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NASA TM- 86470

FY 1984 SCIENTIFIC AND TECHNICAL REPORTS, ARTICLES, PAPERS, AND PRESENTATIONS

Compiled by Joyce E. Turner
Management Operations Office

November 1984

National Aeronautics and Space Administration
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This document presents formal NASA technical reports, papers published in technical journals, and presentations by MSFC personnel in FY 84. 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.

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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 1984 SCIENTIFIC AND TECHNICAL REPORTS, ARTICLES, PAPERS, AND PRESENTATIONS

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TM-82547 November 1983

FY 1983 Scientific and Technical Reports, Articles, Papers, and Presentations. Compiled by Sarah S. Thacker. Management Operations Office. N84-14974

This document presents formal NASA technical reports, papers published in technical journals, and presentations by MSFC personnel in FY 83. 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-82548 October 1983

Materials Processing in Space Program Tasks–Supplement. Compiled by Elizabeth Pentecost. Space Science Laboratory. N84-12196

This report is a supplement to the 1983 Materials Processing in Space Program Task catalog. The purpose of this document is to provide an overview of the program scope for managers and scientists in industry, university, and government communities. The report is structured to include an introductory description of the program, its history, strategy, and overall goals; identification of the organizational structures and people involved; and a description of each research task, together with a list of recent publications.

The tasks are grouped into six categories: Crystal Growth; Solidification of Metals, Alloys, and Composites; Fluids, Transports, and Chemical Processes; and Ultrahigh Vacuum and Containerless Processing Technologies; Combustion experiments; and Experimental Technology.

TM-82549 October 1983

Space Processing Applications Rocket (SPAR) Project SPAR IX Final Report. Compiled by R. Poorman. Marshall Space Flight Center. N84-17239

The Space Processing Applications Rocket Project (SPAR) IX Final Report contains the compilation of the post-flight reports of each of the Principal Investigators (PIs) of the three 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 is coordinated and managed by MSFC as part of the Materials Processing in Space (MPS) 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 ninth of a series of SPAR flights conducted at the White Sands Missile Range (WSMR) and includes the experiments entitled "Directional Solidification of Magnetic Composites" (Experiment No. 76-22/2, "Directional Solidification of Immiscible Aluminum-Indium Alloys" (Experiment Nos. 76-51/1 and 76-51/2), and "Comparative Alloy Solidification" (Experiment No. 76-36/1).

TM-82550 October 1983

Some Properties of a Five-Parameter Bivariate Probability Distribution. J. D. Tubbs, D. W. Brewer, and Orvel E. Smith. Marshall Space Flight Center. N84-15866

The development of a bivariate gamma probability distribution and the development of a new discrete wind gust model are both considered original and significant research accomplishments. In 1981, Smith and Adelfang published in the Journal of Spacecraft a new wind gust model based on a four-parameter bivariate gamma distribution. This gust model related gust magnitude and gust length under the assumption of equal shape parameters of the four-parameter bivariate gamma distribution. This assumption

proved to be inadequate to properly describe the wind gust data sample. Since then a five-parameter bivariate gamma distribution having two shape parameters, two location parameters and a correlation parameter has been developed. This more general bivariate gamma distribution reduces to the known four-parameter distribution. The five-parameter distribution gives a better fit to the gust data. The statistical properties of this general bivariate gamma distribution and a hypothesis test have been investigated. Although these developments have come too late in the Shuttle program to be used directly as design criteria for ascent wind gust loads, the new wind gust model has helped to explain the wind profile conditions which cause large dynamic loads. Other potential applications of the newly developed five-parameter bivariate gamma distribution are in the areas of reliability theory, signal noise, and vibration mechanics.

TM-82551 September 1983

MSFC Exhaust Effluent Diffusion Predictions and Measurements for STS-1, STS-2, STS-3, and STS-4. Compiled by Robert E. Turner. Systems Dynamics Laboratory.

N84-11593

This report presents the results of the Marshall Space Flight Center (MSFC) air quality predictions and measurements made during the launches of the Space Shuttle on April 12, 1981 (STS-1), November 12, 1981 (STS-2), March 22, 1982 (STS-3), and June 27, 1982 (STS-4), from Kennedy Space Center (KSC), Florida. The report discusses the atmospheric conditions, the use of the NASA/MSFC REED code, and the resulting predictions and measurements.

TM-82552 June 1983

In-House Welding Studies Supporting the Prelaunch Assessment of the STS-6 Main Engines. Lisa L. Hawkins. Process Engineering Division, Metals Processes Branch.

N84-11499

This memorandum describes two in-house welding studies undertaken by the Materials and Processes Laboratory as a result of problems with the Challenger engines.

(1) Heat Exchanger Coils: Description of process used to perform these welds, sample test data, recommendations for process improvement.

(2) Weld 56; High-Pressure Fuel Turbo Pump: Description of effort to simulate problem welds, as well as good welds, test data, and conclusions.

TM-82553 September 1983

Containerless Electromagnetic Levitation Melting of Cu-Fe and Ag-Ni Alloys. G. J. Abbaschian and E. C. Ethridge. Space Science Laboratory. N84-12288

This report summarizes one aspect of the work carried out in the Space Science Laboratory of Marshall Space Flight Center under a Technical Exchange Agreement with Eaton Corp. The general aim of this aspect of the program was to investigate the feasibility of producing silver or copper alloys containing finely dispersed nickel or iron particles, respectively, by utilizing containerless electromagnetic levitation casting techniques. A levitation coil was designed to successfully levitate and melt a variety of alloys including Nb-Ge, Cu-Fe, Fe-C, and Ag-Ni. The highest melt temperature achieved by the coil was about 2400°C during melting of Nb-Ge alloys. Samples of 70 Cu-30 Fe and 80 Ag-20 Ni (atomic %), prepared by mechanical pressing of the constituent powders, were levitated and heated either to the solid plus liquid range of the alloys or to the fully liquid region. The samples were then solidified by passing helium gas into the bell jar or they were dropped into a quenching oil. The structure of the samples which were heated to the solid plus liquid range consists of uniform distribution of Fe or Ni particles in their respective matrices. They also contained a considerable amount of entrapped gas bubbles. Upon heating for longer periods or to higher temperatures, the bubbles coalesced and burst, causing the samples to become fragmented and usually fall out of the coil. The structure of the Cu-Fe samples that were fully liquid and solidified while levitated consisted of the fine iron dendrites distributed uniformly in the copper matrix. For Ag-Ni samples, due to the existence of immiscibility gap

in the fully liquid state, the nickel phase had separated into large islands within the silver matrix.

TM-82554 November 1983
Potential Means of Support for Materials Processing in Space—A History of Government Support for New Technology. Eugene C. McKannan. Materials and Processes Laboratory. N84-13205

A debate has been going on in government on the subject of "Should government funds be spent on early research and high-risk development of new technology?" Opponents claim that if a product is worth the effort, then private enterprise will invest in it. Proponents claim that we are all beneficiaries of new technology. Today, the answer impinges on doing materials processing and other commercial endeavors in space. Here, we discuss past experience in nurturing new ideas, and find two themes. In the first, the military initiates development of a given technology for national defense, and the marketplace makes use of the technology. In the second, the government supports large systems developments when the task is too large or risky for entrepreneurs, yet is clearly in the best interest of the nation. NASA has completed advanced research to identify areas of interest. Examples of commercial opportunities are the McDonnell-Douglas Corporation purification process for pharmaceutical products and the Microgravity Research Associates process for growing gallium arsenide crystals in space. Additional technology developments are in the pipeline.

TM-82556 October 1983
Bellows Flow-Induced Vibrations. Dr. C. R. Gerlach, P. J. Tygielsky, and H. M. Smyly. Structures and Propulsion Laboratory. N84-22912

This report summarizes the present understanding of the bellows flow excitation mechanism and of results of a comprehensive test program conducted at MSFC. This, along with other existing test data, is used to refine the analytical model for predicting bellows flow-induced stress. This model includes the effects of an upstream elbow, arbitrary geometry, and multiple plies. A refined computer code for predicting flow-induced stress is described which allows life prediction if a material S-N diagram is available.

TM-82557 November 1983
High Speed Machining of Space Shuttle External Tank Liquid Hydrogen Barrel Panel. James D. Hankins. Materials and Processes Laboratory. N84-14352

This report includes actual and projected optimum High Speed Machining (HSM) data for producing Shuttle External Tank (ET) Liquid Hydrogen Barrel Panels which are aluminum alloy 2219-T87. The data includes various machining parameters; e.g., spindle speeds, cutting speed, table feed, chip load, metal removal rate, horsepower, cutting efficiency, cutter wear (lack of) and chip removal methods. The results of a study by the Lockheed Missiles and Space Company for the George C. Marshall Space Flight Center under Contract NAS8-34508 are included.

TM-82558 November 1983
Solidification Rate Influence on Orientation and Mechanical Properties of MAR-M-246+Hf. David Hamilton. Materials and Processes Laboratory. N84-14290

The influence of solidification rates on the orientation and mechanical properties of MAR-M-246+Hf was studied. The preferred orientation was found to be (001) for single crystals, with all samples with 45° of (001).

Tensile tests were performed at room temperature. The anisotropy of directionally solidified MAR-M-246+Hf was demonstrated by gage section deformation.

Dendrite arm spacing and crystal growth were found to depend on solidification rates and source material conditions. The greatest strength occurred at lower solidification rates. Some single crystals were grown by control of growth rates without seeding.

TM-82559 October 1983

The Marshall Space Flight Center Low-Energy Ion Facility – A Preliminary Report. A. P. Biddle, J. M. Reynolds, W. L. Chisholm, Jr., and R. D. Hunt. Space Science Laboratory. N84-13933

The Low-Energy Ion Facility (LEIF) is designed for laboratory research of low-energy ion beams similar to those present in the magnetosphere. In addition, it provides the ability to develop and calibrate low-energy, less than 50 eV, plasma instrumentation over its full range of energy, mass, flux, and arrival angle. This report describes the current status of this evolving resource. It also provides necessary information to allow users to utilize it most efficiently.

TM-82560 October 1983

Atmospheric Environment for Space Shuttle (STS-8) Launch. D. L. Johnson, C. K. Hill, R. E. Turner, and G. W. Batts. Systems Dynamics Laboratory. N84-14636

This report presents a summary of selected atmospheric conditions observed near Space Shuttle STS-8 launch time on August 30, 1983, at Kennedy Space Center, Florida. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of prelaunch Jimsphere measured vertical wind profiles is given in this report. Also presented are wind and thermodynamic parameters representative of surface and aloft conditions in the SRB descent/impact ocean area. Final meteorological tapes, which consist of wind and thermodynamic parameters versus altitude, for STS-8 vehicle ascent and SRB descent/impact have been constructed. The STS-8 ascent meteorological data tape has been constructed by Marshall Space Flight Center in response to Shuttle task agreement No. 936-53-22-368 with Johnson Space Center.

TM-82561 November 1983

Coil Planet Centrifugation as a Means for Small Particle Separation. Frederick T. Herrmann. Space Science Laboratory. N84-13756

The coil planet centrifuge uses a centrifugal force field to provide separation of particles based on differences in sedimentation rates by flow through a rotating coiled tube. Three main separations are considered: (1) Single phase fresh sheep and human erythrocytes. (2) Single phase fixed sheep and human erythrocytes. (3) Electrophoretically enhanced single phase fresh sheep and human erythrocytes.

TM-82562 November 1983

Research and Technology 1983 Annual Report of the Marshall Space Flight Center. Compiled by Research and Technology Office. N84-16075

The Marshall Space Flight Center conducts research programs in atmospheric science, materials processing in space, and space sciences as well as technology programs in space power, materials processes, and space structures. This Marshall Space Flight Center 1983 Annual Report on Research and Technology contains precises of the more significant scientific and technical results obtained during FY 1983.

TM-82563 October 1983

Development of an Improved Protective Cover/Light Block for Multilayer Insulation. L. M. Thompson, Dr. J. M. Stuckey, Don Wilkes and Dr. Randy Humphries. Materials and Processes Laboratory. N84-15269

This task was directed toward demonstrating the feasibility of using a scrim-reinforced, single metallized, 4-mil Tedlar film as a replacement for the Teflon coated Beta-cloth/single metallized 3-mil Kapton film presently used as the protective cover/light block for multilayer insulation (MLI) on the Orbiter, Spacelab, and other space applications. The proposed Tedlar concept will be lighter and potentially lower in cost. Thermal analysis with the proposed concept was much simpler than with the present system. Tests have already demonstrated that white Tedlar has low alpha (adsorption) degradation in space from U.V. This study indicated that proposed concept was 4400 percent cheaper with nominal weight savings of 50 percent.

TM-82564 December 1983

Evidence Linking Coronal Mass Ejections with Interplanetary "Magnetic Clouds." Robert M. Wilson and Ernest Hildner. Space Science Laboratory. N84-18141

Using proxy data for the occurrence of those mass ejections from the solar corona which are directed earthward, we investigate the association between the post-1970 interplanetary magnetic clouds of Klein and Burlaga and coronal mass ejections. The evidence linking magnetic clouds following shocks with coronal mass ejections is striking; six of nine clouds observed at Earth were preceded an appropriate time earlier by meter-wave type II radio bursts indicative of coronal shock waves and coronal mass ejections occurring near central meridian. During the selected periods when no clouds were detected near Earth, the only type II bursts reported were associated with solar activity near the limbs. Where the proxy solar data to be sought are not so clearly suggested, that is, for clouds preceding interaction regions and clouds within cold magnetic enhancements, the evidence linking the clouds and coronal mass ejections is not as clear; proxy data usually suggest many candidate mass-ejection events for each cloud. Overall, the data are consistent with and support the hypothesis suggested by Klein and Burlaga that magnetic clouds observed with spacecraft at 1 AU are manifestations of solar coronal mass ejection transients. A condensed version of this study is to be published in Solar Physics.

TM-82565 November 1983

Electromagnetic Levitation Coil Fabrication Technique for MSFC Containerless Processing Facilities. E. C. Ethridge, J. Theiss, P. A. Curreri, and G. J. Abbaschian. Space Science Laboratory. N84-18535

The technique described in this report has facilitated the more reproducible fabrication of electromagnetic levitation coils. A split mandrel has been developed upon which the coil is wound. After fabrication the mandrel can be disassembled to remove it from the coil. Previously, it required a full day to fabricate a levitation coil. The success rate for a functional coil was still only 50 percent. With the new technique described in this note about eight coils may be completed in one day and 95 percent of them are good levitation coils.

TM-82566 January 1984

Wind Speed and Direction Shears with Associated Vertical Motion During Strong Surface Winds. Margaret B. Alexander and Dennis W. Camp. Systems Dynamics Laboratory. N84-17756

Strong surface winds recorded at the NASA 150-Meter Ground Winds Tower Facility at Kennedy Space Center, Florida are analyzed to present occurrences representative of wind shear and vertical motion known to be hazardous to the ascent and descent of conventional aircraft and the Space Shuttle. Graphical (percentage frequency distributions) and mathematical (maximum, mean, standard deviation) descriptions of wind speed and direction shears and associated updrafts and downdrafts are included as functions of six vertical layers and one horizontal distance for twenty 5-second intervals of parameters sampled simultaneously at the rate of ten per second during a period of high ($\geq$ 20 kts 10 m s^{-1}) surface winds.

TM-82567 February 1984

Low Loss Injector for Space Shuttle Main Engine, Center Director's Discretionary Fund, Final Report. George L. von Pragenau. Systems Dynamics Laboratory. N84-19469

An efficient propellant injection method is discussed to raise the Space Shuttle Main Engine (SSME) thrust and payload. Relatively large diameter injector elements with low pressure loss are recommended for the main combustion chamber and the pre-burners. Smaller losses admit more propellant flow which then raises thrust. Payload is not only gained by specific impulse but also by thrust. The chamber pressure is stabilized by selecting the proper cavity size for the injector elements while reducing the injection pressure loss which normally is kept high for stability. The rather large injector element recesses provide acoustic damping which makes baffles and

acoustic absorbers unnecessary. The study shows a tenfold reduction of flow induced stresses which are rather high in the present design. Relaxed tolerances, fewer elements, and better maintenance are offered. The study was conducted under a center director discretionary fund assignment.

TM-82568 February 1984

The New MSFC Solar Vector Magnetograph Center Director's Discretionary Fund, Final Report. M. J. Hagyard, E. A. West, and N. P. Cumings. Space Science Laboratory.

N84-19786

The unique MSFC solar vector magnetograph allows measurements of all three components of the Sun's photospheric magnetic field over a wide field-of-view (≈ 6x6 arc min) with spatial resolution determined by a 2.7x2.7 arc second pixel size. Supported by two Center Director's Discretionary Fund Projects, this system has recently undergone extensive modifications to improve its sensitivity and temporal response. The modifications included: replacing an SEC vidicon detector with a solid-state CCD camera; replacing the original digital logic circuitry with an electronic controller and a computer to provide complete, programmable control over the entire operation of the magnetograph; and installing a new polarimeter which consists of a single electro-optical modulator coupled with interchangeable waveplates mounted on a rotating assembly. In this report, we describe the new system, and present results of calibrations and tests that have been performed. Initial observations of solar magnetic fields with the new magnetograph are presented; they indicate that the system is an order of magnitude more sensitive than the original one and has a much higher temporal response (by a factor of ≈30). These new capabilities enhance our continued research in solar vector magnetic fields and our support of NASA's solar missions.

TM-82569 January 1984

A Study of the Solidification Parameters Influencing Structures and Properties in MAR-M246 (Hf). M. H. Johnston and R. A. Parr. Materials and Processes Laboratory.

N84-20675

The nickel-base superalloy MAR-M246(Hf) was studied to determine the factors affecting basic morphology and fatigue properties. Of particular interest was the degradation of fatigue properties with deviation from the [001] growth orientation. Examination of directionally solidified samples showed a dependence of carbide shape and interdendritic segregation on growth rate. Heat treatment studies focused on the gamma prime structure, determining that it reaches maximum growth after twenty-four hours but its size and stability depends on the temperature of the treatment. Fatigue test specimens were oriented crystallographically in the failed and unfailed regions and found to have rotated their orientation during the testing if they were located a significant distance from [001]. This would place increased strain on the crystal and precipitate early failure.

TM-82570 January 1984

The AXAF Technology Program: The Optical Flats Tests. A. C. Williams, J. D. Harper, J. C. Reily, M. C. Weisskopf, C. L. Wyman, and M. Zombeck. Space Science Laboratory. N84-20341

The results of a technology program aimed at determining the limits of surface polishing for reflecting X-ray telescopes is presented in this work. This program is part of the major task of developing the Advanced X-Ray Astrophysical Facility (AXAF). By studying the optical properties of state-of-the-art polished flat surfaces, conclusions have been drawn as to the potential capability of AXAF. Surface microtopography of the flats as well as their figure is studied by X-ray, visual, and mechanical techniques. These techniques and their results are described in this volume.

TM-82571 February 1984

Tethers in Space – Birth and Growth of a New Avenue to Space Utilization. Georg von Tiesenhausen. Program Development.

N84-21607

This report traces the evolution of the ideas of tether applications in space from its origin in the last century past a dormant period of sixty-five years to the mid-seventies. At that time as a

consequence of major revival efforts, NASA entered into serious investigations of the theoretical and practical feasibility of a large number of tethered concepts in space. These efforts culminated in the establishment of the Tethered Satellite System Project now at NASA in the advanced development phase.

The report describes NASA's 1983 extensive planning efforts, first, through a Tether Applications in Space Workshop which generated additional concepts and provided overall assessments and recommendations to NASA, and then through a NASA inter-center Tether Applications in Space Task Group which generated a four-year program plan in the areas of further studies, technology, work and science and applications of tethers in space.

Finally, the report offers an outlook into the future of tether applications that may approach some of the goals of the early visionaries.

TM-82572 January 1984

Atmospheric Environment for Space Shuttle (STS-9) Launch. D. L. Johnson, C. K. Hill, and G. W. Batts, Systems Dynamics Laboratory. N84-24047

This report presents a summary of selected atmospheric conditions observed near Space Shuttle STS-9 launch time on November 28, 1983, at Kennedy Space Center, Florida. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of prelaunch Jimsphere measured vertical wind profiles is given in this report. The final meteorological tape, which consists of wind and thermodynamic parameters versus altitude, for STS-9 vehicle ascent has been constructed. The STS-9 ascent meteorological data tape has been constructed by Marshall Space Flight Center in response to Shuttle task agreement No. 561-81-22-368 with Johnson Space Center.

TM-82573 March 1984

Charge Injection Device Usage in Stellar Tracking Technology. J. W. Gober, D. E. Howard, and J. W. Randolph, Jr. Information and Electronic Systems Laboratory. X84-74832*

This report presents the scientific information produced under the Center Director's Discretionary Fund Task 82-1, "Charge Injection Device Usage in Stellar Tracking Technology." The development of an improved 256 x 256 array Charge Injection Device (CID) and the configuration of a MSFC laboratory to evaluate the improved CID and other solid state stellar sensors are detailed. Detailed descriptions of new interpolation algorithms to determine stellar position and experimental testing of these algorithms with simulated and actual stellar data are provided. Data analysis of contractor-supplied stellar data was performed at MSFC and the accuracy capabilities of the various algorithms were determined and described.

The report shows the improved CID, coupled with the new interpolation algorithms, to be a sensor that is more reliable, more accurate, and capable of satisfying stellar sensor needs for the next two decades.

TM-82574 February 1984

Application of VISSR Atmospheric Sounder (VAS) Data. Gary J. Jedlovec, Systems Dynamics Laboratory. N84-23073

Recent studies using sounding data derived from VAS radiance measurements have projected a hope for increased time and space resolution of the mesoscale environment. Working with this new data, however, presents some problems normally not encountered when using conventional measurements because of the irregular spacing of the data, biases in the data, as well as errors due to cloud contaminated measurements. This report addresses these problems and presents an objective analysis technique which utilizes LFM guess fields to produce a consistent four-dimensional data set which adequately describes the mesoscale environment over a large area. Parameters derived from this data set can be useful in a diagnostic mode by both the operational and research communities.

TM-82575 March 1984

A Statistical Evaluation and Comparison of VISSR Atmospheric Sounder (VAS) Data and Corresponding Rawinsonde Measurements. Gary J. Jedlovec, Systems Dynamics Laboratory. N84-23071

Three mesoscale sounding data sets from the VISSR Atmospheric Sounder (VAS) produced using different retrieval techniques have been evaluated using corresponding ground truth rawinsonde data for 6-7 March 1982. Mean, standard deviations, and RMS differences between the satellite and rawinsonde parameters were calculated over gridded fields in central Texas and Oklahoma. Despite procedures to reduce known time and space discrepancies, large differences exist between each satellite data set and the ground truth data. Biases in the satellite temperature and moisture profiles seem extremely dependent upon the 3-dimensional structure of the atmosphere and range from 1° to 3°C for temperature and 3° to 6°C for dew-point temperature. Atmospheric gradients of basic and derived parameters determined from the VAS data sets produced an adequate representation of the mesoscale environment but their magnitudes were often reduced by 30 to 50 percent.

TM-82577 March 1984

Investigation of Thermospheric Winds Relative to Space Station Orbital Altitudes. Michael Susko. Systems Dynamics Laboratory. N84-25220

An investigation of thermospheric winds, relative to the space station orbital altitudes, has been made in order to provide information that may be useful in an environmental disturbance assessment. Current plans are for this low Earth orbiting facility to orbit at an inclination of 28.5 deg. The orbital altitudes have not yet been defined due to the evolutionary configuration of the Space Station. The upper and lower bounds of the orbital altitudes will be based on constraints set by the drag and expected orbital decay and delivery altitude capability of the Shuttle. It is estimated that the orbital altitude will be on the order of 500 km. This report deals with neutral winds in the region from about 80 to 600 km which have been derived from satellite drag data, Fabry-Perot interferometers, sounding rockets, ground-based optical Doppler techniques, incoherent scatter radar measurements from Millstone Hill combined with the mass spectrometer and lithium trail neutral wind measurements. The equations of motion of the low Earth orbiting facility are also discussed in this report.

TM-82578 April 1984

Space Processing Applications Rocket Project SPAR VIII Final Report. Edited by Roger P. Chassay. Marshall Space Flight Center. N84-25745

The Space Processing Applications Rocket Project (SPAR) VIII Final Report contains the engineering report prepared at the Marshall Space Flight Center (MSFC) as well as the three reports from the principal investigators. These reports also describe 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 immeasurably to an improved comprehension of materials processing in space.

The SPAR project is coordinated and managed by MSFC as part of the Materials Processing in Space (MPS) program of the Office of Space and Terrestrial Applications (OSTA) of NASA Headquarters.

This technical memorandum is directed entirely to the payload manifest flown in the eighth of a series of SPAR flights conducted at the White Sands Missile Range (WSMR) and includes the experiments entitled "Glass Formation Experiment" SPAR 74-42/1R, "Glass Fining Experiment in Low-Gravity" SPAR 77-13/1, and "Dynamics of Liquid Bubbles" SPAR Experiment 77-18/2.

TM-82579 April 1984

Separation Processes During Binary Monotectic Alloy Production. Donald O. Frazier, Barbara R. Facemire, William F. Kaukler, William K. Witherow, and Ursula Fanning. Space Science Laboratory. N84-24773

Generally, attempts to solidify immiscible mixtures to make binary alloys, in-situ, yield poorly dispersed composites. By and large, the situation is more pronounced for hypermonotectic compositions than for either monotectic or hypomonotectic solutions. There is considerable interest among metallurgists to understand processes causing liquid-liquid and solid-liquid phase separations during monotectic alloy solidification. Knowledge of such dynamics must precede accurate predictability of the behaviors of solidifying

metallic systems and control of their microstructure.

If a homogeneous melt is cooled into an immiscible region, the newly formed second phase will generally have a density different from the parent phase, and will separate readily by sedimentation. Observation of microgravity solidification processes indicates that outside of sedimentation, at least two other important effects can separate the phases: (1) critical-point wetting and spreading, and (2) thermal migration of second-phase droplets due to interfacial tension gradients. It is difficult to study these surface tension effects while in a unit gravity field. Considerable work has been done using neutrally buoyant systems, but such systems are generally neutrally buoyant at only one temperature. Therefore, in order to investigate the processes occurring over a temperature range, i.e., between a consolute point and the monotectic temperature, it is necessary to use a low-gravity environment. The MSFC drop tube (and tower), the ballistic trajectory KC-135 airplane, and the Space Shuttle are ideal facilities to aid formation and testing of hypotheses.

Much of the early work in this area focuses on transparent materials so that process dynamics may be studied by optical techniques such as photography for viewing macro-processes; holography for studying diffusional growth, spinodal decomposition and coalescence; ellipsometry for surface wetting and spreading effects; and interferometry and spectroscopy for small-scale spatial resolution of concentration profiles.

Finally, computer models developed from the transparent model studies will be quite helpful when applied to existing metallic specimens already prepared in low gravity. Additional metallic samples solidified in the MSFC drop tower will test the accuracy of predictions based on such studies.

TM-82580 May 1984

Atmospheric Environment for Space Shuttle (STS-11) Launch. D. L. Johnson, C. K. Hill, and G. W. Batts. Systems Dynamics Laboratory. N84-25194

This report presents a summary of selected atmospheric conditions observed near Space Shuttle STS-11 launch time on February 3, 1984, at Kennedy Space Center, Florida. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of prelaunch Jimsphere measured vertical wind profiles is given in this report. Also presented are wind and thermodynamic parameters representative of surface and aloft conditions in the SRB descent/impact ocean area. Final meteorological tapes, which consist of wind and thermodynamic parameters versus altitude, for STS-11 vehicle ascent and SRB descent/impact have been constructed. The STS-11 ascent meteorological data tape has been constructed by Marshall Space Flight Center in response to Shuttle task agreement No. 561-81-22-368 with Johnson Space Center.

TM-82581 April 1984

Determination of the Succinonitrile-Benzene and Succinonitrile-Cyclohexanol Phase Diagrams by Thermal and UV Spectroscopic Analysis. W. Kaukler, D. O. Frazier, and B. Facemire. Space Science Laboratory. N84-25778

Equilibrium temperature-composition diagrams were determined for the two organic systems, succinonitrile-benzene and succinonitrile-cyclohexanol. Measurements were made using the common thermal analysis methods and UV spectrophotometry. Succinonitrile-benzene monotectic was chosen for its low affinity for water and because UV analysis would be simplified. Succinonitrile-cyclohexanol was chosen because both components are transparent models for metallic solidification, as opposed to the other known succinonitrile-based monotectics.

TM-82583 May 1984

Pyrotechnic Shock: A Literature Survey of the Linear Shaped Charge (LSC). James Lee Smith. Systems Dynamics Laboratory. N84-28109

The purpose of this report is to review linear shaped charge (LSC) literature for the past 20

years. The following topics are discussed: (1) LSC Configuration, (2) LSC Usage, (3) LSC Induced Pyroshock, (4) Simulated Pyrotechnic Testing, (5) Actual Pyrotechnic Testing, (6) Data Collection Methods, (7) Data Analysis Techniques, (8) Shock Reduction Methods, and (9) Design Criteria. Although no new discoveries have been made in LSC research, charge shapes have been improved to allow better cutting performance, testing instrumentation has been refined, and some new explosives, for use in LSC, have been formulated. However, little progress has been made in LSC induced pyroshock.

TM-82584 May 1984

An Investigation Into the Probabilistic Combination of Quasi-Static and Random Accelerations. Richard W. Shock and Lenox P. Tuell. Systems Dynamics Laboratory. N84-28111

The development of design load factors for aerospace and aircraft components and experiment support structures, which are subject to a simultaneous vehicle dynamic vibration (quasi-static) and acoustically generated random vibration, require the selection of a combination methodology. Typically, the procedure is to define the quasi-static and the random generated response separately, and arithmetically add or root sum square to get combined accelerations. Since the combination of a probabilistic and a deterministic function yield a probabilistic function, a viable alternate approach would be to determine the characteristics of the combined acceleration probability density function and select an appropriate percentile level for the combined acceleration. The following paper develops this mechanism and provides graphical data to select combined accelerations for most popular percentile levels.

TM-82586 May 1984

Pattern Recognition for Space Applications, Center Director's Discretionary Fund Final Report. Maurice E. Singley. Systems Analysis and Integration Laboratory.

Results and conclusions are presented on the application of recent developments in pattern recognition to spacecraft star mapping systems. Sensor data for two representative starfields were processed by an adaptive shape-seeking version of the Fc-V algorithm with good results. Also, some newly proposed cluster validity measures were evaluated, but not found especially useful to this application. Recommendations are given for two system configurations worthy of additional study.

TM-82587 June 1984

The ASTRO-1 Preliminary Design Review Coupled Loads Analysis. David S. McGhee Systems Dynamics Laboratory. N84-29246

Results of the ASTRO-1 Preliminary Design Review coupled loads analysis are presented M6.0Y Generic Shuttle mathematical models were used. Internal accelerations, interface forces, relative displacements, and net c.g. accelerations were recovered for two ASTRO-1 payloads in tandem configuration. Twenty-seven load cases were computed and summarized. Load exceedences were found and recommendations made.

TM-86451 June 1984

Mesoscale Observations of Lightning from Space Shuttle. B. Vonnegut, O. H. Vaughan, Jr., M. Brook, and P. Krehbiel. Marshall Space Flight Center.

Motion pictures have been taken at night by astronauts on the space shuttle showing lightning discharges that spread horizontally at speeds of 10^5 msec^{-1} for distances over 60 km. Tape recordings have been made of the accompanying optical pulses detected with a photocell optical system. The observations show that lightning is often a mesoscale phenomena that can convey large amounts of electric charge to earth from an extensive cloud system via a cloud-to-ground discharge.

TM-86452 May 1984

Dielectric Cure Monitoring: Preliminary Studies. Benjamin E. Goldberg and Marie Louise Semmel. Materials and Processes Laboratory.

Preliminary studies have been conducted on two types of dielectric cure monitoring systems employing both epoxy resins and phenolic composites. An Audrey System was used for 23 cure

monitoring runs with very limited success. Nine complete cure monitoring runs have been investigated using a Micromet System. Two additional measurements were performed to investigate the Micromet's sensitivity to water adsorption in a post-cure carbon-phenolic material. While further work is needed to determine data significance, the Micromet system appears to show promise as a feedback control device during processing.

An additional conductivity related term has been indicated for the dielectric permittivity, ϵ'. This term, heretofore unreported, appears to have significance for high conductivity epoxy and phenolic composites. Previous work on dielectric cure monitoring has always been performed on a parallel plate electrode system; this type of system appears only marginally compatible with epoxy and phenolic composites.

TM-86453 June 1984

A High Voltage Electrical Power System for Low Earth Orbit Applications. John R. Lanier, Jr. and John R. Bush, Jr. Information and Electronic Systems Laboratory.

This report discusses the results of testing a high voltage electrical power system (EPS) breadboard using high voltage power processing equipment developed at Marshall Space Flight Center and Ni-Cd batteries. These test results are used to extrapolate to an efficient, reliable, high capacity EPS for near term low Earth orbit, high power applications. EPS efficiencies, figures of merit, and battery reliability with a battery protection and reconditioning circuit are presented.

TM-86454 July 1984

Radial SI Latches Vibration Test Data Review. Phillip M. Harrison and James Lee Smith. Systems Dynamics Laboratory.

Dynamic testing of the Space Telescope Scientific Instrument Radial Latches was performed as specified by the designated test criteria. No structural failures were observed during the test. The alignment stability of the instrument simulator was within required tolerances after testing. Particulates were discovered around the latch bases, after testing, due to wearing at the "B" and "C" latch interface surfaces. This report covers criteria derivation, testing, and test results.

TM-86455 July 1984

Nighttime Observations of Thunderstorm Electrical Activity from a High Altitude Airplane. M. Brook, C. Rhodes, O. H. Vaughan, Jr., R. E. Orville, and B. Vonnegut. Marshall Space Flight Center.

Two sets of observations from a NASA U-2 airplane flying at approximately 20 km altitude over nocturnal thunderstorms are reported. Photographs show frequent lightning activity in the upper part of the cloud. In some cases, only the diffuse illumination produced by the lightning can be seen. In other cases unobscured segments of lightning channels 1 km or longer are visible in clear air around and above the cloud. Multiple images of lightning channels, accidentally displaced on the film during transport of the film in the camera, indicate multiple discharges in the same channel. Photographs taken through a diffraction grating show that the lightning has a spectrum similar to that which has been observed in the lower troposphere. Lightning spectra obtained with a slitless line-scan spectrometer show strong singly ionized nitrogen emissions at 463.0 and 500.5 nm. Field changes measured with an electric field-change meter correlate with pulses measured with a photocell optical system.

Optical signals corresponding to dart leader, return stroke, and continuing current events are readily distinguished in the scattered light emerging from the cloud surface. The variation of light intensity with time in lightning events, such as dart leaders, which radiate light first from a location within the cloud and later from outside (beneath) the cloud are consistent with the predicted modification of optical lightning signals by clouds as given by Thomason and Krider [1]. As a result, it appears that satellite based optical sensor measurements cannot provide reliable information on current rise times in return strokes. On the other hand, discrimination between cloud-to-ground and intracloud flashes and the counting of ground strokes is possible using the optical pulse pairs which have been identified with leader, return-stroke events in the

cloud-to-ground flashes studied. If confirmed by further studies as a regularly identifiable occurrence, the pulse pairs together with other criteria, could form the basis for the reliable identification of ground strokes from a satellite by the use of an optical detector alone.

It has been found unexpectedly that a multitude of weak lightning channels commonly exists in the clear air above or around cloud tops. This indicates that lightning is capable of introducing chemical species, ions, and space charge directly into the upper troposphere and lower stratosphere.

TM-86456 August 1984

Testing and Evaluation of Vespel up to 450°F When Used in Nuts and Bolts as a Self-Locking Element. Carl M. Wood. Marshall Space Flight Center.

The object of this investigation was to evaluate Vespel for potential application on the Solid Rocket Booster to replace all-metal deformed self-locking nuts and anchor nuts and be used as self-locking elements for bolts and screws. The Vespel self-locking elements were tested for prevailing torque retention at room temperature, after heating to 450°F and exposure for 3 hr, breakaway torque at 450°F and for vibration at a level consistent with the maximum expected on the SRB at lift-off and reentry.

The investigation revealed Vespel has properties that can provide a self-locking capability for threaded fasteners up to 450°F and it can be used in nuts and anchor nuts for installation on the SRB. Vespel elements in bolts did not meet all our SRB requirements for reuse, however, we have defined a design for Vespel elements in nuts/anchor nuts that fully meets all requirements.

It is recommended that No. 10, 1/4 in. and 5/16 in. nuts/anchor nuts be procured for use on the SRB. This system will eliminate the galling problems now encountered and achieve a much higher reuse life than the present deformed nut design.

TM-86457 August 1984

Computer Vision for Real-Time Orbital Operations – Center Director's Discretionary Fund Final Report (Project No. 82-27). F. L. Vinz, L. L. Brewster, and L. D. Thomas. Information and Electronic Systems Laboratory.

This report describes machine vision research at Marshall Space Flight Center which has potential benefit for the NASA Space Station program and its associated Orbital Maneuvering Vehicle (OMV). Initial operation of OMV for orbital assembly, docking, and servicing will be manually controlled from the ground by means of an on-board TV camera. These orbital operations may later be accomplished autonomously by machine vision techniques which use the TV camera as a sensing device. Classical machine vision techniques are described in this report. An alternate method was developed and is described which employs a syntactic pattern recognition scheme. It has the potential for substantial reduction of computing and data storage requirements in comparison to the Two-Dimensional Fast Fourier Transform (2D FFT) image analysis. The method embodies powerful heuristic pattern recognition capability by identifying image shapes such as elongation, symmetry, number of appendages, and the relative length of appendages.

TM-86458 July 1984

On Long-Term Periodicities in the Sunspot Record. Robert M. Wilson. Space Science Laboratory.

Sunspot records have been systematically maintained, with the knowledge that an 11-year average period exists, since about 1850. Thus, the sunspot record of highest quality and considered to be the most reliable is that of cycle 8 through the present. On the basis of cycles 8 through 20, we have used various combinations of sine curves to approximate the observed $\bar{R}_{MAX}$ values (where $\bar{R}_{MAX}$ is the smoothed sunspot number at cycle maximum). We find that a three-component sinusoidal function, having an 11-cycle and a 2-cycle variation on a 90-cycle periodicity, yields computed $\bar{R}_{MAX}$ values which fit, reasonably well, observed $\bar{R}_{MAX}$ values for

the modern sunspot cycles. Extrapolation of the empirical function forward in time allows us to project values of R_{MAX} for cycles 21 and 22. For cycle 21, the function projects a value of 157.3, very close to the actually observed value of 164.5 and to that predicted earlier by Sargent [64] - 154. For cycle 22, the function projects a value of about 107. Linear regressions identified in Wilson [44] have been applied to cycle 22, yielding the result that it will probably be a long-period cycle (cycle duration > 132 months). A major feature of this report is an extensive bibliography on techniques used to estimate the time-dependent behavior of sunspot cycles.

TM-86459 August 1984

Laser Furnace Technology for Zone Refining, MSFC Center Director's Discretionary Fund Final Report, Project No. 82-26. Donald B. Griner. Information and Electronic Systems Laboratory.

A carbon dioxide laser experiment facility was constructed to investigate the problems in using a laser beam to zone refine semiconductor and metal crystals. The hardware includes a computer to control scan mirrors and stepper motors to provide a variety of melt zone patterns. The equipment and its operating procedures are described.

TM-86460 September 1984

Natural Environment Design Criteria for the Space Station Definition and Preliminary Design (First Revision). William W. Vaughan. Systems Dynamics Laboratory.

This document provides the natural environment design criteria requirements for use in the Space Station and its Elements (SSPE) definition and preliminary design studies. It addresses the atmospheric dynamic and thermodynamic environments, meteoroids, radiation, physical constants, etc., and is intended to enable all groups involved in the definition and preliminary design studies to proceed with a common and consistent set of natural environment criteria requirements.

TM-86461 August 1984

Induced Environment Contamination Monitor – Preliminary Results from the Spacelab 1 Flight. Edited by E. R. Miller. Space Science Laboratory.

The STS-9/Induced Environment Contamination Monitor (IECM) mission is briefly described. Preliminary results and analyses are given for each of the 10 instruments comprising the IECM. The final section presents a summary of the major results.

TM-86462 July 1984

Materials Testing of the IUS Techroll Seal Material. Ronald L. Nichols and William B. Hall. Materials and Processes Laboratory.

As a part of the investigation of the control system failure on IUS-1 flight to position a Tracking and Data Relay Satellite (TDRS) in geosynchronous orbit, a study was undertaken to evaluate the techroll seal materials properties under severe flight environment conditions.

This study evaluated the materials utilized in the techroll seal for possible failure modes. Studies undertaken included effect of temperature on the strength of the system, effect of fatigue on the strength of the system, thermogravimetric analysis, thermomechanical analysis, differential scanning calorimeter analysis, dynamic mechanical analysis, and peel test.

These studies indicate that if the seal failed due to a materials deficiency, the most likely mode was excessive temperature in the seal. In addition, the seal material is susceptible to fatigue damage which could have been a contributing factor.

TM-86463 August 1984

LEO Atomic Oxygen Effects on Spacecraft Materials – STS-5 Results. Ann F. Whitaker. Materials and Processes Laboratory.

Effects of LEO atomic oxygen have been measured on a variety of spacecraft materials which obtained exposure on STS-5. Material degradation dependency on temperature was found in one material. Of the five paints flown,

only S13GLO was unaffected. Generally, the glossy paints became Lambertian and the diffuse coatings improved. Scanning electron microscope examinations indicated removal of urethane and epoxy paint binder materials. Reaction products were evident on the surfaces of Z302 paint and Mylar. Thin films showed thickness losses ranging from negligible loss in Teflon to considerable loss in Mylar and Kapton. Glossy films such as black Kapton and white Tedlar became diffuse. Kevlar 29 rope lost tensile strength and silver solar cell interconnect material oxidized. Oxidation on the backside of an elevated silver specimen indicated that reflections of oxygen atoms were occurring and that reflecting surfaces, probably Kapton, were not fully accommodating the incident atoms.

TM-86464 August 1984

High-Pressure Hydrogen Testing of Single Crystal Superalloys for Advanced Rocket Engine Turbopump Turbine Blades. Wendy S. Alter, Richard A. Parr, Dr. Mary H. Johnston, and Joseph P. Strizak. Materials and Processes Laboratory.

A screening program determined the effects of high-pressure hydrogen on selected candidate materials for advanced single crystal turbine blade applications. The alloys chosen for the investigation were CM SX-2, CM SX-4C, Rene N-4, and PWA 1480. Testing was carried out in hydrogen and helium at 34 MPa and room temperature, with both notched and unnotched single crystal specimens. Results show a significant variation in susceptibility to Hydrogen Environment Embrittlement (HEE) among the four alloys and a marked difference in fracture topography between hydrogen and helium environment specimens.

TM-86465 July 1984

Payload Crew Training Complex Simulation Engineer's Handbook. Dr. David L. Shipman. Systems Analysis and Integration Laboratory.

The Simulation Engineer's Handbook is a guide for new engineers assigned to Experiment Simulation and a reference for engineers previously assigned. The experiment simulation process, development of experiment simulator requirements, development of experiment simulator hardware and software, and the verification of experiment simulators are discussed. The training required for experiment simulation is extensive and is only referenced in the handbook.

TM-86466 September 1984

A Review of Micrometeoroid Flux Measurements and Models for Low Orbital Altitudes of the Space Station. Michael Susko. Systems Dynamics Laboratory.

A review of meteoroid flux measurements and models for low orbital altitudes of the Space Station has been made in order to provide information that may be useful in design studies and laboratory hypervelocity impact tests which simulate micrometeoroids in space for design of the main wall of the Space Station. This report deals with the meteoroid flux mass model, the defocusing and shielding factors that affect the model, the probability of meteoroid penetration of the main wall of a Space Station. Whipple (1947) suggested a meteoroid bumper, a thin shield around the spacecraft at some distance from the wall, as an effective device for reducing penetration, which has been discussed in this report. The equations of the probability of meteoroid penetration, the average annual cumulative total flux, ϕ, and the equations for the thickness of the main wall and the bumper are presented in this report.

TM-86467 September 1984

Real-Time Solar Magnetograph Operation System Software Design and User's Guide. Caroline Wang. Space Science Laboratory.

This document presents the Real-Time Solar Magnetograph (RTSM) Operation system software design on PDP11/23+ and the User's Guide.

RTSM operation software is for Real-Time Instrumentation Control, data collection and data management.

The data will be used for vector analysis, plotting or graphics display. The processed data

can then be easily compared with solar data from other sources, such as the Solar Maximum Mission (SMM).

TM-86468 September 1984

NASA Thunderstorm Overflight Program – Atmospheric Electricity Research; An Overview Report on the Optical Lightning Detection Experiment for Spring and Summer 1983. Otha H. Vaughan, Jr. Systems Dynamics Laboratory.

This report presents an overview of the NASA Thunderstorm Overflight Program (TOP)/ Optical Lightning Experiment (OLDE) being conducted by the Marshall Space Flight Center and university researchers in atmospheric electricity. Discussed in this report are the various instruments flown on the NASA U-2 aircraft, as well as the ground instrumentation used in 1983 to collect optical and electronic signatures from the lightning events. Samples of some of the photographic and electronic signatures are presented. Approximately 4132 electronic data samples of optical pulses were collected and are being analyzed by the NASA and university researchers. A number of research reports are being prepared for future publication. These reports will provide more detailed data analysis and results from the 1983 spring and summer program.

TM-86469 September 1984

Studies of Solar Magnetic Fields During the Solar Maximum Year. M. J. Hagyard. Space Science Laboratory.

This report is a review of observations and studies of solar magnetic fields that were carried out during the period of the Solar Maximum Year (SMY), January 1980 to June 1981, with the goal of providing an overview of what was learned about solar magnetic fields during the SMY. The review covers the subjects of the relationship between solar magnetic fields and flares, the role of magnetic fields in the sunspot phenomenon, the magnetic-canopy structure overlying the supergranular network as well as the turbulent magnetic fields within the network, the fields within the polar crown prominences, and the solar magnetic cycle.

TP-2258 July 1983

Space Shuttle Exhaust Cloud Properties. B. J. Anderson and V. W. Keller. Systems Dynamics Laboratory. N84-14606

A data base describing the properties of the exhaust cloud produced by the launch of the Space Transportation System and the acidic fallout observed after each of the first four launches was assembled from a series of ground and aircraft based measurements made during the launches of STS 2, 3, and 4. Additional data were obtained from ground-based measurements during firings of the 6.4 percent model of the Solid Rocket Booster at the Marshall Center. Analysis indicates that the acidic fallout is produced by atomization of the deluge water spray by the rocket exhaust and deposited downwind. Aircraft measurements in the STS-3 ground cloud showed an insignificant number of ice nuclei. Although no measurements were made in the column cloud, the possibility of inadvertent weather modification caused by the interaction of ice nuclei with natural clouds appears remote.

TP-2263 September 1983

Liquid Management in Low-Gravity Using Baffled Rotating Containers. Roger F. Gans. Systems Dynamics Laboratory. N84-15427

Possible static configurations of liquids in rotating cylindrical containers with baffles evenly spaced in the axial direction are found. The force balance is among surface tension, centrifugal force and gravity. Two "instabilities" are found in this parameter space: type I is the inability of the liquid to form an interface attached to the baffles; type II is the inability for multi-baffled configurations to sustain interfaces between each pair of baffles. The type I analysis is confirmed through a laboratory based equipment. Applications to orbiting containers are discussed.

TP-2264 September 1983

The Generalized Euler-Mascheroni Constants. O. R. Ainsworth and L. W. Howell. Systems Dynamics Laboratory. N84-15880

Methods for evaluating the Euler-Mascheroni constants which appear in the Laurent expansion of Reimann zeta function about Z=1 are presented. The first 32 of these numbers are listed.

TP-2295 January 1984

Ultra-High Molecular Weight Silphenylene-Siloxane Polymers. W. J. Patterson, N. H. Hundley, and L. M. Ludwick. Materials and Processes Laboratory. N84-19564

Silphenylene-siloxane copolymers with molecular weights above one million were prepared using a two-stage polymerization technique. The technique was successfully scaled up to produce 50 grams of this high polymer in a single run. The reactive monomer approach was also investigated using the following aminosilanes: bis-(dimethylamino)dimethylsilane, N, N-bis(pyrrolidinyl)dimethylsilane and N, N-bis (gamma-butyrolactam)dimethylsilane. Thermal analyses were performed in both air and nitrogen. The experimental polymers decomposed at 540° to 562°C, as opposed to 408° to 426°C for commercial silicones. Differential scanning calorimetry showed a glass transition (Tg) at -50° to -55°C for the silphenylene-siloxane copolymer while the commercial silicones had Tg's at -96° to -112°C.

TP-2314 December 1983

Automatic Rendezvous and Docking: A Parametric Study. Richard Dabney. Systems Dynamics Laboratory. N84-23677

A technique for achieving autonomous rendezvous and docking of two orbiting space vehicles is described. Results of a digital computer simulation of the technique are presented and used to evaluate its performance under a wide variety of conditions, including docking with tumbling spacecraft. The interrelationships between initial range, tumbling rates, fuel consumption, and time requirements are explored; factors which limit performance are identified and beneficial modifications proposed.

TP-2313 March 1984

A Spatial Model of Wind Shear and Turbulence for Flight Simulation. C. Warren Campbell. Systems Dynamics Laboratory. N84-24044

A three-dimensional model which combines measurements of wind shear in the real atmosphere with three-dimensional Monte Carlo simulated turbulence was developed. The

measurement of three-dimensional wind shear is a recent development. Measurements were made on a rather coarse (~200 m) grid scale so that high frequency, short length scale turbulence information was not included. Some of the missing frequencies are important to aircraft response and hence for flight simulation. The missing turbulence must be added to the wind shear measurements. The spatial model adds three-dimensional, Monte Carlo simulated turbulence conforming to the von Karman model. The turbulence was generated in the frequency domain and transformed to the space domain using Fast Fourier Transform techniques. The resulting turbulence is three-dimensional and contains lateral and vertical as well as longitudinal correlations associated with isotropic turbulence. The resulting Gaussian, isotropic turbulence is multiplied by a spatially varying gust intensity and added to the wind shear data set winds. The resulting simulated wind field is nonisotropic, non-Gaussian, and nonlinear as are winds in the real atmosphere. Previous turbulence simulations were either one-dimensional or accounted for two- or three-dimensionality in an artificial way. With the present model, the wind field over the body of an aircraft can be simulated and all aerodynamic loads and moments calculated. The inclusion of three-dimensional variation of winds and turbulence is believed to be a significant advance over previous wind simulation models.

TP-2315 February 1984

Shock Response Spectra Variational Analysis for Pyrotechnic Qualification Testing of Flight Hardware. James Lee Smith. Systems Dynamics Laboratory. N84-23676

Shock response spectra data from flight certification tests were analyzed to determine envelope variation with respect to mean values in each axis. An overall variation of ±8.61 dB or 169 percent exists for the data. This large variation may be attributed to one or more of the following:

(1) Instrumentation Problems may exist.

(2) Variations in the source charge (blasting caps) such as shape or explosive load may exist.

(3) Two blasting caps were used to excite the pyrotechnic plate tester. Delay time between charge firings may have varied.

The cause or causes of the variations need to be identified and researched to prevent future pyro-shock problems.

TP-2323 April 1984

Finite-Difference Fluid Dynamics Computer Mathematical Models for the Design and Interpretation of Experiments for Space Flight. Glyn O. Roberts, William W. Fowlis, and Timothy L. Miller. Space Science Laboratory. N84-23852

A major objective of NASA's Spacelab is to exploit the microgravity environment of an orbiting vehicle for science and technology. There are many fundamental fluid dynamics experiments and materials processing studies involving fluid motions which can only achieve their full potential in a low-gravity environment. The many constraints and high costs of space experimentation mean that quantitative and detailed scientific and engineering design studies should be performed before proceeding to the construction of flight apparatus. However, for experiments involving fluid dynamics, such studies are not easily performed. Analytical methods are severely limited in their range of applicability by fundamental mathematical difficulties. Experimental measurement cannot, in principle, be performed until the apparatus is built and flown, but even laboratory analogs can present substantial difficulties to a detailed measurement program. The solution to the above difficulties can often be found in numerical modeling. Recent advances in numerical modeling methods mean that accurate numerical models for many fluid flow problems can now be developed in a systematic manner, and the continued improvement in computer hardware means that these models can be run in a relatively short time. In particular, models of non-turbulent, incompressible fluid flows in simple geometries can be developed to provide accurate and detailed data.

Numerical methods are used to design a spherical baroclinic flow model experiment of the large-scale atmosphere flow for Spacelab.

The dielectric simulation of radial gravity is only dominant in a low-gravity environment. Computer codes are developed to study the processes at work in crystal growing systems which are also candidates for space flight. Crystalline materials rarely achieve their potential properties because of imperfections and component concentration variations. Thermosolutal convection in the liquid melt can be the cause of these imperfections. Such convection is suppressed in a low-gravity environment.

Two- and three-dimensional finite-difference codes are being used for this work. Nonuniform meshes and implicit iterative methods are used. The iterative method for steady solutions is based on time-stepping but has the options of different time steps for velocity and temperature and of a time step varying smoothly with position according to specified powers of the mesh spacings. This allows for more rapid convergence. The code being developed for the crystal growth studies allows for growth of the crystal at the solid-liquid interface. The moving interface is followed using finite differences; shape variations are permitted. For convenience in applying finite differences in the solid and liquid, a time-dependent coordinate transformation is used to make this interface a coordinate surface.

TP-2325 April 1984

A Comparative Look at Sunspot Cycles. Robert M. Wilson. Space Science Laboratory. N84-24520

On the basis of cycles 8 through 20, spanning about 143 years, observations of sunspot number, smoothed sunspot number, and their temporal properties have been used to compute means, standard deviations, ranges, and frequency of occurrence histograms for a number of sunspot cycle parameters (e.g., $\bar{R}_{MIN}$, $\bar{R}_{MAX}$, ASC, DES, etc.). The resultant "schematic" sunspot cycle has been contrasted with the "mean" sunspot cycle, obtained by averaging smoothed sunspot number as a function of time, tying all cycles (8 through 20) to their minimum occurrence date. A relatively good approximation of the time variation of smoothed sunspot number for a given cycle is possible if sunspot cycles are regarded in terms of being either HIGH- or LOW-$\bar{R}_{MAX}$ cycles or LONG- or SHORT-PERIOD cycles, especially the latter. Further, sunspot cycles denoted HIGH-$\bar{R}_{MAX}$ usually are SHORT-PERIOD cycles and those denoted LOW-$\bar{R}_{MAX}$ usually are LONG-PERIOD cycles. Linear regression analyses have been performed comparing late cycle parameters with early cycle parameters and solar cycle number (SCN), and the early occurring cycle parameters $\bar{R}_{MIN}$, $\overset{\Delta}{GPV}$, $\bar{R}_{13}$ and $\sum_{t=0}^{24} R_Z(t)$, especially the latter two, can be used to estimate later occurring cycle parameters with relatively good success, based on cycle 21 as an example. The sunspot cycle record clearly shows that the trend for both $\bar{R}_{MIN}$ and $\bar{R}_{MAX}$ was toward decreasing value between cycles 8 through 14 and toward increasing value between cycles 14 through 20. Linear regression equations have also been obtained for several measures of solar activity – R_A, R_Z (now R_I), $\bar{R}_{13}$, F_{2800}, and $\bar{F}_{13}$ on the basis of provisional and final values.

TP-2331 March 1984

Magnetohydrodynamic Power Generation. James Lee Smith. Systems Dynamics Laboratory. N84-25458

"Magnetohydrodynamic (MHD) Power Generation" is a concise summary of MHD theory, history, and future trends. Results of the major international MHD research projects are discussed. Data from MHD research is included. Economics of initial and operating costs are considered.

TP-2332 April 1984

Geometric Interpretations of the Discrete Fourier Transform (DFT). C. Warren Campbell. Systems Dynamics Laboratory. N84-24114

A recent tendency in technical literature has been to ignore the relationship of the DFT to the real world. Rather the DFT has become an end unto itself. This attitude is somewhat surprising since the DFT's reason for existence is its relationship to the real, i.e., continuous, world. One-, two-, and three-dimensional DFTs and geometric interpretations of their periodicities

are presented. These operators are examined in light of their relationship with the two-sided, continuous Fourier transform. Discrete or continuous transforms of real functions have certain symmetry properties. These symmetries are examined in detail for the one-, two-, and three-dimensional cases. Extension to higher dimensions is straight-forward.

TP-2337 February 1984

A Stochastic Model for Photon Noise Induced by Charged Particles in Multiplier Phototubes of the Space Telescope Fine Guidance Sensors. Leonard W. Howell and Hans F. Kennel. Systems Dynamics Laboratory. N84-26398

The Space Telescope (ST) will be subjected to charged particle strikes in its space environment. ST's onboard Fine Guidance Sensors utilize multiplier phototubes (PMT) for attitude determination. These tubes, when subjected to charged particle strikes, generate "spurious" photons in the form of Cerenkov radiation and fluorescence which give rise to unwanted disturbances in the pointing of the telescope.

This paper presents a stochastic model for the number of these spurious photons which strike the photocathode of the multiplier phototube which in turn produce the unwanted photon noise. The model is applicable to both galactic cosmic rays and charged particles trapped in the Earth's radiation belts.

The model which has been programmed allows for easy adaptation to a wide range of particles and different parameters for the phototube of the multiplier.

The probability density functions for photon noise caused by protons, alpha particles, and carbon nuclei were generated using thousands of simulated strikes. These distributions will be used as part of an overall ST dynamics simulation.

The sensitivity of the density function to changes in the window parameters has also been investigated.

TP-2377 August 1984

Development of In-Situ Stiffness Properties for Shuttle Booster Filament Wound Case. V. Verderaime. Systems Dynamics Laboratory.

Subscale tests were extensively used to develop a data base on elastic properties of graphite-epoxy wound pressure vessels. Scaling phenomena were observed to influence biaxial strains. Causes for scaling are proposed and lamina models with scaling factors are presented.

NASA CONFERENCE PUBLICATIONS

CP-2274 April 1983
Proceedings: Sixth Annual Workshop on Meteorological and Environmental Inputs to Aviation Systems. Edited by Walter Frost and Dennis W. Camp. Marshall Space Flight Center. N83-33827

CP-2288 October 1983
NASA/MSFC FY-83 Atmospheric Research Review. Compiled by Robert E. Turner and Dennis W. Camp. Systems Dynamics Laboratory. N83-36587

CP-2303 February 1984
Frontiers of Remote Sensing of the Oceans and Troposphere from Air and Space Platforms. Proceedings of Commission F Symposium and Workshop, Israel, May 14-23, 1984. N84-27262

CP-2312 April 1984
Proceedings of the Seventh Annual Workshop on Meteorological and Environmental Inputs to Aviation Systems. Edited by Dennis W. Camp and Walter Frost. Marshall Space Flight Center.

CP-2313 August 1984
Second Symposium on Space Industrialization. Edited by Camille M. Jernigan. Marshall Space Flight Center.

CP-2329 July 1984
NASA/MSFC FY-84 Atmospheric Processes Research Review. Compiled by William W. Vaughan and Fay Porter. Systems Dynamics Laboratory.

NASA REFERENCE PUBLICATION

RP-1127 July 1984
Preliminary Vibration, Acoustic, and Shock Design and Test Criteria for Components on the Solid Rocket Boosters (SRB), Lightweight External Tank (LWT), and Space Shuttle Main Engines (SSME). Systems Dynamics Laboratory.

NASA CONTRACTOR REPORTS
(Abstracts for these reports may be obtained from STAR)

CR-3751 August 1983
Analysis of Large Space Structures Assembly – Man/Machine Assembly Analysis. Monitored by Jack W. Stokes, Jr. NASA8-32989. Essex Corporation. N84-13208

CR-3752 October 1983
The Influence of Convective Activity on the Vorticity Budget. Tamara L. Townsend and James R. Scoggins. NAS8-33776. Texas A&M University. N84-13736

CR-3766 May 20, 1983
Alternative Experiments Using the Geophysical Fluid Flow Cell. John E. Hart. NAS8-31958. University of Colorado. N84-15706

CR-3771 October 10, 1983
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