECTRIC .....	9
<b>OTHER GOVERNMENT AGENCIES</b> .....	<b>10</b>
AIR FORCE.....	10
<b>UNIVERSITIES AND R&amp;D INSTITUTES</b> .....	<b>11</b>
JOHNS HOPKINS UNIVERSITY (JHU).....	11
UCLA .....	11
<b>UPCOMING EVENT</b> .....	<b>12</b>

internal to NASA, except where it supports our effort to adopt Voluntary Consensus Standards. We appreciate the effort and "vision" Yosi Bar-Cohen has put into this task, and solicit your

contributions and suggestions on how to help us meet objectives.

## **NMPWG**

**BACKGROUND** -Y. Bar-Cohen [yosi@jpl.nasa.gov](mailto:yosi@jpl.nasa.gov)  
The NASA M&P Working Group (NMPWG) was formed in 1992, where each NASA Center has a coordinator and an alternate member. Initially, NMPWG concentrated on the formation of NASA wide specifications using mature documents from individual NASA Centers. The NMPWG Standardization effort is now directed towards the adaptation of Non-Government Organizations (NGS) standards as well as the transfer of NASA's mature standards to become NGS documents.

The first NASA-wide meeting of NMPWG was held in March 1993 at the Jet Propulsion Laboratory (JPL), Pasadena, CA. The most recent NMPWG meeting was the 5<sup>th</sup> one and it was held in August this year at JSC, Houston, TX. Up until 1995, the effort was managed by Richard Weinstein, NASA HQ, and Chaired by Tim O'Donnell with the assistance of Yoseph Bar-Cohen, JPL. Currently, the effort is chaired by Frank Key and Co-Chaired by Dennis Griffin, MSFC. The Standardization efforts are now under the responsibility of Gabriel Wallace and Paul Gill, MSFC.

To support the NMPWG activity, JPL created in 1994 a homepage and its URL address is <http://nasa-mp.jpl.nasa.gov/jpl-mp/homepage.htm>. This homepage has seen significant web-traffic, where over 77,000 hits were recorded in a period of 3 months.

### **5<sup>th</sup> NASA M&P INTERCENTER COMMITTEE MEETING HELD IN JULY AT JSC - Dennis Griffin, [dennis.griffin@msfc.nasa.gov](mailto:dennis.griffin@msfc.nasa.gov)**

The Project and Environmental Engineering Division of Marshall Space Flight Center's (MSFC) Materials and Processes Laboratory chaired the 5th annual meeting of the NASA M&P Intercenter Committee, more commonly called the NASA M&P Working Group or NASA M&P Standards Meeting. The primary

purpose of the meeting was to gain consensus from the various NASA M&P organizations on current efforts towards the development of engineering standards. As the current Public Law (104-113), Office of Management and Budget Circular and NASA policy encourage or require the government agencies to pursue the use and development of voluntary consensus standards (VCS), most of the M&P standards presented during this meeting were non-government standards. MSFC presented six draft or committee International Standards Organization (ISO) standards for materials testing. Consensus was gained for the flammability and promoted combustion test standard. The group agreed to participate in the development of a unified American Society of Testing Methods (ASTM) G86 standard for pressurized and ambient, liquid and gaseous oxygen mechanical impact testing rather than continue the development of two ISO standards that had been drafted. The toxic offgassing and electrical wire insulation flammability ISO standards require additional coordination to resolve differences with the Russian, Japanese and European Space Agencies prior to their promotion as ISO committee drafts. KSC presented fluid characteristics and precision cleaning standards as ISO drafts, which will require additional work to be compatible with NASA practices. JPL gained concurrence for two materials specifications proposed as ASTM standards for a flexible structural epoxy and low outgassing room temperature vulcanizing rubber. MSFC indicated that the working group would prepare two additional proposals for ISO standards for an arc-tacking test method and design criteria for controlling stress corrosion cracking. KSC discussed a NASA-wide standard for non-flight welding, which JSC indicated they would not accept. MSFC and KSC also discussed efforts we are participating in with the American Welding Society committee D17 for an aerospace welding standard, which the group supported. The meeting was successful with agreement being obtained for many of the important VCS

standards that will result from the efforts of the M&P working group.

## **NASA STANDARDS NEWS**

*Cheng Hsieh and Yoseph Bar-Cohen, 818-354-8105, [chsieh@jpl.nasa.gov](mailto:chsieh@jpl.nasa.gov)*

### **NASA STANDARDIZATION PROGRAM**

**HOMEPAGE** - Recently, MSFC

([paul.gill@msfc.nasa.gov](mailto:paul.gill@msfc.nasa.gov)) has created a homepage to support the NASA Standardization program. The URL address is <http://standards.nasa.gov/>. This homepage can be accessed from the NASA Materials and Processes (M&P) Homepage: <http://nasa-mp.jpl.nasa.gov/jpl-mp/homepage.htm>

MSFC ([rick.joiner@msfc.nasa.gov](mailto:rick.joiner@msfc.nasa.gov)) also formed a homepage to allow access to MAPTIS and the NASA M&P databases. The URL address of this homepage is: <http://map1.msfc.nasa.gov/>

To support the transition of M&P standards to NGS organizations, JPL created an NGS homepage with the URL address <http://nasa-mp.jpl.nasa.gov/jpl-mp/ngs-org/homepage.htm>. The NGS homepage can also be accessed from the NASA M&P Standards Working Group Homepage as item number 6.1.

**JPL's NGS Survey** - In October 1996, JPL solicited the opinion of selected individuals from M&P organization across the aerospace industry to determine their interest to support the formation of space related M&P standards. The emphasis was supposed to be on transition of NASA standards from the various Centers. The individuals that were contacted are affiliated with over 20 companies and the response was very positive. The majority of the responses indicated willingness to active participation in review as well as providing input to standards that will be transitioned to technical societies (i.e., ASTM or SAE). Most responses indicated the clear recognition of the potential cost saving to the space M&P technical and commercial community.

## **ENGINEERING STANDARDS STEERING COUNCIL (ESSC) -**

This Council was impaneled in 1996 and had the first meeting held on April 1996 at MSFC. Gabriel Wallace of MSFC is the chairman and the members are: Mark Mallinson of ARC, Steve Brodeur of GSFC, Chuck Shinbrot of JPL, Elric McHenry of JSC, Charles Cockrell of LaRC, Daniel Gauntner of LeRC, Mark Strickland of MSFC, Michael Phipps of MSFC, Gerald Pitalo of SSC, Larry Schultz of KSC, Michael Arebalo of DFRC, Paul Gill of MSFC/HQ and Dick Weinstein of NASA/HQ. This council was established to coordinate the directive from NASA Administrator for general standardization of NASA-wide engineering standards. The goal was to provide standards system to NASA & contractor community, which can make NASA programs more productive. The emphasis will be on using voluntary non-government standards.

## **NASA CENTERS ACTIVITY**

### **GSFC**

#### **OUTGASSING DATA IS NOW AVAILABLE ONLINE -** *Tim Van Sant*

*John.T.VanSant.1@gafc.nasa.gov*

*Neil Walter Neil.A.Walter.1@gafc.nasa.gov*

The Materials Engineering Branch at Goddard Space Flight Center (GSFC) has established an online database of outgassing tests for selecting spacecraft materials. The online version of the database is available via the web and includes a capability to browse, search, and download data. Previously published in hardcopy as RP-1124, Revision 3 "Outgassing Data for Selecting Spacecraft Materials". This database contains the results of more than twenty years of material testing.

The test data is obtained in accordance with ASTM E595-93 "Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment". The test involves heating a specimen of material to 125°C for 24 hrs while in vacuum. Specimen mass is measured before and after the test to

determine total mass loss (TML). A small plate at 25°C is placed in close proximity to the specimen to determine the collected volatile condensable material (CVCM). Thousands of materials of interest to the aerospace community have been tested including potting compounds, foams, elastomers, films, tapes, insulation, shrink tubing, adhesives, coatings, fabrics, tie cords, and lubricants.

The E595 data is most often used as a screening test for spacecraft materials. Actual surface contamination from the outgassing of materials will, of course, vary with environment and quantity of material used. The criteria of TML < 1.0% and CVCM < 0.1% has been typically used to screen materials from an outgassing standpoint in spaceflight applications.

The outgassing database can be accessed from the home page of GSFC's Materials Engineering Branch at <http://arioch.gsfc.nasa.gov/313/>. Scroll to the bottom of the page and select Outgassing Database.

### **JPL**

**PRECISION CLEANING OF SPACECRAFT PROPULSION HARDWARE** - Dave Bame 818-354-3658, Hartwell Long 818-354-3287 & Tim O'Donnell 818-354-5465.

The spacecraft propulsion hardware cleaning community is faced with two important issues today. First is the replacement of Freon traditionally used for both fuel and oxidizer systems with a new standard, proven, general cleaning solution, or a set of solutions if there is a fuel and oxidizer applications conflict. The replacement cleaning agent(s) must be (1) propellant and material compatible for long (> 15 yrs) space missions, (2) environmentally benign, and (3) simple to work with (quick evaporation, noncombustible, etc.). The second issue concerns the cleaning of the new MEMS micro-components: The current processes focus only on particles larger than 5 microns, which must be supplemented with the

capability to detect, remove, and count particles as small as 0.05 microns. JPL's Thermal and Propulsion Engineering Section is embarking on a small experimental program in this area

**OZONE DEPLETING CHEMICALS (ODC) REPLACEMENT** - Cheng Hsieh, 818-354-8105, [chsieh@jpl.nasa.gov](mailto:chsieh@jpl.nasa.gov)

For cleaning of mechanical components, JPL has evaluated many candidates and used adhesive bonding to investigate the acceptability of the candidate cleaners. Also evaluated were parameter that included materials compatibility, flammability, toxicity, outgassing characteristics are others. Du Pont KCS 9546 (MCA Plus), Inland Technology's X-Caliber and Brulin 815GD were judged to be the best and are recommended as replacements for freon as cleaning agent for mechanical components. For cleaning manual electronic assembly operations, (Dr. Kirk Bonner, 818-354-1320, [kbonner@jpl.nasa.gov](mailto:kbonner@jpl.nasa.gov)) has completed the evaluation of a dozen of candidates and has recommended Asahi's AK 225T and Du Pont Vertrel XMS as the replacement cleaners for 1, 1, 1 trichloroethane (TCA).

**TRANSITION OF STD FROM JPL TO ASTM** - Cheng-Hsien Hsieh, 818-354-8105 [chsieh@pop.jpl.nasa.gov](mailto:chsieh@pop.jpl.nasa.gov)

Two proposed standards, "Standard Specification for Structural Epoxy (flexible) Adhesive for Bonding Metallic and Nonmetallic Materials," and "Standard Specification for Silicone Rubber Room Temperature Vulcanizing Low Outgassing Materials" were submitted to ASTM Committer D14.60 and were out for committee balloting around July, 1997. These two proposed standards were also sent to all NASA centers and several industry experts for review and comments.

**ELECTROACTIVE POLYMER (EAP) MUSCLE ACTUATORS** - Yoseph Bar-Cohen, [yosi@jpl.nasa.gov](mailto:yosi@jpl.nasa.gov)

Electroactive polymer actuators that behave similar to biological muscles are being developed for space applications. This task is performed under the Telerobotic program of Code S and is conducted jointly with LaRC and the University of New Mexico at Albuquerque. Two families of materials were developed: (a) bending actuators - Perfluorinated Ion-exchange membrane platinum (IEMP) composites, and (b) longitudinal actuators - employing electrostatically activated EAPs. These materials have enabled new technologies and applications, including surface wiper for dust removal from solar cells and optical windows, as well as a miniature manipulator arm that is driven by EAPs. The bending actuator drives the gripper and the longitudinal muscle lifts the arm.



Surface wiper removing dust from a glass window using Perfluorinated Ion-exchange membrane platinum.

## **JSC**

### ***JSC MOVES TOWARD ISO REGISTRATION -***

*Lubert Leger, lubert.j.leger1@jsc.nasa.gov*  
JSC's Manufacturing, M&P Technology Division is participating with other Center divisions in activities in preparation for a third party audit in November. Successfully passing this audit will lead to ISO registration early next year. The ISO standard requires that all processes that affect product quality must be documented and followed. Specifically, materials and manufacturing documentation have been generated and updated to reflect the ISO standard requirements. Approximately 40

process specifications and 56 work instructions have been generated to date. Process specifications are called out on JSC drawings using an electronic drawing release system recently developed. Work instructions are used by in-house technicians to perform the required work. More information is available on URL address: <http://www.jsc.nasa.gov/jsc/internal/home.html>.

## **KSC**

### ***ISO STANDARD ON CLEANING -***

*Coleman Bryan,*

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The ISO 14952 Cleaning Standard is in final draft form. The last comments on the Cleanliness Levels Table in Part 2, which were due by Sept. 30, are being used to finalize the document. Once it is completed it will be sent for translation to French and subsequent balloted as a Draft ISO Standard (DIS) by the 120 member countries. This could become an ISO Standard within the next year.

### ***ASTM G-86 LOX/GOX MECHANICAL IMPACT TEST METHOD -***

The ballot period for this document has closed and so far there were no negatives comments. However, ASTM may not have forwarded all the responses. All comments will be discussed at the ASTM meeting in San Diego in November. Once all comments are addressed and G-86 is in the final format, the process to put it into ISO format will begin. Hopefully, we will have it ready for the first ballot at the working group level and the ballot results can be discussed at the Spring ISO Subcommittee meeting.

## **LeRC**

### ***A NEW DIRECTOR & AERO PROJECT - John***

*Reagan John.R.Reagan@LeRC.nasa.gov*

Bill Wessel (formerly LaRC) joined NASA Lewis on September 29, as the Director of OSEMA. He is very enthusiastic about developing M&P skills at LeRC while reinforcing past strengths. Further, the LeRC M&P is looking forward to applying M&P techniques to the Aero projects in a cost effective, value added manner.

## **MSFC**

Dennis Griffin, [dennis.griffin@msfc.nasa.gov](mailto:dennis.griffin@msfc.nasa.gov)

**THIRD CONFERENCE ON AEROSPACE ENVIRONMENTAL TECHNOLOGY** - The NASA and several aerospace industry partners are sponsoring the 3rd Aerospace Environmental Technology Conference (AETC) on June 1-3, 1998, in Huntsville, Alabama. The elimination of Chlorofluorocarbons (CFCs), Halons, Trichloroethane (TCA), other ozone depleting chemicals, and specific hazardous materials is well underway. The phase-out of these chemicals has mandated changes and new developments in aerospace materials and processes. The aerospace community is beyond discovery and initiation of these new developments is in the implementation phase.

The purpose of this AETC is to provide a forum for engineers, scientists, and managers to describe, review, and critically assess the evolving replacement and clean propulsion technologies from the standpoint of their significance, application, impact on aerospace systems, and utilization by the research and development community. The use of these new technologies, their selection and qualification, their implementation, and the needs and plans for further developments would be discussed from the standpoint of the NASA, DoD, and aerospace industry. The presentation of technical papers addressing these issues is encouraged. Potential speakers may submit abstracts to Ms. Tammy Townsend at fax number 205-544-5877 by November 14, 1997.

The previous two AETCs have been very successful - each yielded a typical attendance of approximately 500 participants and 40 exhibitors. Various facets of the aerospace industry, academia, the federal government, and small businesses were well represented. The editor of the Precision Cleaning publication called the 1996 AETC "informative and detailed."

The general chair for the 3rd AETC is Robert J. Schwinghamer, associate technical director of MSFC. The program chair is Ann F. Whitaker, director, M&P Lab at MSFC; the technical program chair is Dennis E. Griffin, Division Chief of the Project and Environmental Engineering Division in MSFC-M&P Lab. Additional information can be obtained from the AETC homepage

[http://map1.msfc.nasa.gov/www\\_Root/html/aetc.html](http://map1.msfc.nasa.gov/www_Root/html/aetc.html) or by contacting Ms. Tamara

Landers/MSFC at telephone 205-544-6818 or Rhonda Chaney /University of Alabama Huntsville at 800-239-6015. Potential exhibitors are encouraged to contact Bob Cothran of UAH at 1-800-448-4035.

## **MATERIALS AND PROCESSES ACTIVITIES WITH ISO**

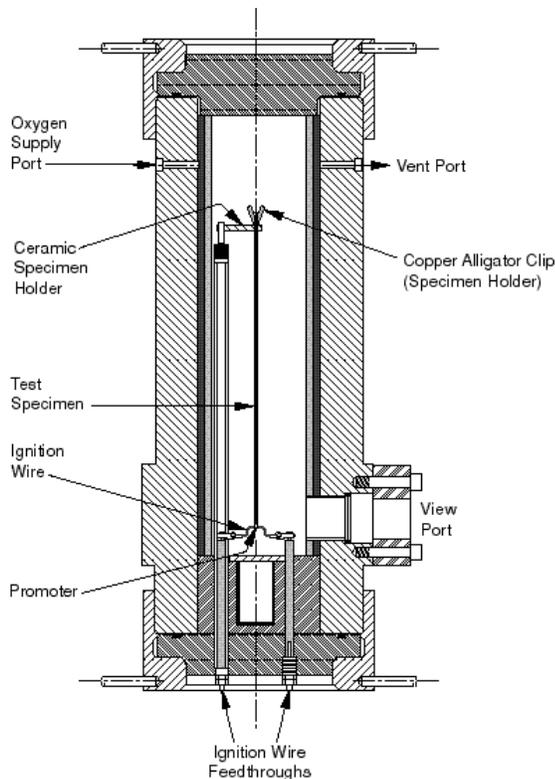
- In October 1994, ISO Subcommittee SC-14/Technical Committee TC-20/Working Group WG1, approved a proposal from the NASA for the introduction of materials testing standards as new work item N33. The document number and name assigned was ISO Working Draft (WD) 14624, "Material Flammability, Odor, Offgassing and Compatibility." The NASA point of contact was C. Frank Key, deputy director, MFSC M&P Laboratory. Dennis E. Griffin of MSFC had developed the draft document based on NASA Handbook 8060.1C, which contains 18 individual test methods for materials safety characteristics.

ISO and NASA agreed that only the most internationally pertinent test methods should be considered individually; therefore, ISO WD 14624 was divided into six subparts:

- ISO WD 14624-1, "Test Method for Determination of Upward Flame Propagation of Aerospace Materials"
- ISO WD 14624-2, "Test Method for Determination of Aerospace Electrical Wire Insulation and Accessory Flammability"
- ISO WD 14624-3, "Test Method for Determination of Offgassed Products from Aerospace Materials and Assembled Articles"
- ISO WD 14624-4, "Test Method for Determination of Upward Flammability of Aerospace Materials in Gaseous Oxygen"

- ISO WD 14624-5, "Test Method, Mechanical Impact of Materials in Ambient Pressure Liquid Oxygen"
- ISO WD 14624-6, "Test Method, Mechanical Impact of Materials in Elevated Pressure Liquid Oxygen and Gaseous Oxygen."

The first four documents were presented to ISO SC14/TC20 in April 1995, and the last two in August 1996. In May 1996, the NASA point of contact was changed to MSFC, M&P Lab/Freida Lowery.



In October 1996, ISO WD 14624-3 was tabled due the large number of comments from most of the member countries in WG1. Since many of these comments contradicted each other, it has been decided that the best format for resolving these issues is a face-to-face meeting scheduled for November 1997, for which representatives from each of the WG1 member countries have been invited to participate. The result of this meeting will be a rewritten 14624-3 document that can be circulated prior to the May 1998 meeting of WG 1.

In August 1996, ISO WD 14624-5 and -6 were circulated for comments; however, no

comments were received. In August 1997, at the NASA Materials and Processes Group meeting, NASA decided to withdraw these two documents in favor of the new ASTM G86 document, which incorporates both documents. The withdrawal of this document from ISO consideration was presented at the September 1997 meeting.

In February of 1997, ISO 14624-1, -2, and -4 were raised to Committee Draft (CD) level and circulated for comments. The results of that circulation are highlighted below.

ISO CD 14624-1: Few comments were received, other than requests for cosmetic and format changes. Plans are to incorporate these changes prior to the May 1998 meeting, and to circulate the documents again.

ISO CD 14624-2: Although the European Space Agency (ESA) expressed concerns with part C of the document, they agreed to leave this section intact. Other than ESA's concerns, few non-American comments were received, except those requesting cosmetic and format changes. Plans are to incorporate these changes prior to the May 1998 meeting and then to recirculate the documents. The September meeting of the NASA Materials and Processes Group resulted in several changes to this document that will be incorporated prior to circulation for the May 1998 meeting. Both parts B and C were deleted, leaving only the portion of the document taken from NHB 8060.1C. The deleted parts were added, individually, to insure that the document could support the needs of ESA's programs and some of NASA's oldest programs, respectively. It is expected that ESA will not be pleased with the deletion of part B.

ISO CD 14624-4: Only format comments were received. Format will be altered in keeping with standard ISO format prior to the May 1998 meeting.

Although it was moved to raise ISO CD 14624-4 to a Draft International Standard (DIS), enough comments were received at the CD

level to postpone this at least until the May 1998 meeting of WG1.

At the November ISO SC 14/TC 20 meeting in Russia, two additional new work initiatives were proposed by NASA. The first proposed to develop an ISO document that would provide design criteria and test data results for controlling failures due to stress corrosion cracking, and the other was to develop an international standard for determining the susceptibility of electrical wire insulation materials to arc tracking phenomena.

## **SSC**

**ADOPTION OF PDT-OI-E22** - Bill St. Cyr  
*William St\_Cyr@ssc.nasa.gov*

The Propulsion Test Directorate at SSC recently adopted an organizational instruction (PTD-OI-E22) on M&P Control of Critical Propulsion Facilities and Systems covering new test facilities and modifications to existing test facilities and systems. A materials selection list for liquid and gaseous oxygen systems was also prepared based on KSC's documents 79K09560 and 79K09561. Responsibility for M&P resides within the system design organization with material usage agreements (MUA) and independent review required only for materials in oxygen service not covered by the materials selection list or at pressures exceeding that specified in the materials selection list.

## **TECHNICAL SOCIETIES**

### **ASTM**

**ASTM INITIATING SPACE RELATED STDs** -  
*Gene Borson GeneB476@aol.com*

ASTM Committee E21 has a new proposed standard in the committee review/balloting cycle. The standard is entitled, "Selection of Spacecraft Materials."

## **SAMPE**

**SAMPE WILL HOLD SYMPOSIUM ON SPACE M&P** - Susan Ruth 310-336-6765

*Ruth@courier3.aero.org*

SAMPE is planning to dedicate its next Symposium to issues related to the development or application of materials for the space industry. The Symposium will be held at Anaheim, California from May 31 to June 4, 1998. Some of the topics of this Symposium will include testing performed on a material, description of process controls/parameters, description/discussion of hardware, as well as specialized topics such as material behavior in space environment, thermal control, contamination, or testing associated with environmentally acceptable alternatives to historical materials.

## **Space M&P, Manufacturing Community**

**MP3 MEETING TO BE HELD IN NOVEMBER** -

*Susan Ruth, Aerospace Corp. 310-336-6765*

*susan.c.ruth@aero.org*

The Aerospace Corporation is planning to hold the next Team Meeting of the Manufacturing Problem Prevention Program (MP3) on November 18-19, 1997. The meeting will be held at the El Segundo facility in California, near LAX. The focus topic will be "Composites - How to improve cost effectiveness, quality and reliability." The detailed agenda will be available at the beginning of October. This MP3 is sponsored by the US Air Force, Space and Missile Systems Center with the objective of making information available to the space community in order to prevent problems. The team consists of government and industry representatives.

## **SPACE INDUSTRY**

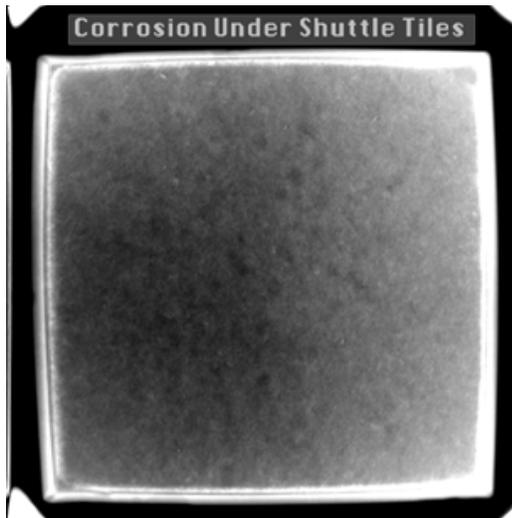
### **Aerospace Corporation**

**REDUCTION OF MANUFACTURING COST** -

*Susan Ruth, Ruth@courier3.aero.org*

Due to our customers' demands, Aerospace Corp. has initiated efforts to determine the Cost of Manufacturing. This initiative is the result of the changes in the fiscal picture for the

government acquisition functions. These changes led to a growing interest in assessing not only technical risk of being able to achieve requirements, but also understanding the associated cost risk. The corporation's Cost Analysis section has, for many years, evaluated and analyzed the actual costs of programs and compared the costs to a variety of vehicles attributes. More recently, the Vehicle Producability and Manufacturing Section has begun a collaboration with the Cost Analysis Section, relying on activity based costing. The objective of this effort is to see if a process can be developed to have activity based costing independent of the contractor community and then validate it with real data. Since this is a new initiative, there is no sufficient data to share yet.



Corrosion under Shuttle Tiles detected by Reverse Geometry radiography

### **Digiray**

#### **REVERSE GEOMETRY FOR SPACE**

**APPLICATIONS** - Richard D. Albert, 510-838-1510 [info@digiray.com](mailto:info@digiray.com)

Reverse Geometry X-ray is an emerging radiographic technology that allows imaging with very small detectors. It offers low background noise, high resolution images in 3-D and laminographic views. Recently, a portable reverse geometry X-ray system was developed by Digiray under a contract from LaRC. The system was used to inspect tiles mounted on the OV105 Endeavor Space

Shuttle in Palmdale, California under an SBIR contract with Boeing North America, Defense and Space Systems. The test results are included in the Boeing's Laboratory Report ANDTEL #97006, dated June 25, 1997 and was prepared by Steve Senne. Shuttle tiles mounted on aluminum supplied by Joseph Halupnik of Raytheon, a contractor of JSC, were also X-rayed. Corrosion was also detected under honeycomb covered space shuttle tiles and example is shown in the next Figure.

### **General Electric**

#### **ENGINEERING M&P INFORMATION**

**SERVICE (EMPIS)** - Dan Potts (203) 985-3005  
[ge.empis@corporate.ge.com](mailto:ge.empis@corporate.ge.com) or

EMPIS is a business system as well as an integral part of the engineering product design. EMPIS is 40,000+ pages of technical data on 30,000+ materials, 10.2 million machine parts (mostly fasteners), 1000+ finishes, processes, and test methods assembled in 82 volumes of specifications, design properties data, and purchasing vendor sources of supply. EMPIS is embedded in subscribers' designs and is distributed to subscribers' design and manufacturing components worldwide in 492 cities, 64 states and provinces, and 23 countries. The Government & Engineering Documentation Service monitors American national, international and government trends in configuration and data management requirements, MIL-FED specification development, Continuous Acquisition and Life-cycle Support (CALs) requirements, and other activities relevant to CE businesses in design, manufacturing and procurement. The EMPIS *Corporate Engineering Documentation Manual*, controls design, product definition, drawing numbers, drawing formats, model numbers, etc. of subscriber products worldwide and is an EMPIS volume.

## OTHER GOVERNMENT AGENCIES

### **AIR FORCE**

#### ***AIR FORCE SPACE RELATED ACTIVITY -***

*Dan Cleyrat, ML Space Materials Office 937-255-9081*

The Air Force's Materials Directorate has the corporate responsibility for all M&P across the AF be it aircraft or space applications with the exception of propellant materials (liquid and solid fuel materials). The responsibility to the propulsion materials is under the Propulsion Directorate at Edwards AFB. This effort was established by the Director, Dr Vincent Russo, in order to steer the Materials Directorate towards more support of the space sector. In doing so, he redirected a portion of his fiscal resources towards the area and established an infrastructure appointing an individual to lead what he calls the Space "Special Emphasis Area" (SEA). This activity is presently led by Mr. Michael Stropki with on site operational support by Mr. Dan Cleyrat of Anteon Corporation. The ML Space SEA is the focal point for all space and missile materials and processes (and now manufacturing) activities. Within the Directorate, lead engineers are supporting the various materials technical areas for space. Additionally, the Directorate established a partnership with the Phillips Lab, which in part recognizes SEA as their arm for all materials requirements.

Presently, there are several materials initiatives that have brought together the other DoD services and NASA. One such activity is the Integrated High Payoff Rocket Propulsion Technology (IHPRPT). Included in this effort is an IHPRPT Materials Working Group which includes as its members the AF, Army, Navy, NASA, and industry. Another area of materials requirements cooperation with NASA is the Military Spaceplane and X-33 activities. These areas of cooperation are expected to grow in the near future.

Last year, the first ever AF Space Materials Program Review was conducted and it was held

in Dayton, Ohio. The objective was to review the Directorate's programs that are supporting the space and missile sector. This review will be conducted again next year with a format that will possibly include other services and NASA.

#### ***NASP MATERIALS LESSONED LEARNED***

***WORKSHOP*** - This Workshop will be held from October 28 to 29, 1997 at the AFRL Materials Directorate, Wright Patterson AFB, Dayton, OH. This workshop is open only to US government agencies and government agency contractors. This Workshop should be of interest to those who are concurrently working on advanced launch (spacelift) programs such as MSP, IHPRPT, RLV, X-33, etc. The focus will be on materials and structures technology.

The National Aerospace Plane (NASP) was a large technology program to develop and demonstrate technologies necessary to support the development of a liquid H<sub>2</sub> fueled scramjet powered single stage to orbit vehicle. The program started as a cost shared program with 5 airframe and 3 engine contractors and NASA and Air Force lab support. Early in the program 2 airframe and 1-engine contractors dropped out. Also, it became apparent that there were many materials of common interest to the contractors and not enough money for each to separately develop the materials and processes that are required. Materials were recognized as a critical/enabling technology and that most were emerging materials that required a large aggressive development and characterization effort even for an experimental vehicle. A consortium was proposed and established to develop the critical materials of common interest and to take these materials out of the competition. Thus, the NASP Materials and Structures Augmentation Program (NASP Materials ASAP) began. This was a \$150 Million development program to bring to vehicle readiness 5 broad materials systems. They were: C/C, CMC; Titanium aluminides; Titanium matrix composites; very high thermal conductivity materials and composites; and

high temperature-high conductivity-light weight materials. All these were concerned with possible H<sub>2</sub> effects at low temperature and high temperature, at high pressure in heat exchangers and at low pressure from leakage.

This workshop will cover the NASP program background, philosophy, and its evolution with a description of the Materials ASAP program and related design and test activities. The individual areas will then be reviewed in a workshop/discussion mode, describing the objectives, approaches, findings and lessons learned. The style will be to have a short introduction with most of the time left to question and answer type discussions prompted by an occasional achievement, failure, etc. chart. This is not a NASP data dump or a detailed technical briefing (reports and follow up discussions can do that). This is to be a workshop/ discussion led by the attendee interests and the time dedicate to each subject will be dependent on the expressed interest.

## **UNIVERSITIES AND R&D INSTITUTES**

### ***Johns Hopkins University (JHU)***

#### ***NONLINEAR ULTRASONIC INSPECTION OF ADHESIVE BONDS*** - Robert Green,

[robert.green@jhu.edu](mailto:robert.green@jhu.edu) or [cnde@jhu.edu](mailto:cnde@jhu.edu)

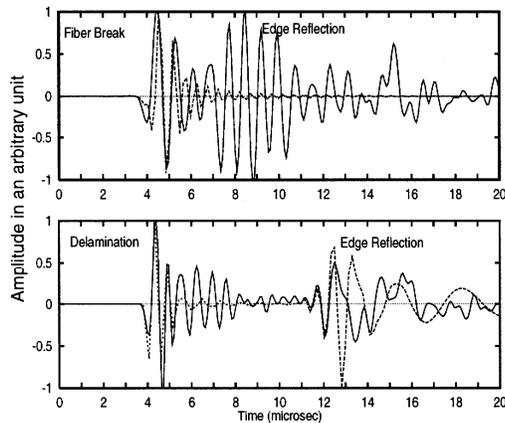
Recently, research at The Johns Hopkins University, Center for Nondestructive Evaluation, has been initiated to use nonlinear ultrasonic methods to evaluate adhesive bond quality, and to quantitatively determine parameters. Nonlinear ultrasonic waves differ from linear ultrasonic waves, which are commonly employed in nondestructive testing applications, in several important aspects. One of these is that an initially sinusoidal longitudinal wave of a given frequency distorts as it propagates through a material, due to energy transfer from the fundamental to

harmonics. Sample boundaries, such as an interface between two adjacent media can, under certain conditions, be particularly efficient sources for nonlinear elastic phenomena if passed by a large amplitude ultrasonic wave. Thus, monitoring the amount of harmonic generation as such a wave propagates through an adhesive bond can potentially be used to characterize its integrity. Data has shown that that the second harmonic generation measurements permit clear differentiation between normal adhesive bonds and bonds having an embedded protective polyester peel ply between two aluminum plates, whereas linear ultrasonic techniques are not as conclusive. This research is being sponsored by NASA Langley Research Center, program manager Dr. Mark Roberts.

### ***UCLA***

#### ***NEW TECHNIQUE OF MONITORING FRACTURE INITIATION*** - Ajit K. Mal, [ajit@seas.ucla.edu](mailto:ajit@seas.ucla.edu)

Researchers Ajit Mal and Dawei Guo at the University of California, Los Angeles have developed an innovative technique to monitor the initiation of fracture in aerospace and aircraft structures subject to service loads. The technique is based on the measurement and analysis of elastic waves produced at micro-fracture initiation sites and carried by guided waves along the structural component. Examples of measured and calculated waveforms due to micro-fractures in a graphite epoxy panel are shown in the figure. The technique can, in principle, be used in aircraft or aerospace structures to monitor their degradation under service conditions. This research is part of a broader project on characterization of the materials degradation due to corrosion and fatigue in aerospace structures funded by the Air Force Office of Scientific Research.



Experimental (solid lines) and theoretical (dashed lines) signals from microfracture events in crossply composites.

- 28-29 Oct 97 WPAFB, OH  
NASP/HYTECH Materials  
Lesson Learned Workshop,  
WPAFB, OH
- 30-31 Oct 97 2nd IHRPT Materials  
Working Group Meeting,  
Dayton OH
- 28-29 Oct 97 RLV Human in Space  
Workshop, League City, TX
- 18-19 Nov 97 MP3 Meeting, El Segundo  
CA
- 31 May -4 June, 98 SAMPE Int'l Symposium,  
Anaheim, California
- June 1-3, 98 3rd Aerospace  
Environmental Tech. Conf.,  
Huntsville, AL
- 12-16 July 98 3<sup>th</sup> Pacific Rim International  
Conf. on Advanced M&P

## UPCOMING EVENT

- 23 Oct 97 MultiFunctional Structures  
Review, KAFB, OH
- 27 Oct 97 ML Ceramics for IHRPT  
Program Kickoff Meetings,

### **NASA MATERIALS & PROCESSES UPDATE (NMPU)**

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