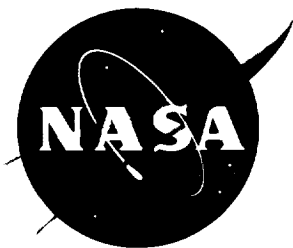


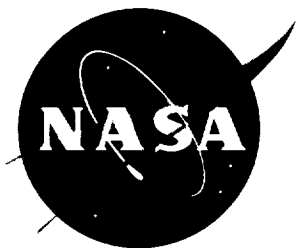
NASA Technical Memorandum 108502
Volume I



FY 1995 Scientific and Technical Reports, Articles, Papers, and Presentations

*Compiled by
Joyce E. Turner*

October 1995



NASA Technical Memorandum 108502
Volume I

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National Aeronautics and Space Administration
Marshall Space Flight Center • MSFC, Alabama 35812

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FOREWORD

In accordance with the NASA Space Act of 1958, the MSFC has provided for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof.

Since July 1, 1960, when the George C. Marshall Space Flight Center was organized, the reporting of scientific and engineering information has been considered a prime responsibility of the Center. Our credo has been that "research and development work is valuable, but only if its results can be communicated and made understandable to others."

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GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama

FY 1995 SCIENTIFIC AND TECHNICAL REPORTS,
ARTICLES, PAPERS, AND PRESENTATIONS

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TM-4715 August 1995
 The NASA/MSFC Global Reference Atmospheric Model—1995 Version (GRAM-95). C.G. Justus,* W.R. Jeffries III, S.P. Yung,* and D.L. Johnson. Systems Integration and Analysis Laboratory. *Computer Sciences Corp.
 N96-11695

The latest version of the Global Reference Atmospheric Model (GRAM-95) is presented and discussed. GRAM-95 uses the new Global Upper Air Climatic Atlas (GUACA) CD-ROM data set, for 0- to 27-km altitudes. As with earlier versions, GRAM-95 provides complete geographical and altitude coverage for each month of the year. Individual years 1985 to 1991 and a period-of-record (1980 to 1991) can be simulated for the GUACA height range. GRAM-95 uses a specially developed data set, based on Middle Atmosphere Program (MAP) data, for the 20- to 120-km height range, and the NASA Marshall Engineering Thermosphere (MET) model for heights above 90 km. Fairing techniques assure a smooth transition in the overlap height ranges (20 to 27 km and 90 to 120 km). In addition to the traditional GRAM variables of pressure, density, temperature, and wind components, GRAM-95 now includes water vapor and 11 other atmospheric constituents (O₃, N₂O, CO, CH₄, CO₂, N₂, O₂, O, A, He, and H). A new, variable-scale perturbation model provides both large-scale and small-scale deviations from mean values for the thermodynamic variables and horizontal and vertical wind components. The perturbation model includes new features that simulate intermittency (patchiness) in turbulence and small-scale perturbation fields. The density perturbations and density gradients (density shears) computed by the new model compare favorably in their statistical characteristics with observed density perturbations and density shears from 32 space shuttle reentry profiles. GRAM-95 provides considerable improvement in wind estimates from the new GUACA data set, compared to winds calculated from the geostrophic wind relations previously used in the 0- to 25-km height range. The GRAM-95 code has been put into a more modular form, easier to incorporate as subroutines in other programs (e.g., trajectory codes). A complete user's guide for running the program, plus sample input and output, is provided.

TM-108468 October 1994
 Dynamics Explorer 1, Retarding Ion Mass Spectrometer Summary Spectrograms—82/001 to 82/109 Spin-Time Spectrograms for H⁺, He⁺, O⁺, N⁺, O⁺⁺, M/Z = 2, and Molecular Ions. By DE 1/RIMS Investigators. Space Sciences Laboratory.
 N95-15607

The Retarding Ion Mass Spectrometer (RIMS) experiment onboard the Dynamics Explorer 1 (DE 1) satellite was designed to perform energy and mass-per-charge analysis on low-energy ions (<50 eV) with mass/charge ratios ranging from 1 to 40 amu/Z. The DE 1 satellite, carrying the RIMS experiment, was launched into an elliptical polar orbit on August 3, 1981. The ~7.5 hour orbit has perigee of 675 km altitude and apogee of 24,875 km altitude. This document, and those that follow in this series, contains summary RIMS data spectrograms for each orbit for which RIMS data are available. The RIMS instrument began returning science data on day 280 of 1981 and continued to return usable data until the end of the DE mission in March 1991. It should be noted that studies of the RIMS data set should be conducted only with a thorough awareness of the material described in the introduction section presented here, or in collaboration with a scientist familiar with RIMS data analysis.

TM-108469 October 1994
 Metrication in a Global Environment. J. Aberg. Systems Analysis and Integration Laboratory.
 N95-14919

A brief history about the development of the metric system of measurement. The need for the U.S. to implement the "SI" metric system in the international markets, especially in the aerospace and general trade. Development of metric implementation and experiences locally, nationally, and internationally are included.

TM-108471 December 1994
 NASA Marshall Space Flight Center Solar Observatory Report—March–May 1994. J.E. Smith. Space Sciences Laboratory. N95-70576

This report provides a description of the NASA Marshall Space Flight Center's Solar Vector Magnetograph Facility and gives a summary of its observations and data reduction during March–May 1994. The systems that make up the facility are a magnetograph telescope, an H- α telescope, a Questar telescope, and a computer code.

TM-108472 November 1994
 Vehicle Health Management Using Adaptive Techniques—CDDF Final Report (No. 92-12). J.H. Kim and R. Kissel. Program Development Office.
 N95-15609

Automated engine diagnostics using cognitive computing methodologies are investigated. Space shuttle main engine vibrational data are used to test the algorithms.

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TM-108473 December 1994
Analytical Control Test Plan and Microbiological Methods for the Water Recovery Test. M.S. Traweek and J.D. Tatar,* editors. Structures and Dynamics Laboratory. *ION Electronics.
N95-19061

Qualitative and quantitative laboratory results are important to the decision-making process. In some cases, they may represent the only basis for deciding between two or more given options or processes. Therefore, it is essential that handling of laboratory samples and analytical operations employed are performed at a deliberate level of conscientious effort. Reporting erroneous results can lead to faulty interpretations and result in misinformed decisions.

This document provides analytical control specifications which will govern future test procedures related to all Water Recovery Test (WRT) Phase III activities to be conducted at the National Aeronautics and Space Administration/Marshall Space Flight Center (NASA/MSFC). This document addresses the process which will be used to verify analytical data generated throughout the test period, and to identify responsibilities of key personnel and participating laboratories, the chains of communication to be followed, and ensure that approved methodology and procedures are used during WRT activities. This document does not outline specifics, but provides a minimum guideline by which sampling protocols, analysis methodologies, test site operations, and laboratory operations should be developed.

TM-108474 January 1995
Guidelines for Qualifying Cleaning and Verification Materials. D. Webb. Materials and Processes Laboratory.
N95-20694

This document is intended to provide guidance in identifying technical issues which must be addressed in a comprehensive qualification plan for materials used in cleaning and cleanliness verification processes. Information presented in this report is intended to facilitate development of a definitive checklist that should address all pertinent materials issues when down selecting a cleaning/verification media.

TM-108475 January 1995
A 20-k Payload Launch Vehicle Fast Track Development Concept Using an RD-180 Engine and a Centaur Upper Stage. Compiled by Ronald Toelle. Space Transportation and Exploration Office.
N95-19648

A launch vehicle concept to deliver 20,000 lb of payload to a 100-nmi orbit has been defined. A new liquid oxygen/kerosene booster powered by an RD-180 engine was designed while using a slightly modified Centaur upper stage. The design, development, and test program met the imposed 40-month schedule by elimination of major structural testing by increased factors of safety and concurrent engineering concepts. A growth path to attain 65,000 lb payload is developed.

TM-108476 January 1995
Preliminary Control System Design and Analysis for the Space Station Furnace Facility Thermal Control System. M.E. Jackson. Structures and Dynamics Laboratory.
N95-20560

This report presents Space Station Furnace Facility (SSFF) thermal control system (TCS) preliminary control system design and analysis. The SSFF provides the necessary core systems to operate various materials processing furnaces. The TCS is defined as one of the core systems, and its function is to collect excess heat from furnaces and to provide precise cold temperature control of components and of certain furnace zones. Physical interconnection of parallel thermal control subsystems through a common pump implies the description of the TCS by coupled nonlinear differential equations in pressure and flow. This report formulates the system equations and develops the controllers that cause the interconnected subsystems to satisfy flow rate tracking requirements. Extensive digital simulation results are presented to show the flow rate tracking performance.

TM-108477 January 1995
Advanced Liquid Oxygen (LO₂) Propellant Conditioning Concept Testing. G.L.E. Perry, J.D. Suter, and S.G. Turner. Propulsion Laboratory.
N95-22672

Advanced methods of liquid oxygen (LO₂) propellant conditioning were studied as part of an effort for increasing reliability and operability while reducing cost of future heavy lift launch vehicles. The most promising conditioning concept evaluated was no-bleed (passive recirculation) followed by low-bleed, helium injection, and use of a recirculation line. Full-scale cryogenic testing was performed with a sloped feedline test article to validate models of behavior of LO₂ in the feedline and to prove no-bleed feasibility. Test data are also intended to help generate design guidelines for the development of a main propulsion system feed duct. A design-of-experiments matrix of over 100 tests was developed to test all four propellant conditioning concepts and the impact of design parameters on the concepts.

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Liquid nitrogen was used as the test fluid. The work for this project was conducted from October 1992 through January 1994 at the hydrogen cold flow facility of the west test area of MSFC. Test data have shown that satisfactory temperatures are being obtained for the no-bleed conditioning concept.

TM-108479 February 1995
Transport Phenomena in the Micropores of Plug-Type Phase Separators. M.M. Fazah. Propulsion Laboratory. N95-20561

This study numerically investigates the transport phenomena within and across a porous-plug phase separator. The effect of temperature differential across a single pore and of the sidewall boundary conditions, i.e., isothermal or linear thermal gradient, are presented and discussed. The effects are quantified in terms of the evaporation mass flux across the boundary and the mean surface temperature. A two-dimensional finite element model is used to solve the continuity, momentum, and energy equations for the liquid.

The temperature differentials across the pore interface of 1.0, 1.25, and 1.5 K are examined and their effect on evaporation flux and mean surface temperature is shown. For isothermal side boundary conditions, the evaporation flux across the pore is directly proportional and linear with ΔT . For the case of an imposed linear thermal gradient on the side boundaries, Biot numbers of 0.0, 0.15, and 0.5 are examined. The most significant effect of Biot number is to lower the overall surface temperature and evaporation flux.

TM-108480 October 1994
FY 1994 Scientific and Technical Reports, Articles, Papers, and Presentations. Compiled by Joyce E. Turner. Management Operations Office. N95-23225

This document presents formal NASA technical reports, papers published in technical journals, and presentations by MSFC personnel in FY94. It also includes papers of MSFC contractors.

After being announced in STAR, all of the NASA series reports may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

The information in this report may be of value to the scientific and engineering community in determining what information has been published and what is available.

TM-108481 February 1995
Statistically Generated Weighted Curve Fit of Residual Functions for Modal Analysis of Structures. P.S. Bookout. Structures and Dynamics Laboratory. N95-22950

A statistically generated weighting function for a second-order polynomial curve fit of residual functions has been developed. The residual flexibility test method, from which a residual function is generated, is a procedure for modal testing large structures in an external constraint-free environment to measure the effects of higher order modes and interface stiffness. This test method is applicable to structures with distinct degree-of-freedom interfaces to other system components. A theoretical residual function in the displacement/force domain has the characteristics of a relatively flat line in the lower frequencies and a slight upward curvature in the higher frequency range. In the test residual function, the above-mentioned characteristics can be seen in the data, but due to the present limitations in the modal parameter evaluation (natural frequencies and mode shapes) of test data, the residual function has regions of ragged data. A second-order polynomial curve fit is required to obtain the residual flexibility term. A weighting function of the data is generated by examining the variances between neighboring data points. From a weighted second-order polynomial curve fit, an accurate residual flexibility value can be obtained. The residual flexibility value and free-free modes from testing are used to improve a mathematical model of the structure. The residual flexibility modal test method is applied to a straight beam with a trunnion appendage and a space shuttle payload pallet simulator.

TM-108482 March 1995
Simplified Liquid Oxygen Propellant Conditioning Concepts. N.L. Cleary, K.A. Holt, and R.H. Flachbart. Propulsion Laboratory. N95-24558

Current liquid oxygen feed systems waste propellant and use hardware, unnecessary during flight, to condition the propellant at the engine turbopumps prior to launch. Simplified liquid oxygen propellant conditioning concepts are being sought for future launch vehicles. During a joint program, four alternative propellant conditioning options were studied: (1) passive recirculation, (2) low bleed through the engine, (3) recirculation lines, and (4) helium bubbling. The test configuration for this program was based on a vehicle design which used a main recirculation loop that was insulated on the downcomer and uninsulated on the upcomer. This produces a natural convection recirculation flow. The test article for this program simulated a feedline

which ran from the main recirculation loop to the turbopump. The objective was to measure the temperature profile of this test article. Several parameters were varied from the baseline case to determine their effects on the temperature profile. These parameters included: flow configuration, feedline slope, heat flux, main recirculation loop velocity, pressure, bleed rate, helium bubbling, and recirculation lines. The heat flux, bleed rate, and recirculation line configurations produced the greatest changes from the baseline temperature profile. However, the temperatures in the feedline remained subcooled. Any of the options studied could be used in future vehicles.

TM-108483 March 1995
 Permeability Testing of Composite Material and Adhesive Bonds for the DC-XA Composite Feedline Program. A.T. Nettles. Materials and Processes Laboratory. N95-23551

Hercules™ IM7/8552 carbon/epoxy and Hysol™ EA 9394 epoxy adhesive bonded between composite/titanium were tested for permeability after various numbers of thermal cycles between 100 °C and liquid nitrogen (-196 °C). The specimens were quenched from the 100 °C temperature into liquid nitrogen to induce thermal shock into the material. Results showed that the carbon/epoxy system was practically impermeable even after 12 thermal cycles. The EA 9394 adhesive bondline was more permeable than the carbon/epoxy, but vacuum mixing tended to minimize the permeability and keep it within allowable limits. Thermal cycling had little effects on the permeability values of the bondline specimens.

TM-108484 April 1995
 Space Sciences Laboratory Publications and Presentations, January 1–December 31, 1994. Compiled by T.W. Moorehead. Space Sciences Laboratory. N95-30780

This document lists the significant publications and presentations of the Space Sciences Laboratory during the period January 1–December 31, 1994. Entries in the main part of the document are categorized according to NASA Reports (arranged by report number), Open Literature, and Presentations (arranged alphabetically by title). Also included for completeness is an appendix (arranged by report number) listing preprints issued by the Laboratory during this reporting period. Some of the preprints have not been published; those already published are so indicated. Most of the articles listed under Open Literature have appeared in refereed professional journals, books, monographs, or conference proceedings. Although many published abstracts are even-

tually expanded into full papers for publications in scientific and technical journals, they are often sufficiently comprehensive to include the significant results of the research reported. Therefore, published abstracts are listed separately in a subsection under Open Literature. Questions or requests for additional information about the entries in this report should be directed to Gregory S. Wilson (ES01, 544-7579) or to one of the authors. The organizational code of the cognizant SSL branch or office is given at the end of each entry.

TM-108485 March 1995
 Dynamics Explorer 1, Retarding Ion Mass Spectrometer Summary Spectrograms—82/110 to 82/229 Spin-Time Spectrograms for H⁺, He⁺, O⁺, N⁺, O⁺⁺, M/Z = 2, and Molecular Ions. DE 1/RIMS Investigators. Space Sciences Laboratory. N95-24763

The Retarding Ion Mass Spectrometer (RIMS) experiment onboard the Dynamics Explorer 1 (DE 1) satellite was designed to perform energy and mass-per-charge analysis on low-energy ions (<50 eV) with mass/charge ratios ranging from 1 to 40 amu/Z. The DE 1 satellite, carrying the RIMS experiment, was launched into an elliptical polar orbit on August 3, 1981. The ~7.5 hour orbit has perigee of 675 km altitude and apogee of 24,875 km altitude. This document, and those that follow in this series, contains summary RIMS data spectrograms for each orbit for which RIMS data are available. The RIMS instrument began returning science data on day 280 of 1981 and continued to return usable data until the end of the DE mission in March 1991. It should be noted that studies of the RIMS data set should be conducted only with a thorough awareness of the material described in the introduction section presented here, or in collaboration with a scientist familiar with RIMS data analysis.

TM-108486 March 1995
 Dynamics Explorer 1, Retarding Ion Mass Spectrometer Summary Spectrograms—82/230 to 82/265 Spin-Time Spectrograms for H⁺, He⁺, O⁺, N⁺, O⁺⁺, M/Z = 2, and Molecular Ions. DE 1/RIMS Investigators. Space Sciences Laboratory. N95-24764

The Retarding Ion Mass Spectrometer (RIMS) experiment onboard the Dynamics Explorer 1 (DE 1) satellite was designed to perform energy and mass-per-charge analysis on low-energy ions (<50 eV) with mass/charge ratios ranging from 1 to 40 amu/Z. The DE 1 satellite, carrying the RIMS experiment, was launched into an elliptical polar orbit on August 3, 1981. The ~7.5 hour orbit has perigee of 675 km altitude and apogee of 24,875 km altitude. This

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document, and those that follow in this series, contains summary RIMS data spectrograms for each orbit for which RIMS data are available. The RIMS instrument began returning science data on day 280 of 1981 and continued to return usable data until the end of the DE mission in March 1991. It should be noted that studies of the RIMS data set should be conducted only with a thorough awareness of the material described in the introduction section presented here, or in collaboration with a scientist familiar with RIMS data analysis.

TM-108487 April 1995
 The Spacelab Scientific Missions: A Comprehensive Bibliography of Scientific Publications. Compiled by Dr. Marsha Torr. Payloads Project Office. N95-26084

November 1993 represented the 10-year anniversary of the flight of Spacelab 1 mission, with the first precursor mission (OSTA-1) being launched 2 years earlier. Since that time, a total of 27 shuttle missions have been flown, using the Spacelab system as a facility for conducting scientific research in space. The missions flown to date have allowed a total of approximately 500 Principle Investigator class investigations to be conducted in orbit. These investigations have constituted major scientific efforts in astronomy/astrophysics, atmospheric science, Earth observation, life sciences, microgravity science, and space plasma physics.

An initial survey of the scientific products gleaned from Spacelab missions already flown was sent to the Principle Investigators. In that survey, information was gathered from the investigators on the scientific highlights of their investigations and statistical measurements of overall success—such as papers published. This document is a compilation of the papers that have been published to date in refereed literature.

TM-108488 March 1995
International Space Station Alpha Trace Contaminant Control Subassembly Life Test Final Report. J.D. Tatara* and J.L. Perry. Structures and Dynamics Laboratory. *ION Electronics. N95-26364

The environmental control and life support system (ECLSS) life test program (ELTP) began with trace contaminant control subassembly (TCCS) life testing on November 9, 1992, at 0745. The purpose of the test, as stated in the NASA document "Requirements for Trace Contaminant Control Subassembly High Temperature Catalytic Oxidizer Life Testing (Revision A)," was to "provide for the long duration operation of the ECLSS TCCS HTOCO (high temperature catalytic oxidizer) at normal operating

conditions. . . (and thus). . . to determine the useful life of ECLSS hardware for use on long duration manned space missions." Specifically, the test was designed to demonstrate thermal stability of the HTOCO catalyst. The report details TCCS stability throughout the test. Graphs are included to aid in evaluating trends and subsystem anomalies. The report summarizes activities through the final day of testing, January 17, 1995 (test day 762).

TM-108489 March 1995
 Transonic Aerodynamic Characteristics of a Proposed Wing-Body Reusable Launch Vehicle Concept. A.M. Springer. Structures and Dynamics Laboratory. N95-30712

A proposed wing-body reusable launch vehicle was tested in the NASA Marshall Space Flight Center's 14x14-inch trisonic wind tunnel during the winter of 1994. This test resulted in the vehicle's subsonic and transonic, Mach 0.3 to 1.96, longitudinal and lateral aerodynamic characteristics. The effects of control surface deflections on the basic vehicle's aerodynamics, including a body flap, elevons, ailerons, and tip fins, are presented.

TM-108490 May 1995
 Analysis of Stress Concentration in the Dutton Groove Regions of the Super Lightweight External Tank. R. Ahmed. Structures and Dynamics Laboratory. N95-30328

Because the 2195 aluminum-lithium material of the super lightweight external tank (SLWT ET) has a lower toughness than the 2219 aluminum used in previous ET's, careful attention must be paid to stress concentrations. This report details the analysis performed on some of the stress concentrations in the orthogrid panels of the liquid hydrogen tank.

TM-108491 May 1995
 Bearing Defect Signature Analysis Using Advanced Nonlinear Signal Analysis in a Controlled Environment, CDDF Final Report (No. 93-10). T. Zoladz, E. Earhart, and T. Fiorucci. Structures and Dynamics Laboratory. N95-28364

Utilizing high-frequency data from a highly instrumented rotor assembly, seeded bearing defect signatures are characterized using both conventional linear approaches, such as power spectral density analysis, and recently developed nonlinear techniques such as bicoherence analysis. Traditional low-frequency (less than 20 kHz) analysis and high-frequency envelope analysis of both accelerometer and acoustic emission data are used to recover characteristic bearing distress information buried

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deeply in acquired data. The successful coupling of newly developed nonlinear signal analysis with recovered wideband envelope data from accelerometers and acoustic emission sensors is the innovative focus of this research.

TM-108492 May 1995
ANSYS Duplicate Finite-Element Checker Routine. R. Ortega. Structures and Dynamics Laboratory. N95-29824

An ANSYS finite-element code routine to check for duplicated elements within the volume of a three-dimensional (3-D) finite-element mesh was developed. The routine developed is used for checking floating elements within a mesh, identically duplicated elements, and intersecting elements with a common face. A space shuttle main engine alternate turbopump development high pressure oxidizer turbopump finite-element model check using the developed subroutine is discussed. Finally, recommendations are provided for duplicate element checking of 3-D finite-element models.

TM-108493 June 1995
Probability of Detection of Defects in Coatings With Electronic Shearography. S.S. Russell, M.D. Lansing,* C.M. Horton,* and W.J. Gnacek.* Materials and Processes Laboratory. *The University of Alabama, Huntsville. N95-29374

The goal of this research was to utilize statistical methods to evaluate the probability of detection (POD) of defects in coatings using electronic shearography. The coating system utilized in the POD studies was to be the paint system currently utilized on the external casings of the NASA space transportation system reusable solid rocket motor boosters. The population of samples was to be large enough to determine the minimum defect size for 90-percent POD of 95-percent confidence POD on these coatings. Also, the best methods to excite coatings on aerospace components to induce deformations for measurement by electronic shearography were to be determined.

TM-108494 June 1995
CRRES Combined Radiation and Release Effects Satellite Program. Compiled by B.L. Giles, M.A. McCook,* M.W. McCook,* and G.P. Miller.* Space Sciences Laboratory *The University of Alabama, Huntsville. N96-11211

The various regions of the magnetosphere-ionosphere system are coupled by flows of charged particle beams and electromagnetic waves. This coupling gives rise to processes that affect both technical and nontechnical aspects of life on Earth.

The CRRES program sponsored experiments which were designed to produce controlled and known input to the space environment and the effects were measured with arrays of diagnostic instruments. Large amounts of material were used to modify and perturb the environment in a controlled manner, and response to this was studied. The CRRES and PEGSAT satellites were dual-mission spacecraft with a NASA mission to perform active chemical-release experiments, grouped into categories of tracer, modification, and simulation experiments. Two sounding rocket chemical release campaigns completed the study.

TM-108495 June 1995
Composite Processing Development to Improve Interlaminar Strength Using Ply Interface Particles, MSFC Center Director's Discretionary Fund Final Report, Project No. 93-13. A. Nettles. Materials and Processes Laboratory. N95-30334

The interlaminar shear strength of carbon/epoxy laminates was to be improved by placing particles of aluminum between plies of prepreg tape used for the layup. Difficulty in aligning the aluminum whiskers in the transverse direction prevented any gain in strength. A discussion of shear within a laminate is presented to better understand the results.

TM-108496 July 1995
Utility Aspects of Space Power: Load Management Versus Source Management. B. Walls. Astrionics Laboratory. N96-11963

Electrical power, as an area of study, is relatively young as compared to language, chemistry, physics, mathematics, philosophy, metallurgy, textiles, transportation, or farming. Practically all of the technology that has enabled the huge, continent-spanning power grids that have become ubiquitous in developed countries was developed in the last 150 years. In fact, Tesla's advocacy of alternating current for transmission just won out in the beginning of this century. Despite the novelty of the field as a whole, space power applications are, of course, much newer. This paper will look at the history of space power and compare it to its older sibling on Earth, forming a basis for determining appropriate transitions of technology from the terrestrial realm to space applications.

TM-108497 August 1995
Trace Chemical Contaminant Generation Rates for Spacecraft Contamination Control System Design. J.L. Perry. Structures and Dynamics Laboratory.

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A spacecraft presents a unique design challenge with respect to providing a comfortable environment in which people can live and work. All aspects of the spacecraft environmental design including the size of the habitable volume, its temperature, relative humidity, and composition must be considered to ensure the comfort and health of the occupants. The crew members and the materials selected for outfitting the spacecraft play an integral part in designing a habitable spacecraft because material off-gassing and human metabolism are the primary sources for continuous trace chemical contaminant generation onboard a spacecraft. Since these contamination sources cannot be completely eliminated, active control processes must be designed and deployed onboard the spacecraft to ensure an acceptably clean cabin atmosphere. Knowledge of the expected rates at which contaminants are generated is very important to the design of these processes. Data from past spacecraft missions and human contaminant production studies have been analyzed to provide this knowledge. The resulting compilation of contaminants and generation rates serve as a firm basis for past, present, and future contamination control system designs for space and aeronautics applications.

TM-108499

September 1995

Interim Report on the Space Station Water Degradation Study Covering the First 24 Months of Exposure. P.S. McRight and M.C. Roman. Propulsion Laboratory.

This report describes the MSFC space station water degradation study (WDS) and presents interim results from the first 24 months of testing. The WDS simulates the stagnant storage of water in distribution lines before the activation of the space station's water processor by storing processed water at ambient temperature in valved sections of 1-in stainless steel and titanium tube. The WDS seeks to determine whether the water quality will degrade unacceptably

and whether microbial growth will proceed to an unmanageable extent during extended stagnation. During the first 24 months, significant changes have occurred. Although iodine, which is used as a biocide, was nearly depleted within the first 6 months of testing, microbial growth has been minimal. This report describes the decrease in iodine concentration and the results of microbial and biofilm analyses. Increases in total organic carbon, iodide, chloride, nickel, iron, and chromium concentrations are presented and discussed. The observed increase in conductivity and the decreases in pH and turbidity are also presented. The authors conclude that, with proper preparation, potable water can be stored under stagnant conditions without unmanageable degradation in water quality; a flushing operation and subsequent processing of the degraded water should render the water system ready for use.

TM-108500

September 1995

A Guidance and Control Assessment of Three Vertical Landing Options for RLV. M. Gallaher, D. Coughlin, and K. Krupp. Structures and Dynamics Laboratory.

The National Aeronautics and Space Administration is considering a vertical lander as a candidate concept for a single-stage-to-orbit reusable launch vehicle (RLV). Three strategies for guiding and controlling the inversion of a reentering RLV from a nose-first attitude to a vertical landing attitude are suggested. Each option is simulated from a common reentry state to touchdown, using a common guidance algorithm and different controllers. Results demonstrate the characteristics that typify and distinguish each concept and help to identify peculiar problems, level of guidance and control sophistication required, feasibility concerns, and areas in which stringent subsystem requirements will be imposed by guidance and control.

TP-3512 October 1994
 Buckling of Composite Beams (CDDF Final Report, Project 91-20). P. Thompson. Structures and Dynamics Laboratory. N95-14913

Presented in this report are the results of an investigation of the twisting/warping deformations occurring in open-section composite beams. A series of C and L channels were manufactured using both hand layup and the innovative "hot-drape forming" techniques. A transverse tip load was applied at the free end of the cantilevered open-section beams. The test setup allowed the tip load to be applied at various locations along the plane of and at the beam's shear center. Charts are included in this report depicting various angles of ply layups, loads applied, and load application points.

A major verification resulting from this study is that the shear center of an open section composite beam can be altered, if not completely controlled, through laminate layup. Also, it was observed that the choice of the material system does not have an effect on the amount of deformation, as expected, and the material affects the location of an unsymmetric open section composite beam's true shear center. The results from this study have provided a foundation for further investigation into the apparent shifting of the shear center location in open-section composite beams.

TP-3534 February 1995
 The Corrosion Protection of 2219-T87 Aluminum by Organic and Inorganic Zinc-Rich Primers. M.D. Danford, D.W. Walsh,* and M.J. Mendrek. Materials and Processes Laboratory. *California Polytechnic State University.

The behavior of zinc-rich primer-coated 2219-T87 aluminum in a 3.5-percent Na-Cl was investigated using electrochemical techniques. The alternating current (ac) method of electrochemical impedance spectroscopy (EIS), in the frequency range of 0.001 to 40,000 Hz, and the direct current (dc) method of polarization resistance (PR) were used to evaluate the characteristics of an organic, epoxy zinc-rich primer and an inorganic, ethyl silicate zinc-rich primer. A dc electrochemical galvanic corrosion test was also used to determine the corrosion current of each zinc-rich primer anode coupled to a 2219-T87 aluminum cathode. Duration of the EIS/PR and galvanic testing was 21 days and 24 h, respectively. The galvanic test results demonstrated a very high galvanic current between the aluminum cathode and both zinc-rich primer anodes ($37.9 \mu\text{A}/\text{cm}^2$ and $23.7 \mu\text{A}/\text{cm}^2$ for the organic and inorganic primers, respectively). The PR results demonstrated a much higher corrosion rate of the zinc in the inorganic primer than in the organic primer, due primarily to the higher porosity in the former. Based on this investigation, the inorganic

zinc-rich primer appears to provide superior galvanic protection and is recommended for additional study for application in the solid rocket booster aft skirt.

TP-3535 February 1995
 Launch Vehicle Flight Control Augmentation Using Smart Materials and Advanced Composites (CDDF 93-05). C. Barret. Structures and Dynamics Laboratory. N95-21346

The Marshall Space Flight Center has a rich heritage of launch vehicles that have used aerodynamic surfaces for flight stability such as the Saturn vehicles and flight control such as on the Redstone. Recently, due to aft center-of-gravity locations on launch vehicles currently being studied, the need has arisen for the vehicle control augmentation that is provided by these flight controls. Aerodynamic flight control can also reduce engine gimbaling requirements, provide actuator failure protection, enhance crew safety, and increase vehicle reliability, and payload capability. In the Saturn era, NASA went to the Moon with 300 ft² of aerodynamic surfaces on the Saturn V.

Since those days, the wealth of smart materials and advanced composites that have been developed allow for the design of very lightweight, strong, and innovative launch vehicle flight control surfaces. This paper presents an overview of the advanced composites and smart materials that are directly applicable to launch vehicle control surfaces.

TP-3545 March 1995
 The Corrosion Protection of AISI™ 1010 Steel by Organic and Inorganic Zinc-Rich Primers. M.D. Danford and M.J. Mendrek. Materials and Processes Laboratory. N95-25677

The behavior of zinc-rich primer-coated AISI™ 1010 steel in 3.5-percent Na-Cl was investigated using electrochemical techniques. The alternating current (ac) method of electrochemical impedance spectroscopy (EIS), in the frequency range of 0.001 to 40,000 Hz, and the direct current (dc) method of polarization resistance (PR), were used to evaluate the characteristics of an organic, epoxy zinc-rich primer and an inorganic, ethyl silicate zinc-rich primer. A dc electrochemical galvanic corrosion test was also used to determine the corrosion current of each zinc-rich primer anode coupled to a 1010 steel cathode. Duration of the EIS/PR and galvanic testing was 21 days and 24 h, respectively. The galvanic test results demonstrated a very high current between the steel cathode and both zinc-rich primer anodes (38.8 and $135.2 \mu\text{A}/\text{cm}^2$ for the organic and inorganic primers, respectively). The results of corrosion rate determinations demonstrated a much higher corrosion rate of the zinc in the inorganic primer than in the organic primer, due primarily to the

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higher porosity in the former. EIS equivalent circuit parameters confirmed this conclusion. Based on this investigation, the inorganic zinc-rich primer appears to provide superior galvanic protection and is recommended for additional study for application on solid rocket booster steel hardware.

TP-3550 March 1995
Effect of Processing Parameters on Surface Finish for Fused Deposition Machinable Wax Patterns. F.E. Roberts III. Materials and Processes Laboratory. N95-26769

This report presents a study on the effect of material processing parameters used in layer-by-layer material construction on the surface finish of a model to be used as an investment casting pattern. The data presented relate specifically to fused deposition modeling using a machinable wax.

TP-3551 May 1995
CORSSSTOL: Cylinder Optimization of Rings, Skin, and Stringers With Tolerance Sensitivity. J. Finckenor and M. Bevill. Structures and Dynamics Laboratory. N95-28215

Cylinder optimization of rings, skin, and stringers with tolerance (CORSSSTOL) sensitivity is a design optimization program incorporating a method to examine the effects of user-provided manufacturing tolerances on weight and failure. CORSSSTOL gives designers a tool to determine tolerances based on need. This is a decisive way to choose the best design among several manufacturing methods with differing capabilities and costs.

CORSSSTOL initially optimizes a stringer-stiffened cylinder for weight without tolerances. The skin and stringer geometry are varied, subject to stress and buckling constraints. Then the same analysis and optimization routines are used to minimize the maximum material condition weight subject to the least favorable combination of tolerances. The adjusted optimum dimensions are provided with the weight and constraint sensitivities of each design variable. The designer can immediately identify critical tolerances. The safety of parts made out of tolerance can also be determined.

During design and development of weight-critical systems, design/analysis tools that provide product-oriented results are of vital significance. The development of this program and methodology provides designers with an effective cost- and weight-saving design tool. The tolerance sensitivity method can be applied to any system defined by a set of deterministic equations.

TP-3553 May 1995
Developmental Problems and Their Solution for the Space Shuttle Main Engine Alternate Liquid Oxygen High-Pressure Turbopump: Anomaly or Failure Investigation the Key. R. Ryan and L.A. Gross. Structures and Dynamics Laboratory. N95-28263

The space shuttle main engine (SSME) alternate high-pressure liquid oxygen pump experienced synchronous vibration and ball bearing life problems that were program threatening. The success of the program hinged on the ability to solve these development problems. The design and the solutions to these problems are engirded in the lessons learned and experiences from prior programs, technology programs, and the ability to properly conduct failure or anomaly investigations. The failure investigation determines the problem cause and is the basis for recommending design solutions. For a complex problem, a comprehensive solution requires that formal investigation procedures be used, including fault trees, resolution logic, and action items worked through a concurrent engineering-multidiscipline team. The normal tendency to use an intuitive, cut-and-try approach will usually prove to be costly, both in money and time, and will reach a less than optimum, poorly understood answer. The SSME alternate high-pressure oxidizer turbopump development has had two complex problems critical to program success: (1) high synchronous vibrations and (2) excessive ball bearing wear. This paper will use these two problems as examples of this formal failure investigation approach. The results of the team's investigation provides insight into the complexity of the turbomachinery technical discipline interacting/sensitivities and the fine balance of competing investigations required to solve problems and guarantee program success. It is very important to the solution process that maximum use be made of the resources that both the contractor and Government can bring to the problem in a supporting and noncompeting way. There is no place for the not-invented-here attitude. The resources include, but are not limited to: (1) specially skilled professionals, (2) supporting technologies, (3) computation codes and capabilities, and (4) test and manufacturing facilities.

TP-3554 May 1995
Analysis of Stress Concentration at Holes in Components Made of 2195 Aluminum-Lithium. R. Ahmed. Structures and Dynamics Laboratory. N95-30613

Because the 2195 aluminum-lithium of the super lightweight external tank (SLWT ET) has a lower toughness than the 2219 aluminum used in previous ET's, careful attention must be paid to stress concentration in the SLWT ET. This report details

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the initial analysis performed by NASA to determine the material properties required to ensure structural integrity in these critical areas.

TP-3556 May 1995
The Solar Array-Induced Disturbance of the Hubble Space Telescope Pointing System. C.L. Foster, M.L. Tinker, G.S. Nurre, and W.A. Till. Structures and Dynamics Laboratory.
N95-28214

The investigation of the vibrational disturbances of the Hubble space telescope that were discovered soon after deployment in orbit is described in detail. It was found that the disturbances were particularly evident during orbital day-night crossings, and that the magnitudes of the disturbances were considerably larger than the design jitter requirements. This paper describes the process by which the vibrations were characterized and isolated to a particular mechanism. The analysis of the flight data and comparisons with computer simulation results showed that the source of disturbances was the thermally driven deformation of the solar arrays in conjunction with frictional effects in the array mechanisms. The control system was successfully modified to attenuate the disturbances to tolerable levels pending mechanical and thermal redesign of the solar arrays. The new arrays were installed during the first space telescope servicing mission and, in combination with the enhanced control system algorithm, reduced the disturbances to satisfactory levels.

TP-3558 May 1995
Test Load Verification Through Strain Data Analysis. V. Verderaine and F. Harrington. Structures and Dynamics Laboratory.
N95-28718

A traditional binding acceptance criterion on polycrystalline structures is the experimental verification of the ultimate factor of safety. At fracture, the induced strain is inelastic and about an order-of-magnitude greater than designed for maximum expected operational limit. At this extreme strained condition, the structure may rotate and displace at the applied verification load such as to unknowingly distort the load transfer into the static test article. Testing may result in erroneously accepting a submarginal design or rejecting a reliable one. A technique was developed to identify, monitor, and assess the load transmission error through two back-to-back surface-measured strain data. The technique is programmed for expediency and convenience. Though the method was developed to support affordable aerostructures, the method is also applicable for most high-performance air and surface transportation structural systems.

TP-3560 May 1995
A Conceptual Design for the Attitude Control and Determination System for the Magnetosphere Imager Spacecraft. M.E. Polites and C.K. Carrington. Structures and Dynamics Laboratory.
N95-28721

This paper presents a conceptual design for the attitude control and determination (ACAD) system for the Magnetosphere Imager (MI) spacecraft. The MI is a small spin-stabilized spacecraft that has been proposed for launch on a Taurus-S expendable launch vehicle into a highly elliptical polar Earth orbit. Presently, launch is projected for 1999. The paper describes the MI mission and the ACAD requirements and then proposes an ACAD system for meeting these requirements. The proposed design is low-power, low-mass, very simple conceptually, highly passive, and consistent with the overall MI design philosophy, which is faster-better-cheaper. Still, the MI ACAD system is extremely robust and can handle a number of unexpected, adverse situations on orbit without impacting the mission as a whole. Simulation results are presented that support the soundness of the design approach.

TP-3562 May 1995
Study of Localized Corrosion in Aluminum Alloys by the Scanning Reference Electrode Technique. M.D. Danford. Materials and Processes Laboratory.

Localized corrosion in 2219-T87 aluminum (Al) alloy, 2195 aluminum-lithium (Al-Li) alloy, and welded 2195 Al-Li alloy (4043 filler) have been investigated using the relatively new scanning reference electrode technique (SRET). Anodic sites are more frequent and of greater strength in the 2195 Al-Li alloy than in the 2219-T87 Al alloy, indicating a greater tendency toward pitting for the latter. However, the overall corrosion rates are about the same for these two alloys, as determined using the polarization resistance technique. In the welded 2195 Al-Li alloy, the weld bead is entirely cathodic, with rather strongly anodic heat affected zones (HAZ) bordering both sides, indicating a high probability of corrosion in the HAZ parallel to the weld bead.

TP-3578 August 1995
Low-Pressure Electrical Discharge Experiment to Simulate High-Altitude Lightning Above Thunderclouds. M.A. Jarzembski and V. Srivastava.* Space Sciences Laboratory.
*Global Hydrology and Climate Center.

Recently, extremely interesting high-altitude cloud-ionosphere electrical discharges, like lightning above thunderstorms, have been observed from NASA's space shuttle missions and during airborne and ground-based experiments. To understand these

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discharges, a new experiment was conceived to simulate a thundercloud in a vacuum chamber using a dielectric in particulate form into which electrodes were inserted to create charge centers analogous to those in an electrified cloud. To represent the ionosphere, a conducting medium (metallic plate) was introduced at the top of the chamber. It was found that for different pressures between ~1 and 300 mb, corresponding to various upper atmospheric altitudes, different discharges occurred above the simulated thundercloud, and these bore a remarkable similarity to the observed atmospheric phenomena. At pressures greater than 300 mb, these discharges were rare and only discharges within the simulated thundercloud were observed. Use of a particulate dielectric was critical for the successful simulation of the high-altitude lightning.

TP-3581

August 1995

Aluminum U-Groove Weld Enhancement Based on Experimental Stress Analysis. V. Verderaime and R. Vaughan. Structures and Dynamics Laboratory. N96-10864

Though butt-welds are among the most preferred joining methods in aerostructures because of their sealing and assembly integrity and general elastic performance, their inelastic mechanics are generally the least understood. This study investigated experimental strain distributions across a thick aluminum U-grooved weld and identified two weld process considerations for improving the multipass weld strength. The extreme thermal expansion and contraction gradient of the fusion heat input across

the tab thickness between the grooves produce severe peaking, which induces bending moment under uniaxial loading. The filler strain hardening decreased with increasing filler pass sequence. These combined effects reduce the weld strength, and a depeaking index model was developed to select filler pass thicknesses, pass numbers, and sequences to improve the welding process results over the current normal weld schedule.

TP-3583

September 1995

Impact Damage Resistance of Carbon/Epoxy Composite Tubes for the DC-XA Liquid Hydrogen Feedlines. A.T. Nettles. Materials and Processes Laboratory. N96-11539

Low-velocity impacts were inflicted upon two elbow sections of carbon/epoxy feedline that are to be a part of the Delta Clipper-XA flight vehicle. A soap-based liquid leak detector solution was used to inspect the impact sites for leaks of pressurized gas that was pumped into the tube. Visual surface damage was noted and recorded for each impact site. After impact testing of each of the two sections of tubes was completed, the damage zones were dissected from the tube and cross sectioned through the impact site. These specimens were polished after potting them in epoxy and were examined for microcracking using a fluorescent dye penetrant technique. The results showed that nonvisible damage could cause microcracking, thereby resulting in leaks through the tube wall.

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Jeff Brewer. N95-26785

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- AMBASTHA, A. Udaipur Solar Observatory
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HAGYARD, M.J. ES82
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- AMES, G. Blue Line Eng.
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- BRAY, B. EO45
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- BROWN, A.M. ED22
 FERRI, A.A. GA Institute of Technology
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- BROWN, R.W. PD34
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- BULLOCH, J.L. Michigan Tech University
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- COLE, J. XX01
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- CRAFT, H.G., JR. LA01
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- CROSSON, W.L. ES44
LAYMON, C.A. ES44
A Remote Sensing Based Approach to Account for Sub-Grid Scale Variability of Land Surface Properties. For presentation at the Conference on Hydrology, AMS annual meeting, Dallas, TX, January 15-20, 1995.
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WHITE, S.M. University of Maryland
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		WEISSKOPF, M.C.	ES84
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		SKINNER, G.K.	University of Birmingham (UK)
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JOHNSON, G.W.	PT51		
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		GUILLORY, A.R.	ES41
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GUO, H.	NM Highlands University	HAKKILA, J.	Mankato State University
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PENN, B.	ES76	HORACK, J.M.	UAH
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An Approach for Implementing Distributed Planning for Space Station Payload Operations. For presentation at the 1995 AIAA Space Programs and Technologies Conference and Exhibit, Huntsville, AL, September 26–28, 1995.		MEEGAN, C.A.	ES84
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| BRIGGS, M.S. | | UAH | Optimization of Many-Burn Orbital Transfer. For presentation at the AAS/AIAA Astrodynamics Conference, Halifax, Nova Scotia, Canada, August 14–17, 1995. For publication in AIAA Journal of Guidance and Control. |
| PACIESAS, W.S. | | UAH | |
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| ZHANG, S.N. | Universities Space Research Assoc. | | |
| RUBIN, B.C. | Universities Space Research Assoc. | | |
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- SAMBAMURTHI, J.K. ED33
 ALVARADO, A. ED33
 MATHIAS, E.C. Thiokol

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- Plume Diagnostics of SRM Static Firings for Pressure Perturbation Studies. For publication in *Journal of Propulsion and Power*.
- SAMBAMURTHI, J.K. ED33
Plume Particle Collection and Sizing From Static Firing of Solid Rocket Motors. For publication in *Journal of Propulsion and Power*.
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- SANGHADASA, M. UAH
BARR, T.A., JR. UAH
CLARK, R.D. NM Highlands University
MARTINEZ, A. NM Highlands University
ROMERO, E. NM Highlands University
TAN, L. NM Highlands University
CARDELINO, B.H. Atlanta University Center
MOORE, C.E. ES75
PENN, B. ES76
Nonlinear Optical Characterization of Substituted 4-Nitro-N, N-Dimethylanilines. For presentation at the Optical Society of America, Portland, OR, September 10–15, 1995.
- SANGHADASA, M. UAH
WU, B. UAH
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PENN, B. ES76
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DARWISH, A. Alabama A&M University
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- SCHMIDT, G.R. EP25
NADARAJAH, A. UAH
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- SCHORR, A.A. EE53
SPEAS, K. Thiokol
WALKER, R. Thiokol
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- SCHUTZENHOFER, L.A. ED26
BLALOCK, S.J. ED26
JOHNSTON, L.M. ED26
MIMS, K.K. ED26
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TINKER, M.L. ED26
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WILSON, R.B. ES84
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- SEN, S. USRA
STEFANESCU, D.M. University of Alabama
CURRERI, P.A. ES75
DHINDAW, B.K. University of Alabama
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- SHANG, H.M. Engineering Sciences, Inc.
CHEN, Y.S. Engineering Sciences, Inc.
LIAW, P. Engineering Sciences, Inc.
WANG, T.-S. ED32
Investigation of Chemical Kinetics Integration Algorithms for Reacting Flows. For presentation at the 33rd Aerospace Sciences Meeting and Exhibit, Reno, NV, January 9–12, 1995.

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JACKSON, M.E. ED14
Sliding Mode Thermal Control System for Space Station Furnace Facility. For presentation at the 27th IEEE Southeastern Symposium on System Theory, Starkville, MS, March 12-14, 1995.
- SIBILLE, L. ES76
NADARAJAH, A. ES76
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- SINGH, J. Pennsylvania State University
JERMAN, G. EH23
POORMAN, R. EH23
BHAT, B.N. EH23
KURUVILLA, A.K. IIT Research Institute
Mechanical Properties and Microstructural Stability of Wrought, Laser, and Electron Beam Glazed Narloy-Z Alloy at Elevated Temperatures. For publication in Metallurgical Transactions.
- SMITH, D.D. ES76
ABDELDAYEM, H.
PALEY, M.S.
SHIELDS, A.
WITHEROW, W.K.
FRAZIER, D.O.
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LEVENTHAL, M. University of Maryland
CAVALLO, R. University of Maryland
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- SMITH, S.A. ES42
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- SMITHERMAN, D.V., JR. PP02
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- SNYDER, R.S. ES71
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- SORENSEN, J.E. ES83
STONE, N.H. ES83
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- SOUTULLO, B.C. JA71
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- SPENCER, R.W. ES43
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Microwave Sounding Unit Six-Hourly Datasets for Climate and Process Studies. For presentation at the 1995 AGU Meeting, Baltimore, MD, May 29-June 2, 1995.

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- SRIVASTAVA, V. USRA
BOWDLE, D.A. UAH
JARZEMBSKI, M.A. ES43
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CHAMBERS, D.M. Micro Craft Inc.
CUTTEN, D.R. UAH
High-Resolution Remote Sensing of Atmospheric Sulfate Aerosols from Backscatter Using Focused CO₂ Doppler Lidars. For publication in Geophysical Research Letters, Baltimore, MD.
- STEFANESCU, D.M. University of Alabama
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LEON, J. University of Alabama
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- STIGLER, R.-D. Universitat of Bodenkultur, Austria
RUKER, F. Universitat of Bodenkultur, Austria
KATINGER, D. Universitat of Bodenkultur, Austria
ELLIOT, G. University of Bath, UK
HENKLEIN, P. Humboldt-Universitat of Berlin, Germany
HE, X.M. ES76
CARTER, D.C. ES76
NUGEL, E. Humboldt-Universitat of Berlin, Germany
KRAMER, A. Humboldt-Universitat of Berlin, Germany
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WINNINGHAM, J.D. Southwest Research Inst.
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- Instituto Fisica Spazio Interplanetario/CNR, Italy
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Instituto Fisica Spazio Interplanetario/CNR, Italy
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- SU, C.-H. ES75
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Growth of Wide Band Gap II-VI Compound Semiconductors by Physical Vapor Transport. For publication in Crystal Growth Research, Washington, DC.
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WATRING, D.A. ES75
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- SU, C.-H. ES75
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MAZURAK, K. ES75
LEHOCZKY, S.L. ES75
LIU, H.-C. ES75
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Mass Flux of ZnSe, ZnSeTe, and ZnCdSe and Crystal Growth of ZnSe by PVT. For presentation at the 11th International Conference on Crystal Growth, The Hague, The Netherlands, June 18-23, 1995.
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| COBB, S.D. | ES75 | TELESCO, C.M. | ES84 |
| SCRIPA, R.N. | UAB | DAVIDSON, J.A. | ES84 |
| Crystal Growth of HgZnTe by Directional Solidification in Microgravity. For presentation at the 34th AIAA Aerospace Sciences Meeting, Reno, NV, January 15-18, 1996. | | WERNER, M.W. | ES84 |
| | | 10-30 μ m Maps of the Central 5 Parsecs of the Galaxy: Heating of the Cavity and Neutral-Gas Disk. For publication in <i>Astrophysical Journal</i> , Tucson, AZ. | |
| SUESS, S.T. | ES82 | TINKER, M.L. | ED26 |
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| SUGGS, R.J. | | TOMLIN, D.D. | ED13 |
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| | | CIBRARIO, B. | ED13 |
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| SUITS, M. | EH13 | TRINH, H.P. | EH32 |
| LANSAW, J. | Aerojet | Prediction of the Engine Performance and Wall Erosion Due to Film Cooling for the "Fast Track" Thrust Chamber. For presentation at the Propulsion Engineering Research Center—Sixth Annual Symposium, Cleveland, OH, September 13-14, 1994. | |
| Use of Ultrasonic Inspection Techniques for the Advanced Main Combustion Chamber. For presentation at the JANNAF Conference on NDE in Aerospace, Hill AFB, UT, October 24-28, 1994. | | | |
| SULKANEN, M.E. | ES84 | UBERTINI, P. | |
| KOLODZIEJCZAK, J.J. | | Istituto di Astrofisica Spaziale, Italy | |
| CHARTAS, G. | | BASSANI, L. | Istituto TESRE, Italy |
| Numerical Simulation of Electron-Impact X-Ray Sources. For presentation at the SPIE's International Symposium, San Diego, CA, July 9-14, 1995. | | BAZZANO, A. | Istituto di Astrofisica Spaziale, Italy |
| | | COLE, R. | Leicester University |
| SULLIVAN, R.M. | ED28 | LAPINGTON, J. | MSSL, UK |
| The Effect of Water on the Thermal Expansion Behavior of FM5055 Carbon Phenolic. For presentation at the ASME Summer Applied Mechanics and Materials Conference, Los Angeles, CA, June 28-30, 1995. | | MAS, M. | LAEFF, Spain |
| | | NATALUCCI | Istituto di Astrofisica Spaziale, Italy |
| | | RAMSEY, B. | ES84 |
| | | SOGGIU, E. | Istituto di Astrofisica Spaziale, Italy |
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| | | Integral X-Ray Monitor: A Proposal for the Hard X-Ray Imager On-Board Integral. For presentation at the Imaging in High Energy Astronomy, Frascati, Italy, September 26-30, 1994. | |
| SWARTZ, D.A. | ES84 | VAN DER HOOFT, F. | University of Amsterdam |
| SUTHERLAND, P.G. | ES84 | KOUVELIOTOU, C. | University of Amsterdam |
| HARKNESS, R.P. | ES84 | VAN PARADIJS, J. | University of Amsterdam |
| Gamma-Ray Transfer and Energy Deposition in Supernovae. For publication in <i>Astrophysical Journal</i> , Chicago, IL. | | RUBIN, B. | University of Amsterdam |
| | | FINGER, M. | University of Amsterdam |
| SZOFRAN, F.R. | ES75 | HARMON, A. | ES84 |
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| MCCLENDON, R.K. | JA21 | |
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| VANLANDINGHAM, F. | Computer Sciences Corp. | |
| LUCHETTI, K. | Computer Sciences Corp. | |
| ROBINSON, J. | Orbital Sciences Corp. | |
| SULLIVAN, D. | EL44 | |
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| WALKER, J.L. | UAH | |
| HILL, E.V.K. | Embry-Riddle Aero U | |
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| Vibration Convection of Fluids in a Crystal Growth Cavity. For presentation at the 34th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, January 15-18, 1996. | | |
| WANG, J.-C. | Alabama A&M University | |
| WATRING, D.A. | ES75 | |
| GILLIES, D.C. | ES75 | |
| LEHOCZKY, S.L. | ES75 | |
| Interface Morphology Effects on Lateral Compositional Distribution for Magnetically Stabilized Growth of HgCdTe. For presentation at the Ninth Alabama Materials Research Conference, Birmingham, AL, September 26-27, 1995. | | |
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| <p>WANG, T.-S. ED32
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RICKS, K.G. EB64
WEIR, J.M. EB64
Parallel Simulation of a Large Scale Aerospace System in a Multicomputer Environment. For presentation at the IEEE Transactions on Aerospace and Electronic Systems, Rockville, MD, September 1995.</p> |
| <p>WANG, T.-S. ED32
MCCONNAUGHEY, P. ED32
WARSI, S. Sverdrup
CHEN, Y.-S. Engineering Sciences, Inc.
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ROBINSON, J.H. ED13
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| <p>WATRING, D.A. ES75
The Effects of Vertical Magnetic Fields on Segregation in HgCdTe. For presentation at the Second International Conference on Solidification and Gravity, Miskolc, Hungary, April 25–28, 1995.</p> | <p>WEST, E.A. ES82
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Thermal Characterization of the Universal Multizone Crystallizer. For presentation at the Second International Conference on Solidification and Gravity, Miskolc, Hungary, April 25–28, 1995.</p> | <p>WEST, E.A. ES82
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| <p>WEDDENDORF, B. ED55
The Automatic Locking Orthotic Knee Brace Joint. For presentation at NASA Technology 2004, Washington, DC, November 8–10, 1994.</p> | <p>WHITESIDES, R.H. ERC, Inc.
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| <p>WEISSKOPF, M.C. ES84
O'DELL, S.L. ES84
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VAN SPEYBROECK, L.P.</p> | <p>WHORTON, M. ED12
CALISE, A.J. ED12
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CALISE, A.J. Georgia Inst. of Tech.
BUSCHEK, H. Bodenseewerk</p> |

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- FOCUS: Fixed Order Compensation for Uncertain Systems. For presentation at the 1995 Matlab Conference, Cambridge, MA, October 16-18, 1995.
- WIEDERHOLD, M.L. University of Texas
SMITHERS, G.A. EH32
STEYGER, P.S.
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- WILLIAMSEN, J. ED52
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SERRANO, J. ED52
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- WILSON, C.A. ES84
FINGER, M.H. USRA
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- WILSON, C.A. ES84
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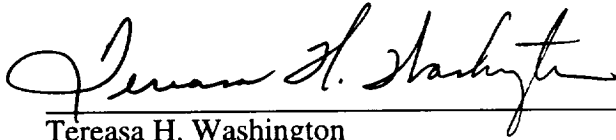
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APPROVAL

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Compiled by Joyce E. Turner

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Tereasa H. Washington
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