

NASA Technical Memorandum

NASA TM-86575

FY 1986 SCIENTIFIC AND TECHNICAL REPORTS, ARTICLES, PAPERS, AND PRESENTATIONS

Compiled by Joyce E. Turner
Management Operations Office

October 1986

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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 1986 SCIENTIFIC AND TECHNICAL REPORTS,
ARTICLES, PAPERS, AND PRESENTATIONS

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July 1985

Atmospheric Environment for Space Shuttle (STS-51B) Launch. G. L. Jasper, D. L. Johnson, C. K. Hill, and G. W. Batts. System Dynamics Laboratory. N86-12917

This report presents a summary of selected atmospheric conditions observed near Space Shuttle STS-51B launch time on April 29, 1985, at Kennedy Space Center, Florida. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of pre-launch Jimsphere measured vertical wind profiles is given in this report. The final atmospheric tape, which consists of wind and thermodynamic parameters versus altitude, for STS-51B vehicle ascent has been constructed. The STS-51B ascent atmospheric data tape has been constructed by Marshall Space Flight Center's Atmospheric Sciences Division to provide an internally consistent data set for use in post flight performance assessments.

This is the last regular formal report of Space Shuttle launched from Kennedy Space Center, Florida. The Atmospheric Effects Branch will maintain atmospheric environment data files for reference on future missions through the first few Vandenberg Air Force Base (VAFB) launches.

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October 1985

An Integrated Development Facility for the Calibration of Low-Energy Charged Particle Flight Instrumentation - Center Director's Discretionary Fund Final Report. Alan P. Biddle and John M. Reynolds. Space Science Laboratory. N86-22914

A system has been developed specifically for the calibration and development of thermal ion instrumentation. The system is optimized to provide an extended beam (approximately 80 cm^2) with usable current rates, $\sim 1 \text{ pA/cm}^2$, at beam energies as low as 1 eV, with much higher values available with increasing energy. The beam energy spread is typically less than 2 eV/charge, and the average angular divergence is approximately 2.5 deg. A tandem electrostatic and variable geometry magnetic mirror configuration within the ion source optimizes the use of the ionizing electrons, thus decreasing the gas and non-thermal electron throughput to the instrument chamber while improving the current density uniformity. The system

is integrated under microcomputer control to allow automatic control and monitoring of the beam energy and composition and the mass- and angle-dependent response of the instrument under test. The data can be transmitted in nearly real-time to the interested investigators for comparison with expected results over existing computer networks. The system is pumped by a combination of carbon vane and cryogenic sorption roughing pumps and ion and liquid helium operating pumps. This allows testing and final calibration of flight instrumentation in an ultraclean environment.

TM-86527

October 1985

DE 1 RIMS Operational Characteristics. R. C. Olsen, R. H. Comfort, M. O. Chandler, T. E. Moore, J. H. Waite, Jr., D. L. Reasoner, and A. P. Biddle. Space Science Laboratory. N86-13365

The Retarding Ion Mass Spectrometer on the Dynamics Explorer 1 spacecraft observes both the thermal and superthermal ($< 50 \text{ eV}$) ions of the ionosphere and inner magnetosphere. It is capable of measuring the detailed species distribution function of these ions in many cases. It was equipped with an integral electrometer to permit in-flight calibration of the detector sensitivities and variations thereof. This document is intended as a guide to understanding the RIMS data set. The reduction process from count rates to physical quantities is discussed in some detail. The procedure used to establish in-flight calibration is described, and results of a comparison with densities derived from plasma wave measurements are provided. Finally, a discussion is provided of various anomalies in the data set, including changes of channeltron efficiency with time, spin modulation of the axial sensor heads, apparent potential differences between the sensor heads, and failures of the radial head retarding potential sweep and of the -Z axial head aperture plane bias. Studies of the RIMS data set should be conducted only with a thorough awareness of the material presented here, or in collaboration with one of the scientists actively involved with RIMS data analysis.

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September 1985

Turbine Blade Thermal Fatigue Testing, Pratt and Whitney Aircraft Hollow Core Blades. Jeff Ingram and Loren Gross. Structures and Propulsion Laboratory. N86-14271

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The results of low cycle fatigue testing on turbine blades for use in hydrogen/oxygen rocket engines is covered in this report. Cored blade and cored blades with circulation were tested in the MSFC thermal fatigue tester. Both blade configurations showed significant low cycle fatigue life improvements when compared to baseline solid blades.

TM-86529

August 1985

Computed Tomography for Non-Destructive Evaluation of Composites: Applications and Correlations. B. Goldberg, L. Hediger, and E. Noel. Materials and Processes Laboratory.

N86-16268

The state-of-the-art fabrication techniques for composite materials are such that stringent species-specific acceptance criteria must be generated to insure product reliability. Non-destructive evaluation techniques including computed tomography (CT), x-ray radiography (RT), and ultrasonic scanning (UT) have been investigated and compared to determine their applicability and limitations to graphite epoxy, carbon-carbon, and carbon-phenolic materials. While the techniques appear complementary, CT is shown to provide significant, heretofore unattainable data. Finally, a correlation of NDE techniques to destructive analysis is presented.

TM-86530

November 1985

Auroral Thermosphere Temperatures from Observations of 6300 Å Emissions. John C. Bird, Gary R. Swenson, and Richard H. Comfort. Space Science Laboratory.

N86-15755

Doppler temperatures determined from observations of the atomic oxygen OI 6300 Å line during March 1984 at the University of Alaska/Fairbanks are presented. Temperatures were obtained from Fabry-Perot Interferometer pressure scans using a Fourier transform smoothing and fitting technique; this technique is presented in detail. The temperatures and the spread in the temperatures were consistent from day to day. On the clear nights of March 10-13, the temperatures were 800, 750, 750, and 800 K, respectively, with a spread of ± 100 K. These temperatures are compared to the MSIS (84) model atmosphere for similar geomagnetic conditions and found to be in general agreement; they are also consistent with results obtained by other investigators.

TM-86531

October 1985

The Application of Diffusion Theory to the Analysis of Hydrogen Desorption Data at 25°C. Merlin D. Danford. Materials and Processes Laboratory.

N86-15359

The application of diffusion theory to the analysis of hydrogen desorption data (coulombs of H₂ desorbed versus time) has been studied. From these analyses, important information concerning hydrogen solubilities and the nature of the hydrogen distributions in the metal has been obtained. Two nickel base alloys, Rene' 41 and Waspaloy, and one ferrous alloy, 4340 steel, were studied in this work. For the nickel base alloys, it was found that the hydrogen distributions after electrolytic charging conformed closely to those which would be predicted by diffusion theory. For Waspaloy samples charged at 5,000 psi, it was found that the hydrogen distributions were essentially the same as those obtained by electrolytic charging. The hydrogen distributions in electrolytically charged 4340 steel, on the other hand, were essentially uniform in nature, which would not be predicted by diffusion theory. A possible explanation has been proposed. Finally, it has been found that the hydrogen desorption is completely explained by the nature of the hydrogen distribution in the metal, and that the "fast" hydrogen is not due to surface and sub-surface hydride formation, as was originally proposed.

TM-86533

September 1985

Consideration of Radar Target Glint from ST During OMV Rendezvous. M. W. McDonald, L. B. Malone, and E. H. Gleason. Information and Electronic Systems Laboratory.

N86-16456

This report discusses the nature of radar target glint and the factors upon which it depends when using the Hubble Space Telescope as a radar target. An analysis of the glint problem using a 35 MHz or 94 MHz radar on the orbital maneuvering vehicle is explored. A strategy for overcoming glint is suggested.

TM-86534

January 1986

Hex Ball Torque Test. B. A. Robinson and C. L. Foster. Structures and Propulsion Laboratory.

N86-23973

A series of torque tests were performed on four flight-type hex ball universal joints in order to characterize and determine the actual load-carrying

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capability of this device. The universal joint is a part of manual actuation rods for scientific instruments within the Hubble Space Telescope. It was found that the hex ball will bind slightly during the initial load application. This binding did not affect the function of the universal joint, and the units would "wear-in" after a few additional loading cycles. The torsional yield load was approximately 50 ft-lb, and was consistent among the four test specimens. Also, the torque required to cause complete failure exceeded 80 ft-lb. It is concluded that the hex ball universal joint is suitable for its intended applications.

TM-86535 January 1986
A Process Activity Monitor for AOS/VS. R. A. McKosky, S. W. Lindley, and J. S. Chapman. Shuttle Projects Office. N86-19950

With the ever increasing concern for computer security, users of computer systems are becoming more sensitive to unauthorized access. One of the initial security concerns for the Shuttle Management Information System was the problem of users leaving their workstations unattended while still connected to the system. This common habit was a concern for two reasons: it ties up resources unnecessarily and it opens the way for unauthorized access to the system. The Data General JV/10000 does not come equipped with an automatic time-out option on interactive peripherals. The purpose of this memorandum is to describe a system which monitors process activity on the system and disconnects those users who show no activity for some time quantum.

TM-86536 October 1985
Unique Variable Polarity Plasma Arc Welding for Space Shuttle. R. J. Schwinghamer. Materials and Processes Laboratory. N86-19617

Since the introduction of the Plasma Arc Torch by Linde in 1955 and subsequent to the work at Boeing in the 1960's, significant improvements crucial to success have been made in the Variable Polarity Plasma Arc (VPPA) Process at the Marshall Space Flight Center. This report gives several very important advantages to this process, and it discusses the genesis of PA welding, genesis of VPPA welding, theory of VPPA welding, special equipment requirements, weld property development, results with other aluminum alloys, and the eventual successful VPPA transition to production operations.

TM-86537 February 1986
Corrosion Fatigue of 2219-T87 Aluminum Alloy. Vernotto C. McMillan. Materials and Processes Laboratory. N86-22689

Corrosion fatigue studies were conducted on bare, chemical conversion coated, and anodized 2219-T87 aluminum alloy. These tests were performed using a rotating beam machine running at a velocity of 2500 rpm. The corrosive environments tested were distilled water, 100 ppm NaCl, and 3.5 percent NaCl. Results were compared to the endurance limit in air. An evaluation of the effect of protective coatings on corrosion fatigue was made by comparing the fatigue properties of specimens with coatings to those without.

TM-86538 March 1986
Design and Verification Guidelines for Vibroacoustic and Transient Environments. Component Analysis Branch, Systems Dynamics Laboratory. N86-23975

Design and verification guidelines for vibroacoustic and transient environments contain many basic methods that are common throughout the aerospace industry. However, there are some significant differences in methodology between NASA/MSFC and others — both government agencies and contractors. The purpose of this document is to provide the general guidelines used by the Component Analysis Branch, ED23, at MSFC, for the application of the vibroacoustic and transient technology to all launch vehicle and payload components and experiments managed by NASA/MSFC. This document is intended as a tool to be utilized by the MSFC program management and their contractors as a guide for the design and verification of flight hardware.

TM-86539 February 1986
A Torque, Tension, and Stress Corrosion Evaluation of High Strength A286 Bolts. J. W. Montano. Materials and Processes Laboratory. N86-21950

This report addresses the problems associated with overtorque applied to the Booster Separation Motor (BSM) Igniter Adapter high strength [200 KSI (1379 Mpa)] A286 CRES bolts and the threaded holes of the 7075-T73 aluminum alloy BSM cases. Our evaluation included torque, tensile, and stress corrosion tests incorporating the A286 CRES bolts and the 7075-T73 aluminum alloy BSM cases.

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The tensile test data includes ultimate tensile load (UTL), Johnson's 2/3 yield load (J2/3YL), proportional limit load (PLL), and total bolt stretch. Torque tension data includes torque, torque induced load, and positive and negative break-away torque.

Stress corrosion test data reflect the overtorque and the resulting torque induced loads sustained by the A286 CRES bolts torqued into a 7075-T73 aluminum alloy forged dome with threaded holes. After 60 days of salt fog exposure, the positive and the negative break-away torques, the subsequent mechanical property tensile test results, and the BSM dome threaded hole axial tensile pullout loads are reported.

TM-86540 March 1986
Containerless Glass Fiber Processing — MSFC Center Director's Discretionary Fund Final Report. E. C. Ethridge and R. J. Naumann. Space Science Laboratory.

An Acoustic Levitation Furnace system is described that was developed for testing the feasibility of containerless fiber pulling experiments. It is possible to levitate very dense materials such as platinum at room temperature. Levitation at elevated temperatures is much more difficult. Samples of dense heavy metal fluoride glass were levitated at 300°C. It is therefore possible that containerless fiber pulling experiments could be performed. Fiber pulling from the melt at 650°C is not possible at unit gravity but could be possible at reduced gravities. The Acoustic Levitation Furnace is described, including engineering parameters and processing information. It is illustrated that a shaped reflector greatly increases the levitation force aiding the levitation of more dense materials.

TM-86541 February 1986
A Computational Study of Multiple Jet and Wall Interaction. Warren Campbell. Systems Dynamics Laboratory. N86-24937

In the fuel preburner of the Space Shuttle Main Engine, face plate, injector, and baffle erosion have been observed. The observed patterns of erosion suggest that flame attachment to the walls is a contributing factor. To better understand the physical phenomena involved, a portion of the preburner was modeled computationally. The simulated "preburner" had three two-dimensional jets entering a cavity adjacent to a baffle. The computational model employed

the Patankar Spalding algorithm with upwind differencing. The turbulence model was a standard $k-\epsilon$ model with wall functions. The effect of incoming boundary conditions on turbulent kinetic energy and dissipation, k and ϵ , was studied. The results indicate a very strong sensitivity to these boundary conditions over certain ranges of values.

TM-86542 March 1986
Calibration of the ISEE Plasma Composition Experiment. C. R. Baugher, R. C. Olsen, and D. L. Reasoner. Space Science Laboratory. N86-26348

The Plasma Composition experiment on the ISEE-1 satellite was designed to measure ions from 1 to 16 amu, at energies from near zero to 16 keV. The two nearly identical flight instruments were calibrated by means of preflight laboratory tests and in-flight data comparisons. This document presents most of the details of those efforts, with special emphasis on the low energy (0-100 eV) portion of the instrument response. The analysis of the instrument includes a ray-tracing calculation, which follows an ensemble of test particles through the detector.

TM-86543 April 1986
Thermal Performance Evaluation of the Infrared Telescope Dewar Subsystem. Eugene W. Urban. Space Science Laboratory. N86-25305

A series of seven thermal performance tests were conducted with the superfluid helium dewar of the Infrared Telescope Experiment from November 1981 to August 1982. Test objectives included measuring key operating parameters, simulating operations with an attached instrument cryostat, and validating servicing, operating, and safety procedures. This report is a comprehensive summary of all test activities and results.

TM-86544 March 1986
Effects of Seawater and Deionized Water at 0 to 80°C on the Flexural Properties of a Glass/Epoxy Composite. B. G. Penn, J. G. Daniels, F. E. Ledbetter, III, M. L. Semmel, B. G. Goldberg, W. T. White, and J. M. Clemons. Space Science Laboratory. N86-24758

The effect on the flexural properties of a glass/epoxy composite of immersion in deionized water or

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seawater at 0°, 25°, and 80°C for 451 hr was examined. The percent weight gain at 0° and 25°C was low (0.06 to 0.17 percent) and there was no significant change in the flexural properties for these environmental conditions.

At 80°C there was a decrease in the flexural strength of 17 and 20 percent in seawater and deionized water, respectively. This is a comparison to control samples exposed to 80°C heat alone. These decreases were found to be nearly reversible once the samples were dried. Optical microscopy did not reveal cracking of the matrix. The flexural modulus was essentially unaffected by exposure to deionized water and seawater at 80°C.

TM-86545 April 1986
Kinematics, Composition and Thermodynamics of the Mesopause, Turbopause Region of the Atmosphere (Between 80 and 120 km) Related to the Aeroassisted Orbit Transfer Vehicle (AOTV) Operations. Michael Susko. Systems Dynamics Laboratory. N86-26735

This report addresses the mesopause-turbopause region (80 to 120 km) of the atmosphere which is frequently used as a boundary between the thermosphere and mesosphere for models of the atmosphere. The initialization of models is important since uncertainties may lead to significant changes in the computations of total density at greater altitudes. In this transition region, the experimental data base for the total gas density and the constituents of smaller abundance is very limited. The turbopause height (h_t) may vary from 90 to 120 km and no pronounced dependence of h_t on season, local time, or solar activity is determined.

The importance of atmospheric turbulence is discussed and its important role in the mesosphere and lower atmosphere by influencing the thermal balance of the upper atmosphere, as well as the distribution of different atmospheric constituents, is presented. The number of measurements of turbulence at these altitudes is small. Data from radio meteors, noble gas ratio analysis, and luminescent cloud analysis reveal no definite conclusion or systematic variation of the turbulence region. The heat input by gravity waves is a dominant term in the energy balance equation. Also gravity waves, either directly or through a mechanism of turbulence generation, enhance the mixing ability of

the atmosphere. Internal gravity waves produce variations in the density as well as concentration of atomic oxygen.

The uncertainty in the atmospheric density variation, according to Walberg (1985), leads to control system design problems for the AOTV relative to the amount of control authority required to deal with the unpredictable variation in density.

TM-86546 April 1986
Inertial Upper Stage (IUS-3) Reaction Control System (RCS) Hydrazine Propellant Tank Assembly (PTA) Elastomeric Bladder Life Analysis. Henry M. Lee. Structures and Propulsion Laboratory. X86-10299

This report presents the strains and time-to-rupture analysis performed for the IUS-3 RCS hydrazine PTA serial number (S/N) 0010 elastomeric bladder. Because the bladder, constructed of AF-E-332 material, will be subjected to a fully pressurized preflight life in a 1-g environment in the vertical position for about three years, it became mandatory that the time-to-rupture life be quantified by analysis. This paper shows the analytical energy solution utilized in the calculation of the required bladder strains and subsequent life prediction.

Results of the analysis revealed a conservative estimate of peak bladder strain at 82.5 percent where it folds over a circumferential retainer ring. The life related to the peak strain was found to be 3.48 years.

TM-86547 April 1986
Surface Film Effects on Drop Tube Undercooling Studies - Center Director's Discretionary Fund Final Report. E. C. Ethridge and W. F. Kaukler. Space Science Laboratory. N86-26410

The effects of various gaseous atmospheric constituents on drop-tube solidified samples of elemental metals were examined from a microstructural standpoint. All specimens were prepared from the purest available elements, so effects of impurities should not account for the observed effects. The drop-tube gas has a definite effect on the sample microstructure. Most dramatically, the sample cooling rate is affected. Some samples receive sufficient cooling to solidify in free fall while others do not, splating at the

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end of the drop tube in the sample catcher. Gases are selectively absorbed into the sample. Upon solidification gas can become less soluble and as a result forms voids within the sample. The general oxidation/reduction characteristics of the gas also affect sample microstructures.

In general, under the more favorable experimental conditions including reducing atmospheric conditions and superheatings, examination of sample microstructures indicates that nucleation has been suppressed. This is indicated by underlying uniform dendrite spacings throughout the sample and with a single dendrite orientation through most of the sample. The samples annealed yielding a few large grains and single or "bi-crystal" samples were commonly formed. This was especially true of samples that were inadvertently greatly superheated. This is in contrast with results from a previous study in which surface oxides were stable and contained numerous sites of nucleation. The number of nucleation events depends upon the surface state of the specimen as determined by the atmosphere and is consistent with theoretical expectations based upon the thermodynamic stability of surface oxide films. Oxide-free specimens are characterized by shiny surfaces, with no observable features under the scanning electron microscope at 5000X.

TM-86548 July 1986
Space Processing Applications Rocket (SPAR)
Project SPAR X Final Report. Compiled by R.
Poorman. Spacelab Payload Project Office.
N86-28972

The Space Processing Applications Rocket Project (SPAR) X Final Report contains the compilation of the post-flight reports from each of the Principal Investigators (PIs) on the four selected science payloads, in addition to the engineering report as documented by the Marshall Space Flight Center (MSFC). This combined effort also describes pertinent portions of ground-based research leading to the ultimate selection of the flight sample composition, including design, fabrication and testing, all of which are expected to contribute to an improved comprehension of materials processing in space.

The SPAR project was coordinated and managed by MSFC as part of the Microgravity Science and Applications (MSA) program of the Office of Space

Science and Applications (OSSA) of NASA Headquarters.

This technical memorandum is directed entirely to the payload manifest flown in the tenth of a series of SPAR flights conducted at the White Sands Missile Range (WSMR) and includes the experiments entitled "Containerless Processing Technology," SPAR Experiment 76-20/3; "Directional Solidification of Magnetic Composites," SPAR Experiment 76-22/3; "Comparative Alloy Solidification," SPAR Experiment 76-36/3; and "Foam Copper," SPAR Experiment 77-9/1R.

TM-86549 May 1986
Applications of Tethers in Space – A Review of
Workshop Recommendations. Georg von
Tiesenhausen, Editor. Advanced Systems
Office, Program Development.

N86-28115

Well-organized and structured efforts of considerable magnitude involving NASA, industry, and academia have explored and defined the engineering and technological requirements of the use of tethers in space and have discovered their broad range of operational and economic benefits. The results of these efforts have produced a family of extremely promising candidate applications. The extensive efforts now in progress are gaining momentum and a series of flight demonstrations are being planned and can be expected to take place in a few years. This report provides an analysis and a review of NASA's second major workshop on Applications of Tethers in Space held in October 15-17, 1985, in Venice, Italy. It provides a summary of an up-to-date assessment and recommendations by the NASA Tether Applications in Space Program Planning Group, consisting of representatives of seven NASA Centers and responsible for tethers applications program planning implementation as recommended by the workshop panels.

TM-86551 June 1986
Evaluation of Solar Array Flight Experiment
Response During Flight for Extension/Retraction
Phase. Jerry Slaby. Systems Dynamics
Laboratory. N86-31606

This is a post flight evaluation of the Solar Array Flight Experiment's (SAFE) deployment dynamics that explains the encountered resonances.

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TM-86552 June 1986
Hubble Space Telescope Meteoroid/Debris
Protection Analysis. Jennifer Horn and Juan
Maldonado. Structures and Propulsion
Laboratory. N86-29737

A system level failure could occur if the Hubble Space Telescope's (ST) capability to operate as a facility on-orbit is critically reduced or when a significant reduction in the quality of science data is registered. Failure could occur if a meteoroid/debris impact damages a component of a major support subsystem or if a meteoroid/debris penetration causes straylight contamination in the light shield, forward shell, aft shroud, or through the aperture door.

The ST was analyzed to find the probability of no critical penetration. A straylight leakage repair technique was recommended for the aft shroud, the region found most likely to be critically penetrated.

TM-86553 July 1986
Effects of External Environments on the Short
Beam Shear Strength of Filament Wound
Graphite/Epoxy (Center Director's Discretionary
Fund Final Report). B. G. Penn and J. M.
Clemons. Space Science Laboratory and
Materials and Processes Laboratory.
N86-32528

Filament wound graphite/epoxy samples were immersed in seawater, deionized water, and toluene at room temperature and 80°C for 5, 15, and 43 days, and in methanol at room temperature for 15 and 43 days. The percent weight gains and short beam shear strengths were determined after environmental exposure. Samples immersed in deionized water and seawater had higher percent weight gains than those immersed in toluene at room temperature and 80°C. The percent weight gains for samples immersed in methanol at room temperature were comparable to those of deionized water and seawater immersed samples. A comparison of percent decreases in short beam shear strengths could not be made due to a large scatter in data. This may indicate defects in samples due to machining or variations in material properties due to processing.

This research was sponsored by the Center Director's Discretionary Fund Project (No. 84-5, "Effects of External Environments on the Failure Mode and

Mechanical Properties of an Epoxy and Graphite/Epoxy Composite System").

TM-86554 July 1986
A Digital Imaging Photometry System for
Cometary Data Acquisition - Center Director's
Discretionary Fund Final Report. K. S. Clifton,
C. M. Benson, and G. A. Gary. Space Science
Laboratory. N86-32373

This report describes a digital imaging photometry system developed in the Space Science Laboratory at the Marshall Space Flight Center as part of the Center Director's Discretionary Fund (CDDF). The photometric system used for cometary data acquisition is based on an intensified secondary electron conduction (ISEC) vidicon coupled to a versatile data acquisition system which allows real-time interactive operation. Field tests on the Orion and Rosette nebulas indicate a limiting magnitude of approximately $m_v = 14$ over the 40 arcmin field-of-view. Observations were conducted of Comet Giacobini-Zinner in August 1985. The resulting data are discussed in relation to the capabilities of the digital analysis system. The development program concluded on August 31, 1985.

TM-86555 September 1986
Ice Nucleus Activity Measurements of Solid
Rocket Motor Exhaust Particles. Compiled by
Vernon W. Keller. Systems Dynamics Laboratory.
N86-32925

The ice nucleus activity of exhaust particles generated from combustion of Space Shuttle propellant in small rocket motors has been measured. The activity at -20°C was substantially lower than that of aerosols generated by unpressurized combustion of propellant samples in previous studies. The activity decays rapidly with time and is decreased further in the presence of moist air. These tests corroborate the low effectivity ice nucleus measurement results obtained in the exhaust ground cloud of the Space Shuttle. Such low ice nucleus activity implies that Space Shuttle induced inadvertent weather modification via an ice phase process is extremely unlikely.

TM-86556 December 1985
Lubrication Handbook for the Space Industry;

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Part A: Solid Lubricants; Part B: Liquid Lubricants. Ernest L. McMurtrey. Materials and Processes Laboratory. N86-31730

This handbook is intended to provide a ready reference for many of the solid and liquid lubricants used in the space industry. Lubricants and lubricant properties are arranged systematically so that designers, engineers, and maintenance personnel in the space industry can conveniently locate data needed for their work.

This handbook is divided into two major parts (A and B). Part A is a compilation of solid lubricant suppliers information on chemical and physical property data of more than 250 solid lubricants, bonded solid lubricants, dispersions and composites. Part B is a compilation of chemical and physical property data of more than 250 liquid lubricants, greases, oils, compounds, and fluids. The listed materials cover a broad spectrum from manufacturing and ground support to hardware applications of spacecraft.

TM-86557 July 1986
Determination of Solid Rocket Motor (SRM) Case Segment Growth. Lisa Hanks Mitchell. Materials and Processes Laboratory. N86-31653

This report presents an assessment of case growth for two D6AC steel SRM case segments with multiple flight use and a comparison of these two cases with two new cases. Dimensional changes in the sealing diameter areas were recorded for the used cases and after each hydroproofing of the new cases.

TM-86559 August 1986
Viewport Concept for Space Station Modules. Freddie Douglas, III. Structures and Propulsion Laboratory.

This report addresses the generic design of a 20-in. diameter viewport for the space station modules. It should possess the capabilities of meteoroid/debris protection (with no metallic cover), redundancies in its meteoroid/debris protection, and pressure sealing systems. In addition, it should provide ease of change out for maintenance or repair. The design does not take into account the bumper-shield effect of the outermost panes in the meteoroid/debris analysis.

TM-86561 August 1986
Shifts in Shuttle SRM Performance Because of Ammonium Perchlorate Crystal Shape on Missions 51-I/J and 61-A/B. Douglas L. Blackwell. Systems Analysis and Integration Laboratory.

The design of the Space Shuttle vehicle configuration requires that the SRMs produce thrust within tightly-controlled limits. These limits provide assurance that Shuttle ascent performance goals will be achieved within the vehicle flight load constraints. The SRM's will initially describe the excellent performance reproducibility of the 24 SRMs during the first 12 flights [STS-8 through STS-26 (Mission 51-F)] using the HPM SRM. Secondly, this report will describe the transient phenomena which interrupted the reproducibility in the first 20 sec of flight for four flights (Missions 51-I/J and 61-A/B). The cause of this 20 sec phenomena is postulated to be a change in the crystal shape of the ammonium perchlorate used in the propellant. This shape change coincided with the performance shift on these four flights. The ballistic effect of the crystal shape change is manifested as a change to the generic "HUMP" or "BARF" curve of the Shuttle SRM thrust/pressure-time curve. As the crystal shape change was corrected by the vendor, the performance produced by the Shuttle SRM returned to normal.

NASA TECHNICAL PAPERS

TP-2550 January 1986
 A Stochastic Model for Particle Impingements on Orbiting Spacecraft. Leonard W. Howell, Jr. Systems Dynamics Laboratory.

N86-19095

A general methodology for simulating particle impingements on orbiting spacecraft is developed. Major steps in the modeling process are presented as (1) modeling objective, (2) construction of the spacecraft geometrical model, (3) simulation of the particles in the space environment, (4) particle impact and subsequent events of interest, and (5) results of the simulation.

A simulation of the expected meteoroid impingements on the Hubble Space Telescope and the resulting angular momentum transfers which can cause telescope pointing disturbances is given to illustrate these methods.

TP-2556 January 1986
 Hydroburst Test of a Carbon-Carbon Involute Exit Cone. Roy M. Sullivan. Structures and Propulsion Laboratory.

X86-10234

This report documents the hydroburst test of the aft portion of the PAM-D exit cone. The test fixture, test instrumentation, and test procedure are described in detail. The hydrostatic pressure required to buckle the cone was recorded at 9.75 psi.

Meanwhile, the PAM-D exit cone was modeled using the finite element method and a theoretical buckling pressure (8.76 psi) was predicted using the SPAR finite element code. This report discussed the modeling technique which was employed.

By comparing the theoretical to predicted critical pressures, this report verifies the modeling technique and calculates a material knockdown factor for the carbon-carbon exit cone.

TP-2569 March 1986
 Investigation of Solid Plume Criteria to Produce Flight Plume Effects on Multibody Configuration in Wind Tunnel Tests. Alonzo L. Frost and Charlie C. Dill. Systems Dynamics Laboratory.

N86-21507

An investigation to determine the sensitivity of the Space Shuttle base and forebody aerodynamics to the size and shape of various solid plume simulators was conducted. Families of cones of varying angle and base diameter, at various axial positions behind a Space Shuttle launch vehicle model, were wind tunnel tested. This parametric evaluation yielded base pressure and force coefficient data which indicated that solid plume simulators are an inexpensive, quick method of approximating the effect of engine exhaust plumes on the base and forebody aerodynamics of future, complex multibody launch vehicles.

TP-2572 March 1986
 Star 48 Solid Rocket Motor Nozzle Analyses and Instrumented Firings. Robert L. Porter. Structures and Propulsion Laboratory.

N86-20460

This report presents the analyses and testing performed by NASA in support of an expanded and improved nozzle design data base for use by the U.S. solid rocket motor industry. A production nozzle with a history of one ground failure and two flight failures was selected for analyses and testing.

The stress analysis was performed with the Champion computer code developed by the U.S. Navy. Several improvements were made to the code. Strain predictions were made and compared to test data.

Two short duration motor firings were conducted with highly instrumented nozzles. The first nozzle had 58 thermocouples, 66 strain gages, and 8 bondline pressure measurements. The second nozzle had 59 thermocouples, 68 strain measurements, and 8 bondline pressure measurements. Most of this instrumentation was on the nonmetallic parts, and provided significantly more thermal and strain data on the nonmetallic components of a nozzle than has been accumulated in a solid rocket motor test to date.

TP-2573 March 1986
 Analysis of Jimsphere Pairs for Use in Assessing Space Vehicle Ascent Capability. Charles K. Hill. Systems Dynamics Laboratory.

N86-21506

NASA TECHNICAL PAPERS

The purpose of this research was to develop a data base of paired detailed wind profiles for use in evaluating Shuttle Transportation System (STS) ascent capability. Since launch decision is based on a wind measured about 3.5 hr before launch, a data base of paired detailed profiles is needed. Method and technique on the reduction process and analysis is also presented. Guidelines used in selecting the pairs of profiles were established to insure a valid and representative data base. σ_u values for 3.5 hr at 12 km altitude show 8 percent increase from the transition case to the winter case and 18 percent decrease from the transition case to the summer case. σ_v values for 3.5 hr at 12 km altitude shows 12 percent increase from the transition case to the winter case and 17 percent decrease from the transition case to the summer case. A special feature of the 7- and 10.5-hr cases is that σ_v increases by as much as 30 percent from the transition to the winter profiles. This large increase does not appear in the σ_u data. Comparisons of the calculated values of 3.5-hr standard deviations of u and v with actual component deviations measured during Space Shuttle launch conditions confirm that the statistical values are representative.

TP-2574 March 1986
Reverification of Techroll Seal Used in the IUS Nozzle. R. L. Porter. Structures and Propulsion Laboratory. X86-10233

The Inertial Upper Stage (IUS) uses a Techroll Seal in the nozzle design of each of its two solid rocket motors. As a result of the small solid rocket motor (SRM-2) anomaly of the STS-6 space shuttle flight, additional seal testing, motor firings, and structural analyses have been conducted. This paper begins with a background of the nozzle configuration, followed by a description of the design features of the Techroll Seal, and concludes with the post-flight seal testing, motor firings, structural analyses, and design changes. Although the Techroll Seal, which is constructed of two plies of Kevlar sandwiched between layers of neoprene, was designed and qualified prior to flight, a significant amount of highly instrumented testing and analysis has been accomplished since the flight anomaly. The additional analysis and testing shows the significant effects of the nozzle gimbal angle and the increase in seal temperature due to gas leakage and pyrolysis gas. It was learned that the critical design condition for the seal occurs much later in the motor burn than at the time of maximum chamber and seal pressure, as concluded in the original design analyses.

TP-2575 March 1986
Graphical Techniques to Assist in Pointing and Control Studies of Orbiting Spacecraft. Leonard W. Howell and Joseph H. Ruf. Systems Dynamics Laboratory. N86-21559

Computer generated graphics are developed to assist in the modeling and assessment of pointing and control systems of orbiting spacecraft.

Three-dimensional diagrams are constructed of the Earth and of geometrical models which resemble the spacecraft of interest. Orbital positioning of the spacecraft model relative to the Earth and the orbital ground track are then displayed. A star data base is also available which may be used for telescope pointing and star tracker field-of-views to visually assist in spacecraft pointing and control studies.

A geometrical model of the Hubble Space Telescope (HST) is constructed and placed in Earth orbit to demonstrate the use of these programs. Simulated star patterns are then displayed corresponding to the primary mirror's FOV and the telescope's star trackers for various telescope orientations with respect to the celestial sphere.

TP-2576 March 1986
Analytical and Numerical Studies of the Thermo-capillary Flow in a Uniformly Rotating Floating Zone. William W. Fowles and Glyn O. Roberts. Space Science Laboratory. N86-23851

The microgravity environment of an orbiting vehicle permits crystal growth experiments in the presence of greatly reduced buoyant convection in the liquid melt. Crystals grown in ground-based laboratories do not achieve their potential properties because of dopant variations caused by flow in the melt. The floating zone crystal growing system is widely used to produce crystals of silicon and other materials. However, in this system the temperature gradient on the free sidewall surface of the melt is the source of a thermocapillary flow which does not disappear in the low-gravity environment.

Smith and Greenspan theoretically examined the idea of using a uniform rotation of the floating zone system to confine the thermocapillary flow to the melt

sidewall leaving the interior of the melt passive. These workers considered a cylinder of fluid with an axial temperature gradient imposed on the cylindrical sidewall. They considered a half zone and examined the linearized, axisymmetric flow in the absence of crystal growth. They found that rotation does confine the linear thermocapillary flow.

In this paper the simplified model of Smith and Greenspan is extended to a full zone and both linear and non-linear thermocapillary flows are studied theoretically. Analytical and numerical methods are used for the linear flows and numerical methods for the non-linear flows. It was found that the linear flows in the full zone have more complicated and thicker boundary layer structures than in the half zone, and that these flows are also confined by the rotation. However, for the simplified model considered and for realistic values for silicon, the thermocapillary flow is not linear. The nonlinear flows were examined by first computing a weakly nonlinear flow and then computing the fully nonlinear flow. The weakly nonlinear flow is steady, has less boundary layer character, and penetrates more deeply into the interior than the linear flow but still shows some rotational confinement. The fully nonlinear flow is strong and unsteady (a weak oscillation is present) and it penetrates the interior. Some non-rotating flow results are also presented.

Since silicon has a large value of thermal conductivity, one would expect the temperature fields to be determined by conduction alone. This is true for the linear and weakly nonlinear flows, but for the stronger nonlinear flow the results show that temperature advection is also important. Thus, this work reveals that for the nonlinear flow, a radiative sidewall boundary condition would be an improvement over the specified temperature boundary condition used in this paper and previously by others. Such a boundary condition would weaken the sidewall axial temperature gradient and hence the thermocapillary flow allowing the confining effect of rotation to play a stronger role. Hence, uniform rotation may still be a means of confining the flow and the results obtained define the procedure to be used to examine this hypothesis.

TP-2577

March 1986

Pocketing Mechanics of SRM Nozzle Liner.
Vincent S. Verderaime. Systems Dynamics
Laboratory. N86-23974

A systems approach was adopted to study the pocketing phenomena on a solid rocket nozzle liner. The classical thermoelastic analysis was used to identify marginally strained regions on the composite liner erosion surface and at a depth coincident with the peak value of the across ply coefficient of thermal expansion. A failure criterion was introduced which included a thermal term and permitted failure assessment over the charred liner. The method was verified by satisfactory application to a reported related experiment. Liner pocketing mechanism was attributed to very localized material degradation caused during manufacturing process either by reduction of fiber strength and/or by concentration of resin volume fraction. Pocketing scenario over the degraded material was constructed with supporting formulation to predict size of fissures with respect to degraded material size and location in the liner and with burn time. Sensitivities of liner material parameters were determined to influence test programs designed to update mechanical data base of carbon cloth phenolic over the char temperature range.

TP-2598

May 1986

Solar Array Flight Dynamic Experiment. Richard
W. Schock. Systems Dynamics Laboratory.

The purpose of the Solar Array Flight Dynamic Experiment (SAFDE) is to demonstrate the feasibility of on-orbit measurement and ground processing of large space structures dynamic characteristics. Test definition or verification provides the dynamic characteristic accuracy required for control systems use. An illumination/measurement system was developed to fly on space shuttle flight STS-41D. The system was designed to dynamically evaluate a large solar array called the Solar Array Flight Experiment (SAFE) that had been scheduled for this flight. The SAFDE system consisted of a set of laser diode illuminators, retroreflective targets, an "intelligent" star tracker receiver and the associated equipment to power, condition, and record the results. In six tests on STS-41D, data was successfully acquired from 18 retroreflector targets and ground processed, post flight, to define the solar array's dynamic characteristic. The flight experiment proved the viability of on-orbit test definition of large space structures dynamic characteristics. Future large space structures controllability should be greatly enhanced by this capability.

NASA TECHNICAL PAPERS

TP-2603

May 1986

Effects of Variables Upon Pyrotechnically Induced Shock Response Spectra. James Lee Smith. Systems Dynamics Laboratory.

Throughout the aerospace industry, large variations of 50 percent (6 dB) or more are continually noted for linear shaped charge (LSC) generated shock response spectra (SRS) from flight data (from the exact same location on different flights) and from plate tests (side by side measurements on the same test). A research program was developed to investigate causes of these large SRS variations. A series of ball drop calibration tests to verify calibration of accelerometers and a series of plate tests to investigate charge and assembly variables were performed. The resulting data were analyzed to determine if and to what degree manufacturing and assembly variables, distance from the shock source, data acquisition instrumentation, and shock energy propagation affect the SRS. LSC variables consisted of coreload, standoff, and apex angle. The assembly variable was the torque on the LSC holder. Other variables were distance from source of accelerometers, accelerometer mounting methods, and joint effects. Results indicated that LSC variables did not affect SRS as long as the plate was severed. Accelerometers mounted on mounting blocks showed significantly lower levels above 5000 Hz. Lap joints did not affect SRS levels. The test plate was mounted in an almost free-free state; therefore, distance from the source did not affect the SRS either. Several varieties and brands of accelerometers were used – all varieties except one demonstrated very large variations in SRS. One accelerometer gave very good repeatable results throughout the program. Instrumentation is the cause of the large variations in SRS. SRS from the same source are indeed repeatable.

TP-2607

June 1986

Development Testing of Large Volume Water Sprays for Warm Fog Dispersal. V. W. Keller, B. J. Anderson, R. A. Burns, G. G. Lala, M. B. Meyer, and K. V. Beard. Systems Dynamics Laboratory.

A new brute-force method of warm fog dispersal is described. The method uses large volume recycled water sprays to create curtains of falling drops through which the fog is processed by the ambient wind and spray induced air flow. Fog droplets are removed by coalescence/rainout. The efficiency of the technique

depends upon the drop size spectra in the spray, the height to which the spray can be projected, the efficiency with which fog laden air is processed through the curtain of spray, and the rate at which new fog may be formed due to temperature differences between the air and spray water. Results of a field test program, implemented to develop the data base necessary to assess the proposed method, are presented. Analytical calculations based upon the field test results indicate that this proposed method of warm fog dispersal is feasible. Even more convincingly, the technique was successfully demonstrated in the one natural fog event which occurred during the test program. Energy requirements for this technique are an order of magnitude less than those to operate a thermokinetic system. An important side benefit is the considerable emergency fire extinguishing capability it provides along the runway.

TP-2620

July 1986

Numerical Modeling of Physical Vapor Transport in a Vertical Cylindrical Ampoule, With and Without Gravity. Timothy L. Miller. Systems Dynamics Laboratory.

N86-29040

Numerical modeling has been performed of the fluid dynamics in a prototypical physical vapor transport crystal growing situation. Cases with and without gravity have been computed. Dependence of the flows upon the dimensionless parameters aspect ratio and Peclet, Rayleigh, and Schmidt numbers is demonstrated to a greater extent than in previous works. Most notably, it is shown that the effects of thermally-induced buoyant convection upon the mass flux on the growth interface crucially depend upon the temperature boundary conditions on the sidewall (e.g., whether adiabatic or of a fixed profile, and in the latter case the results depend upon the shape of the profile assumed).

TP-2634

September 1986

A Mechanical Property and Stress Corrosion Evaluation of VIM-ESR-VAR Work Strengthened and Direct Double Aged Inconel 718 Bar Material. J. W. Montano. Materials and Processes Laboratory. N86-30753

This report presents the mechanical properties and the stress corrosion resistance of triple melted

[vacuum induction melted (VIM), electro-slag remelted (ESR), and vacuum arc remelted (VAR)], solution treated, work strengthened and direct double aged Inconel 718 alloy bars [4.00 in. (10.16 cm) and 5.75 in. (14.60 cm) diameter] processed by Wyman Gordon.

Tensile, charpy v-notched impact, and compact tension specimens were tested at ambient temperature in both the longitudinal and transverse directions. Longitudinal tensile and yield strengths in excess of 220 ksi (1516.85 MPa) and 200 ksi (1378.00 MPa) respectively, were realized at ambient temperature.

Additional charpy impact and compact tension tests were performed at -100°F (-73°C). Longitudinal charpy impact strength equalled or exceeded 12.0 ft-lbs (16.3 Joules) at ambient and at -100°F (-73°C) while longitudinal (LC) compact tension fracture toughness strength remained above 79 ksi $\sqrt{\text{in}}$. (86.80 MPa $\sqrt{\text{m}}$) at ambient and at -100°F (-73°C) temperatures.

No failures occurred in the longitudinal or transverse tensile specimens stressed to 75 and 100 percent of their respective yield strengths and exposed to a salt fog environment for 180 days. Tensile tests performed after the stress corrosion test indicated no mechanical property degradation.

TP-2636

September 1986

The Variation of Corrosion Potential With Time for Coated Metal Surfaces. Merlin D. Danford and Ward W. Knockemus. Materials and Processes Laboratory. N86-30837

The variation of corrosion potential (E_{CORR}) with time has been measured for 4130 steel coated with a preservative compound and for primer coated 2219-T87 aluminum. The data for coated steel samples show a great deal of scatter, and a smoothing procedure has been developed to enable proper interpretation of the data. The E_{CORR} -time curves for coated steel exhibit a maximum, in agreement with the results of previous studies, where the data were the average of those for a large number of samples, while the present data were obtained from a single sample. In contrast, the E_{CORR} -time curves for primer coated 2219-T87 aluminum samples show no significant variations, although considerable activity is indicated by the resistance-time and corrosion rate-time curves.

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- An X-Ray Algorithm. For presentation at the Alabama Electron Microscopy Society Meeting, Birmingham, AL, March 20-21, 1986.
- ODOM, JAMES B. TA01
MITCHELL, ROYCEE. TA81
Technology and the Hubble Space Telescope Satellite. For presentation at the Electronics and Aerospace Systems Conference (EASCON '86), Washington, D.C., September 8-10, 1986.
- OLSEN, R. C. ES53
CHAPPELL, C. R.
Statistical Models of Equatorially Trapped Plasma. For presentation at the First Huntsville Workshop on Magnetosphere/Ionosphere Plasma Models, Guntersville, AL, October 13-16, 1986.
- OLSEN, R. EL15
GUINAN, D. Grumman
QUINN, A. EL15
Telerobotic Orbital Servicing Technology Development. For presentation at the Remote Systems and Robotics in Hostile Environments Conference, Pasco, WA, March 29-April 2, 1987.
- OLSEN, R. C. ES51
CHAPPELL, C. R.
Conical Ion Distributions Near One Earth Radius. For presentation at the XXVI COSPAR Workshop, Toulouse, France, June 30-July 12, 1986.
- OLSEN, R. C. ES53
SHAWHAN, S. D.
GALLAGHER, D. L.
GREEN, J. L.
CHAPPELL, C. R.
ANDERSON, R. R.
Plasma Observations at the Earth's Magnetic Equator. For publication in the Journal of Geophysical Research, Washington, D.C.
- OWEN, ROBERT B. ES73
KROES, ROGER L.
WITHEROW, WILLIAM K.
Results and Further Experiments Using Spacelab Holography. For publication in Optics Letters, Washington, DC.
- OWEN, ROBERT B. ES73
Research in Materials Processing Using a Low Gravity Simulation Aircraft. For publication in the University of Colorado Low-Gravity Science Seminar Proceedings, Boulder, CO.
- OWEN, R. B. ES73
GIARRATANO, P. J.
ARP, V. D.
The Use of Holography to Measure Heat Transfer in High Gradient Systems. For presentation at the Optical Society of America 1986 Annual Meeting, Seattle, WA, October 19-24, 1986.
- OWEN, R. B. ES73
BROOM, B. H.
SNYDER, R. S.
DANIEL, R.
Liquid Drop Stability for Protein Crystal Growth in Microgravity Simulated on the KC-135 Aircraft. For publication by Aviation, Space and Environmental Medicine, San Antonio, TX.
- OWENS, J. K. ES55
TORR, M. R.
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The Dayglow Spectrum at 150 km. For presentation at the Fall Meeting, 1986 American Geophysical Union, San Francisco, CA, December 8-12, 1986.
- OWENS, J. K. ES55
TORR, MARSHA R.
TORR, D. G.
The Dayglow Spectrum at 150 km I: 2000 to 8000 Å. For presentation at the 1986 Spring AGU Meeting, Baltimore, MD, May 19-23, 1985.
- OWENS, S. F. ED42
MUKERJEE, T.
SINGHAL, A. K.
PRZEKWAŚ, A. J.
GLYNN, D. R.
COSTES, N. C.
Numerical Analysis of Flow in the Hot Gas Manifold of the Space Shuttle Main Engine. For publication in the AIAA Journal of Spacecraft and Rockets.

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| <p>OWENS, S. F.
MUKERJEE, T.
SINGHAL, A. K.
PRZEKOWAS, A. J.
GLYNN, D. R.
COSTES, N. C.</p> | <p>ED42</p> | <p>PETERS, P. N.
GREGORY, J. C.
SISK, R. C.</p> | <p>ES63</p> |
| <p>Numerical Analysis of Flow in the Hot Gas Manifold of Space Shuttle Main Engine. For presentation at the AIAA/ASME/SAE/ASEE 22nd Joint Propulsion Conference, Huntsville, AL, June 16-18, 1986.</p> | | <p>Oxygen Atom Velocity Distributions as Viewed from a Spacecraft and Their Use to Determine Thermospheric Temperatures. For publication in Geophysical Research Letters, Washington, D.C.</p> | |
| <p>PABLO, J. D.
MACHADO, MARCOSE.</p> | <p>ES52
(NAS/MSFC)</p> | <p>PETERSON, W. K.
MOORE, T. E.
SHELLY, E. G.
WAITE, J. H., JR.
BOARDSEN, S. A.
GURNETT, D. A.</p> | <p>ES53</p> |
| <p>Steps Towards Understanding Deep Atmospheric Heating in Flares. For publication in the Proceedings of the NSO/SMM Summer Meeting, Sunspot, NM, August 1985.</p> | | <p>Observations of Transverse Ion Energization on Auroral Field Lines from Dynamics Explorer-1. For presentation at the Fall Meeting of the American Geophysical Union, San Francisco, CA, December 9-13, 1985.</p> | |
| <p>PARKER, JOER.
MORGAN, SAMUEL H.</p> | <p>PD11</p> | <p>PORTER, J. G.
REICHMANN, E. J.
MOORE, R. J.
HARVEY, K. L.</p> | <p>NRC
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SPRC</p> |
| <p>Superconducting Gravity Gradiometer on the Space Shuttle. For presentation at the 14th Gravity Gradiometer Conference, USAF Academy, Colorado Springs, CO, February 11-12, 1986.</p> | | <p>Associations of Compact C IV Events, He I 10830 Å Dark Points, and Magnetic Structures. For presentation at the 167th Meeting of the American Astronomical Society, Houston, TX, January 5-9, 1986.</p> | |
| <p>PARNELL, T. A.
MIYAJI, S.
TAKAHASHI, Y.</p> | <p>ES65</p> | <p>PORTER, JASONG.
GEBBIE, KATHARINE B.
NOVEMBER, LAURENCE J.</p> | <p>ES52
ES52</p> |
| <p>Magnetic Pulsar Acceleration and X-ray Photo-disintegration of Heavy Nuclei in the SN-II Remnant. For publication in the Bulletin of the American Physical Society, New York, NY.</p> | | <p>Magnetic Location of C IV Events in the Quiet Network. For publication in the Proceedings of the SMM Conference on Coronal and Prominence Plasmas, Berkely Springs, WV, April 7-10, 1986.</p> | |
| <p>PETERS, P. N.
GREGORY, J. C.
KARR, G. R.</p> | <p>ES63</p> | <p>PORTER, JASONG.
GEBBIE, KATHARINE B.
NOVEMBER, LAURENCE J.</p> | <p>ES52
ES52</p> |
| <p>A Measurements of the Angular Distribution of 5 eV Oxygen Atoms Scattered Off a Solid Surface in Earth Orbit. For presentation and publication at the Rarefied Gas Dynamics, 15 Conference, Grado, Italy, July 16, 1986.</p> | | <p>The Excitation of Helium Resonance Lines in Solar Flares. For publication in the National Solar Observatory/SMM Summer Meeting, Workshop Proceedings.</p> | |
| <p>PETERS, P. N.
SWANN, J. T.
GREGORY, J. C.</p> | <p>ES63</p> | <p>POTEET, WADEM.
OWEN, ROBERT B.</p> | <p>ES73</p> |
| <p>Effects on Optical Systems from Interactions with Oxygen Atoms in Low Earth Orbits. For publication in Applied Optics, Newton Highlands, MA.</p> | | <p>A Compact Field Color Schlieren System for Use in Microgravity Materials Processing. For publication in Optical Engineering, Bellingham, WA.</p> | |

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| POWELL, LUTHER E. | KA01 | Growth Kinetics of Tetragonal Lysozyme Crystals. For publication in The Journal of Crystal Growth, Amsterdam: The Netherlands. |
| GOSS, ROBERT | | |
| SPENCER, RICHARD | Martin | |
| NASA's Robotic Servicing Role for Space Station. For presentation at the Thirty-Seventh IAF Congress, Innsbruck, Austria, October 7, 1986. | | |
| POWELL, LUTHER E. | KA01 | |
| U.S. Laboratory. For presentation at the Second NASA Symposium on the Space Station: Preliminary Design and Program, Washington, D.C., August 18-20, 1986. | | |
| POWELL, LUTHER E. | KA01 | |
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| POWELL, LUTHER E. | KA01 | |
| STEBBINS, JERRY | Boeing | |
| Logistics Resupply Scenario for the Space Station. For presentation at the Thirty-Seventh IAF Congress, Innsbruck, Austria, October 7, 1986. | | |
| PRAKASH, C. | ED42 | |
| SINGHAL, A. | | |
| SCHAFFER, C. F. | | |
| Thermofluid Analysis of the Space Shuttle Main Engine Fuelside Preburner Using a Multifluid Mixing Model. For presentation at the AIAA/SAE/ASEM 22nd Joint Propulsion Conference, Huntsville, AL, June 16-18, 1985. | | |
| PUSEY, MARCL. | ES73 | |
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| NAUMANN, ROBERT J. | | |
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| PUSEY, MARC L. | ES73 | |
| NAUMANN, ROBERT J. | | |
| QUINN, ALBERTA W. | EL15 | |
| THOMPSON, WILLIAM M. | | |
| Teleoperators for On-Orbit Manipulation and Viewing. For presentation at the Remote Systems and Robotics in Hostile Environment Conference, Pasco, WA, March 29-April 4, 1987. | | |
| QUINN, ALBERTA | EL15 | |
| OLSEN, ROY E. | Grumman | |
| Advanced Orbital Servicing Capabilities Development. For presentation at the 16th Intersociety Conference on Environmental Systems, San Diego, CA, July 14-16, 1986. | | |
| QUINN, ALBERTA W. | EL15 | |
| CLARK, M. | Rockwell | |
| THOMPSON, W. | NSA | |
| SHIELDS, N. | Essex | |
| A Robot Device for Orbital Equipment Transfer. For presentation at the Robots 1986 Society of Manufacturing Engineers, Conrad Hilton, Chicago, IL, April 20-24, 1986. | | |
| RAMSEY, B. | ES65 | |
| WEISSKOPF, M. C. | | |
| The Performance of a Multistep Proportional Counter for Use in X-Ray Astronomy. For publication by IEEE-1986 Nuclear Science Symposium, Washington, D.C., October 29-31, 1986. | | |
| RAMSEY, B. D. | ES65 | |
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| RAMSEY, B. D. | ES65 | |
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| A Fluorescent Gated Proportional Counter for X-Ray Astronomy. For publication in the SPIE Proceedings, Cannes, France. | | |

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| RAMSEY, B.
WEISSKOPF, M. C.
ELSNER, R. F. | ES65 | Electron Gun on the Orbiter. For presentation to the 1986 Fall Meeting American Geophysical Union, San Francisco, CA, December 8-12, 1986. |
| A Multistep Detector for X-Ray Astronomy. For presentation at the American Astronomical Society 167th Meeting and for publication in the Bulletin AAS, Houston, TX, January 5, 1986. | | |
| RAMSEY, B. | ES65 | Ion Cyclotron Resonance with Thermal Helium Near the Plasmopause. For presentation at the AGU Spring Meeting, Baltimore, MD, May 19-23, 1986. |
| Development of a Multistep Detector for X-Ray Astronomy. For publication in the SPIE Proceedings, Cannes, France, December 3, 1985. | | |
| RAO, D. | Rocketdyne | REISS, D. A. ES72 |
| STRUCK, H. G. | ED31 | KROES, R. L. |
| Flow Induced Vibration in the SSME Injector Head. For presentation at the 1986 Conference on Advanced Earth-to-Orbit Technology, Huntsville, AL, May 13-16, 1986. | | ANDERSON, E. E. |
| RAY, JOHNR. | ES65 | Growth Kinetics of the (001) Face of TGS Below the Ferroelectric Transition Temperature. For publication in the Journal of Crystal Growth, Amsterdam. |
| SMALLEY, LARRY L. | | REYNOLDS, NATHANIEL D. ED42 |
| Equation of State Spinning Fluids in the Einstein-Cartan Theory. For publication in The Physical Review, Ridge, NY. | | MILLER, TIMOTHY L. |
| RAY, JOHN R. | ES65 | Almost Symmetric Instability at Unit Prandtl Number. For publication in the Journal of the Atmospheric Sciences, Boston, MA. |
| SMALLEY, LARRY L. | | RHODES, PERCY H. ES73 |
| Consistency Relations for Spinning Matter in Gravitational Theories. For presentation at the Meeting of the American Physical Society, Williamsburg, VA, November 20-22, 1986. | | SNYDER, ROBERT S. |
| RAY, JOHNR. | ES65 | Sample Band Spreading Phenomena in Ground and Space-Based Electrophoretic Separators. For publication in Electrophoresis, Springer-Verlag: West Germany. |
| SMALLEY, LARRY L. | | ROBERTS, W. T. PS02 |
| Consistency Relations for Spinning Matter in Gravitational Theories. For publication in Physical Review D, Ridge, NY. | | DABBS, J. R. |
| RAY, W. L. | EP25 | Implementation Plan for the Advanced Solar Observatory. For publication in Solar Physics. |
| POLICELLI, F. J. | | ROBERTS, WILLIAM T. PS02 |
| ITCHKAWICH, T. J. | | Overview of Space Station Attached Payloads in Areas of Solar Physics, STO, Physics, and Plasma Physics. For presentation at the AIAA, Space Station in the 21st Century Conference, Reno, Nevada, September 3-5, 1986. |
| Improved Large Diameter Pressure Seal Using the Seal Capture Device. For presentation at the AIAA Conference, Huntsville, AL, June 16-18, 1986. | | ROBERTSON, FRANKLIN R. ED43 |
| REASONER, D. L. | ES53 | Use of GOES IR Data in Estimating Synoptic-Scale Rainfall: Algorithm Development and Transferability. For publication in the Journal of Climate and Applied Meteorology. |
| BUSH, R. I. | | |
| Ambient Ion Perturbations/Induced by an | | |

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- RUPP, CHARLES C. PS04
Marshall Amateur Radio Club Experiment Post Flight Data Analysis. For presentation at the 1986 GAS Experimenters Symposium, Goddard Space Flight Center, October 7-8, 1986.
- RUTLEDGE, WILLIAMS. PP03
Methodology for Parametric Government Estimates. For presentation to the 20th Anniversary Conference National Estimating Society, Orange, CA, June 12-13, 1986.
- RYAN, RICHARD M. EP23
GROSS, LOREN A.
Effects of Geometry and Material on LCF Life of Turbine Blades Used on Lox/Hydrogen Rocket Engines. For presentation at the AIAA/SAE/ASME/ASEE 22nd Joint Propulsion Conference, Huntsville, AL, June 16-18, 1985.
- SANDLIN, A. C. ES74
ANDREWS, J. B.
CURRERI, P.
The Influence of Interfacial Energy and Gravitational Effects on the Directionally Solidified Microstructure of Hypermonotectic Alloys. For presentation at the 1987 TMS Annual Meeting, Denver, CO, February 24-27, 1987.
- SASAKI, S. ES53
ROBERTS, W. T.
REASONER, D. L., et al.
Gas Ionization Induced by a High Speed Plasma Injection in Space. For publication in the Geophysical Research Letters, Washington, D.C.
- SCHOCK, RICHARD W. ED24
Solar Array Flight Dynamic Experiment. For presentation at the Rocky Mountain Guidance and Control Conference, Keystone, CO, February 1-5, 1986.
- SCHOCK, RICHARD W. ED24
Solar Array Flight Dynamic Experiment. For presentation at the 1986 ITEA Symposium, Huntsville, AL, September 30-October 2, 1986.
- SCHRAMM, FRED SA55
The Expansion of Automatic Identification Systems in Shuttle Propulsion System Manufacturing. For presentation at the 22nd AIAA/SAE/ASME/ASEE Joint Propulsion Conference, Huntsville, AL, June 16-18, 1986.
- SCHRAMM, HARRY F. SA55
The Evolution of Bar Coding in NASA. For presentation at the SCAN-TECH'85 Meeting, Baltimore, MD, December 2-6, 1985.
- SCHWANIGER, ARTHUR J. ED13
Low G Measurements by NASA. For presentation at the Measurement and Characterization of the Acceleration Environment on the Shuttle and Space Station, Guntersville, AL, August 12, 1986.
- SCHWARTZ, D. A. ES65
McKINNON, J.
MURRAY, S. S.
PRIMINI, F. A.
VAN SPEYBROECK, L. P.
ZOMBECK, M. V.
DAILEY, C. C.
REILY, J. C.
WEISSKOPF, M. C.
X-Ray Testing of the AXAF Technology Mirror Assembly (TMA) Mirror. For publication in the Proceedings of SPIE, Willingham, WA.
- SCHWINGHAMER, R. J. EH01
Variable Polarity Plasma Arc Welding for Space Shuttle. For publication in Aerospace America, New York, NY, October 1986.
- SHEALY, DAVID L. ES52
HOOVER, RICHARD B.
GABARDI, D. R.
Multilayer X-Ray Imaging Systems. For presentation at the Conference on X-Ray Imaging II - SPIE, San Diego, CA, August 21-22, 1986.
- SISSON, JAMES M. FA31
Development Status of First Tethered Satellite System. For publication by AIAA and presentation at the AIAA Conference, Reno, NV, January 5-9, 1986.
- SMALLEY, LARRY L. ES65
Brans-Dicke-Type Models with Nonmetricity. For publication in Physical Review, Ridge, New York.

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| <p>SMALLEY, LARRY L. ES65
Geometrization of Spin. For presentation at the Meeting of the American Physical Society, Williamsburg, VA, November 20-22, 1986.</p> | <p>SNODDY, WILLIAM C. PA01
GALLOWAY, WILLIAM E. PA14
YOUNG, ARCHIE PD32
Using the OMV for the Placement and Retrieval of Spacecraft and Platforms. For presentation at the 1986 American Astronautical Society Guidance and Control Conference, Keystone, CO, February 1-5, 1986.</p> |
| <p>SMALLEY, LARRY L. ES65
Is There A Connection Between Nonmetricity and the Large Numbers Hypothesis? For publication in Essays in Gravity Competition, Gravity Research Foundation, Gloucester, MA.</p> | <p>SNYDER, ROBERT ES73
NAUMANN, ROBERT ES71
HERREN, BLAIR ES73
CARTER, DAN ES73
DELUCAS, LAWRENCE J., et al.
Preliminary Investigations of Protein Crystal Growth Using the Space Shuttle. For publication in the Journal of Crystal Growth, The Netherlands.</p> |
| <p>SMALLEY, LARRY L. ES65
FENNELLY, A. J.
An Interpretation of Orbital Residuals in Earth Satellites as Evidence for Macroscopic Nonmetricity in Gravitation. For publication in Physical Review Letters, Ridge, NY.</p> | <p>SNYDER, ROBERT S. ES73
Microgravity Pharmaceutical Processes. For presentation at the IEEE EASCON '85 Conference, Washington, D.C., October 20-31, 1985.</p> |
| <p>SMALLEY, LARRY L. ES65
Discrete Dirac Equation on a Finite Half-Integer Lattice. For publication in IL Nuovo Cimento, Bologna, Italy.</p> | <p>SRINIVAS, R. TBE
DABBS, J. R. PS02
HOWELL, J. T. PD11
System Concept for the Pinhole/Occluder Facility Payload. For presentation at the 37th International Astronautical Federation Congress, Innsbruck, Austria, October 4-11, 1986.</p> |
| <p>SMALLEY, LARRY L. ES65
On The Extension of Geometric Optics from Riemannian to Riemann-Cartan Spacetime. For publication in Physics Letters, Amsterdam, Holland.</p> | <p>STEFANESCU, D. ES72
CURRERI, P.
FISKE, M.
Microstructural Variations Induced by Gravity Level During Directional Solidification of Near-Eutectic Iron-Carbon Type Alloy. For publication in Metallurgical Transactions, Pittsburgh, PA.</p> |
| <p>SMITH, ROBERTE. ED41
NASA/MSFC Global Reference Atmosphere Model '86. For presentation at the 26th Plenary Meeting of COSPAR, Toulouse, France, June 30-July 12, 1986.</p> | <p>STEFANESCU, D. M. ES74
FISKE, M. R.
CURRERI, P. A.
Behavior of Insoluble Particles During Parabolic Flight Solidification Processing of Fe-C-Si and Fe-C-V Alloys. For presentation at the 18th Technical Conference of the Society for the Advancement of Materials and Process Engineering, Seattle, WA, October 7-9, 1986.</p> |
| <p>SNODDY, WILLIAM C. PA01
Earth to Mars - The First Step. For presentation at the Mars Conference, Washington, D.C., July 21-23, 1986.</p> | |
| <p>SNODDY, WILLIAM C. PA01
Facilitating the Commercial Use of Low Gravity. For presentation at the Space Business '86: The New Research Frontier, New York, NY, November 19-21, 1986.</p> | |
| <p>SNODDY, WILLIAM C. PA01
MORGAN, DR. SAMUEL H., JR.
Advanced Scientific/Industrial Missions as Perceived by NASA/MSFC. For presentation at the AIAA 3rd Space Systems Technology Conference, San Diego, CA, June 9-12, 1986.</p> | |

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| <p>STONE, N. H. ES51
A Scientific Overview of the First TSS Mission. For presentation at the AIAA 24th Aerospace Science Meeting, Reno, NV, January 6-7, 1986.</p> | <p>TAKAHASHI, YOSHIYUKI ES65
MIYAJI, SHIGEKI
PARNELL, THOMAS A.
WEISSKOPF, MARTIN C.
The Enhancement in the High Energy Cosmic-Ray Spectrum and Its Origin in Type-II Supernovae. For publication in Nature, London, England.</p> |
| <p>SU, CHING-HUA ES72
Growth Rate of CdS by Vapor Transport in a Closed Ampoule. For publication in the Journal of Crystal Growth, North-Holland Publishing Co., Amsterdam.</p> | <p>TAKAHASHI, YOSHIYUKI ES63
High and Ultrahigh Energy Nucleus-Nucleus Interactions. For publication in Physics in Collisions 5, Proceedings of International Conference held in France, July 1985.</p> |
| <p>SU, CHING-HUA ES72
Heat Capacity, Enthalpy of Mixing, and Thermal Conductivity of $Hg_{1-x}Cd_xTe$ Pseudobinary Melts. For publication in the Journal of Crystal Growth, Amsterdam.</p> | <p>TAYLOR, KENNETH R. PS05
Opportunities for Commercial Participation in Microgravity Material Processing. For presentation to the Twenty-Third Space Congress, Canaveral Council of Technical Societies, Cocoa Beach, FL, April 22-25, 1986.</p> |
| <p>SU, CHING-HUA ES72
LEHOCZKY, S. L.
SZOFRAN, F. R.
A Method to Eliminate Wetting During the Homogenization of HgCdTe. For publication in the Journal of Applied Physics, New York.</p> | <p>TAYLOR, ROY A. EH15
A Space Debris Simulation Facility for Spacecraft Materials Evaluation. For presentation at the 18th National SAMPE Technical Conference, Seattle, WA, October 7-9, 1986.</p> |
| <p>SUESS, STEVENT. ES52
Magnetic Clouds and the Pinch Effect. For presentation at the American Geophysical Union Fall Annual Meeting, San Francisco, CA, December 8-12, 1986.</p> | <p>TELESCO, C. M. ES63
The Infrared Properties of Interacting Galaxies. For presentation at the 168th American Astronomical Society Meeting, Ames, IA, June 22-26, 1986, and for publication in the Bulletin AAS, Washington, D.C.</p> |
| <p>SUESS, STEVENT., et al. ES52
Topology of the Heliospheric Current Sheet at the Time of the Halley's Comet-Giotto Encounter. For presentation at the 168th Meeting of the American Astronomical Society, Ames, IA, June 22-26, 1986.</p> | <p>TELESCO, C. M., et al. ES63
Thermal-Infrared and Visual Imaging of Comet Giacobini-Zinner. For publication in Astrophysical Journal (Letters), Chicago, IL.</p> |
| <p>SWENSON, G. R. ES63
MENDE, S. B.
CLIFTON, K. S.
STS-9 Shuttle Glow: RAM Angle Effect and Absolute Intensities. For publication in Geophysical Research Letters, Washington, D.C.</p> | <p>TELESCO, C. M. ES63
DECHER, R.
WOLSTENCROFT, R. D.
Mid-Infrared Mapping of NGC 1808: Star Formation in a Hot Spot Galaxy. For presentation at Star Formation in Galaxies, Pasadena, CA, June 16-19, 1986.</p> |
| <p>SZOFRAN, F. R. ES72
LEHOCZKY, S. L.
Bridgman Growth of Mercury Cadmium Telluride Alloys. For presentation at the First International Conference on Processing of Electronic Materials, Santa Barbara, CA, February 23-28, 1986.</p> | |

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- THOM, ROBERT L. EH14
Improvement in Cavitation Erosion Resistance of Stainless Steel AMS 5749 by N⁺ Ion Implantation. For presentation at the AVE International Conference on Metallurgical Coatings, San Diego, CA, April 7-11, 1986.
- THOM, R. L. EH14
DOLAN, F. J.
Rolling Contact Fatigue Life of Zirconium Nitride Ion Plated AMS-5749 Bearing Steel. For presentation and publication at the 1986 Conference on Advanced Earth-to-Orbit Technology, MSFC, AL, May 13-16, 1986.
- THOMAS, LAWRENCE D. EL83
Systems Analysis for Optimum Commonality Determination. For presentation at the AIAA 25th Aerospace Sciences Meeting, Reno, NV, January 12, 1987.
- THOMPSON, R. G. EH42
NUNES, A. C.
CALLAGHAN, M. L.
Microcrack Formation and Fatigue Initiation in the Heat Affected Zone of Nickel Alloy Welds. For presentation at the International Trends in Welding Research Conference, American Society for Metals, Gatlinburg, TN, May 19-22, 1986.
- THOMSON, J. PA01
Liquid Rocket Engines for Second Generation STS Launch Vehicles. For presentation at the Twenty-Third Congress, Kennedy Space Center, FL, April 22-25, 1986.
- THRONSON, H. A., JR. ES63
TELESCO, C. M., et al.
Star Formation in the Magellanic Irregular Galaxy NGC 4449. For publication in the Astrophysical Journal, Chicago, IL.
- THRONSON, HARLEY A., JR. ES63
TELESCO, C. M.
Star Formation in Active Dwarf Galaxies. For publication in Astrophysical Journal, Chicago, IL.
- TORR, MARSHA R. ES55
RANTANEN, R. O.
- TORR, D. G.
A Study of Induced Emissions in the Vicinity of the Space Shuttle. For presentation at the AIAA 25th Aerospace Sciences Meeting, Reno, NV, January 12-15, 1987.
- TORR, MARSHA R. ES55
ERWIN, E.
TORR, D. G.
Mesospheric NO from Spacelab 1. For presentation at the 1986 AGU Spring Meeting, Baltimore, MD, May 19-23, 1986.
- TORR, MARSHA R. ES55
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- TORR, MARSHA R. ES55
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The Optical Environment of the Spacelab 1 Mission. For presentation at the AIAA Meeting on Shuttle Environment and Operations II, Houston, TX, November 13-15, 1985.
- TORR, MARSHA R. ES55
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The Optical Environment of the Spacelab 1 Mission. For publication in the AIAA Journal of Spacecraft and Rockets, New York, NY.
- TORR, MARSHA R. ES55
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Compiled by Joyce E. Turner

The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.



C. D. Bean
Director, Administrative Operations Office