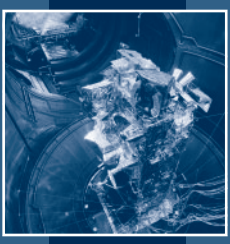
# MISSION SUCCESS THROUGH ENVIRONMENTAL TEST

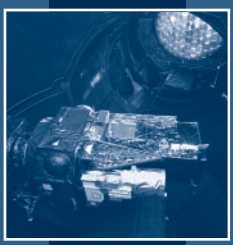
## 22nd Space Simulation Conference

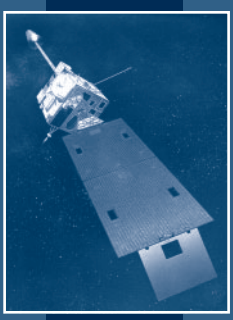
*October 21–24, 2002*

*Turf Valley Resort and Conference Center*

*Ellicott City, Maryland*







IEST NASA AIAA ASTM CSA JHU/APL

# Message from the General Chair

## *Mission Success Through Environmental Test*

Welcome to the 22nd Space Simulation Conference. Once again we have the opportunity to meet with our peers in the environmental testing field to discuss important topics of mutual interest. In this ever-changing world of aerospace testing we are faced with many challenges, and this conference should help provide solutions to some of the problems you encounter on your job.

One of the main challenges we face is providing cost-effective testing services to our customer, the project manger. With decreases in budgets and advances in modeling and computer simulation it becomes more and more difficult to convince some project managers to fund a comprehensive environmental testing program, but we should be able to cite many examples where mission success is the direct result of a well planned environmental test program.

At the 22nd Space Simulation Conference we hope to provide tutorials and a wide variety of papers that present information on recent developments and test activities in the world of space simulation testing. Whether you work in government service, academia, or the corporate arena, you have seen many cultural changes during the past few years, and we hope you will gain some insight as to how others have dealt with these changes.

We are honored to have as our keynote speaker Mr. William F. Tosney from The Aerospace Corporation in California. Bill will show how data from across the industry is helping to shape the efforts of government and industry to reinvigorate the goal of mission success for space systems. It will be a pleasure to welcome as our luncheon speaker on Thursday Mr. Frank Cepollina from NASA's Goddard Space Flight Center. Mr. Cepollina is the manager of the Hubble Space Telescope Development Project and is responsible for the on-orbit servicing of the Hubble Space Telescope. Also, it will be a pleasure to have Mr. Mick Roy in attendance at the conference. Mick works for Northrop Grumman in Baltimore and is president of our host society, the Institute of Environmental Sciences and Technology. Also in attendance at this year's conference will be top vendors who supply our industry with the latest in technologically advanced products, equipment, and facilities. Please take the time to visit the vendors' tabletop displays and thank them for their participation in the conference.

Our venue this year is the beautiful Turf Valley Resort and Conference Center. I invite you to take advantage of the full services and recreational opportunities provided by the resort. Whether it is an early morning round of golf or an evening

swim in the pool, I think you will find this location outstanding in every respect.

Please join us for our evening reception at the Baltimore and Ohio Railroad Museum in downtown Baltimore and our tour of the National Institute of Standards and Technology in Gaithersburg. Both of these events will be memorable highlights of the conference.

I want to take this opportunity to thank all of our speakers and authors for their efforts to provide high-quality papers and presentations. I also want to give a great big thank you to the technical program committee and conference management committee; without their help this conference would not have been possible. Most of all I want to thank and acknowledge our technical program chair Bill Breeden for his hard work in organizing the program; John Hazen, our finance and conference advisor, for his counsel, which made my job much easier; Hal Fox, our publicity chair, for all his support with the conference web site and program publication; and Bill Wilkinson, who once again provided an excellent tutorial program.

Welcome and enjoy the conference.

*Terry C. Fisher*
General Chair

**Hotel and IEST Information**
**Hotel contact numbers: 888-833-8873**
**410-465-1500**
**IEST contact number: 847-255-1561**

# 22nd Space Simulation Conference

***October 21–24, 2002***
***Turf Valley Resort and Conference Center***
***Ellicott City, Maryland***

## *Monday, October 21, 2002*
## *TUTORIAL*

7:30 am **Registration**

8:10 am **Introduction**

*Co-Chair:* *William O. Wilkinson,*
*The Johns Hopkins University*
*Applied Physics Laboratory*
*Co-Chair:* *Michael Yachmetz*
*ManTech/NSI*

8:15 am **Session A-1**
**Contamination Control Engineering for the Hubble Space Telescope**
*Jacqueline Townsend*
*NASA Goddard Space Flight Center*

**Session B-1**
**Applied Vibration Testing Methods**
*Donald R. Baker*
*ManTech/NSI*

10:00 am **Session A-2**
**Implementing the New ISO Contamination Control Standards**
*Richard A. Matthews*
*Filtration Technology Inc.*

**Session B-2**
**Personnel Safety in Environmental Test Facilities**
*Melonie Scofield*
*ManTech/NSI*

11:45 am Lunch (on your own)

1:15 pm **Session A-3**
**Doing Things Right in Space Programs System Development**
*Thomas Sarafin*
*Instar Engineering and Consulting, Inc.*

**Session B-3**
**Basic Opto-Mechanical Alignment Technique**
*Kevin W. Redman*
*ManTech/NSI*

4:30 pm Tutorial Sessions End

## *TUTORIAL DESCRIPTION*

### Session A-1

CONTAMINATION CONTROL ENGINEERING FOR THE HUBBLE SPACE TELESCOPE
*Jacqueline Townsend*
*HST Contamination Manager*
*NASA Goddard Space Flight Center*

Contamination control for the Hubble Space Telescope (HST) is a constant balancing act. NASA plans for the HST to be an active observatory through the year 2010, for a total of 20 years of cutting-edge scientific performance. Enabling this ambitious plan is a series of servicing missions designed to upgrade, maintain, and repair the telescope's instruments and systems. These servicing missions are essentially on-orbit integration and test activities in an uncontrolled environment. Contamination control in such circumstances requires both precision and creativity. A strategy must be found that balances the immediate and long-term needs of the HST, the easiest approach for the crew with the risk of the activity, and the heritage of successful techniques with the demands of the current situation. The specific balances that must be struck for the HST contamination control program may be unique, but the need to balance competing requirements is common to every contamination control strategy. In this tutorial, the

contamination control strategies for the HST Servicing Mission 3B will be discussed from the general approach to the resolution of specific issues. Emphasis will be placed on the trade-off inherent in each decision and the more creative elements of the program.

## Session A-2

IMPLEMENTING THE NEW ISO CONTAMINATION CONTROL STANDARDS
*Richard A. Matthews*
*Senior Contamination Consultant*
*Filtration Technology Inc.*

Mr. Matthews will give an in-depth tutorial on the current implementation of the ISO/TC 209 Contamination Control Document that is replacing the U.S. FED-STD. 209. Dick will also discuss cleanroom design and contamination control strategies to meet the challenging requirements of flight instruments in next century.

## Session A-3

DOING THINGS RIGHT IN SPACE PROGRAMS SYSTEM DEVELOPMENT
*Thomas Sarafin*
*Instar Engineering and Consulting, Inc.*

This tutorial is aimed at all technicians, engineers, and managers involved in the design or test of space and launch vehicles or their components. The objective is to improve your understanding of what it takes to develop systems that are dependable yet cost-effective. The philosophy here is quality first, with total cost being reduced through good engineering. The course introduces ten principles for doing things right and then explores the three that apply most to system development and test.

## Session B-1

APPLIED VIBRATION TESTING METHODS
*Donald R. Baker*
*ManTech International Corporation at GSFC*

The Applied Vibration Test tutorial provides an overview of vibration testing with a minimal amount of theory and mathematics. The tutorial first provides an overview of the equipment, processes, and determina-

tion of vibration test equipment capabilities involved in closed-loop controlled vibration testing. Next, the tutorial provides a more in-depth review of each piece of equipment required for vibration testing, including the shaker, amplifier, control system, response instrumentation, and test item fixturing. Finally, vibration control system operation and vibration test control strategies will be reviewed, including a review vibration test response limiting and touching on force limit vibration testing.

## Session B-2

PERSONNEL SAFETY IN ENVIRONMENTAL TEST FACILITIES
*Melonie Scofield*
*Senior Administrator for Safety & Health*
*ManTech International Corporation at GSFC*

Ms. Scofield will present a concise update on safety in an active environmental test facility, covering such subjects as confined spaces, cryogenics, and ergonomics as well as lessons learned from testing different items in close proximity and hazards involved with upgrading facilities. Ms. Scofield is the Senior Administrator for Safety and Health at ManTech in support of the GSFC Environmental Test Laboratory.

## Session B-3

BASIC OPTO-MECHANICAL ALIGNMENT TECHNIQUE
*Kevin W. Redman*
*Senior Optical Engineer*
*ManTech International Corporation at GSFC*

This tutorial introduces the purpose and types of opto-mechanical alignment activities conducted at GSFC (usually pre/post-environmental testing). It will address various types of alignment operations, objectives, and setup. Also covered will be the types and uses of optical metrology equipment, including theodolites, levels, transits, and autocollimators (examples of each instrument may be available for attendees to examine). The tutorial will also address current metrology systems such as theodolite coordinate measuring, laser trackers, and photogrammetry cameras. A mathematical introduction to the analysis of theodolite autocollimation data will complete the tutorial.

## *Tuesday, October 22, 2002*
## *CONFERENCE*

7:30 am **Registration**

8:30 am **Welcome—Conference General Chair**
*Terry C. Fisher*
*NASA/Caltech-Jet Propulsion Laboratory*

8:40 am **Welcome—President IEST**
*Mick Roy*

8:45 am **Keynote Speaker**
*William F. Tosney*
*The Aerospace Corporation*

9:20 am **Welcome—Technical Program Chair**
*William N. Breeden III*
*Lockheed Martin Astronautics*

### SESSION 1—DYNAMICS TESTING

*Chair:* *Raj Singhal, Canadian Space Agency*
*Co-Chair:* *Elie Choueiry, Canadian Space Agency*

9:30 am **VISPERS—An Intelligent System to Support Vibroacoustic Testing**
*Jerome E. Manning, Cambridge Collaborative, Inc.; Kent B. Bradford, The Aerospace Corporation*

9:55 am **Dynamic Testing of a Subscale Sunshield for the Next Generation Space Telescope (NGST)**
*Brian P. Ross, John D. Johnston, and James T. Smith, NASA Goddard Space Flight Center*

10:20 am Coffee Break/Visit Vendor Booths

10:50 am **Boosted Modal Survey Testing for Dynamic Qualification of Large Satellite Spacecraft**
*M. Degener, DLR – Deutsches Zentrum für Luft und Raumfahrt Institute of Aeroelasticity*

11:15 am **Control System Upgrade for a Mass Property Measurement Facility**
*William Vaughan Chambers, ManTech International Corp.*

11:40 am **ISCOC—The Integrated System for Calibration and Overall Checkout of the Vibration Test Facility**
*Elbert E. N. Macau and Anderson M. Carvalho, Laboratório de Integração e Testes (LIT) Instituto Nacional de Pesquisas Espaciais (INPE)*

12:05 pm Lunch (on your own)

## SESSION 2—NEW CAPABILITIES AND FACILITIES

*Chair:* *Don Benson, Northrop-Grumman ESSS*
*Co-Chair:* *Dave Feick, Northrop -Grumman ESSS*

1:30 pm **The Development of a Portable Heater Control System for Thermal Vacuum Testing at NASA/GSFC**
*Chris Johnson, John Palmer, and Jim Mills, ManTech Aerospace*

1:55 pm **A New Type of Test Facility for the Investigation of Degradation Effects of Thin Foil Samples for a Solar Sail Mission Concerning the Simultaneous Influence of Space Environment Properties**
*F. Lura, D. Hagelschuer, and S. Babben, DLR - Institute of Space Sensor Technology and Planetary Exploration; A. I. Glotov and Y. Tschaly, State Scientific Centre of Russia, Institute of Physics and Power Engineering*

2:20 pm **Relocation of the Cryo-Test Facility to NASA-MSFC**
*Jimmy D. Sisco, NASA Marshall Space Flight Center*

2:45 pm Afternoon Break/Visit Vendor Booths

3:15 pm **A Vibration Isolation System for Use in a Large Thermal/Vacuum Facility**
*Don Hershfeld, ManTech International Corp.*

3:40 pm **Development of a Large Vibration Slip Table**
*Otto Brunner, European Space Agency/ ESTEC*

4:05 pm **Cold Vibration Facility at CSL Premises**
*Antonio Cucchiaro, Christophe Grodent, Pierre Jamotton, and Jean-Sébastien Servaye, Centre Spatial de Liège, Université de Liège; Christophe Delrez, AMOS*

4:30 pm **Chinese New Large Space Environment Simulation Facility**
*Huang Bencheng, Pang Hewei, and Zhou Chuangliang, Beijing Institute of Spacecraft Environment Engineering, Chinese Academy of Space Technology*

4:55 pm Session Ends

5:45 pm **Buses Leave Turf Valley for Baltimore Conference Reception at the B&O Railroad Museum**

9:30 pm **Buses Leave Baltimore for Return Trip to Turf Valley**

## *Wednesday, October 23, 2002*

7:30 am **Registration**

### SESSION 3—THERMAL VACUUM TESTING

*Chair:* *Ed Packard, NASA Goddard Space Flight Center*

8:00 am **Environmental Testing for MESSENGER: Mercury's First Orbiting Spacecraft**
*Carl J. Ercol, The Johns Hopkins University Applied Physics Laboratory*

8:25 am **Outer Planet Spacecraft Temperature Testing and Analysis**
*Alan R. Hoffman and Arturo Avila, NASA Jet Propulsion Laboratory*

8:50 am **20 in 31—20 Satellite Thermal Vacuum Tests in 31 Months**
*John Compton and Tim Reynolds, Space Systems/Loral*

9:15 am **Industrial Practice and Perspectives for the Thermal Vacuum Testing of Space Components and Systems**
*E. Comandatore, P. Giordano, and P. Messidoro, Alenia Spazio S.p.A.; G. Sembenini and L. Sicari, Dipartimento di Ingegneria Aeronautica e Spaziale Politecnico di Torino*

9:40 am Coffee Break/Visit Vendor Booths

## SESSION 4—MATERIALS AND CONTAMINATION

*Chair:* *Bob Moss, Consultant*
*Co-Chair:* *Gene Borson, Consultant*

10:10 am **Relationship of Molecular Contamination to the Change in Solar Absorptance of the GOES-8 Spacecraft**
*Jack Sanders, Swales Aerospace*

10:35 am **Space Environment Combined Effects on Materials and Structures by Mathematical Models Application**
*P. d'Avanzo and M. Marchetti, Dipartimento di Ingegneria Aerospaziale e Astronautica, DIAA Università di Roma "La Sapienza"*

11:00 am **Long-Term Measurement of Molecular Contamination in a Cleanroom Using a Temperature-Controlled Quartz Crystal Microbalance (TQCM)**
*William J. Mitchell, QSS Group, Inc.*

11:25 am **Accuracy and Precision of the ASTM E-595 Outgassing Test at 125°C and 180°C**
*Robert Moss, Consultant (retired from Space Systems/Loral)*

11:50 am **Real-Time Molecular Contamination Monitoring During Spacecraft Development**
*Zhou Chuangliang, Huang Bencheng, and Pang Hewei, Beijing Institute of Spacecraft Environment, Engineering Chinese Academy of Space Technology*

12:15 am Lunch on your own

**SESSION 5—STUDIES AND NEW APPROACHES**

*Chair:* *Bob Tomkiewicz, The Johns Hopkins University Applied Physics Laboratory*

*Co-Chair:* *Hadi Navid, The Johns Hopkins University Applied Physics Laboratory*

1:30 pm **MARS EXPRESS—A Challenging European Mission to Mars. The Verification, Integration and Test Approach**
*Pietro Giordano and Diego Gerbaz, ALENIA Spazio S.p.A; GianLuca Sembenini, Dipartimento di Ingegneria Aeronautica e Spaziale Politecnico di Torino*

1:55 pm **A Mainenance and Repair Database for Test Laboratories**
*William N. Breeden III, Lockheed Martin Space Systems*

2:20 pm **Remaining Life Assessment of Electronics of Space Shuttle Remote Manipulator System**
*Vidyasagar Shetty, Diganta Das, and Michael Pecht, CALCE Electronic Products and Systems Center, University of Maryland; David Hiemstra and Stephen Martin, MacDonald Dettwiler Space and Advanced Robotics Ltd*

2:45 pm Afternoon Break/Visit Vendor Booths

3:15 pm **Testing as Part of a Sound Engineering Approach**
*Thomas P. Sarafin, Instar Engineering and Consulting, Inc.*

3:40 pm **Getting the Most Out of a Facility Renovation**
*Thomas E. Hansz, AIA, Mark T. Hemmingway, PE, Facility Planning & Resources, Inc.*

4:05 pm **Simulation Model and Test Validation on Dynamic Temperature Field of Spacecraft**
*Jia Yang, Beijing Institute of Spacecraft Environment Engineering; Liu Qiang, Chinese Academy of Space Technology*

4:30 pm Session Ends

## *Thursday, October 24, 2002*

7:30 am **Registration**

**SESSION 6—INSTRUMENTATION AND DATA ACQUISITION**

*Chair:* *Otto Brunner, European Space Agency/ESTEC*

*Co-Chair:* *Manfred Degener, DLR*

8:00 am **Replacement of a Large Control and Data Acquisition System for Thermal Vacuum Application**
*Elie Choueiry, David Florida Laboratory Canadian Space Agency*

8:25 am **New Quiet Ground System at Goddard Environmental Laboratory**
*Patrick K. Harris, ManTech International Corp.*

8:50 am **Profile of a Large/High End Data Acquisition and Analysis System for Spacecraft Vibration Testing**
*B S Jagadesh Babu, V Ramesh Naidu, J N Hemanta Kumar, and N K Mishra, Environmental Test Facilities, ISRO Satellite Centre*

9:15 am Coffee Break/Visit Vendor Booths

9:45 am **Alignment Measurements of the Microwave Anisotropy Probe (MAP) Instrument in a Thermal/Vacuum Chamber Using Photogrammetry**
*Michael D. Hill, Edward A. Packard, and Henry P. Sampler, Goddard Space Flight Center; Acey A. Herrera and J. Allen Crane, Swales Aerospace, Inc.; Carlos Aviado, ManTech International*

## SESSION 7—MATERIALS AND CONTAMINATION II

*Chair:* *Rick Lehmann, Boeing Satellite Systems*

10:10 am **The Design of a Remotely Operated Shutter (ROS) for Thermal Vacuum Testing**
*Kate Hale, NASA Goddard Space Flight Center; Chris Skocik, ManTech International Corporation*

10:35 am Session Ends

11:15 am **Conference Luncheon**
*Speaker: Frank Cepollina, NASA Goddard Space Flight Center*

1:00 pm **Buses Depart Turf Valley for a Tour of the National Institute of Standards and Technology (NIST), Gaithersburg, Maryland**

4:30 pm **Buses Depart NIST for Return to Turf Valley**

5:00 pm **Buses Arrive at Turf Valley**

## TOUR OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

The National Institute of Standards and Technology (NIST) develops technologies, measurement methods, and standards that help U.S. companies compete in the global marketplace. Congress created NIST in 1901 at the start of the industrial revolution to provide the measurements and standards needed to resolve and prevent disputes over trade and to encourage standardization. That's why you can have confidence that a gallon of milk contains one gallon and that the electric meter at your house accurately gauges how much electricity you use. On Thursday, October 24, buses will transport conference attendees from the Turf Valley Resort to NIST, located in Gaithersburg, Maryland. We will visit the NIST Standards Museum and the building housing the Vacuum Standards and Calibration Facility. The tour is expected to last approximately 3 hours.

## RECEPTION AT B&O RAILROAD MUSEUM

Please join us for our conference reception on Tuesday evening, October 22, in the 1884 Baldwin Roundhouse, a 22-sided, 136-foot-high architectural masterpiece at the famous B&O Railroad Museum in Baltimore. Buses will transport conference attendees from the Turf Valley Resort to the

museum in downtown Baltimore. The B&O Railroad Museum possesses one of the oldest and most comprehensive railroad collections in the Western Hemisphere. Its roster of rolling stock, historic buildings, and assortment of small artifacts make it a mecca of American railroading. The collection covers almost every aspect of an industry interwoven into the folklore and culture of America. The Museum's collection dates from the very first days of the B&O Railroad with the laying of the First Stone on July 4, 1827. The B&O Railroad Museum is dedicated to the preservation and interpretation of American railroading through the history and legacy of the Baltimore and Ohio Railroad, the Chesapeake and Ohio Railway, the Western Maryland Railway, and the regional railroads of the mid-Atlantic. In 1999, the B&O Railroad Museum joined the Smithsonian Institution's Affiliates Program, becoming the first railroad museum and the first museum in Maryland to hold that distinction. It is in the unique position of occupying the exact physical location where railroading was first established in America in 1827 and where the B&O Railroad Company grew and developed into a major national force.

## William F. Tosney

*Conference Keynote Speaker*

Bill Tosney is an Associate Principal Director in the Engineering and Technology Group at The Aerospace Corporation. His primary responsibilities include coordination and development test and evaluation requirements, engineering-based knowledge management solutions, risk management, and evaluation of systems engineering requirements.

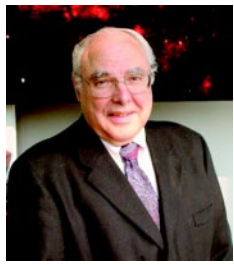
His 26-year career covers a number of diverse technical areas, including polymer chemistry, instrumentation and process control, offshore petroleum engineering, Space Shuttle failure analysis, space test and evaluation, and systems engineering. He recently served as a panel member on the Launch Vehicle Broad Area Review, supported NASA's Independent Review of Faster, Better, Cheaper, and is a an AIAA Distinguished Lecturer. He is currently leading a study to assess the adequacy of satellite test practices across the industry, including an evaluation of advances in modeling, simulation, and enterprise-wide information management strategies. He has written and co-authored over 25 technical papers and teaches several classes in The Aerospace Institute on the subject of testing and risk assessment.

Bill has been recognized for numerous contributions over the years. He received The Institute of Environmental Science Otto Hamburg Award in 1997 for work evaluating orbital experience and ground test practices, an Aerospace Group Achievement Award in 1989 for his contributions to understanding satellite test effectiveness, and the Schlumberger Offshore Engineer of the Year Award in 1984.

Bill will show how data from across the industry is helping to shape the efforts of government and industry to reinvigorate the goal of mission success for space systems.

## Frank Cepollina

*Luncheon Keynote Speaker*



As head of NASA's Hubble Space Telescope Development Project, Mr. Frank Cepollina is responsible for the development and installation of all the new science instruments and hardware that keep Hubble on the cutting edge. His distinguished career includes work on NASA's first serviceable Multimission Modular Spacecraft, the Explorer Platform, and serving as Project Manager for the Solar Maximum Repair Mission. Mr. Cepollina directed the design of the generic servicing platforms and instrument carriers that would be used on Hubble and many other NASA spacecraft. He has been involved in designing Hubble's astronaut interfaces and power tools since the inception of the Shuttle Program. He will discuss the benefits of satellite servicing, particularly with regard to Hubble.

### *Technical Program Committee*

Donald M. Benson
Northrop-Grumman ESSS

Otto Brunner
European Space Agency/ESTEC

Rick Lehmann
Boeing Satellite Systems (formerly Hughes Space and Communications)

Robert Moss
Space Systems Loral

Ed Packard
NASA Goddard Space Flight Center

Dr. Raj K. Singhal
Canadian Space Agency

Robert Tomkiewicz
The Johns Hopkins University
Applied Physics Laboratory

## *Meeting Management Committee*

General Chair
Terry C. Fisher
Caltech Jet Propulsion Laboratory

Technical Program Chair
William Breeden III
Lockheed Martin Astronautics

Past General Chair/Finances
John D. Hazen
Boeing Phantom Works

Vendor Displays Chair
John D. Campbell
Consultant

Publicity Chair
Harold G. Fox
Consultant

Publication Chair
Stan Wojnar
NASA Goddard Space Flight Center

Tutorial Co-Chair
William O. Wilkinson
The Johns Hopkins University
Applied Physics Laboratory

Tutorial Co-Chair
Michael Yachmetz
ManTech/NSI

IEST Executive Director
Julie Kendrick, CAE
Institute of Environmental Sciences and Technology

Program provided by The Johns Hopkins University
Applied Physics Laboratory.