NASA TECHNICAL MEMORANDUM

NASA TM 78138

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FY 1977 SCIENTIFIC AND TECHNICAL REPORTS, ARTICLES, PAPERS, AND PRESENTATIONS

Compiled by O. L. White
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George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama
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<td>ABSTRACT</td>
<td>This document presents formal NASA technical reports, papers published in technical journals, and presentations by MSFC personnel in FY 77. It also includes papers of MSFC contractors. After being announced in STAR or L STAR, all of the NASA series reports may be obtained from the Scientific and Technical Information Facility, P.O. Box 8757, Baltimore/Washington International Airport, Baltimore, MD 21240. The information in this report will be of value to the scientific and engineering community in determining what information has been published and what is available.</td>
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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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# FY 1977 Scientific and Technical Reports, Articles, Papers, and Presentations

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This document contains about 7600 references on the metric system and conversion to the metric system. These references include all known documents on the metric system as of December 1975, the month of enactment of the Metric Conversion Act of 1975. This bibliography includes books, reports, articles, presentations, periodicals, legislation, motion pictures, TV series, film strips, slides, posters, wall charts, education and training courses, addresses for information, and sources for metric materials and services. The bibliography is comprehensively indexed for quick retrieval.

This report defines a procedure for developing a statistical air quality assessment for the launch of an aerospace vehicle from the Kennedy Space Center in terms of existing climatological data sets. The procedure can be refined as developing meteorological conditions are identified for use with the NASA-Marshall Space Flight Center Rocket Exhaust Effluent Diffusion (REED) description. Fundamentally, this procedure involves the use of classical climatological regimes for the long-range analysis that can be narrowed as the synoptic and mesoscale structure is identified. Only broad synoptic regimes are identified at this stage of analysis. However, as the statistical data matrix is developed, these synoptic regimes will be refined in terms of the resulting eigenvectors as applicable to aerospace air quality predictions.

This document summarizes the experiment objectives, design/operational concepts, and final results of each of nine scientific experiments conducted during the first Space Processing Applications Rocket (SPAR) flight flown by NASA in December 1975. The nine individual SPAR experiments, covering a wide and varied range of scientific materials processing objectives, were entitled: Solidification of Pb-Sb Eutectic, Feasibility of Producing Closed-Cell Metal Foams, Characterization of Rocket Vibration Environment by Measurement of Mixing of Two Liquids, Uniform Dispersions of Crystallization Processing, Direct Observation of Solidification as a Function of Gravity Levels, Casting Thoria Dispersion-Strengthened Interfaces, Contained Polycrystalline Solidification, and Preparation of a Special Alloy for Manufacturing of Magnetic Hard Superconductor Under Zero-g Environment.

This report establishes a theoretical background for the compilation process by dividing it into five phases and explaining the concepts and algorithms that underpin each. The five selected phases are lexical...
analysis, syntax analysis, semantic analysis, optimization, and code generation. Several methods for both top-down and bottom-up syntax analysis are illustrated via examples. Graph theoretical optimization techniques are likewise presented, and approaches to code generation are described for both one-pass and multipass compilation environments. Following the initial tutorial sections, more than 20 tools that have been developed to aid in the process of writing compilers are surveyed. Care is taken to categorize each according to the theoretical framework just established. A uniform notation is used throughout this portion rather than resorting to that notation used by each individual system. Eight of the more recent compiler development aids are selected for special attention – SIMCMP/STAGE2, LANG-PAK, COGENT, XPL, AED, CWIC, LIS, and JOCT. The concluding sections assess the impact of compiler development aids, describe some of their shortcomings, and inspect some of the areas of research currently in progress.

TM X-3509 March 1977
Solar Absorption Characteristics of Several Coatings and Surface Finishes.
James R. Lowery. N77-20567

The results of a study conducted to determine the solar absorption characteristics of several films potentially favorable for use as receiving surfaces in solar energy collectors are presented. Included in the investigation were chemically produced black films, black electrodeposits, and anodized coatings.

The results of this study showed that black nickel exhibited the best combination of selective optical properties of any of the coatings studied. A serious drawback to black nickel was its high susceptibility to degradation in the presence of high moisture environments. Electroplated black chrome generally exhibited high solar absorptivities, but the emissivity varied considerably and was also relatively high under some conditions. The black chrome had the greatest moisture resistance of any of the coatings tested. Black oxide coatings on copper and steel substrates showed the best combination of selective optical properties of any of the chemical conversion films studied.

TM X-73342 July 1976
Computer Simulation Results of Attitude Estimation of Earth Orbiting Satellites. Shanying R. Kou. Systems Dynamics Laboratory. N76-32213

Computer simulation results of attitude estimation of Earth-orbiting satellites (including Space Telescope) subjected to environmental disturbances and noises are presented in this report. Decomposed linear recursive filter and Kalman filter were used as estimation tools. Six programs were developed for this simulation, and all were written in BASIC language and were executed in computers HP 9830A and HP 9866A. Simulation results show that a decomposed linear recursive filter is accurate in estimation and fast in response time. Furthermore, for higher order systems, this filter has computational advantages (i.e., less integration errors and roundoff errors) over Kalman filter.

TM X-73343 September 1976

The major coordinate systems as well as the transformations and transformation angles between them for the Space Telescope are defined in this report. The
coordinate systems were primarily developed for use in pointing and control system analysis and simulation. Additional useful information (on nomenclature, symbols, quaternion operations, etc.) is contained in the appendices.

**TM X-73344 November 15, 1976**

A system engineering and economic analysis was conducted to establish typical reference baselines for the photovoltaic, solar thermal, and nuclear Satellite Power Systems. Tentative conclusions indicate that feasibility and economic viability are characteristic of the Satellite Power System and, therefore, deserve additional study. Many key issues exist but appear resolvable with the anticipated technological advances of the next decades.

**TM X-73345 September 1976**

Since the earlier days of the patent by the Israeli scientists (Nebenzahl and Leven, 1973), a virtual explosion of information on Laser Isotope Separation (LIS) has occurred. Research is apparently going on in several European countries and particularly in Russia. References vary from German patents to the Soviet Journal of Quantum Electronics, the American Science Journal, and then finally to the Science Fiction magazine, Analog.

An overview of the various categories of the LIS methodology is given together with illustrations showing a simplified version of the LIS technique, an example of the two-photon photoionization category, and a diagram depicting how the energy levels of various isotope influence the LIS process.

Applications have been proposed for the LIS system which, in addition to the use to enrich uranium, could in themselves develop into programs of tremendous scope and breadth. Such applications as treatment of radioactive wastes from light-water nuclear reactors, enriching the deuterium isotope to make heavy-water, and enriching the light isotopes of such elements as titanium for aerospace weight-reducing programs.

Economic comparisons of the LIS methodology with the current method of gaseous diffusion indicate an overwhelming advantage; the laser promises to be 1000 times more efficient. The technique could also be utilized in chemical reactions with the tuned laser serving as a universal catalyst to determine the speed and direction of a chemical reaction.

**TM X-73346 September 1976**

During the manned operation of the Skylab Apollo Telescope Mount, the Marshall Space Flight Center/The Aerospace Corporation solar X-ray telescope (S-056) observed many solar flares and transient solar phenomena. This report correlates those X-ray observations with events reported by H-alpha observers and those
recorded by integrating X-ray satellite detectors. Data included for individual events are:

1. Type of H-alpha activity
2. H-alpha begin, maximum, and end times
3. SOLRAD 9 or VELA X-ray (1 to 8 A) peak flux and time of peak flux
4. Begin time of S-056 observations
5. Approximate heliographic location

Minor X-ray transients and structural changes are not included in this report.

TM X-73347 September 1976

The main tool for comparing remote sensing classification results with ground truth information is a contingency table derived from overlaying digital classification and ground truth maps. The purpose of this report is to explore methods of deriving a maximum amount of information from the contingency table and of modifying the contingency table to provide more information. This report contains 15 different statistical criteria derived from a contingency table that can be used to evaluate tabular classification results, which unfortunately provide little information on the visual characteristics of a classification map. Tabular results provide information relating mainly to how much rather than where, which is the purpose of a map. Therefore modifications are proposed to the contingency table which contain information on the spatial complexity of the test site, on the relative location of classification errors, on how well the classification maps agree with the ground truth maps, and which reduce back to the original information normally contained in a contingency table.

TM X-73348 September 1976

The objectives of this work are to identify effects that are observed in Landsat image data when the image data are geographically corrected using the nearest neighbor, bilinear interpolation and bicubic interpolation registration techniques, and to identify potential impacts of registration on image compression and classification.

TM X-73349 April 1976

The purpose of this study was to provide a quantitative cost for various Spacelab flight hardware configurations, along with varied software development options. The three major conclusions reached as a result of this study are as follows:

1. Spacelab program cost for software development and maintenance is independent of experimental hardware and software options.
2. Distributed standard computer concept simplifies software integration without a significant increase in cost.

3. Decision on flight computer hardware configuration should not be made until payload selection for a given mission and a detailed analysis of the mission requirements are completed.

This report is published in five volumes: Volume I contains the Executive Summary (Presentation); Volume II, Study Elements and Approach; Volume III, Spacelab Cost Data; Volume IV, Spacelab User Cost Data (Central Experiment Computer); and Volume V, Spacelab User Cost Data (Distributed Computer).

This is Volume I: Executive Summary (Presentation).

TM X-73349 April 1976
Spacelab Experiment Computer Study

The purpose of this study was to provide a quantitative cost for various Spacelab flight hardware configurations, along with varied software development options. The three major conclusions reached as a result of this study are as follows:

1. Spacelab program cost for software development and maintenance is independent of experimental hardware and software options.

2. Distributed standard computer concept simplifies software integration without a significant increase in cost.

3. Decision on flight computer hardware configuration should not be made until payload selection for a given mission and a
detailed analysis of the mission requirements are completed.

This report is published in five volumes: Volume I contains the Executive Summary (Presentation); Volume II, Study Elements and Approach; Volume III, Spacelab Cost Data; Volume IV, Spacelab User Cost Data (Central Experiment Computer); and Volume V, Spacelab User Cost Data (Distributed Computer).

This is Volume III: Spacelab Cost Data, which provides the detailed costing methods and cost data.

This report is published in five volumes: Volume I contains the Executive Summary (Presentation); Volume II, Study Elements and Approach; Volume III, Spacelab Cost Data; Volume IV, Spacelab User Cost Data (Central Experiment Computer); and Volume V, Spacelab User Cost Data (Distributed Computer).

This is Volume IV: Spacelab User Cost Data (Central Experiment Computer).

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A high voltage electrostatic field enhances the rate of normal convective cooling. This cooling rate is a function of starting temperature and voltage applied, and an inverse function of atmospheric pressure or the heat capacity of the surrounding media. It appears that the cooling rate is also a function of current flow; however, additional work is needed to separate other variables from the effect of current flow.

The maximum increase in heat loss over the normal convective cooling was approximately 0.167°C/sec (0.3°F/sec) at 316°C (600°F) and 20000 V. From the data taken it is assumed that the added rate of cooling would be increased with higher temperatures and higher voltages.

It appears that a high voltage field disrupts the molecular layer of air surrounding a hot body and increases the rate of convective cooling.

Future tests are planned to further characterize this phenomenon and to determine applications for electrostatic cooling.

The Saturn launch vehicle's guidance and control system is so complex that the reliability of a simplex system is not adequate to fulfill mission requirements. Thus, to achieve the desired reliability, redundancy encompassing a wide range of types and levels was employed. At one extreme, the lowest level, basic components (resistors, capacitors, relays, etc.) are employed in series, parallel, or quadruplex arrangements to insure continued system operation in the presence of possible failure conditions. At the other extreme, the highest level, complete subsystem duplication is provided so that a backup subsystem can be employed in case the primary system malfunctions. In between these two extremes, many other redundancy schemes and techniques are employed at various levels. Basic redundancy concepts are covered to gain insight into the advantages obtained with various techniques. Points and methods of application of these techniques are included. The theoretical gain in reliability resulting from redundancy is assessed and compared to a simplex system. Problems and limitations encountered in the practical application of redundancy are discussed as well as techniques verifying proper operation of the redundant channels. As background for the redundancy application discussion, a basic description of the guidance and control system is included.
Skylab to study the Sun. It studied the Sun's atmosphere located from 0.5 to 5.0 solar radii above the Sun's limb. Such a telescope is so sensitive to contamination around the spacecraft that it caused a major contamination abatement program to be initiated at the conception of Skylab. This report analyzes the coronagraph's data, showing the successfulness of that abatement program.

TM X73354 November 1976
Laser Doppler Systems in Atmospheric Turbulence. S. S. R. Murty. Electronics and Control Laboratory N77-14297

This report is concerned with the estimation of the loss of heterodyne signal power for the Marshall Space Flight Center laser Doppler system due to the random changes in the atmospheric index of refraction. The current status in the physics of low-energy laser propagation through turbulent atmosphere is presented, as well as the analysis and approximate evaluation of the loss of the heterodyne signal power due to the atmospheric turbulence. The losses due to the atmospheric absorption, scattering, and turbulence are estimated for the conditions of the January 1973 flight tests, and theoretical and experimental signal to noise values are compared. In addition, the maximum and minimum values of the atmospheric attenuation over a two-way path of 20 km range are calculated as a function of altitude using models of atmosphere, aerosol concentration, and turbulence.

TM X-73355 September 1976

The energy crisis and a national concern for conserving energy resources have caused Congress to establish the Energy Research and Development Administration (ERDA). The ERDA has enlisted the Marshall Space Flight Center to perform certain aspects of a research and development program directed toward demonstrating the practical use of solar heating within 3 years and combined solar heating and cooling within 5 years. In conjunction with this solar research and development effort, it became apparent that a method of testing and evaluating solar panel coatings and designs and solar collector subsystems was necessary to quickly and easily make comparisons between representative candidate samples of each. An experimental apparatus was constructed and utilized in conjunction with both a solar simulator and actual sunlight to test and evaluate various solar panel coatings, panel designs, and scaled-down collector subsystems. Data were taken by an automatic digital data acquisition system and reduced and printed by a computer system. The solar collector test setup, data acquisition system, and data reduction and printout systems were considered to have operated very satisfactorily. Test data indicated that there is a practical or useful limit in scaling down beyond which scaled-down testing cannot produce results comparable to results of larger scale tests. Test data are presented herein as are schematics and pictures of test equipment and test hardware.

TM X-73357 December 1976

An overview of the data analysis results reported in the literature, to date, of the 15
June 1973 1B/M3 flare is presented. Some 30 papers have been published relative to this event. This work was performed to assist the participants of the Skylab Solar Workshop Series B on Solar Flares to become familiar with one of the best observed flares during the Skylab mission.

TM X-73358 November 29, 1976
Charged Particle Radiation Environment for the Spacelab and Other Missions in Low Earth Orbit — Revision A. John W. Watts, Jr. and Jerry J. Wright. Space Sciences Laboratory. N77-16979

The physical charged particle dose to be encountered in low Earth Orbit Spacelab missions is estimated for orbits of inclinations from 28.5 to 90° and altitudes from 200 to 800 km. The dose encountered is strongly altitude dependent, with a weaker dependence on inclination. Doses range from 0.007 rads/day at 28.5° and 200 km to 1.57 rads/day at 28.5° and 800 km behind a 5.0 g/cm² shield. Geomagnetically trapped protons were the primary source of damage over most of the range of altitudes and inclinations, with galactic cosmic rays making a significant contribution at the lowest altitudes.

TM X-73359 January 1977

This report presents the ambient and cryogenic temperature mechanical properties and the ambient temperature stress corrosion properties of annealed, straightened, and centerless ground Nitronic 60 stainless steel alloy bar material.

The mechanical properties of longitudinal specimens were evaluated at test temperatures from ambient to liquid hydrogen. The tensile test data indicated increasing strength with decreasing temperature to -320°F (-196.0°C). Below liquid nitrogen temperature the smooth tensile and notched tensile strengths decreased slightly while the elongation and reduction of area decreased drastically. The Charpy V-notched impact energy decreased steadily with decreasing test temperature.

Stress corrosion tests were performed on longitudinal tensile specimens and transverse "C"-ring specimens exposed to: alternate immersion in a 3.5% NaCl bath; humidity cabinet; and a 5% salt spray atmosphere. The longitudinal tensile specimens experienced no corrosive attack. Approximately 3/4 of the transverse "C"-rings exposed to alternate immersion and to salt spray experienced a pitting attack on the top and bottom ends. The "C"-rings exposed to the humidity cabinet indicated only mild rusting.

Additional stress corrosion tests were performed on transverse tensile specimens which were machined from an annealed, straightened, and centerless ground 2.50-inch (6.35 cm) diameter bar. No failures occurred in the 90% stressed specimens exposed for 90 days in the alternate immersion and salt spray environments.

TM X-73360 January 1977
Apollo-Soyuz Test Project — Composite of MSFC Final Science Report. Advanced Projects Office. N77-19121

This report summarizes the experimental procedures of nine experiments conducted during the Apollo-Soyuz Test
An attempt is made to understand the structure and decay of a trailing vortex through the numerical solutions of the full Navier-Stokes equations. Unsteady forms of the governing equations are recast in terms of circulation, vorticity, and stream function as dependent variables, and a second upwind finite difference scheme is used to integrate them with prescribed initial and boundary conditions. A discussion of the boundary conditions at the outer edge and at the outflow section of the trailing vortex is included. Different models of the flow are postulated, and solutions are obtained describing the development of the flow as integration proceeds in time. A parametric study is undertaken with a view to understand the various phenomena that may possibly occur in the trailing vortex. Using the Hoffman and Joubert law of circulation at the inflow section, the results of the present investigation are compared with the experimental data of Chigier and Corsiglia on a Convair 990 wing model and a rectangular wing. With an exponentially decaying law of circulation at the inflow section and an adverse pressure gradient at the outer edge of the trailing vortex, solutions depict vortex bursting through the sudden expansion of the core and/or through the stagnation and consequent reversal of the flow on the axis. It is found that this bursting takes place at lower values of the swirl ratio as the Reynolds number increases.

TM X-73362 January 1977
A Long-Lived Coronal X-Ray Arcade.
J. P. McGuire, E. Tandberg-Hanssen,
K. R. Krall, S. T. Wu, J. B. Smith, Jr.,
and D. M. Speich. Space Sciences
Laboratory. N77-17993
A large, long-lived, soft X-ray emitting arch system was observed during the last Skylab mission. This arcade of arches stayed in the same approximate position for several solar rotations. This report suggests that these long-lived arches owe their stability to the stable coronal magnetic-field configuration. A global constant $a$ force-free magnetic field analysis, as developed by Nakagawa et al., is used to describe the arches, and a marked resemblance is noted between the theoretical magnetic-field configuration and the observed X-ray emitting feature.

The equipment and procedure used to measure the test plane uniformity produced by the MSFC 405 lamp solar simulator array are presented along with details on the computer program used to analyze the measurement data. The results of the first measurement are given which showed the uniformity not to be as good as expected. The best uniformity obtained had a standard deviation of 4 percent with peak-to-peak values of $\pm 11$ percent.

Tethers have been proposed for many space applications such as retrieving stranded astronauts, stationkeeping two orbiting vehicles, and suspending scientific payloads into the upper reaches of the atmosphere from a main orbiting vehicle. Subsequent to these proposals, a new ingredient has been added. Namely, a closed-loop control system has been added to the tether reel which improves control over the tethered satellite. In addition to increasing the stability of the tethered satellite along local vertical, this control system can be used for deployment and retrieval of tethered satellites. This conceptual design study describes a tether system for suspending a science payload at an altitude of 120 km from a Space Shuttle Orbiter flying at an altitude of 200 km. In addition to the hardware conceptual designs, various aspects concerning Orbiter accommodations are discussed.
In July 1976, a Team of MSFC Science and Engineering personnel was formed to assess the technical adequacy of the High Energy Astronomy Observatory-B (HEAO-B) Attitude Control and Determination Subsystem (ACDS). As a result of their analysis of the ACDS, the Team found no reason why the ACDS will not perform its specified activities adequately. The Team's activities culminated in their participation in the HEAO-B Critical Design Review.


During the Skylab mission (May 1973 through February 1974), the X-ray event analyzer (X-REA), a part of the ATM/S-056 X-ray telescope experiment, monitored the 2.5 to 7.25 Å and 6.1 to 20 Å solar X-ray fluxes. As the mission progressed, it became apparent that the proportional counters of the X-REA were decreasing in sensitivity. This report presents findings, based on a comparison of simultaneous observation of a number of flares obtained with the X-REA and SOLRAD 9 instruments, which reveal the degree of deterioration of the counters with time. These corrections can then be applied to observed data, thus allowing a more accurate determination of the flux levels during the late mission phases and, thereby, extending the usefulness of the X-REA as a plasma diagnostic tool.


The dissolution of GaAs in Ga was studied to determine the nature and cause of faceting effects. Ga was allowed to dissolve single crystalline faces under isothermal conditions. Of the crystalline planes with low number indices, only the (100) surface showed a direct correlation of dissolution sites to dislocations. The type of dissolution experienced depended on temperature, and there were three distinct types of behavior.


The ATM/S-056 X-Ray Experiment operated successfully on Skylab from May 1973 to February 1974. The S-056 observations consist of 27,000 photographs (filter-heliograms) obtained by the X-ray telescope and 1100 h of proportional counter data obtained by the X-ray event analyzer in the soft X-ray region of the solar spectrum. This report contains a description of the S-056 data together with additional relevant information that may be needed by users of the data. Although the report is intended primarily to describe the data that were sent to the National Space Science Data Center, it should also be useful to other users.

Data for NASA's AVE V Experiment: 25-mb Sounding Data and Synoptic Charts. Mark E. Humbert and Kelly Hill. Space Sciences Laboratory. N77-20698

This report describes the AVE V Experiment and presents tabulated rawinsonde data at 25-mb intervals from the surface to 25 mb for the 23 stations.
participating in the experiment. Soundings were taken between 0000 GMT, June 11, and 1200 GMT, June 12, 1976. The methods of data processing and accuracy are briefly discussed. An example of contact data is also included.

TM X-73371 December 1976
Stephen J. Denton and C. K. Liu.
Preliminary Design Office. N77-22168

With special reference to design of fuel tanks in space vehicles, the principles of fracture mechanics are reviewed. An approximate but extremely simple relationship among (1) the operating stress level, (2) the length of crack, and (3) the number of cycles of failure is derived, from which any one of the variables can be computed approximately from the knowledge of the other two, if the loading schedule (mission of the tank) is not greatly altered.

Two sample examples illustrating the procedures of determining the allowable safe operating stress corresponding to a set of assumed loading schedule is included in this report. The selection of sample examples is limited by the relatively meager available data on the candidate material for various stress ratios in the cycling.

TM X-73372 December 1976

A systems model reflecting the current "in-house" design concepts of Satellite Power Stations (SPS) was developed. The model is of sufficient scope to include the interrelationships of the following major design parameters: the transportation to and between orbits; assembly of the SPS; and maintenance of the SPS.

The systems model is composed of a set of equations that are nonlinear with respect to the system parameters and decision variables. The model determines a "figure of merit" from which alternative concepts concerning transportation, assembly, and maintenance of satellite power stations can be studied. A hybrid optimization model was developed to optimize the system's decision variables. The optimization model consists of a random search procedure and the optimal-steepest descent method. A FORTRAN computer program was developed to enable the user to optimize nonlinear functions using the model. Specifically, the computer program was used to optimize Satellite Power Station system components.

TM X-73373 February 1977
Manufacturing Complexity Analysis. Dr. Leon M. Delionback. Systems Analysis and Integration Laboratory. N77-20440

This report explains the principle of complexity analysis and its special relationship with learning/cost improvement curve theory.

A "bottoms up" approach for the analysis of the complexity of a typical system is presented. Starting with the subsystems of an example system, the step-by-step procedure for analysis of the complexity of an overall system is given. The learning curves for the various subsystems are determined as well as the concurrent numbers of relevant design parameters. Then trend curves are plotted for the learning curve slopes versus the various design-oriented parameters, e.g.
number of parts versus slope of learning curve, or number of fasteners versus slope of learning curve, etc.

Representative cuts are taken from each trend curve, and a figure-of-merit analysis is made for each of the subsystems. Based on these values, a characteristic curve is plotted which is indicative of the complexity of the particular subsystem (Figure-of-merit versus learning curve slope). Each such characteristic curve is based on a universe of trend curve data taken from data points observed for the subsystem in question. Thus, a characteristic curve is developed for each of the subsystems in the overall system.

A composite complexity analysis is performed to determine the manufacturing complexity for the overall system. A procedure is outlined to define the steps in computation for this value (along with an illustrative example).

In the discussion a narrative description is given for the limitations in scope of the manufacturing complexity analysis with examples of some of the cost elements that are not included.

**TM X-73374**

November 1976


Analytical analysis and computer simulation results of the Miniaturized Pointing Mount as an instrument pointing system are presented. Miniaturized Pointing Mount performance results include inertial pointing, slewing, tracking, and rastering. Typical instrument characteristics are used as well as some parameter variations of instrument and Miniaturized Pointing Mount characteristics.

**TM X-73375**

April 1977


This report presents the ambient and cryogenic temperature mechanical properties and the ambient temperature stress corrosion properties of hot rolled and centerless ground Nitronic 32 stainless steel bar material.

The mechanical properties of longitudinal specimens were evaluated at test temperatures from ambient to liquid hydrogen. The tensile test data indicated increasing smooth tensile strength with decreasing temperature to liquid hydrogen temperature. However, below -200°F (-129.0°C) the notched tensile strength decreased slightly and below -320°F (-196.0°C) the decrease was significant. The elongation and reduction of area decreased drastically at temperatures below -200°F (-129.0°C). The Charpy V-notched impact energy decreased steadily with decreasing test temperature.

Stress corrosion tests were performed on longitudinal tensile specimens stressed to 0, 75, and 90% of the 0.2% yield strength and on transverse “C”-ring specimens stressed to 75 and 90% of the yield strength and exposed to: alternate immersion in a 3.5% NaCl bath, humidity cabinet environment, and a 5% salt spray atmosphere. The longitudinal tensile specimens experienced no corrosive attack; however, the “C”-rings exposed to the alternate immersion and to the salt spray environment experienced some shallow etching and pitting, respectively. Small cracks appeared in two of the “C”-rings after one month.
NASA TECHNICAL MEMORANDA

exposure to the salt spray. Metallographic examination did not reveal the branching phenomenon associated with stress corrosion cracking.

TM X-73376 February 1977

An attempt was made to observe the discrete X-ray source Sco X-1 with ATM instrumentation on 20 September 1973 between 0856 and 0920 UT. This report presents the results of analysis of the X-ray data obtained with the ATM/S-056 X-ray event analyzer, in particular the flux observed with the 1.71 to 4.96 keV counter. No photographic image of the source was obtained because Sco X-1 was outside the field of view of the X-ray telescope.

TM X-73377 January 1977
The Contribution of Interstellar Particles to the Interplanetary Dust Complex. Gilmer Allen Gary. Space Sciences Laboratory. N77-24038

The Poynting-Robertson effect acting on interstellar particles passing by the Sun was shown to have the potential to capture and possibly to contribute some of these particles to the interplanetary dust complex. When the probability of encounter of the Sun with interstellar clouds is considered, the quasi-equilibrium mass rate of accretion by this mechanism is comparable to the mass loss rate of the interplanetary complex. The mechanism then produces a quasi-equilibrium condition to maintain the interplanetary particle complex. This requires that the interstellar particles have a repulsive force due to radiation pressure less than the attractive gravitational force. If this assumption is correct for a significant fraction of the particles, then at intervals an interstellar cloud may pass sufficiently close to the Sun to allow the Poynting-Robertson effect to replenish the interplanetary complex.

The previously proposed mechanisms of gravitational encounters and the solar gravitational lens as a method of capture of interstellar particles are shown to be insufficient. Corrections to the formulations of these two methods are given, and a closed form formula of the Poynting-Robertson effect on hyperbolic orbits about a star is derived.

TM X-73378 February 1977

An elementary model of freely falling observers and emitters within a black hole’s radius is examined to determine the redshift spectrum reaching a typical observer. The model is independent of scale, the fundamental unit being the radius (mass) of the black hole. The observers/emitters all follow the same kinds of trajectories: radially inward and starting from rest at spatial infinity. The “test-particle” role is assumed throughout; i.e., the observers/emitters do not themselves contribute to the gravitational field of the system. By means of redshift formulas and luminosity distance to the emitters, a picture of actual redshifts and blueshifts, with their intensities, emerges for an observer within the black hole’s radius. No luminosity distances greater than approximately one-half the radius are considered in this particular study; nevertheless, redshifts and blueshifts up to approximately 0.6 are seen in portions of the observer’s celestial sphere (i.e., his sky). An exotic application can be made, as a
curiosity, to a black hole the size of the universe, resulting in a particular anisotropic “cosmology.”

TM X-73379 February 1977

The application of a specific digital computer system (known as the Image Data Processing System) to the analysis of three NASA-sponsored metallurgical experiments is discussed in some detail. Some of the basic hardware and software components of the Image Data Processing System are presented as deemed necessary for the understanding of the text. Many figures are presented in the discussion of each experimental analysis in an attempt to show the accuracy and speed that the Image Data Processing System affords in analyzing photographic images dealing with metallurgy, and in particular with material processing.

TM X-73380 February 1977

Bulk and thin films of FeTe have been studied Mössbauer spectroscopically. It was found that FeTe has one noncubic Fe$^{2+}$ site which is $3d^2$ $4s$ $4p^3$ hybridized. The presence of dangling bands is indicated in spectra of FeTe thin films. The films show a tendency of texture formation. The substrate is observed to influence the film structure and nature of bonds in films.

TM X-73390 April 1977

This report summarizes the progress made in the testing, evaluation, and correction of MSFC's 7.5 kW Electron Research, Incorporated (ERI) Electron Beam Welder in support of Space Shuttle Main Engine component welding at Rocketdyne in Canoga Park, California.

The objective of this project was to locate and correct the deficiencies in MSFC's 7.5 kW ERI electron beam welder and coordinate with Rocketdyne all data that would help to eliminate similar problems with their ERI equipment.

This report describes 17 areas that were deficient in the 7.5 kW ERI welding system, or checkout, and the associated corrective action taken to improve its operational performance.

The areas investigated during this project are not all inclusive but each particular modification or preventive measure provided a definite improvement in system performance. An overall improvement of 20 times the original reliability has been obtained at full rated capacity.

TM X-73391 April 1977
The High Energy Astronomy Observatory-A (HEAO-A) observatory, scheduled for launch in late June 1977, will spend most of its orbital lifetime in a scanning mode, spinning from 0.03 to 0.1 rpm about an axis aligned with the Sun. The dates of availability in the scan band are given for a list of 248 X-ray sources. Celestial maps of source locations and scan planes, and examples of the nighttime elevation of available sources are presented. This document is intended to aid ground-based observers in planning coordinated observations with HEAO-A.

TM X-73392 April 1977

Line-focusing acrylic Fresnel lenses with application potential in the 200° to 370° C range are being analytically and experimentally evaluated. Investigations previously conducted with a 56 cm wide lens have been extended by the present study to experimentation/analyses with a 1.8 by 3.7 m lens. A measured peak concentration ratio of 64 with 90 percent of the transmitted energy focused into a 5.0 cm width was achieved. A peak concentration of 61 and a 90 percent target width of 4.5 cm were analytically computed. The experimental and analytical lens transmittance was 81 percent and 86 percent, respectively. Thus, the analytical/experimental lens performance correlation is considered good. The lens also was interfaced with a receiver assembly and operated in the collection mode. The collection efficiency ranged from 42 percent at 100°C to 26 percent at 300°C, whereas an efficiency of 40 percent at 300°C was anticipated. Apparently, the reflective cavity surrounding the absorber tube did not perform as expected. Therefore, future receiver assemblies will decrease or eliminate reliance on reflective surfaces; i.e., the energy focused directly on the absorber tube surfaces will be increased. Efficiency improvements to the 40 to 50 percent range are anticipated.

TM X-73393 May 1977

This report supplements NASA TM X-73300, April 15, 1976. These reports are compilations of bibliographies from the principal investigator groups of the Apollo Telescope Mount (Skylab solar observatory facility) that gathered data from May 28, 1973, to February 8, 1974. The analysis of these data is presently under way and is expected to continue for several years.

The publications listed in this report are divided into the following categories: (1) Journal Publications, (2) Journal Publications Submitted, (3) Other Publications, (4) Presentations — National and International Meetings; and (5) Other Presentations. An author index is included together with errata for the first report.

TM X-73394 April 1977

The problems of orbit transportation have been addressed significantly during the past 5 years. An Interim Upper Stage (IUS)
and a Spinning Solid Upper Stage (SSUS) are being developed for operation in the early 1980's. Current long-range planning efforts indicate a need for extended space operations capabilities which are greater than that provided by IUS and SSUS.

This is a system study for a transportation system which will follow the IUS and SSUS. Included are concepts, concept comparisons, trends, parametric data, etc. associated with the future system. Relevant technical and programmatic information is developed. This information is intended to focus future activity to identify attractive options and to summarize the major issues associated with the future development of the system. A comprehensive summary of the study is included in the body of the report in section XVI.

It is primarily the developing need for Earth synchronous orbit capabilities which gives cause for further consideration of orbital transportation systems at this time. Transportation needs for manned and unmanned synchronous orbit systems are foreseen. Total recoverability and reusability with minimum refurbishment are goals for future orbit transport systems.

To establish a common basis for identifying current transportation concepts, an Orbit Transfer Vehicle (OTV) is defined as a propulsive (velocity producing) rocket or stage. When used with a crew transfer module, a manned sortie module or other payloads, the combination becomes an Orbit Transfer System (OTS). Standardization of OTV's and OTS's is required.

The electrophoresis of six columns was accomplished on the Apollo-Soyuz Test Project (ASTP). After separation, these columns were frozen in orbit and were returned for ground-based analyses. One major goal of the MA-011 experiment was the assessment of the separation achieved in orbit by slicing these frozen columns. The slicing of the frozen columns required a new device, and this report describes the development of that device.

This report presents an abbreviated description of the High Energy Astronomy Observatory (HEAO-A) Program, including spacecraft subsystems, scientific instrumentation, and the mission operations concept. Also, scientific participants such as Principal Investigators and Co-investigators are presented. This report is prepared as an aid to HEAO Guest Observers. Most of the material relating to the scientific instruments has been supplied by the investigators.

This handbook seeks to fulfill the need for a book or collection of aids to assist in estimating cost. It contains a description of a work breakdown structure and briefly treats the necessity of analyzing the requirements for a cost element. A part of the handbook is devoted to standards for...
specific production type standards and to an assemblage of "factors" which can be applied to manufacturing or production cost for determining associated costs.

**TM X-73398**  July 1977

This document consists of listings of technical briefs, reports, and papers pertaining to research being performed by MSFC personnel and contractors in the field of solar energy.

**TM 78120**  September 1977

This report presents a new type of modular dc power supply power sharing technique that was developed for the Apollo Telescope Mount (ATM) electrical power system on the Skylab. The advantages and disadvantages of various techniques used in the past are reviewed and compared to the new method. The new technique design is discussed, and results of its implementation in the ATM power system are reviewed.

**TM-78121**  July 1977

In early 1973 the Marshall Space Flight Center (MSFC) initiated an effort to develop and establish an automatic data processing system to be used primarily for the preparation of industrial-engineering-type manhour-and-material cost estimates. This computer system, termed PACE (Pricing and Cost Estimating), was established and has evolved over the past several years through the PACE I and PACE II systems into a highly versatile and highly flexible tool which significantly reduces computation time, eliminates computational errors, and reduces typing and reproduction time for estimators and pricers. Because this system makes all mathematical and clerical functions automatic once basic inputs are derived, the time of estimators, estimate managers, secretarial personnel, and engineers involved in the estimating and cost analysis process can be devoted to publication of ground rules, and collection, analysis, and adjustment of inputs and rationale. This system also reduces the manhours required for manual computations and documentation.

This handbook has been prepared to facilitate use by those not familiar with the PACE II system or with detailed automatic data processing techniques; therefore, an attempt has been made to be explanatory and specific in all areas where actions are required to implement and activate the system. (The PACE I system is described in detail in TM X-73325.)

**TM-78122**  July 1977

The sensitometry and film calibration effort for the NASA-MSFC/The Aerospace Corporation Skylab/ATM S-056 X-Ray Telescope is summarized. The apparatus and procedures used by Sperry/MSFC and by Aerospace Corporation are described.
together with the two types of flight film used, Kodak SO-212 and SO-242. The sensitometry and processing of the flight film are discussed, and the results are presented in the form of the characteristic curves and related data. The use of copy films is also discussed.

**TM-78123** April 1977

**A Preliminary Investigation of the Environmental Control and Life Support Subsystem (EC/LSS) for the Space Construction Base Manufacturing Modules.** Hubert B. Wells. Preliminary Design Office. N77-29788

This report presents the preliminary Prephase A data of the Environmental Control and Life Support Subsystem (EC/LSS) for a typical Space Construction Base manufacturing module. A space processing module, which is capable of performing production biological experiments, was chosen as a baseline configuration.

The module would be manned approximately 12 h/day by a crew of two (an engineer and technician). By assuming a three-man maximum capacity, consideration can be given to the use of existing EC/LSS assemblies such as Spacelab, Orbiter, or Regenerative Life Support Evaluation (RLSE). Spacelab assemblies were given preference because of their later production schedule. The primary Spacelab assemblies and components considered for use are humidity and temperature control, ventilation fan, cabin fan, water separator, condensate storage, overboard dumping, distribution system, contaminant monitoring, cabin sensors, and fire and smoke detection. Carbon dioxide removal, atmospheric supply, and pressure control are furnished by the Habitability Module/Subsystems Module.

Contaminant control is accomplished by the RLSE contaminant control assembly.

**TM-78124** June 1977

**Multipurpose Interactive NASA Information System (MINIS).** Data Systems Laboratory. N77-28987

The Multipurpose Interactive NASA Information System (MINIS) was developed to provide remote, interactive information retrieval capability for various types of data bases to be processed on different types of small and medium size computers.

This report presents to the layman user an explanation of how to use the system for three different data bases: (1) Landsat Photo Look-Up, (2) Land-Use, and (3) Census/Socio-Economic. Each of the data base elements is shown together with other detailed information that a user would require to contact the system remotely, to transmit inquiries on commands, and to receive the results of the queries or commands.

**TM-78127** August 1977


A concept is provided for a Geophysical Fluid Flow Cell (GFFC). Sufficient detail is given to allow the start of a GFFC design effort. A brief background of the scientific studies to be conducted with the GFFC and the theoretical basis for GFFC operation are also included.

**TM 78128** July 1977

**Some Basic Mathematical Methods of Diffusion Theory.** A. C. Giere. Space Sciences Laboratory.
An introductory treatment of the fundamentals of diffusion theory is presented, starting with molecular diffusion and leading up to the statistical methods of turbulent diffusion. The concepts and equations of diffusion are developed on an elementary level, with emphasis on atmospheric applications.

The vacuum environment in the wake region of presently planned large space vehicles is calculated using simplified models of the particle fluxes from the various sources. The fluxes which are calculated come directly from the ambient, are due to spacecraft emissions and are due to self-scattering of spacecraft emissions. Using nominal values for the surface emissions, the flux density at 550 km altitude is calculated at \( \sim 10^7 \text{cm}^{-2} \text{s}^{-1} \). For an experiment involving rapid deposition of vaporized material, this may result in contamination levels of \(< 1 \text{ part in } 10^9\) occurring in the bulk material. Calculations indicate that the flux density on a wake vacuum experiment conducted in the vicinity of the Shuttle will be substantially greater than that behind unmanned craft. However, it is possible that, under appropriate circumstances, meaningful wake vacuum experiments still could be conducted using the Shuttle facilities.
A theoretical model of the 6300 Å OI airglow emission has been developed based on the assumptions that both the charged and neutral portions of the Earth's upper atmosphere are in steady state conditions of diffusive equilibrium. Intensities of the 6300 Å OI emission line have been calculated using electron density-true height profiles from a standard C-4 ionosonde and exospheric temperatures derived from Fabry-Perot interferometer measurements of the Doppler-broadened 6300 Å emission line shape as inputs to the model. Reaction rate coefficient values, production mechanism efficiencies, solar radiation fluxes, absorption cross sections, and models of the neutral atmosphere have been varied parametrically to establish a set of acceptable inputs which will consistently predict 6300 Å emission intensities that closely agree with intensities observed during the post-sunset twilight period by an airglow observatory consisting of a Fabry-Perot interferometer and a turret photometer.

Emission intensities that can only result from the dissociative recombination of molecular oxygen ions were observed during the latter portion of the observational period. They were used with limiting values, taken from the literature, of the quenching coefficients and the production mechanism efficiencies to establish a representative model of the atmosphere. Based on current knowledge of the nearby hydroxyl bands and the configuration of the equipment used to obtain the observational data, theoretical calculations indicate that contamination of the 6300 Å OI emission should be on the order of or less than 3 percent; however, these results are very sensitive to the wavelengths of the individual lines and their intensities relative to the 6300 Å OI intensity.

The combination of a model atmosphere, production mechanism efficiencies, and quenching coefficient values was used during the earlier portion of the period when the dissociative photoexcitation and direct impact excitation processes were contributing to the intensity to establish best estimates of solar radiation fluxes in the Schumann-Runge continuum and associated absorption cross sections.

Results of this analysis show that the Jacchia 1971 model of the upper atmosphere combined with the Ackerman (1970) recommended solar radiation fluxes and associated absorption cross sections produces theoretically calculated intensities that more closely agree with the observed intensities than all the other combinations when the following set of reaction rate coefficients and efficiencies is used:

\[
\begin{align*}
O^+ + O_2 & \rightarrow O_2^+ + O \quad 2 \times 10^{-11}\, \text{cm}^3\, \text{s}^{-1} \\
O_2^+ + e & \rightarrow O^* + O \quad 1.95 \times 10^{-7} (300/T)^{0.7}\, \text{cm}^3\, \text{s}^{-1} \quad \text{with an efficiency} \\
& \quad \text{of producing an} \ O(1\,\text{D}) \text{ atom of} \ 0.50 \pm 0.32 \pm 0.12 \\
O^+ + N_2 & \rightarrow NO^+ + N \quad 1 \times 10^{-12}\, \text{cm}^3\, \text{s}^{-1} \\
NO^+ + e & \rightarrow N + O \quad 4.5 \times 10^{-7} (300/T)\, \text{cm}^3\, \text{s}^{-1} \quad \text{with no} \ O(1\,\text{D}) \text{ atoms being produced} \\
O(1\,\text{D}) + O_2 & \rightarrow O(3\,\text{P}) + O_2^* \quad 5 \times 10^{-11}\, \text{cm}^3\, \text{s}^{-1}
\end{align*}
\]
O(1D) + N₂ → O(3P) + N₂⁺ \( (1^+0.00) \)
\[ \times 10^{-10} \text{ cm}^3 \text{ s}^{-1} \]

However, the analysis showed that the third source of O(1D) atoms, by conjugate point photoelectrons, contributed significantly to the overall observed intensity during the early portion of the post-sunset twilight period with the contribution decreasing with increasing conjugate point solar zenith angle. No O(1D) atoms were produced by this mechanism after conjugate point sundown, assuming a screening height of 180 km. when the conjugate point solar zenith angle was approximately 103°.

TN D-8366 November 1976

The theoretical reflectance of X-rays from various materials and evaporated films is presented. A computer program has been written that computes the reflected intensity as a function of the angle of the incident radiation. The quantities necessary to generate the efficiency and their effect on the data are demonstrated. Five materials were chosen for evaluation: (1) fused silica, (2) chromium, (3) beryllium, (4) gold, and (5) a thin layer contaminant. Fused silica is a versatile and common material; chromium has high reflection efficiency at X-ray wavelengths and is in the middle of the atomic number range; beryllium contains a single atomic shell and has a low range atomic number; gold contains multiple atomic shells and has a high atomic number; the contaminant is treated as a thin film in the calculations and results are given as a function of thickness for selected wavelengths. The theoretical results are compared to experimental data at \( \lambda = 8.34 \) Å.

TN D-8409 February 1977

Problems dealing with corrosion and corrosion protection of solar heating and cooling systems are discussed. A test program was conducted to find suitable and effective corrosion inhibitors for systems employing either water or antifreeze solutions for heat transfer and storage. Aluminum-mild steel-copper-stainless steel assemblies in electrical contact were used to simulate a multimetallic system which is the type most likely to be employed. Several inhibitors show promise for this application.

TN D-8420 February 1977

A land use map of a five county area in North Alabama was generated from Landsat data using a supervised classification algorithm. There was good overall agreement between the land use designated and known conditions, but there were also obvious discrepancies. In ground checking the map, two types of errors were encountered — shift and misclassification — and a method was developed to eliminate or greatly reduce the errors. Randomly selected study areas containing 2525 pixels were analyzed. Overall, 76.3 percent of the pixels were correctly classified. A contingency coefficient of correlation was calculated to be 0.7 which is significant at the \( \alpha = 0.01 \) level. The study showed that land use maps generated by computers from Landsat data are useful for overall land use by regional
agencies. However, care must be used when making detailed analysis of small areas.

The procedure used for conducting the ground truth study together with data from representative study areas is presented in this report.

TN D-8429 February 1977

A Scanning Laser Doppler Velocimeter (SLDV) system was employed at a test site on the Gila River Indian Reservation south of Phoenix, Arizona, for the purpose of detecting, tracking, and measuring the velocity flow field of naturally occurring tornado-like flows (dust devils) in the atmosphere. Approximately 80 dust devils were observed with the system during the test period from August 10 through August 16, 1975. This report provides a review and general description of the dust devil phenomenon and outlines the test program, measurement system, and data processing techniques used to collect information on the dust devil flow field. The general meteorological conditions occurring during the test program are also described, and the information collected on two selected dust devils are discussed in some detail to show the type of information which can be obtained with a SLDV system. The results from these measurements agree well with those of other investigators and illustrate the potential for the SLDV in future endeavors; consequently, recommendations are given for a comprehensive test program using a variety of sensors for obtaining a more complete description of the dust devil phenomenon.

TN D-8435 February 1977
Evaluation of Quasi-Square Wave Inverter as a Power Source for Induction Motors. Buddy V. Guynes, Roger L. Haggard, and John R. Lanier, Jr. Electronics and Control Laboratory. N77-18559

This study investigates the relative merits of quasi-square wave inverter-motor technology versus a sine wave inverter-motor system. The empirical results of several tests on various sizes of wye-wound induction motors are presented with mathematical analysis to support the conclusions of this study. This study concludes that, within the limitations presented in this report, the quasi-square wave inverter-motor system is superior to the more complex sine wave system for most induction motor applications in space.

TN D-8445 March 1977

The purpose of this investigation was to assess the effectiveness of mesoscale models in explaining perturbations observed in vertical detailed wind profile measurements in the troposphere and lower stratosphere. The structure and persistence of the data were analyzed and interpreted in terms of several physical models with the goal of establishing explanations for the observed persistent features of the mesoscale flow patterns.

The experimental data used in the investigation were obtained by a unique detailed wind profile measurement system.
This system is capable of providing resolution of 50 to 100 m wavelengths for the altitude region from approximately 200 m to 18 km. The system consists of a high-resolution tracking radar and special super-pressure balloon configuration known as a Jimsphere.

These results show that a battery reconditioned with this circuit returns to greater than 90 percent of its original capacity (greater than nameplate capacity) and follows a typical new battery degradation curve even after over 20,000 simulated orbital cycles for a 4 year period.

This report addresses applications of the circuit and makes recommendations relative to its use. Its application in low voltage (22 to 36 Vdc) power systems and high voltage (100 to 150 Vdc) power systems is discussed. The implications are that the high voltage systems have a greater need for battery reconditioning than its low voltage counterpart, and that using these circuit techniques, the expected life of a battery in low Earth orbit can be up to 5 years.

The circuit presented in this paper is simple and small enough to be included in a typical battery charge/power control assembly, yet provides the advantage of a complete "ground-type" battery reconditioning discharge. Test results on the circuit when used to recondition two 24 cell, 20 A-h nickel-cadmium batteries are given.
given. The Shuttle configuration is then described with emphasis on the SSME, ET, and SRB. The materials selection, tracking, and control system used to assure reliability and to minimize cost are described, and salient features and challenges in materials and processes associated with the SSME, ET, and SRB are subsequently discussed.

Line-focusing acrylic Fresnel lenses with application potential in the 200°C to 370°C range are being analytically and experimentally evaluated. Investigations previously conducted with a 56 cm wide lens have been extended by the present study to experimentation/analyses with a 1.8 by 3.7 m lens. A measured peak concentration ratio of 64 with 90 percent of the transmitted energy focused into a 5.0 cm width was achieved. A peak concentration of 61 and a 90 percent target width of 4.5 cm were analytically computed. The experimental and analytical lens transmittance was 81 percent and 86 percent, respectively. Thus, the analytical/experimental lens performance correlation is considered good. The lens also was interfaced with a receiver assembly and operated in the collection mode. The collection efficiency ranged from 42 percent at 100°C to 26 percent at 300°C, whereas an efficiency of 40 percent at 300°C was anticipated. Apparently, the reflective cavity surrounding the absorber tube did not perform as expected. Therefore, future receiver assemblies will decrease or eliminate reliance on reflective surfaces, i.e., the energy focused directly on the absorber tube surfaces will be increased. Efficiency improvements to the 40 to 50 percent range are anticipated.
High and Low Threshold P-Channel Metal Oxide Semiconductor Process and Description of Microelectronics Facility.

David L. Bouldin, William R. Feitner, Ben R. Hollis, and Donald E. Routh.
Electronics and Control Laboratory.

N76-27480

The fabrication techniques and detail procedures for creating P-channel Metal-Oxide-Semiconductor (P-MOS) integrated circuits at George C. Marshall Space Flight Center (MSFC) are described. Examples of P-MOS integrated circuits fabricated at MSFC together with functional descriptions of each are given. Typical electrical characteristics of high and low threshold P-MOS discrete devices under given conditions are provided. A general description of MSFC design, mask making, packaging, and testing procedures is included.

The capabilities described in this report are being utilized in: (1) research and development of new technology, (2) education of individuals in the various disciplines and technologies of the field of microelectronics, and (3) fabrication of many types of specially designed integrated circuits which are not commercially feasible in small quantities for in-house research and development programs.
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Primary Aberrations for Grazing Incidence. Published in Applied Optics.
Upper air soundings taken every 3 hours are used to examine a cold front of average intensity over a period of 24 hours. Vertical cross sections of potential temperature and wind and horizontal analyses are compared and adjusted until they are consistent with one another. These analyses are then used to study the evolution of the front, which is found to consist of a complex system of fronts occurring at all levels of the troposphere. Low-level fronts are strongest at the surface and rapidly weaken with height. Fronts in the middle and upper troposphere are much more intense. The warm air ahead of the fronts is nearly barotropic, while the cold air behind the fronts is baroclinic through deep layers. A deep mixed layer is observed to grow in this cold air.

Examination of cross sections of potential temperature and potential vorticity indicates that the air in at least the upper portions of the upper level fronts originates in the stratosphere. No evidence is found, however, of an extrusion of stratospheric air to very low levels. The structure of the upper level fronts is complex. These fronts are observed to split apart, recombine, and descend to low elevations due to the incorporation of pre-existing stable/baroclinic layers.

An equation for parcel-following frontogenesis in isentropic coordinates is developed and applied. No single process was found to be dominant in changing frontal intensity. Frontogenesis occurs on the leading edge of the fronts and frontolysis on the trailing edge. The magnitudes of the computed frontogenesis decrease downstream from the axis of the upper level trough.

Isentropic trajectories are constructed to verify the computed values of parcel-following frontogenesis. Poor correlations found between the computed and trajectory-following values of frontogenesis are believed to be due to nonlinearities in the field of frontogenesis and to errors in the trajectories.

Vertical velocities are computed using a kinematic technique. Reasonable fields of vertical velocity are obtained in the vicinity of the fronts and jet streaks. Good correlations are found between the vertical displacement between endpoints of the trajectories and the value of computed vertical velocity integrated over the path of the trajectory. The field of vertical velocity is also found to be highly nonlinear.
APPROVAL

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Compiled by O. L. White

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

J. T. SHEPHERD
Director, Administration and Program Support