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Compiled by Joyce E. Turner
Management Operations Office

October 1993

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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 1993 SCIENTIFIC AND TECHNICAL REPORTS, ARTICLES, PAPERS, AND PRESENTATIONS

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TM-103605 October 1992

Solid Propulsion Integrity Program (SPIP) 48-2 Modified NASA (MNASA) Final Report May 1992. S.L. Allums, R.E. Bauman, D.W. Clark, C.D. DeWeese, W.B. Fox, R.D. Gaffin, T.M. Golden, L.D. Herbek, D.M. Holt, T.W. Lawrence, S.W. Lawson, G.T. Story, and M.W. Suits. Propulsion Laboratory. X93-10259

The SPIP 48-2 MNASA motor was test fired in the Solid Propulsion Test Assembly (SPTA) facility on November 6, 1991. The purpose of the SPIP 48-2 test was primarily directed at qualitative comparison of four nonasbestos insulation materials, evaluation of nozzle ablatives and modeling techniques, and the investigation of embedded bondline sensors. Thiokol fabricated the nozzle and cast the cartridges with 88/19 HTPB propellant. Aerojet fabricated the ignition system. In addition, Thiokol installed the propellant cartridge bondline instrumentation. Wyle onsite personnel provided support for assembly and disassembly operation. MSFC personnel performed insulation installation of the materials in the blast tube, designed the tooling required for M&P operations, engineered the motor processing, ran the ballistics, thermal, thermal structural, and thermal radiation analyses, and performed all pre/posttest measurements of the insulation and nozzle components. All test objectives for the firing were at least partially met. The motor case and blast tube structural components showed no heat effects. Nozzle and blast tube insulation materials suffered no significant anomalous erosion. The Wyle "experimental" recession gauge in the insulated blast tube assembly appears to have functioned as designed. The test duration was approximately 28.25 seconds to motor tail-off.

TM-108375 October 1992

Microbiological Analysis of Debris From STS-42 IML-1 by Direct Plating of Rinse Waters. G.A. Smithers. Materials and Processes Laboratory. N93-12174

Microbial analysis of air filter debris from Spacelab mission IML-1 was performed via direct plating of rinse waters on a battery of selective and nonselective nutrient agars. Microbial isolates were identified using Minitek and Biolog technologies. Twenty-four types of bacteria were recovered and classified; a similar number of fungal types was observed, but these were not identified. This procedure can provide information about the proportions of organism types present at the time of debris collection.

TM-108376 October 1992

An Evaluation of Corrosion Protection by Two Epoxy Primers on 2219-T87 and 7075-T73 Aluminum. M.J. Mendrek. Materials and Processes Laboratory. N93-13716

A comparison of the corrosion protection provided by two amine epoxy primers was made using salt fog, alternate immersion, and total immersion as exposure media. The study is the result of a request to use an unqualified low volatile organic carbon (VOC) primer (AKZO 463-6-78) in place of the current primer (AKZO 463-6-3) because environmental regulations have eliminated use of the current primer in many states. Primed, scribed samples of 2219-T87 and 7075-T73 aluminum were exposed to 5-percent NaCl salt fog and 3.5-percent NaCl alternate immersion for a period of 90 days. In addition, electrode samples immersed in 3.5-percent NaCl were tested using electrochemical impedance spectroscopy (EIS). The EG&G model 368 ac impedance measurement system was used to monitor changing properties of AKZO 463-6-78 and AKZO 463-6-3 primed 2219-T87 aluminum for a period of 30 days. The response of the corroding system to a frequency scan can be modeled in terms of an equivalent circuit consisting of resistors and capacitors in a specific arrangement. Each resistor/capacitor combination represents physical processes taking place within the electrolyte, at the electrolyte/primer surface, within the coating, and at the coating/substrate surface. Values for the resistors and capacitors are assigned following a nonlinear least squares fit of the data to the equivalent circuit. Changes in the values of equivalent circuit parameters during the 30-day exposure allow assessment of the time to and mechanism of coating breakdown.

TM-108377 October 1992

The Mechanism of Bolt Loading. H.M. Lee. Structures and Dynamics Laboratory. N93-12412

This report shows that the mechanism of bolt loading for preloaded fasteners can be effectively portrayed through simple spring models and some algebraic manipulations. Understanding schematically what is involved in such joints provides insight into the distribution of loads. The equations developed confirm that for both symmetric and nonsymmetric joints the loading plane factor (η) and the

stiffness factor (ϕ) directly affect the load seen in preloaded fasteners. The manner in which an external loading is transferred through the joint can be explained as energy dissipated in the various springs of both the abutment and the bolt itself.

TM-108378 October 1992
Shear Joint Capability Versus Bolt Clearance. H.M. Lee. Structures and Dynamics Laboratory. N93-12419

This report presents the results of a conservative analysis approach into the determination of shear joint strength capability for typical space-flight hardware as a function of the bolt-hole clearance specified in the design. These joints are comprised of high-strength steel fasteners and abutments constructed of aluminum alloys familiar to the aerospace industry. A general analytical expression was first arrived at which relates bolt-hole clearance to the bolt shear load required to place all joint fasteners into a shear transferring position. Extension of this work allowed the analytical development of joint load capability as a function of the number of fasteners, shear strength of the bolt, bolt-hole clearance, and the desired factor of safety. Analysis results clearly indicate that a typical spaceflight hardware joint can withstand significant loading when less than ideal bolt hole clearances are used in the design.

TM-108379 October 1992
Glass Fiber Processing for the Moon/Mars Program (Center Director's Discretionary Fund Final Report). D.S. Tucker, E. Ethridge, and P. Curreri. Materials and Processes Laboratory. N93-13115

Glass fiber has been produced from two lunar soil simulants. These two materials simulate lunar mare soil and lunar highland soil compositions, respectively. Short fibers containing recrystallized areas were produced from the as-received simulants. Doping the highland simulant with 8 weight percent B_2-O_3 yielded a material which could be spun continuously. The effects of lunar gravity on glass fiber formation were studied utilizing NASA's KC–135 aircraft. Gravity was found to play a major role in final fiber diameter.

TM-108380 October 1992
Design of a Welded Joint for Robotic, On-Orbit Assembly of Space Structures. W.K. Rule and F.P. Thomas. Structures and Dynamics Laboratory. N93-12682

A preliminary design for a weldable truss joint for on-orbit assembly of large space structures is described. The joint was designed for ease of assembly, for structural efficiency, and to allow passage of fluid (for active cooling or other purposes) along the member through the joint. The truss members were assumed to consist of graphite/epoxy tubes to which were bonded 2219-T87 aluminum alloy end fittings for welding on-orbit to truss nodes of the same alloy. A modified form of gas tungsten arc welding was assumed to be the welding process. The joint was designed to withstand the thermal and structural loading associated with a 120-ft diameter tetrahedral truss intended as an aerobrake for a mission to Mars.

TM-108381 October 1992
An Intelligent Position-Specific Training System for Mission Operations (CDDF Final Report Project Number 90-20). M.P. Schneider. Mission Operations Laboratory. N93-13156

Marshall Space Flight Center's (MSFC's) payload ground controller training program provides very good generic training; however, ground controller position-specific training can be improved by including position-specific training systems in the training program.

This report explains why MSFC needs to improve payload ground controller position-specific training. The report describes a generic syllabus for position-specific training systems, a range of system designs for position-specific training systems, and a generic development process for developing position-specific training systems. The report also describes a position-specific training system prototype that was developed for the crew interface coordinator payload operations control center ground controller position.

The report concludes that MSFC can improve the payload ground controller training program by incorporating position-specific training systems into the training program. The report recommends that MSFC investigate the possibility of developing position-specific training systems for each ground controller position; however, MSFC should not develop position-specific training systems unless payload ground controller position experts will be available to participate in the development process.

TM-108382 November 1992
Process Comparison Study (CDDF Final Report Project Number 89-03). T. Golden and J. Krawiec. Materials and Processes Laboratory.
N93-13429

A process comparison study was conducted using four different advanced manufacturing techniques to fabricate a composite solid rocket booster systems tunnel cover. Costs and labor hours were tracked to provide the comparison between the processes. A relative structural comparison of the components is also included. The processes utilized included filament winding, pultrusion, automated tape laying, and thermoplastic thermoforming. The hand layup technique is also compared. Of the four advanced processes evaluated, the thermoformed thermoplastic component resulted in the least total cost. The automated tape laying and filament winding techniques closely followed the thermoplastic component in terms of total cost; and, these techniques show the most promise for high quality components and lower production costs. The pultruded component, with its expensive tooling and material requirements, was by far the most expensive process evaluated, although the results obtained would not be representative of large production runs.

TM-108383 November 1992
A Comparison of Chromic Acid and Sulfuric Acid Anodizing. M.D. Danford. Materials and Processes Laboratory. N93-13378

Because of federal and state mandates restricting the use of hexavalent chromium, it was deemed worthwhile to compare the corrosion protection afforded 2219-T87 aluminum alloy by both Type I chromic acid and Type II sulfuric acid anodizing per MIL-A-8625. Corrosion measurements were made on large, flat 2219-T87 aluminum alloy sheet material with an area of 1 cm^2 exposed to a corrosive medium of 3.5-percent sodium chloride at pH 5.5. Both ac electrochemical impedance spectroscopy and the dc polarization resistance techniques were employed. The results clearly indicate that the corrosion protection obtained by Type II sulfuric acid anodizing is superior, and no problems should result by substituting Type II sulfuric acid anodizing for Type I chromic acid anodizing.

TM-108384 November 1992
Optimal Control Computer Programs. F. Kuo. Structures and Dynamics Laboratory.
N93-13289

The solution of the optimal control problem, even with low order dynamical systems, can usually strain the analytical ability of most engineers. The understanding of this subject matter, therefore, would be greatly enhanced if a software package existed that could simulate simple generic problems. Surprisingly, despite a great abundance of commercially available control software, few, if any, address the part of optimal control in its most generic form. The purpose of this paper is, therefore, to present a simple computer program that will perform simulations of optimal control problems that arise from the first necessary condition and the Pontryagin's maximum principle.

TM-108385 October 1992
A Plan for Spacecraft Automated Rendezvous. A.W. Deaton, J.J. Lomas, and L.D. Mullins. Systems Analysis and Integration Laboratory.
N93-15392

An automated rendezvous approach has been developed that utilizes advances in technology to reduce real-time/near real-time flight operations support personnel to an acceptable level that is near the minimum without jeopardizing the success of the mission. The on-board flight targeting uses a rule-based system to select the pursuit vehicle phasing orbits and uses precise navigation updates from the pursuit/target spacecraft made possible by the global positioning system receivers/processors on both spacecraft to adjust the phasing orbits and achieve rendezvous. The ascent-to-orbit targeting for the pursuit vehicle has been successfully decoupled from the on-orbit orbit transfer phasing targeting. Typical launch window data have been developed for the heavy lift launch vehicle and cargo transfer vehicle for a Space Station *Freedom* rendezvous mission.

TM-108386 December 1992
The Effect of Tensile Stress on Hydrogen Diffusion in Metal Alloys. M.D. Danford. Materials and Processes Laboratory. N93-16701

The effect of tensile stress on hydrogen diffusion has been determined for Type 303 stainless steel, A286 CRES, and Waspaloy and IN100 nickel-base alloys. It was found that hydrogen diffusion coefficients are not significantly affected by stress, while the hydrogen permeabilities are greatly affected in Type 303 stainless steel and A286 CRES (iron-based alloys), but are affected little in Waspaloy (nickel-base) and not affected at all in IN100 (nickel base).

These observations might be taken as an indication that hydrogen permeabilities are affected by stress in iron-based alloys, but only slightly affected in nickel-based alloys. However, it is too early to make such a generalization based on the study of only these four alloys.

TM-108387 December 1992

Space Station *Freedom* Phase III Water Recovery System Water Recovery Test Stage 7 Test Report. K.J. Parrish, K.O. Niehuss, K.E. Robinson, A.N. Jones, K.R. Payne, and D.W. Terrell. Systems Analysis and Integration Laboratory. X93-10314

A series of tests has been conducted at the NASA Marshall Space Flight Center (MSFC) to evaluate the performance of a predevelopment water recovery system. Potable and urine reclamation systems were integrated with end-use equipment items and successfully operated in open, partially closed, and totally closed modes for a total of 59 days. Significant discoveries were made during this test operation. This test report summarizes the test configuration, events, anomalies, and results pertaining to the system's operation.

TM-108388 December 1992

A Preliminary Evaluation of VPPA Versus GTA Welding. W.R. Gamwell, C. Russell, T.W. Malone, and A. Nunes. Materials and Processes Laboratory. X93-10313

Mechanical properties were evaluated to determine whether the variable polarity plasma arc (VPPA) welding process produced welds in alloy 718 with equivalent room temperature structural performance to current space shuttle main engine (SSME) weld manufactured by the constant current gas tungsten arc welding (GTAW) process. Welding was performed on 0.25-in alloy 718 plate material purchased in a 1,900 °F solution annealed condition. GTAW was accomplished using nine passes, whereas VPPA welding was accomplished using two passes. Post-welded panels were heat treated to the STA-1 condition. Post-welded specimens had weld beads left intact or machined flush. All mechanical property data and statistical analyses are provided in the accompanying tables. Student t and Weibull analyses are included.

Analyses showed that for flush specimens, the VPPA welding process produces welds with equivalent room temperature structural performance to welds manufactured by the GTAW process. For intact bead specimens, the GTAW process produced welds with better ultimate tensile strength and percent elongation, but it was not possible to distinguish a difference in fatigue life between the two processes.

TM-108389 December 1992

Study of the Glass Formation of High Temperature Superconductors (CDDF Final Report Project No. 89-04). E.C. Ethridge, W.F. Kaukler, and T. Rolin. Space Science Laboratory. N93-15500

A number of compositions of ceramic oxide high T_c superconductors were elevated for their glass formation ability by means of rapid thermal analysis during quenching, optical, and electron microscopy of the quenched samples, and with subsequent DSC measurements. Correlations between experimental measurements and the methodical composition changes identified the formulations of superconductors that can easily form glass. The superconducting material was first formed as a glass; then, with subsequent devitrification, it was formed into a bulk crystalline superconductor by a series of processing methods.

TM-108390 January 1993

Imaging the Sun in Hard X Rays Using Fourier Telescopes. J.W. Campbell. Space Science Laboratory. N93-15203

For several years, solar flares have been observed with a variety of instruments confirming that tremendous amounts of energy are locally stored in the solar magnetic field and then rapidly released during the life of the flare. In concert with observations, theorists have attempted to describe the means by which these energetic events occur and evolve. In an attempt to explain the ambiguities regarding hard x-ray emission from flares, two competing theories have emerged and have stood the test of time. One theory describes the flare in terms of nonthermal, electron beam injection into a thick target while the other uses a thermal approach. Both theories provide results which are reasonably consistent with current observations; but to date, none have been able to provide conclusive evidence as to the validity of either model. This is principally due to the short physical time scales and small size scales involved. So far, the averaging effects of observations taken over large time and size scales have tended to mask the differences. Imaging on short time scales

(i.e., 1 s) and/or small size scales (i.e., 1 arc s) should give definitive answers to these questions. In order to test whether a realistic telescope can indeed discriminate between models, we construct model sources based upon the thermal and the nonthermal models and calculate the emission as a function of time and energy in the range from 10 to 100 keV. In addition, we construct model telescopes representing both the spatial modulation collimator (SMC) and the rotating modulation collimator (RMC) techniques of observation using random photon counting statistics. With these two types of telescopes, we numerically simulate the instrument response to the above two model flares to see if there are distinct x-ray signatures which may be discernible. We find that theoretical descriptions of the primary models of solar flares do indeed predict different hard x-ray signatures for 1-s time scales and at 1- to 5-arc s spatial resolution. However, these distinguishing signatures can best be observed early in the impulsive phase and from a position perpendicular to the plane of the loop. Furthermore, we find that Fourier telescopes with reasonable and currently attainable design characteristics can image these signatures and that given the same sensitive areas and short temporal integration times relative to source evolution (i.e., 1 s), the RMC and the SMC will both provide about the same performance. The ability to image is strongly dependent upon the intensity of the specific loop being observed. Specifically, for 1-s temporal integration times, for 10 keV energy bins, and for complex sources, the intensity threshold is found to be 0.2 photon cm^{-2} s^{-1} keV^{-1} per 4×4-arc s telescope resolution cell at the Earth. For intensities greater than this threshold, clear imaging can be accomplished using our Fourier telescope. However, this is only true for intensities which are within a factor of 10 of the brightest intensity in its immediate vicinity as the dynamic range of the telescope was found to be on the order of 10:1. This limitation has been found to play a role in imaging emission profiles of both models in that weak spatial features are suppressed by brighter ones. Also, we find that the telescope is tolerant to random noise on the detector and that imaging performance is surprisingly resistant to twist (i.e., rotation of the grids with respect to one another) less than 2 arc min in magnitude. Actual fields of view of the telescopes are much less (i.e., 1:4) than the geometric fields of view; however, full Sun coverage is achievable for telescopes using reasonable parameters. In summary, we find that Fourier telescopes are promising approaches for hard x-ray imaging of the Sun and should serve to provide significant insight into the physical processes at work in flares.

TM-108391 January 1993

Passive Recirculation in the National Launch System's Fuel Feedlines. W.R. Wilson and K.A. Holt. Propulsion Laboratory. N93-17941

This report contains the passive recirculation tests on the fuel feedline of the National Launch System (NLS). The majority of testing was performed in February 1992, at the National Institute of Standards and Technology in Boulder, CO. The primary objective was to characterize passive recirculation in the NLS fuel feedline. The objective was met by observing the passive recirculation in a one-fifth scale model of the feedline with clear glass sections. The testing was recorded on video tape and with photographs. A description of the testing apparatus and support equipment is included. The experiment indicates that passive recirculation was occurring; higher angles from the horizontal transfer more heat.

TM-108392 October 1992

FY 1992 Scientific and Technical Reports, Articles, Papers, and Presentations. Compiled by J.E. Turner. Management Operations Office.

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TM-108393 January 1993

Wildfire and MAMS Data From STORMFEST. G.J. Jedlovec and G.S. Carlson. Space Science Laboratory. N93-19898

Early in 1992, NASA participated in an interagency field program called STORMFEST. The STORM-Fronts Experiment Systems Test (STORMFEST) was designed to test various systems critical to the success of STORM I in a very focused experiment. The field effort focused on winter storms in order to investigate the structure and evolution of fronts and associated mesoscale

phenomena in the central United States. This document describes the data collected from two instruments onboard a NASA ER2 aircraft which was deployed out of Ellington Field in Houston, TX, from February 13 through March 15, 1992, in support of this experiment. The two instruments were the Wildfire (a.k.a. the MODIS-N Airborne Simulator, MAS) and the Multispectral Atmospheric Mapping Sensor (MAMS).

TM-108394 February 1993

The Analytical Representation of Viscoelastic Material Properties Using Optimization Techniques. S.A. Hill. Structures and Dynamics Laboratory. N93-19972

This report presents a technique to model viscoelastic material properties with a function of the form of the Prony series. Generally, the method employed to determine the function constants requires assuming values for the exponential constants of the function and then resolving the remaining constants through linear least-squares techniques. The technique presented here allows all the constants to be analytically determined through optimization techniques.

This technique is employed in a computer program named PRONY and makes use of a commercially available optimization tool developed by VMA Engineering, Inc. The PRONY program was utilized to compare the technique against previously determined models for solid rocket motor TP-H1148 propellant and V747-75 Viton fluoroelastomer. In both cases, the optimization technique generated functions that modeled the test data with at least an order of magnitude better correlation. This technique has demonstrated the capability to use small or large data sets and to use data sets that have uniformly or nonuniformly spaced data pairs.

The reduction of experimental data to accurate mathematical models is a vital part of most scientific and engineering research. This technique of regression through optimization can be applied to other mathematical models that are difficult to fit to experimental data through traditional regression techniques.

TM-108395 February 1993

A Summary of Laboratory Testing Performed to Characterize and Select an Elastomeric O-Ring Material to be Used in the Redesigned Solid Rocket Motor of the Space Transportation System. J.E. Turner. Executive Staff. N93-22557

An elastomeric O-ring material is used in the joints of the redesigned solid motors (RSRM's) of the National Space Transportation System (NSTS). The selection of the O-ring material used in the RSRM's was a very thorough process that included efforts by NASA's Marshall Space Flight Center and the Langley Research Center, and the Thiokol Corporation. One of the efforts performed at MSFC was an extensive in-house laboratory test regime to screen potential O-ring materials and ultimately to characterize the elastomeric material that was chosen to be used in the RSRM's. This report summarizes those laboratory tests performed at MSFC.

TM-108396 February 1993

NASA Marshall Space Flight Center Solar Observatory Report—July–December 1992. J.E. Smith. Space Science Laboratory. N93-22665

This report provides a description of the NASA Marshall Space Flight Center's Solar Vector Magnetograph Facility and gives a summary of its observations and data reduction during July to December 1992. The systems that make up the facility are a magnetograph telescope, an H-alpha telescope, a Questar telescope, and a computer code.

TM-108397 February 1993

Calibration, Navigation, and Registration of MAMS Data for FIFE. G.J. Jedlovec and R.J. Atkinson. Space Science Laboratory. N93-22699

The International Satellite Land Surface Climatology Project (ISLSCP) was conducted to study the interaction of the atmosphere with the land surface and the research problems associated with the interpretation of satellite data over the Earth's land surface. The experimental objectives of the First ISLSCP Field Experiment (FIFE) were the simultaneous acquisition of satellite, atmospheric, and surface data and to use these data to understand the processes controlling energy/mass exchange at the surface. The experiment site is a 15×15-km area southeast of Manhattan, KS, intersected by Interstate 70 and Kansas Highway 177. The Konza Prairie portion is 5×5 km and is a controlled experiment site consisting primarily of native tall grass prairie vegetation. The remainder of the site is grazing and farmland with trees along creek beds that are scattered over the area. Airborne multispectral imagery from the Multispectral Atmospheric Mapping Sensor (MAMS) was collected over this region on two days during Intensive Field Campaign –1 (IFC–1) to

study the time and space variability of remotely sensed geophysical parameters. These datasets consist of multiple overflights covering about a 60-min period during late morning on June 4, 1987, and shortly after dark on the following day. Image data from each overpass were calibrated and Earth located with respect to each other using aircraft inertial navigation system parameters and ground control points. These were the first MAMS flights made with 10-bit thermal data.

TM-108398 February 1993

Space Station *Freedom* Environmental Control and Life Support System Phase III Water Recovery Test Stage 7 Final Report. D.L. Carter, D.W. Holder, and C.F. McGriff. Structures and Dynamics Laboratory. X93-10679

A test has been completed at NASA's Marshall Space Flight Center (MSFC) to evaluate the performance of a development water recovery system operating in open-loop and closed-loop mode. This test is referred to a Water Recovery Test (WRT) Stage 7. Potable and urine processing assemblies were integrated with end-use equipment and operated for 59 days. The overall integrated configuration of the test system included a single water recovery loop that combined the potable and hygiene water recovery loops utilized in previous WRT testing. Several physical anomalies occurred to the Potable Water Processor (PWP) in relation to the feed pump and the volatile removal assembly. No significant anomalies associated with the urine processor assembly were encountered. Reclaimed potable water routinely met current Space Station *Freedom* (S.S. *Freedom*) water quality specifications for physical, chemical, and microbiological constituents with few exceptions. Human test subject volunteers showered and washed with reclaimed potable water for 8 days and tasted reclaimed potable water for 6 days. Subjective feedback from the test subjects indicated that the reclaimed potable water compared favorably with untreated tap water and treated facility water.

TM-108399 March 1993

Preliminary Analysis Techniques for Ring and Stringer Stiffened Cylindrical Shells. J. Graham. Preliminary Design Office. N93-23104

This report outlines methods of analysis for the buckling of thin-walled circumferentially and longitudinally stiffened cylindrical shells. Methods of analysis for the various failure modes are presented in one cohesive package. Where applicable, more than one method of analysis for a failure mode is presented along with standard practices. The results of this report are primarily intended for use in launch vehicle design in the elastic range. A Microsoft Excel™ worksheet with accompanying macros has been developed to automate the analysis procedures. These programs are available by request from the author.

TM-108400 March 1993

Space Station *Freedom* Phase III Water Recovery System, Water Recovery Test Stage 8 Test Report. K.J. Parrish, K.O. Niehuss, K.E. Robinson, D.A. Long, K.R. Payne, and D.W. Terrell. Systems Analysis and Integration Laboratory. X93-10778

Water recovery test stage 8 was the last in a series of tests that have been conducted at the NASA Marshall Space Flight Center (MSFC) to evaluate the performance of a predevelopment water recovery system. This particular test built upon the results obtained from water recovery test stage 7 by investigating whether system integrity could be maintained without a presterilizer component in the potable water processor. This test report summarizes the test configuration, events, anomalies, and results pertaining to the system's operation.

TM-108402 April 1993

Space Science Laboratory Publications and Presentations, January 1 to December 31, 1992. Compiled by T.W. Moorehead. Space Science Laboratory. N93-26562

This document lists the significant publications and presentations of the Space Science Laboratory during the period January 1 to December 31, 1992. Entries in the main part of the document are categorized according to NASA Reports (arranged by report number), Open Literature, and Presentations (arranged alphabetically by title). Also included for completeness is an Appendix (arranged by report number) listing preprints issued by the Laboratory during this reporting period. Some of the preprints have not been published; those already published are so indicated. Most of the articles listed under Open Literature have appeared in referred professional journals, books, monographs, or conference proceedings. Although many published abstracts are eventually expanded into full papers for publication in scientific and technical journals, they are often sufficiently comprehensive to include the significant

results of the research reported. Therefore, published abstracts are listed separately in a subsection under Open Literature. Questions or requests for additional information about the entries in this report should be directed to Tauna W. Moorehead (ES01; 544–7581) or to one of the authors. The organizational code of the cognizant SSL branch or office is given at the end of each entry.

TM-108403 April 1993

An Indepth Probabilistic Study of External Tank Attach Ring. F. Pizzano and C.S. Putcha. Systems Safety and Reliability Office.

N93-25671

This report deals with conducting a probabilistic study of the external tank attach ring (ETA) used as an interface between the external tank attach struts and the solid rocket booster. The idea was to use probabilistic distributions for material, geometric, and load properties, to calculate probabilistic margins of safety, and then to compare results against the deterministic factors of safety that were used in the actual design process. The report describes how this was done and discusses some of the road blocks and data problems that were encountered during the study and provides some conclusions. A further refinement of this study is being considered for future work which would make more direct use of finite element analysis data coupled with Monte Carlo simulation. The basic conclusion herein indicates that the probabilistic margins of safety for the cases analyzed (by use of existing data) appear to support deterministic results and actually indicate higher reliabilities.

TM-108404 April 1993

TSS Tether Cable Meteoroid/Orbital Debris Damage Analysis. K.B. Hayashida and J.H. Robinson. Structures and Dynamics Laboratory.

N93-27023

This report summarizes the damage analysis performed on the tether cable used for the tethered satellite system (TSS), for the damage that could be caused by meteoroid or orbital debris impacts. The TSS consists of a tethered satellite deployer and a tethered satellite. The analytical studies were performed at Marshall Space Flight Center (MSFC) with the results from the following tests: (1) hypervelocity impact tests to determine the "critical" meteoroid particle diameter, i.e., the maximum size of a meteoroid particle which can impact the tether cable without causing "failure"; (2) electrical resistance tests on the damaged and undamaged tether cable to determine if degradation of current flow occurred through the damaged tether cables; and (3) tensile load tests to verify the load carrying capability of the damaged tether cables. Finally, the HULL hydrodynamic computer code was used to simulate the hypervelocity impact of the tether cable by particles at velocities higher than can be tested, to determine the extent of the expected tether damage.

TM-108405 May 1993

Microbiology Report for Stage 4/5 Water Recovery Test. M.C. Roman and S.A. Minton. Structures and Dynamics Laboratory.

X93-10790

The Environmental Control and Life Support System (ECLSS) test program for the development of a regenerative reclamation system for Space Station *Freedom* (S.S. *Freedom*) began in 1986 at NASA/Marshall Space Flight Center (MSFC). This report presents microbiological data from the Water Recovery Test (WRT), Stage 4/5 which was conducted from June through July 1991.

WRT Stage 4/5 investigated a dual-loop system with test subjects contributing respiration and perspiration through exercise for potable reclamation, while waste shower, handwash, laundry, oral hygiene, and urine were generated for hygiene reclamation. During WRT Stage 5, test subjects were allowed to taste, but not consume, reclaimed potable water and give subjective opinions of the general palatability. Test subjects were also asked to provide subjective opinions on the quality of reclaimed hygiene water used in showers and handwashes. Reclaimed hygiene water was also used for laundry and urine flush. The Stage 4/5 tests were run concurrently.

TM-108406 June 1993

Design Verification Test Matrix Development for the STME Thrust Chamber Assembly. C.E. Dexter, S.K. Elam, and D.L. Sparks. Propulsion Laboratory. N93-27251

This report presents the results of the test matrix development for design verification at the component level for the National Launch System (NLS) space transportation main engine (STME) thrust chamber assembly (TCA) components, including injector, combustion chamber, and nozzle. A systematic approach was used in the development of the minimum recommended TCA matrix, resulting in a

minimum number of hardware units and a minimum number of hot fire tests.

TM-108407 June 1993

The Role of Grain Boundaries in Hydrogen Diffusion in Metals at 25 °C. M.D. Danford. Materials and Processes Laboratory. N93-29043

The effect of grain size on hydrogen diffusion at 25 °C has been examined for 4340 steel (body-centered cubic) and for Inconel 718 (face-centered cubic). It has been found that the effect of grain size is important for body-centered cubic structures, but plays a much less important role in face-centered cubic structures. Accurate measurements of hydrogen desorption coefficients during hydrogen desorption show that these are not greatly different for both types of structures.

TM-108408 June 1993

Effects of Atomic Oxygen and Ultraviolet Radiation on Candidate Elastomeric Materials for Long Duration Missions—Test Series No. 1. R.C. Linton, M.M. Finckenor, R.R. Kamenetzky, and P. Gray. Materials and Processes Laboratory. N93-29193

Research has been conducted at the Marshall Space Flight Center on the behavior of elastomeric materials after exposure to simulated space environment. Silicone S383 and Viton V747 samples were exposed to thermal vacuum, ultraviolet (UV) radiation, and atomic oxygen and then evaluated for changes in material properties. Characterization of the elastomeric materials included weight, hardness, optical inspection under normal and black light, spectrofluorescence, solar absorptance and emittance, Fourier transform infrared spectroscopy, and permeability. These results indicate a degree of sensitivity to exposure and provide some evidence of UV and atomic oxygen synergism.

TM-108409 June 1993

Computerized Atmospheric Trace Contaminant Control Simulation for Manned Spacecraft. J.L. Perry. Structures and Dynamics Laboratory. N93-28977

Buildup of atmospheric trace contaminants in enclosed volumes such as a spacecraft may lead to potentially serious health problems for the crewmembers. For this reason, active control methods must be implemented to minimize the concentration of atmospheric contaminants to levels that are considered safe for prolonged, continuous exposure. Designing hardware to accomplish this has traditionally required extensive testing to characterize and select appropriate control technologies. Data collected since the Apollo project can now be used in a computerized performance simulation to predict the performance and life of contamination control hardware to allow for initial technology screening, performance prediction, and operations and contingency studies to determine the most suitable hardware approach before specific design and testing activities begin. The program, written in FORTRAN 77, provides contaminant removal rate, total mass removed, and per pass efficiency for each control device for discrete time intervals. In addition, projected cabin concentration is provided. Input and output data are manipulated using commercial spreadsheet and data graphing software. These results can then be used in analyzing hardware design parameters such as sizing and flow rate, overall process performance, and program economics. Test performance may also be predicted to aid test design.

TM-108410 June 1993

Development of a Large Field-of-View KD*P Modulator—MSFC Center Director's Discretionary Fund Final Report (Project No. 91-23). E.A. West. Space Science Laboratory. N93-32378

Magnetographs, which measure polarized light, allow solar astronomers to infer the magnetic field intensity on the Sun. The Marshall Space Flight Center (MSFC) Vector Magnetograph is such an imaging instrument. The instrument requires rapid modulation between polarization states to minimize seeing effects. The accuracy of those polarization measurements is dependent on stable modulators with small field-of-view errors. Although these devices are very important in ground-based telescopes, extending the field of view of electro-optical crystals such as KD*P's (potassium di-deuterium phosphate) could encourage the development of these devices for other imaging applications. This report describes the work that was done at MSFC as part of the Center Director's Discretionary Fund (CDDF) to reduce the field-of-view errors of instruments that use KD*P modulators in their polarimeters.

TM-108411 June 1993

Design of Multiple-Ply Laminated Composite Tapered Beams. P. Rodriguez. Structures and Dynamics Laboratory. N93-31650

A study of a special case of symmetric laminated composite cantilever beams is presented. The approach models beams that are tapered both in depth and width and investigates the effect of the ply layup angle and the ply taper on bending and interlaminar shearing stresses. For the determination of stresses and deflections, the beam stiffness matrices are expressed as linear functions of the beam length. Using classical lamination theory (CLT) the stiffness matrices are determined and assembled at strategic locations along the length of the beam. They are then inverted and necessary stiffness parameters are obtained numerically and extracted for determination of design information at each location chosen. Several ply layup configurations are investigated, and design considerations are presented based on the findings. Finally, recommendations for the design of these beams are presented, and a means for anticipating the location of highest stresses is offered.

TM-108412 June 1993

An Investigation of Squeeze-Cast Alloy 718 (CDDF Final Report No. 90-10). W.R. Gamwell. Materials and Processes Laboratory. N93-31646

Alloy 718 billets produced by the squeeze-cast process have been evaluated for use as potential replacements for propulsion engine components which are normally produced from forgings. Alloy 718 billets were produced using various processing conditions. Structural characterizations were performed on "as-cast" billets. As-cast billets were then homogenized and solution treated and aged according to conventional heat-treatment practices for this alloy. Mechanical property evaluations were performed on heat-treated billets.

As-cast macrostructures and microstructures varied with squeeze-cast processing parameters. Mechanical properties varied with squeeze-cast processing parameters and heat treatments. One billet exhibited a defect-free, refined microstructure, with mechanical properties approaching those of wrought alloy 718 bar, confirming the feasibility of squeeze-casting alloy 718. However, further process optimization is required, and further structural and mechanical property improvements are expected with process optimization.

TM-108413 May 1993

A Browse Facility for Each Science Remote Sensing Data—Center Director's Discretionary Fund Final Report (Project 91-09). P.J. Meyer. Space Science Laboratory. N94-10723

An image data visual browse facility is developed for a UNIX platform using the X Windows 11 system. It allows one to visually examine reduced resolution image data to determine which data are applicable for further research. Links with a relational data base manager then allow one to extract not only the full resolution image data, but any other ancillary data related to the case study. Various techniques are examined for compression of the image data in order to reduce data storage requirements and time necessary to transmit the data on the Internet. Data used for this study were from the WetNet project.

TM-108414 June 1993

Thermal Testing of Aluminized Mylar™. D.L. Lowe II and D.L. Edwards. Materials and Processes Laboratory.

This report summarizes the effect of heat on aluminized Mylar™ film. With the report, a summary of the procedure used in testing the material, background information describing the physical properties of the material, and the experimental results of heating the material at various temperatures are included. This study reveals that aluminized Mylar™ film is thermally stable within the temperature range of 50 to 200 °C. The information compiled in this report will be used to determine if aluminized Mylar™ can be useful in space applications.

TM-108415 June 1993

Space Station Redesign Option A—Modular Buildup Concept. Compiled by Station Redesign Support Team. N94-10808

In early 1993, President Clinton mandated that NASA look at lower cost alternatives to Space Station *Freedom*. He also established an independent advisory committee—the Blue Ribbon Panel—to review the redesign work and evaluate alternatives. Daniel Goldin, NASA Administrator, established a Station Redesign Team that began operating in late March from Crystal City, VA. NASA intercenter teams—one each at Marshall Space Flight Center, Johnson Space Center, and Langley Research Center—provided engineering and other support.

This report summarizes the results of the Option A study done at Marshall Space Flight Center. Two configurations (A-1 and A-2) are covered in this report. Additional data is provided in the briefing package MSFC SRT-001, Final System Review to SRT-002, Space Station Option A Modular Buildup Concept, Volumes 1–5, Revision B, June 10, 1993. In June 1993, President Clinton decided to proceed with a modular concept consistent with Option A, and asked NASA to provide an Implementation Plan by September. All data from the Option A redesign activity was provided to NASA's Transition Team for use in developing the Implementation Plan.

TM-108416 July 1993

Evaluation of Chemical Conversion Material (Protective Coating) Exposed to Space Environmental Conditions, CDDF Final Report (No. 90-07). D.L. Edwards. Materials and Processes Laboratory. N93-32366

This report focuses on the development of an operational Rutherford backscattering spectrometry (RBS) system and shows the application of such a system on a space environmental test.

Thin films of aluminum and tantalum were deposited on diamond substrates. These films were anodized and preexposure characterization spectra obtained using RBS and total hemispherical reflectance. The samples were exposed to energetic protons then postexposure characterization spectra was obtained using the same techniques.

Conclusions based on the comparison of preexposure and postexposure spectra are presented. RBS comparison spectra show no change in the metal/metal oxide interface, while the comparison reflectance data indicate change. Explanations for this reflectance change are presented in this report.

TM-108417 July 1993

NASA Marshall Space Flight Center Solar Observatory Report—January–June 1993. J.E. Smith. Space Science Laboratory. N94-10866

This report provides a description of the NASA Marshall Space Flight Center's Solar Vector Magnetograph Facility and gives a summary of its observations and data reduction during January to June 1993. The systems that make up the facility are a magnetograph telescope, an H-alpha telescope, a Questar telescope, and a computer code.

TM-108418 July 1993

A Study on Strength Evaluations of EDNi/EDCu/NARloy-Z Bonded Joints. J.B. Min and K.L. Spanyer. Structures and Dynamics Laboratory.

Dissimilar material interfaces can be found in many materials and structural bonds such as composite materials, welded parts, inclusion in matrix, bond between metallic and ceramic materials, etc. One of such structural bonds can be seen in the main combustion chamber (MCC) of the space shuttle main engine (SSME). In this study, from a practical sense, the primary concern is to understand the systems response of EDNi/EDCu/NARloy-Z bonded joints using stress values approximated by the finite element method to determine an influence of the variation of structural bond parameters on the bonded joints, and consequently to support a process control for developing defect-free, strong bonded joints of EDNi/EDCu/NARloy-Z in the MCC of the SSME. The results presented in this study could be an appropriate indicator for a good bond of EDNi/EDCu/NARloy-Z layers with the desired thickness of copper deposition in the SSME MCC manufacturing process. Furthermore, the results from this study appear to be applicable to any bonded joints that can be characterized by the parameters and assumptions used in this analysis.

TM-108419 September 1993

Microstructural Evolution of NARloy-Z at Elevated Temperatures. J. Singh, G. Jerman, B.N. Bhat, and R. Poorman. Materials and Processes Laboratory.

Microstructural evolution was studied in samples of wrought and vacuum plasma sprayed (VPS) NARloy-Z exposed to temperatures up to 970 °C (1,780 °F) for up to 60 h. Samples were heated in a vacuum furnace, followed by rapid quenching in helium (He) gas at a cooling rate of ~166 °C (300 °F) per second. Microstructural analyses were conducted using optical microscopy, scanning electron microscopy (SEM), and electron probe microanalysis (EPMA). In both the wrought and VPS conditions, precipitates rich in silver (Ag) and zirconium (Zr) were present in the matrix and at the grain boundaries even after long exposure to elevated temperatures. Islands rich in oxygen (O_2) and Zr were also observed, as well as incipient melting at the grain boundary triple points. Results indicated

that the alloy cannot be homogenized by heat treatment at elevated temperatures.

TM-108421 September 1993

Optimization of the Processing Parameters of High Temperature Superconducting Glass-Ceramics—Center Director's Discretionary Fund Final Report (Project No. 91-04). E.C. Ethridge and W.F. Kaulker. Space Science Laboratory.

A number of promising glass forming compositions of high T_c superconducting Ba-Sr-Ca-Cu-O (BSCCO) materials were evaluated for their glass-ceramic crystallization ability. The BSCCO ceramics belonging to the class of superconductors in the Ba-Sr-Ca-Cu-O system were the focus of this study. By first forming the superconducting material as a glass, subsequent devitrification into the crystalline (glass-ceramic) superconductor can be performed by thermal processing of the glass preform body. Glass formability and phase formation were determined by a variety of methods in another related study. This study focused on the nucleation and crystallization of the materials. Thermal analysis during rapid cooling aids in the evaluation of nucleation and crystallization behavior. Melt viscosity is used to predict glass formation ability.

TM-4437 January 1993

Space Shuttle Solid Rocket Booster Main Parachute Damage Reduction Team Report. G. Watts. Structures and Dynamics Laboratory. N93-18067

This report gives the findings of the space shuttle solid rocket booster main parachute damage reduction team. The purpose of the team was to investigate the causes of main parachute deployment damage and to recommend methods to eliminate or substantially reduce the damage. The team concluded that the two primary causes of significant damage during deployment are vent entanglement and contact of the parachutes with the main parachute support structure. As an inexpensive but effective step toward damage reduction, the team recommends modification of the parachute packing procedure to eliminate vent entanglement. As the most effective design change, the team recommends a pilot chute-deployed soft-pack system. Alternative concepts are also recommended that provide a major reduction in damage at a total cost lower than the pilot chute-deployed soft pack.

TM-4456 March 1993

Materials Science on Parabolic Aircraft—The FY 87–89 KC–35 Microgravity Test Program. P.A. Curreri, Editor. Space Science Laboratory. N93-23171

This document covers research results from the KC–135 Materials Science Program managed by MSFC for the period FY87 through FY89. It follows the previous NASA Technical Memorandum for FY84–86 published in August 1988. This volume contains over 30 reports grouped into eight subject areas covering acceleration levels, space flight hardware, transport and interfacial studies, thermodynamics, containerless processing, welding, melt/crucible interactions, and directional solidification. The KC–135 materials science experiments during FY87–89 accomplished direct science, preparation for space flight experiments, and justification for new experiments in orbit.

TM-4517 August 1993

Spacelab J Experiment Descriptions. T.Y. Miller, Editor. Space Science Laboratory.

This document contains brief descriptions of the experiment investigations for the Spacelab J Mission which was launched from the Kennedy Space Center aboard the *Endeavor* in September 1992.

TP-3288 October 1992

Tensile Properties of Cast Titanium Alloys Titanium-6Al-4V ELI and Titanium-5Al-2.5Sn ELI. E.E. Billinghurst, Jr. Materials and Processes Laboratory. N93-10072

This work was performed to determine the tensile properties of cast, hot isostatic pressed (HIP'ed), and annealed titanium alloys, Ti-6Al-4V ELI and Ti-5Al-2.5Sn ELI, that are candidate materials for the space transportation main engine (STME) liquid hydrogen turbopump impeller. Samples of the cast alloys were HIP'ed, annealed, and machined into tensile specimens. The specimens were tested in air at ambient temperature (70 °F) and also at –423 °F in liquid hydrogen. The Ti-6Al-4V alloy had an average ultimate strength of 129.1 ksi at 70 °F and 212.2 ksi at –423 °F. The Ti-5Al-2.5Sn alloy had an average ultimate strength of 108.4 ksi at 70 °F and 185.0 ksi at –423 °F. The ductility, as measured by reduction of area, for the Ti-6Al-4V averaged 15.2 percent at 70 °F and 8.7 percent at –423 °F, whereas for the Ti-5Al-2.5Sn alloy average reduction of area was 24.6 percent at 70 °F and 11.7 percent at –423 °F.

TP-3303 November 1992

The Effects of Compressive Preloads on the Compression-After-Impact Strength of Carbon/Epoxy. A.T. Nettles and D.G. Lance. Materials and Processes Laboratory. N93-12678

A preloading device was used to examine the effects of compressive prestress on the compression-after-impact (CAI) strength of 16-ply, quasi-isotropic carbon epoxy test coupons. T300/934 material was evaluated at preloads from 200 to 4,000 lb at impact energies from 1 to 9 joules. IM7/8551-7 material was evaluated at preloads from 4,000 to 10,000 lb at impact energies from 4 to 16 joules. Advanced design of experiments methodology was used to design and evaluate the test matrices. The results showed that no statistically significant change in CAI strength could be contributed to the amount of compressive preload applied to the specimen.

TP-3309 December 1992

An Overview of Reliability Growth Models and Their Potential Use for NASA Applications. V.S. Taneja and F.M. Safie. Safety and Mission Assurance Office. N93-15433

In this study, we provide an overview of reliability growth literature over the past 25 years. This includes a thorough literature review of different areas of the application of reliability growth such as design, prediction, tracking/management, and demonstration. Various reliability growth models use different bases on how they characterize growth. Different models are discussed in this report. Also, this report addresses the use of reliability growth models to NASA applications. This includes the application of these models to the space shuttle main engine. For potential NASA applications, we classify growth models in two groups. These groups are characterized in this report.

TP-3316 December 1992

On the Variation of the Nimbus–7 Total Solar Irradiance. R.M. Wilson. Space Science Laboratory. N93-15532

For the interval December 1978 to April 1991, the value of the mean total solar irradiance, as measured by the Nimbus–7 Earth Radiation Budget Experiment channel 10C, was 1,372.02 Wm^{-2}, having a standard deviation of 0.65 Wm^{-2}, a coefficient of variation (mean divided by the standard deviation) of 0.047 percent, and a normal deviate z (a measure of the randomness of the data) of –8.019 (inferring a highly significant nonrandom variation in the solar irradiance measurements, presumably related to the action of the solar cycle). Comparison of the 12-month moving average (also called the 13-month running mean) of solar irradiance to those of the usual descriptors of the solar cycle (i.e., sunspot number, 10.7-cm solar radio flux, and total corrected sunspot area) suggests possibly significant temporal differences. For example, solar irradiance is found to have been greatest on or before mid 1979 (leading solar maximum for cycle 21), lowest in early 1987 (lagging solar minimum for cycle 22), and was rising again through late 1990 (thus, lagging solar maximum for cycle 22), having last reported values below those that were seen in 1979 (even though cycles 21 and 22 were of comparable strength). Presuming a genuine correlation between solar irradiance and the solar cycle (in particular, sunspot number) one infers that the correlation is weak (having a coefficient of correlation $r < 0.84$) and that major excursions (both as "excesses" and "deficits") have occurred (about every 2 to 3 years, perhaps suggesting a pulsating Sun).

TP-3326 January 1993

Systems Design Analysis Applied to Launch Vehicle Configuration. R. Ryan and V.

Verderaime. Structures and Dynamics Laboratory. N93-18141

As emphasis shifts from optimum-performance aerospace systems to least life-cycle costs, systems designs must seek, adapt, and innovate cost improvement techniques in design through operations. The systems design process of concept, definition, and design was assessed for the types and flow of total quality management techniques that may be applicable in a launch vehicle systems design analysis. Techniques discussed are task ordering, quality leverage, concurrent engineering, Pareto's principle, robustness, quality function deployment, criteria, and others. These cost-oriented techniques are as applicable to aerospace systems design analysis as to any large commercial system.

TP-3327 January 1993

Hypersonic Rarefied Wake Characterization. E.B. Brewer. Structures and Dynamics Laboratory. N93-18604

Results of a numerical study using the direct simulation Monte Carlo (DSMC) method are presented for hypersonic rarefied flow over an aeroassisted space transfer vehicle (ASTV). The emphasis of the study is the characterization of the near wake region which includes the ASTV payload. The study covered the transitional flow regime from near continuum to free molecular. Calculations show that the character of the near wake is significantly affected by the presence of the payload. Flow separation occurs when an afterbody is present throughout the transitional flow regime. In contrast, when no afterbody is present, no separation is observed until the flow approaches continuum.

TP-3332 March 1993

Characterizing the Uncertainty in Holddown Post Load Measurements. J.A. Richardson and J.S. Townsend. Structures and Dynamics Laboratory. N93-23721

In order to understand unexpectedly erratic load measurements in the launch-pad supports for the space shuttle, the sensitivities of the load cells in the supports were analyzed using simple probabilistic techniques. NASA engineers use the loads in the shuttle's supports to calculate critical stresses in the shuttle vehicle just before lift-off. The support loads are measured with "load cells" which are actually structural components of the mobile launch platform which have been instrumented with strain gauges. Although these load cells adequately measure vertical loads, the horizontal load measurements have been erratic. The load measurements were simulated in this study using Monte Carlo simulation procedures. The simulation studies showed that the support loads are sensitive to small deviations in strain and calibration. In their current configuration, the load cells will not measure loads with sufficient accuracy to reliably calculate stresses in the shuttle vehicle. A simplified model of the holddown post (HDP) load measurement system was used to study the effect on load measurement accuracy for several factors, including load point deviations, gauge heights, and HDP geometry.

TP-3336 March 1993

Robustness. R. Ryan. Structures and Dynamics Laboratory. N93-22458

Robustness is a buzz word common to all newly proposed space systems design as well as many new commercial products. The image that one conjures up when the word appears is a "Paul Bunyan" (lumberjack design), strong and hearty; healthy with margins in all aspects of the design. In actuality, robustness is much broader in scope than margins, including such factors as simplicity, redundancy, desensitization to parameter variations, control of parameter variations (environments fluctuation), and operational approaches. These must be traded with concepts, materials, and fabrication approaches against the criteria of performance, cost, and reliability. This includes manufacturing, assembly, processing, checkout, and operations. The design engineer or project chief is faced with finding ways and means to inculcate robustness into an operational design. First, however, he must be sure he understands the definition and goals of robustness. This paper will deal with these issues as well as the need for the requirement for robustness.

TP-3347 May 1993

The Dynamic Phenomena of a Tethered Satellite, NASA's First Tethered Satellite Mission (TSS-1). R.S. Ryan, D.K. Mowery, and D.D. Tomlin. Structures and Dynamics Laboratory. N93-27162

The tethered satellite system (TSS) was envisioned as a means of extending a satellite from its base (space shuttle, space station, space platform) into a lower or higher altitude in order to more efficiently acquire data and perform science experiments. This is accomplished by attaching the

satellite to a tether, deploying it, then reeling it in. When its mission is completed, the satellite can be returned to its base for reuse. If the tether contains a conductor, it can also be used as a means to generate and flow current to and from the satellite to the base. When current is flowed, the tether interacts with the Earth's magnetic field, deflecting the tether. When the current flows in one direction, the system becomes a propulsive system that can be used to boost the orbiting system. In the other direction, it is a power generating system. Pulsing the current sets up a dynamic oscillation in the tether, which can upset the satellite attitude and preclude docking. A basic problem occurs around 400-m tether length, during satellite retrieval, when the satellite's pendulous (rotational) mode gets in resonance with the first lateral tether string mode. The problem's magnitude is determined by the amount of skiprope present coming into this resonance condition. This paper deals with the tethered satellite, its dynamic phenomena, and how the resulting problems were solved for the first tethered satellite mission (TSS-1). Proposals for improvements for future tethered satellite missions are included. Results from the first tethered satellite flight are summarized.

TP-3376 May 1993

Stress Corrosion Evaluation of HP 9Ni-4Co-0.30C Steel Plate Welds. P.D. Torres. Materials and Processes Laboratory. N93-28253

A stress corrosion cracking (SCC) investigation was conducted on HP 9Ni-4Co-0.30C steel plate welds (welded by using straight polarity plasma arc and HP 9Ni-4Co-0.20C weld wire) since this material is being considered for use in the Advanced Solid Rocket Motor (ASRM) program. Prior to the welding, the material was double tempered at 538 °C (1,000 °F). After welding, only part of the material was stress relieved at 510 °C (950 °F) for 3 h. Round tensile specimens obtained from nonstress-relieved material were tested in 100-percent relative humidity at 38 °C (100 °F), in 3.5-percent NaCl alternate immersion, and in 5-percent salt spray at 35 °C (95 °F). Specimens obtained from stress-relieved material were tested in alternate immersion. The stress levels were 50, 75, and 90 percent of the corresponding 0.2-percent yield strength (YS).

All the nonstress-relieved specimens exposed to salt spray and alternate immersion failed.

Stress-relieved specimens (exposed to alternate immersion) failed at 75 and 90 percent of YS. No failures occurred at 50 percent of YS in the stress-relieved specimens which indicates a beneficial effect of the stress relief on the SCC resistance of these welds. The stress relief also had a positive effect on the mechanical properties of the welds (the most important being an increase of 21 percent on the YS).

Under the conditions of these tests, the straight polarity plasma arc welded HP 9Ni-4Co-0.30C steel plate was found highly susceptible to SCC in the nonstress-relieved condition. This susceptibility to SCC was reduced by stress relieving.

TP-3410 September 1993

Structural Design/Margin Assessment. R.S. Ryan. Structures and Dynamics Laboratory.

Determining structural design inputs and the structural margins following design completion are some of the major activities in space exploration. The end result is a statement of these margins as stability, safety factors on ultimate and yield stresses, fracture limits (fracture control), fatigue lifetime, reuse criteria, operational criteria and procedures, stability factors, deflections, clearance, handling criteria, etc. The process is normally called a load cycle and is time consuming, very complex, and involves much more than structures. The key to successful structural design is the proper implementation of the process. It depends on many factors: leadership and management of the process, adequate analysis and testing tools, data basing, communications, people skills, and training. This report deals with this process and the various factors involved.

TP-3413 September 1993

Results of an Electrical Power System Fault Study (CDDF Final Report No. N06). N.R. Dugal-Whitehead and Y.B. Johnson. Information and Electronic Systems Laboratory.

This report gives the results of an electrical power system fault study which has been conducted over the last 2 and one-half years. First, the results of the literature search into electrical power system faults in space and terrestrial power system applications are reported. A description of the intended implementations of the power system faults into the Large Autonomous Spacecraft Electrical Power System (LASEPS) breadboard is then presented. Then the actual implementation of the faults into the breadboard is discussed along with a discussion describing the LASEPS breadboard. Finally, the results of the injected faults and breadboard failures are discussed.

CP-3182 November 1992
Second Workshop on Hydrogen Effects on Materials in Propulsion Systems. B.N. Bhat, R.L. Dreshfield, and E.J. Vesely, Jr., Editors. X93-10232

CP-3184 January 1993
NASA/MSFC FY92 Earth Science and Applications Program Research Review. J.E. Arnold and F.W. Leslie, Editors. N93-20067

CP-3192
The 1992 NASA Aerospace Battery Workshop. J.C. Brewer, Compiler. N93-20490

CP-3213 May 1993
Electrical Actuation Technology Bridging. M. Hammond and J. Sharkey, Compilers.

CP-3221 July 1993
Eleventh Workshop for Computational Fluid Dynamic Applications in Rocket Propulsion—Part I and Part II. R.W. Williams, Compiler.

CP-3227 August 1993
Conference on Binary Optics—An Opportunity for Technical Exchange. H.J. Cole and W.C. Pittman, Editors.

RP-1303 May 1993
A Shadowgraph Study of Two Proposed Shuttle-C Launch Vehicle Configurations. A.M. Springer and D.C. Pokora.

CR-4474 November 1992
Development and Application of a Time-Space Conversion Technique for Analysis of Weather Systems Passing Over the Kennedy Space Center. G.S. Forbes. NAG8-754. Pennsylvania State University. N93-15581

CR-4483 January 1993
Discrimination of Ionic Species From Broad-Beam Ion Sources. J.R. Anderson. NGT-50370. Colorado State University. N93-18140

CR-4486 January 1993
Predicting Multiwall Structural Response to Hypervelocity Impact Using the Hull Code. W.P. Schonberg. NAS8-36955. The University of Alabama in Huntsville. N93-18406

CR-4498 March 1993
Inner Magnetosphere Imager (IMI) Instrument Heritage. G.R. Wilson. NGT-01-002-099. The University of Alabama in Huntsville. N93-22685

CR-4503 March 1993
Accurate Computation and Continuation of Homoclinic and Heteroclinic Orbits for Singular Perturbation Problems. M.J. Friedman and A.C. Monteiro. NAS8-36955. The University of Alabama in Huntsville. N93-22672

CR-4529 July 1993
Ultraviolet Spectrometer and Polarimeter Catalog of Observations, Volume 1: Experiments 1–30719 (February 1980–April 1985). W. Henze, Jr., NAS8-35921. Teledyne Brown Engineering.

CR-4529 July 1993
Ultraviolet Spectrometer and Polarimeter Catalog of Observations, Volume 2: Experiments 30720–63057 (April 1985–February 1988). W. Henze, Jr. NAS8-35921. Teledyne Brown Engineering.

CR-4529 July 1993
Ultraviolet Spectrometer and Polarimeter Catalog of Observations, Volume 3: Experiments 63058–99771 (February 1988–November 1989). W. Henze, Jr. NAS8-35921. Teledyne Brown Engineering.

CR-4537 July 1993
A Study of the Merritt Island, Florida Sea Breeze Flow Regimes and Their Effect on Surface Heat and Moisture Fluxes. M.T. Rubes, H.J. Cooper, and E.A. Smith. NAG8-916. Florida State University.

CR-184386 October 1992
Glass Sample Characterization—Final Report. NAS8-36955. The University of Alabama in Huntsville. N93-70146

CR-184387 August 1990
Cryogenic Gyroscope and Space Helium Dewar Systems Research. NAS8-36955. The University of Alabama in Huntsville.

CR-184388 December 1989
Final Report for NAS8-36955, D.O. 7 for the Period 09-19-88 Through 09-18-89. NAS8-36955. The University of Alabama in Huntsville. N93-70312

CR-184389 September 1989
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BLACK, C.D.
ENGLEHAUPT, D. (UAH)
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DRUEDING, T.W. (Boston University)
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HENGEL, J.E. ED33
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FAZAH, M.M. EP53
LAK, T. (Rockwell)
NGUYEN, H.
WOOD, C.C.
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FEHSE, W. (European Space Agency)
TOBIAS, A.
THOMAS, U.
HOODLESS, R. EE84
BUCHANAN, H.
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BROWNING, J.C. (Tennessee State University)
HENRY, G.
MORTON, M.D. (Vanderbilt University)
HALL, D.S.
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FENNELLY, J.A. (UAH)
TORR, D.G.
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YUNG, S. (Boeing)
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FICHTL, G.H. ES01
GALLOWAY, P.N. (Teledyne Brown)
TWICHELL, W.B.
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ROGERS, P.
OTTE, N.
CORSS: Cylinder Optimization of Rings, Skin, and Stringers. For presentation at OPTI '93 Computer Aided Optimum Design of Structures, Zaragoza, Spain, July 7–9, 1993.

FINCKENOR, M.M. EH15
LINTON, R.C.
KAMENETZKY, R.R.
VAUGHN, J.A.
Thermal Control Materials on EOIN-3. For presentation at the AIAA Space Programs and Technology Conference, Huntsville, AL, September 21–23, 1993.

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SIMS, J.A.
HUGHES, M. EP75

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FISHER, M.F. EP56
FOX, E.C.

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FISHMAN, G.J. ES66

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FITZJARRALD, D. ES42
ROBERTSON, F.
BARRON, E. (Pennsylvania State University)
THOMPSON, S.
(National Center for Atmospheric Research)
POLLARD, D.

Simulated Interannual Variability in the Hydrologic Cycle Over North America. For presentation at the Sixth Conference on Climate Variations (AMS), Nashville, TN, January 23–28, 1993.

FONTENLA, J. (UAH)
SCHMIEDER, B. (Observatoire de Paris)
SIMNETT, G. (UAB)
TANDBERG-HANSSEN, E. ES01

Time Evolution of a Mini-Flare as Seen in Ha, UV Lines, and X Rays. For publication in Astronomy and Astrophysics, Meudon, France.

FORSYTHE, E. (USRA)
PUSEY, M. ES76

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FORSYTHE, E. (USRA)
PUSEY, M. ES76

Tetragonal Lysozyme Face Growth Rates—Revisited. For presentation at the Fifth International Conference on Crystallization of Biological Macromolecules, San Diego, CA, August 8–13, 1993.

FRADKOY, Y.E. (Polytechnic Institute)
MANI, S.
GLICKSMAN, M.E.
FRAZIER, D.O. ES74
WITHEROW, W.K.

FACEMIRE, B.R.
DOWNEY, J.P.
ROGERS, J.R.
Mixed Dimensional Coarsening of 3–D Droplets by 2–D Diffusion. For presentation at the 1993 Fall Meeting of the Materials Research Society, Boston, MA, November 29–December 3, 1993.

FULTON, M.A. ES65
RAMSEY, B.D.
KOLODZIEJCZAK, J.J. (Hughes Corp.)
Microstrip Detector Development for X-Ray Astronomy. For presentation at SPIE's 1993 Symposium on Optical Instrumentation and Applied Science, San Diego, CA, July 11–16, 1993.

GADDIS, S.W. ED35
Experimental Study of Three Exit Pressure Distortions on Turbine Performance. For presentation at the 29th Joint Propulsion Conference and Exhibit, Monterey, CA, June 28–July 1, 1993.

GAFFNEY, N.I. (University of Texas)
LESTER, D.F.
TELESCO, C.M. ES63
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UPADHYAY, T.N.
DEATON, A.W. EL58
LOMAS, J.M.
GPS Relative Navigation for Automatic Spacecraft Rendezvous and Capture. For presentation at the National Telesystems Conference, Atlanta, GA, June 16–17, 1993.

GALLAGHER, D. ES53
The Inner Magnetosphere Imager Mission. For presentation at '93 Solar System Plasma Physics Resolution of Processes in Space and Time, Yosemite, CA, February 2–5, 1993.

GANGL, B. EB56
FREESTONE, T.
SIMS, H.
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RABIN, D. (National Solar Observatory)
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SAVILLE, M. (Allied Signal Aerospace Co.)
GU, A.
Foil Bearing Performance in Liquid Nitrogen and Liquid Oxygen. For presentation at the AIAA Joint Propulsion Conference and Exhibit, Monterey, CA, June 28–30, 1993.

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GHAFFARIAN, B. (Sverdrup)
CUMMINGS, R. ED65
Advanced X-Ray Astrophysics Facility (AXAF-I) Thermal Analyses Using Integrated Thermal Analysis System (ITAS) Program. For presentation at the Thermal and Fluid Analysis Workshop '93, Cleveland, OH, August 16–20, 1993.

GILES, B.L. ES53
CHAPPELL, C.R.
MOORE, T.E.
COMFORT, R.H. (UAH)
WAITE, J.H., Jr. (Southwest Research Institute)
Statistical Survey of Pitch Angle Distributions in Core (0–50 eV) Ions From Dynamics Explorer-1: Outflow in the Auroral Zone, Polar

Cap, and Cusp. For publication in the Journal of Geophysical Research, Washington, DC.

GILLIES, D.C. ES75
LARSON, D.J. (Grumman)
LEHOCZKY, S.L. ES75
SZOFRAN, F.R.
ET AL.
Bulk Growth of II-VI Crystals in the Microgravity Environment of USML-1. For presentation at SPIE's International Symposium on Optics, Imaging, and Instrumentation, San Diego, CA, July 11–16, 1993.

GOLDBERG, B.E. EP12
COOK, J.R.
Solid Rocket Combustion Simulator (SRCS). For presentation at the AIAA Conference, Monterey, CA, June 27–July 1, 1993.

GOLDE, R.P. (Thiokol)
CLINTON, R.G. EE51
A Total Quality Management Approach to Solid Rocket Motor Nozzle Problem Solving. For presentation at the Annual JANNAF RNTS Meeting, Sunnyvale, CA, December 8–10, 1992.

GOODMAN, S.J. ES42
CHRISTIAN, H.J.
SCHARFEN, G.
Intercomparisons of Global Lightning and Rainfall Observations From Space. For presentation at the Symposium on Global Electric Circuit, Global Change, and the Meteorology Application of Lightning Information, Nashville, TN, January 23–28, 1994.

GOODMAN, S.J. ES42
LAFONTAINE, F.J.
HUFFMAN, G.J. (USRA)
ADLER, R.F. (GSFC)
An Intercomparison of the Navy Cal/Val and SSM/I Pathfinder Precipitation Algorithms. For presentation at the Shared Processing Network SSM/I Algorithm Symposium, Monterey, CA, June 8–10, 1993.

GOODMAN, S. ES42
RAGHAVAN, R. (USRA)
Investigating the Relation Between Precipitation and Lightning Using Polarimetric Radar Observations. For presentation at the 26th Conference on Radar Meteorology, Norman, OK, May 24–28, 1993.

GOODMAN, S.J. ES44
CROSSON, W.L.
LAYMON, C.A.
DUCHON, C.A.
Surface Energy and Land-Atmosphere Water Budgets During the CaPE Hydrometeorology Project. For presentation at the 1992 AGU Fall Meeting, San Francisco, CA, December 7–11, 1992.

GORDON, S. (Nichols Research)
NUNES, A.C., Jr. EH23
An Investigation Into Geometry Effects Upon the Ultimate Tensile Strengths of Butt Welds. For presentation at the International Conference on Modeling and Control of Joining Processes, Orlando, FL, December 6–8, 1993.

GRAHAM, J.B. PD22
Parametric Study of Shroud Design on Launch Vehicle Performance. For publication in the Journal of Spacecraft and Rockets, Blacksburg, VA.

GRIFFIN, L.W. ED32
HUBER, F.W.
Advancement of Turbine Aerodynamic Design Techniques. For presentation at the ASME International Gas Turbine Conference, Cincinnati, OH, May 24–27, 1993.

GRIFFIN, L.W. ED32
ROWEY, R.J. (Pratt & Whitney)
Analytical Investigation of the Unsteady Aerodynamic Environments in Space Shuttle Main Engine (SSME) Turbines. For presentation at the 1993 ASME International Gas Turbine Conference, Cincinnati, OH, May 24–27, 1993.

GUFFIN, T. EO43
ONKEN, J.
Generic Mission Planning Concepts for Space Astronomy Missions. For presentation at the Second International Symposium on Ground Data Systems for Space Mission Operations, JPL, Pasadena, CA, November 16–20, 1992.

GUITER, S.M. ES53
MOORE, T.E.
Modeling of Heavy Ion Enhancements in the Outer Plasmasphere. For presentation at the Spring AGU Meeting, Baltimore, MD, May 24–28, 1993.

GURULE-LEYBA, S. ES74
COLLINS, J.
MASCARENAS, M.
PENN, B.
CLARK, R.D.
Preparation of 4-Nitroanilines Containing Heterocyclic Amines. For presentation at the Science and Technology Alliance Materials Conference 93, Greensboro, NC, October 27–29, 1993.

HAGYARD, M.J. ES52
Nonpotential Magnetic Fields in Solar Active Regions. For presentation at the IAU Colloquium No. 141, IAU Commission 10, Beijing, China, September 6–12, 1992.

HAGYARD, M.J. ES52
WEST, E.A.
SMITH, J.E.
KENNY, E.G. (Boeing)
Magnetic Field Configuration Associated With Solar Flares in June 1991. For presentation at the 24th SPD Meeting, Stanford, CA, July 13–16, 1993.

HAKKILA, J. (Mankato State University)
MEEGAN, C.A. ES66
PENDLETON, G.N. (UAH)
FISHMAN, G.J. ES66
WILSON, R.B.
ET AL.
Constraints on Galactic Distributions of Gamma-Ray Burst Sources from BATSE observations. For publication in the Astrophysical Journal, Tucson, AZ.

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Marshall Space Flight Center's Virtual Reality Applications Program. For presentation at New York Technology Summit, New York, NY, December 8–11, 1992.

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Ergonomics and VDT Design for Space Environments. For presentation at the Fifth International Conference on Human-Computer Interaction, Orlando, FL, August 8–13, 1993.

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Future Uses of Virtual Reality in Long Duration Space Flight and Other Isolated Environments. For presentation at the 1993 International Space Development Conference, Huntsville, AL, May 27–31, 1993.

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Virtual Reality as a Human Factors Design Analysis Tool: Macro-Ergonomic Application Validation and Assessment of the Space Station *Freedom* Payload Control Area. For presentation at Space Operations Applications Research (SOAR) '93, Houston, TX, August 3–5, 1993.

HAM-BATTISTA, G. (Sverdrup)
HELMICK, G.
HUNT, G.
FRANCK, C. ED25
Finite Element Analysis of the Space Shuttle Main Engine Alternate Turbopump Development (ATD) High Pressure Oxidizer Turbopump (HPOTP). For presentation at the AIAA/ASME/ASCE/AHS 34th Structures, Structural Dynamics and Materials (SDM) Conference, LaJolla, CA, April 19–20, 1993.

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Observation of Hard X-Ray Transients With BATSE. For presentation at the Second Compton Observatory Symposium, College Park, MD, September 20–22, 1993.

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WHEATON, W.A.
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FINGER, M.H.
KOUVELIOTOU, C. (USRA)
PACIESAS, W.S. (UAH)
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FISHMAN, G.J.
PACIESAS, W.S. (UAH)
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PACIESAS, W.S.
FINGER, M.
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WILSON, C.A.
FINGER, M.H. (Computer Sciences Corp.)
BROCK, M.N.
WILSON, R.B.
FISHMAN, G.J.
RUBIN, B.C. (USRA)
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PACIESAS, W.S. (UAH)
PENDLETON, G.N.
Observation of GX 339–4 Hard State Outbursts in 1991 and 1992. For publication in the ApJ Letters, Cambridge, MA.

HARMON, B.A. ES62
FISHMAN, G.J.
PARNELL, T.A.
LAIRD, C.E. (Eastern Kentucky University)
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ESKRIDGE, R. EP53
Experimental Investigation of a Simulated Lox Injector Flow Field. For presentation at the 29th AIAA/SAE/ASME/ASEE Joint Propulsion Conference, Monterey, CA, June 28, 1993.

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Revealing the Solar Interior. For publication in Astronomy Magazine, Waukesha, WI.

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REICHMANN, E.J.
The Shape of the Solar Sunspot Cycle. For presentation at the 24th SPD Meeting, Stanford, CA, July 13–16, 1993.

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Doppler Measurement of the Solar Meridional Circulation. For publication in GONG 1992: Seismic Investigation of the Sun and Stars (Proceedings), Boulder, CO.

HE, X.M. ES76
HOLOWACHUK, E.W. (Bassett Hospital)
NORTON, E.J.
TWIGG, P.D. ES76
CARTER, D.C.

Three-Dimensional Structure of Horse Serum Albumin at 2.7 Å. For publication in FEBS, El Sevier, Amsterdam, The Netherlands.

HELBA, M.J. (Science Applications International)
MOG, R.A. (UAH)
ROBINSON, J.H. ED52
Design Optimization of Multibumper Spacecraft Protective Structures for Space Station *Freedom*. For presentation at the AIAA Space Programs and Technologies Conference, Huntsville, AL, September 21–23, 1993.

HELMICKI, A. (University of Cincinnati)
JAWEED, S.
KOLCIO, K.
KUO, F. ED14
Health Monitoring and Control for the STME: A Case Study. For presentation at the Fourth Annual Health Monitoring Conference for Propulsion Systems, Cincinnati, OH, November 18, 1992.

HERRMANN, M.C. PD24
Small Spacecraft Applications for Future Science Missions. For presentation at the Seventh Annual AIAA/Utah State University Conference on Small Satellites, Logan, UT, September 13–16, 1993.

HERTEL, E.S., Jr. ED52
CHHABILDAS, L.C.
HILL, S.A.
Hyper Velocity Impact Tests and Simulations of Single Whipple Bumper Shield Concepts at 10 km/s. For presentation at the 1992 Hypervelocity Impact Symposium, Austin, TX, November 17, 1992.

HICKEY, M.P. ES44
JAMES, B.F.
ANDERSON, B.J.
SMITH, R.E.
A Comparison of Measured and Modeled Thermospheric Densities and the Implications for Space Station *Freedom*. For presentation at the AIAA 31st Aerospace Sciences Meeting, Reno, NV, January 11–14, 1993.

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HOUGHTON, J.R.
WILKERSON, C.
WILSON, D.A.
Serpentine Optical Fiber Strain Gauge Evaluation. For publication in Applications of Fiber Optic Sensors in Engineering Mechanics, NJ, April 1993.

HINMAN-SWEENEY, E.M. EB62
Enhancing Productivity in Space Through Robotics. For presentation at the International Conference on CAD/CAM Robotics and Factories of the Future, St. Petersburg, Russia, May 17–20, 1993.

HINMAN-SWEENEY, E.M. EB62
Developing an Electronic International Network for Space Communications. For presentation at HCI International, Orlando, FL, August 8–13, 1993.

HO, J.X. ES76
RUKER, F.
KEELING, K.
CARTER, D.C.
Structure of FAB Fragment of 3D6 Monoclonal Antibody IgG and Its Binding to a Fragment of GP–41 of HIV Virus Type I. For presentation at the 16th International Conference of IUCR, Beijing, China, August 21–29, 1993.

HOFMEISTER, W.H. (Vanderbilt University)
MORTON, C.W.
BAYUZICK, R.J.
ROBINSON, M.B. ES75
A Statistical Approach to Understanding Nucleation Phenomena. For presentation at the International Workshop on Undercooled Metallic Melts: Properties, Solidification and Metastable Phases, Cioci, Italy, June 6–11, 1993.

HOLMES, R.R. EJ22
McKECHNIE, T.N.
Plasma Spray in the Space Program: Evolution From Thermal Barrier Coatings to Structures and Back. For presentation at Thermal Barrier Coatings for Aerospace Applications, Toronto, Canada, October 22–23, 1992.

HOLMES, R.R. EH25
ZIMMERMAN, F.R.
KROTZ, P.D. (Rockwell)
McKECHNIE, T.N.
LIAW, Y.K.
Thermal Spray of Refractory Metal Powders for High Temperature Furnace Applications. For

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SHEALY, D.L. (UAB)
GORE, D.
WALKER, A.B.C., Jr. (Stanford University)
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DEFOREST, C.E.
WATTS, R. (Nat. Inst. of Stds. and Tech.)
TARRIO, C.
Ultrahigh Resolution Photographic Films for X-Ray/EUR/FUV Astronomy. For publication in the Proceedings of SPIE, San Diego, CA, July 17–24, 1992.

HOPSON, G.D. KA01
Maintainable Design for Space Station *Freedom*. For presentation at the 44th International Astronautical Congress, Graz, Austria, October 16–22, 1993.

HORACK, J.M. ES66
KOSHUT, T.M. (UAH)
MALLOZZI, R.S.
STOREY, S.D. ES66
EMSLIE, A.G. (UAH)
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A Search for Nonburst Emission From the Positions of Well-Located Gamma-Ray Bursts. For publication in The Astrophysical Journal, Tucson, AZ.

HORACK, J.M. ES62
MEEGAN, C.A.
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PACIESAS, W.S. (UAH)
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PENDLETON, G.N.
BROCK, M.N. ES62
Effects of Location Uncertainties on the Observed Distribution of Gamma-Ray Bursts Detected by BATSE. For publication in The Astrophysical Journal, Tucson, AZ.

HORACK, J.M. ES64
HARMON, B.A.
FISHMAN, G.J.
MEEGAN, C.A.
WILSON, R.B.
PACIESAS, W.S. (UAH)
Detecting Discrete Emission From Well-Localized Gamma-Ray Bursts Using the BATSE Occultation Method. For presentation at the 181st American Astronomical Society Meeting, Washington, DC, January 3–7, 1993.

HOWARD, S. (USRA)
FINGER, M. (Computer Science Corp.)
MEEGAN, C.A. ES66
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PACIESAS, W.S. (UAH)
GIBBY, L. (Boeing)
Search for Correlations of BATSE Gamma-Ray Bursts With Known Objects. For publication in Nature, Washington, DC.

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HOWARD, S. ES66
KEEL, W.C. (University of Alabama)
BYRD, G.
BURKEY, J.
A Simulation Atlas of Tidal Features in Galaxies. For publication in ApJ, Chicago, IL.

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HEAMAN, J.P.
DUNN, M.G. (Calspan)
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BARR, T.A., Jr.
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LEVACK, D.J.H.
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POLETTO, G. (Osservatorio Astrofisico di Arcetri)
SUESS, S.T. ES52
WANG, A.-H. (UAH)
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COUNTER, D. ED33
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PYLE, B.H. (Montana State University)
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LING, J.C. (JPL)
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VALLELY, P. ED14
RYAN, S.

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FRAZIER, D.O.
McMANUS, S.P. (UAH)
ZUTAUT, S.E.
SANGHADASA, M.

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TELESCO, C.M.
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BRAINERD, J.J.
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JOHNSTON, L.
DENNISTON, C.

CZEKALSKI, B.E. (Intergraph)
Finite Element Analysis of a Composite Artificial Ankle. For presentation at The Third National Technology Transfer Conference, Baltimore, MD, December 8, 1992.

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GREGORY, J.C. (UAH)
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NAG, P.
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SELMARTEN, J.D. (Teledyne Brown)
Launch Window Design and Development Process: An Historical Account for the Atmospheric Laboratory for Applications and Science (ATLAS 1) Mission. For presentation at the AAS/AIAA Astrodynamics Conference, Victoria, British Columbia, Canada, August 16–19, 1993.

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PUTCHA, C.S. (California State University)
HERDA, D.A. CT01
BUSH, D.R.
STATUM, D.M. (PRC)
ANDING, B.J. (USBI)
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PLACHTA, D.W. (LeRC)
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FONTENLA, J.M. (UAH)
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COOPER, A.E.
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KOUVELIOTOU, C.
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PENDLETON, G.N.
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QUATTROCHI, D.A. ES42
Use of Thermal Infrared Multispectral Scanner (TIMS) Data for Analysis of Urban Landscape and Vegetation Responses. For presentation at the Workshop on Thermal Remote Sensing of the Energy and Water Balance Over Vegetation in Conjunction With Other Sources, La Londe Les Maures, France, September 20–25, 1993.

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CHANDRASEKAR, V. (Colorado State University)
CAYLOR, I.J. (Colorado State University)
Polarimetric Radar Observations From a Vertically Pointing Radar and Their Significance to Spaceborne Radar Measurements. For presentation at the 26th International Conference on Radar Meteorology, Norman, OK, May 24–28, 1993.

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CHANDRASEKAR, V.
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GOODMAN, S. ES42
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WEIMER, J.J.
YOUNG, P.R. (LaRC)
PETERS, P. ES63
Degradation of Polymers Exposed to Low Earth Orbit Environment on the Long Duration Exposure Facility. For presentation at the High Performance Polymer and Polymer Matrix Composites Symposium, San Francisco, CA, April 12–16, 1993.

RAMACHANDRAN, N. (USRA)
BAUGHER, C. ES71
ROGERS, M. (UAH)
Acceleration Environment on the Space Shuttle and Its Impact on Thermo-Solutal Fluid Mechanics. For presentation at the ASME Winter Annual Meeting, New Orleans, LA, November 28–December 3, 1993.

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SMITH, A.
McDANIELS, D.
VU, B.
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RAMSEY, B.D. ES65
AUSTIN, R.A. (Hughes Corp.)
MINIMATANI, T.
WEISSKOPF, M.C. ES65
GRINDLEAY, J.E. (Harvard)
LUM, K.S.K.
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A Hybrid Gas Detector/Phoswich for Hard X-Ray Astronomy. For presentation at SPIE's 1993 Symposium on Optical Instrumentation and Applied Science, San Diego, CA, July 11–16, 1993.

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HE, K.X.
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PENN, B.G.
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ATHAVALE, M.M.
THOMAS, M.E.
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VENKATESWARLU, P.
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PENN, B.
CLARK, R.D.
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CRONISE, R.C.
VAN ALSTINE, J.M. (UAH)
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HARDESTY, R.M.
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STONE, N.H. ES53
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GENTZ, S.J. EH22
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NURRE, G.S.
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KOSHAK, W.J.
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GUPTA, V.K.
HAWORTH, J.M.
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CLINTON, R.G. EH34
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PACIESAS, W.S.
FINGER, M.H. (Computer Science Corp.)
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MATSON, D. (Aerojet)
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NELLIGAN, T.
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COHEN, B. (Boeing)
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ADAMS, M. ES52
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Spacecraft On-Orbit Coupled Loads Analysis. For presentation at the AIAA 34th Structures, Structural Dynamics, and Materials Conference, LaJolla, CA, April 19–22, 1993.

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OWENS, J.K.
CHANG, T. (UAH)
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TORR, M.R. JA01
RICHARDS, P.G.
FENNELLY, J.A.
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Modeling of Observations of the Airglow and Aurora Taken by the Imaging Spectrometric Observatory (ISO) on the ATLAS 1 Mission. For presentation at the International Association of Geomagnetism Aeronomy's 1993 Conference, Buenos Aires, Argentina, August 8–15, 1993.

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UPADHYAY, T. (Mayflower Communications)
GALDOS, J.I.
RHODEHAMEL, H.W.
DEATON, A.W. EL58
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UYEHARA, H. (Aerospace Corp.)
ZACHARY, A.T.
CIKANEK, H.A., III HA31
Requirements and Development Considerations for the Space Transportation Main Engine Using the QFD Process. For presentation at the AIAA.

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YOUNG, A.C.
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BARBEE, T.W., Jr.
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AUSTIN, R.A. (Hughes Corp.)
DIETZ, K.L. ES65
KOLODZIEJCZAK, J. (Hughes Corp.)
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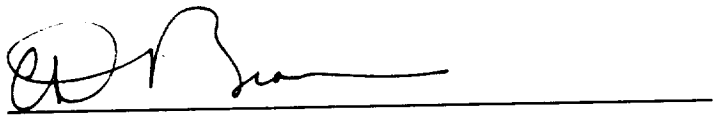
APPROVAL

FY 1993 SCIENTIFIC AND TECHNICAL REPORTS, ARTICLES, PAPERS, AND PRESENTATIONS

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 nuclear energy activities or 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
Human Resources and Administrative Support

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