NASA TECHNICAL MEMORANDUM

NASA TM X-73398

(NASA-TM-X-73398) SOLAR ENERGY BIBLIOGRAPHY (NASA) 32 p HC A03/MF A01 CSCL 10A

N78-13554

Unclas
G3/44 55845

SOLAR ENERGY BIBLIOGRAPHY

Compiled by Stephen Gargus
Management Services Office

July 1977

NASA

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
NASA TM X-73998		

4. TITLE AND SUBTITLE	5. REPORT DATE
Solar Energy Bibliography	July 1977
	6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT #
Compiled by Stephen Gargus	

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NO.
George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812	11. CONTRACT OR GRANT NO.
	13. TYPE OF REPORT & PERIOD COVERED
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, D. C. 20546	Technical Memorandum
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

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

17. KEY WORDS	18. DISTRIBUTION STATEMENT
	Unclassifed-Unlimited

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	31	

PREFACE

The source from which the document is available is quoted in each citation. The addresses for these sources are listed below:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Energy Research and Development Administration
Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

NASA Technology Utilization Office
Attn: AT01
Marshall Space Flight Center, Alabama 35812

Commissioner of Patents
U.S. Patent Office
Washington, D.C. 20231

TABLE OF CONTENTS

	Page
ONGOING RESEARCH	1
TECH BRIEFS	4
PAPERS AND PERIODICALS	8
TECHNICAL REPORTS AND PATENTS	10
SUBJECT INDEX	26

ONGOING RESEARCH

74K11130 NAS8-31100
Thermal Energy Storage Development Study. Lockheed Missiles and Space Co., Huntsville, AL.

Chemical Reactions/Energy Storage/Heat/Heat Storage/Phase Transformations/Solar Energy/Thermal Control Coatings/Thermal Energy/Thermal Protection/Transition Temperature. see N76-13592

75K10164 NAS8-31016
Interconnect and Bonding Technologies for Large Flexible Solar Arrays. Lockheed Missiles and Space Co., Sunnyvale, CA.

Adhesive Bonding/Arrays/Bonding/Degradation/Electrical Properties/Environmental Tests/Flexibility/Flexible Bodies/Joining/Life (Durability)/Mechanical Properties/Mounting/Solar Arrays/Solar Cells/Solar Collectors/Solar Energy Absorbers. see N76-32653

75K10193 NAS8-30758
Development of a Solar Powered Residential Air Conditioner. AiResearch Mfg. Co., Torrance, CA.

Air Conditioning/Air Conditioning Equipment/Cooling/Energy/Heat Exchangers/Residential Areas/Solar Collectors/Solar Energy/Thermal Energy. see N76-30660
N76-30659
N76-30656
N76-30655
N76-30653
N76-20632

75K10205 NAS8-30756
Development of a Solar Powered Residential Air Conditioner. Chrysler Corp., Cape Canaveral FL.

Air Conditioning/Air Conditioning Equipment/Cooling/Cooling Systems/Energy Conservation/Energy Technology/Solar Collectors/Solar Energy Conversion/Thermodynamic Efficiency/Thermodynamic Properties/Thermodynamics.

75K10225 NAS8-31189
Optimization of Absorption Air Conditioning Systems for Solar Energy Applications. Memphis State University, TN.

Air Conditioning/Air Conditioning Equipment/Convective Heat Transfer/Cooling/Economic Factors/Energy Absorption/Energy Conversion/Energy Conversion Efficiency/Heat Transfer/Optimization/Refrigerating/Solar Collectors/Solar Energy/Solar Energy Conversion/Temperature Control/Thermal Absorption/Thermal Energy.
see N77-17560

75K10551 NAS8-31326
Design, Fabrication, Testing, and Delivery of a Solar Collector. Chamberlain Corp., Waterloo, IA.

Design/Design Analysis/Energy/Energy Absorption Films/Energy Conversion/Fabrication/Product Development/Solar Collectors/Solar Energy/Solar Energy Conversion/Solar Generators. see N76-22671

75K10554 NAS8-31309
Design, Fabrication, Installation, and Checkout of a Prototype Sunfall Monitor System. International Business Machines Corp., Huntsville, AL.

Data Processing/Digital Data/Environmental Control/Radiation Measuring Instruments/Sensors/Sky Brightness/Sky Radiation/

Solar Collectors/Solar Energy/Solar Instruments/Solar Radiation/Solar Sensors/Sunlight/Tracking (Position). see N76-10444

75K10612 NAS8-31327
Design, Fabrication, Testing and Delivery of a Solar Energy Collector System for Residential Heating and Cooling. Honeywell, Inc., Minneapolis, MN.

Cooling Systems/Solar Collectors/Solar Energy/Solar Heating. see N77-10638

75K10650 NAS8-31328
Design, Fabrication, Testing and Delivery of a Solar Collector. PPG Industries, Inc., Pittsburgh, PA.

Cooling Systems/Energy Absorption Films/Energy Conversion/Solar Collectors/Solar Energy/Solar Energy Absorbers/Solar Energy Conversion/Solar Heating.

75K10925 NAS8-31437
Development of a Solar Powered Residential Air Conditioner (Generator Optimization). Chrysler Corp., Cape Canaveral, FL.

Air Conditioning/Air Conditioning Equipment/Electric Generators/Energy Conversion/Solar Collectors/Solar Energy/Solar Energy Conversion/Solar Generators.
see N76-24702

75K11328 NAS8-31564
Utilization of Solar Energy for Residential Heating and Cooling Application. Tennessee Technological Univ., Cookeville, TN.

Air Conditioning/Energy Conversion/Energy Conversion Efficiency/Flow Velocity/Fluid Flow/Pumps/Solar Energy/Solar Energy Conversion/Solar Heating/System Effectiveness.

75K11454 NAS8-31670
Solar Cell Selection and Characterization for Solar Electric Propulsion (SEP). Boeing Aerospace Co., Seattle, WA.

Aerospace Environments/Energy Conversion/Energy Conversion Efficiency/Environmental Tests/Planetary Atmospheres/Silicon/Solar Cells/Solar Electric Propulsion/Solar Energy Conversion.

76K10736 NAS8-31662
Design, Fabrication, Assembly, Testing and Delivery of an Earth Based Solar Power. Wyle Labs., Inc., Huntsville, AL.

Electric Power Plants/Energy Conversion/Incentives/Marketing/Solar Collectors/Solar Energy/Solar Energy Conversion/Technology Utilization.

76K11070 NAS8-31293
Solar Heating and Cooling Technical Data and Systems Analysis. University of Alabama., Huntsville, AL.

Cooling/Cooling Systems/Solar Energy/Solar Heating/Systems Analysis.
see N77-17987
N77-12507
N76-32650
N76-15588
N76-15587

76K11313 NCA8-103
An Investigation of Fresnel Lens Utilization in Collecting Solar Energy for Power Generation. Ball State Univ., Muncie, IN.

Electric Generators/Lenses/Solar Collectors/Solar Energy/Solar Energy Conversion/Solar Generators/Sun.

76K11314 NCA8-101
Investigation of Fresnel Lens Utilization in Collecting Solar Energy for Power Generation. Ball State Univ., Muncie, IN.

Electric Generators/Lenses/Solar Collectors/Solar Energy/Solar Energy Conversion/Solar Generators/Sun.

76K11336 NSG-8025
Inhibitor Analysis for a Solar Heating and Cooling System. Southern Univ., Baton Rouge, LA.

Cooling Systems/Solar Heating.
see N77-57516

76K11493 NAS8-31189
Optimization of Absorption. Air Conditioning Systems for Solar Energy Applications. Memphis State Univ., TN.

Absorbers (Equipment)/Air Conditioning Equipment/Cooling Systems/Drying/Solar Energy.
see N77-17560

76K11922 · NSG-8041
Parametric Study of Rock Pile Thermal Storage for Solar Heating. Alabama A&M Univ., Normal, Huntsville, AL.

Buildings/Energy Storage/Heat Storage/Heating/Residential Areas/Rocks/Solar Collectors/Solar Energy/Solar Heating.

76K12132 NAS8-32161
A Feasibility Study of the Satellite Power System Concept. Rockwell International Corp., Downey, CA.

Aluminum/Antennas/Economic Analysis/Electricity/Feasibility Analysis/Gallium Arsenides/Ground Stations/Microwave Antennas/Microwave Transmission/Radio Antennas/Satellite Configurations/Satellite Orbits/Satellite Solar Energy Conversion/Satellite Solar Power Stations/Solar Cells/Solar Energy.

77K10207 NAS8-32398
Measurements of Materials Properties for Solar Cells: Nondestructive Testing by Microwave Means. Marshall Space Flight Center, Huntsville, AL.

Electrical Resistivity/Fatigue Life/Irradiation/Kapton (trademark)/Life (Durability)/Materials Tests/Microwaves/Nondestructive Tests/Optical Measurement/Quartz/Radiation Dosage/Radiation Effects/Silicon/Solar Arrays/Solar Cells/Solar Electric Propulsion/Teflon (trademark).

M-FS-14706 6/71

IMPROVED THERMAL PAINT FORMULATION. Gates, D.W.; Roger, F.O.; Zerlaut, G.A. Marshall Space Flight Center, Huntsville, AL. NAS8-5379. AVAIL: Marshall Space Flight Center, AT01.

B71-10180

Potassium silicate-treated zinc oxide paint stabilizes pigment against ultraviolet-induced, bleachable degradation in infrared region, and permits use of ZnO as pigment in ultraviolet-stable coatings based upon polymethyl siloxane elastomers and resins. Material has low absorption/emittance ratio.

see N72-17532
IITRI-U6002-94

M-FS-21628 3/74

SOLAR-ENERGY CONVERSION SYSTEM PROVIDES ELECTRICAL POWER AND THERMAL CONTROL FOR LIFE-SUPPORT SYSTEMS. Davis, B.K. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01

B73-10524

System utilizes freon cycle and includes boiler turbogenerator with heat exchanger, regenerator and thermal-control heat exchangers, low-pressure and boiler-feed pumps, and condenser. Exchanger may be of interest to engineers and scientists investigating new energy sources. see N75-32581
(patent)

M-FS-21927 10/72

SOLAR POWERED ABSORPTION CYCLE HEAT PUMP USING PHASE CHANGE MATERIALS FOR ENERGY STORAGE. Middleton, R.L. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B72-10615

Solar powered heating and cooling system with possible application to residences is described. Operating principles of system are defined and illustration of typical energy storage and exchange system is provided.
(patent)

M-FS-22562 3/74

SELECTIVE COATING FOR COLLECTING SOLAR ENERGY ON ALUMINUM. Lowery, J.R. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B73-10527

Presently used coatings, which were originally developed for brass, copper, and steel substrates, yield relatively low absorptance/emittance ratios when applied to aluminum. Efficient, black-nickel plating applied to aluminum substrate enhances solar absorptance to 93 percent and reduces emittance to 6 percent. (patent)

M-FS-22563 5/75

A PRACTICAL SOLAR ENERGY HEATING AND COOLING SYSTEM. Oneill, M.J.; McDanal, A.J.; Sims, W.H. Lockheed Missiles and Space Co., Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B73-10156

Recent study has concluded that solar-powered residential heating and cooling system is nontechnically and economically feasible. Proposed system provides space heating, air conditioning, and hot water. Installation costs will be greater than for conventional heating systems, but this difference will eventually be defrayed by very low operating costs. see M-TU-75-3
M-TU-74-3
LMSC-HREC-D306275

M-FS-22743 3/74

SOLAR ENERGY ABSORBER, ACTIVE INFRARED (IR) TRAP. Brantley, L.W., Jr. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B73-10484

Efficiency of solar-energy absorbers may be improved to 95 percent by actively cooling their intermediate glass plates. This approach may be of interest to manufacturers of solar absorbers and to engineers and scientists developing new sources of energy.

see N76-22657
(patent)

M-FS-22744 3/74

SOLAR-ENERGY ABSORBER, ACTIVE INFRARED (IR) TRAP WITHOUT GLASS. Brantley, L.W., Jr. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B73-10485

Absorber efficiency can be improved to 90 percent by removing glass plates and using infrared traps. Absorber configuration may be of interest to manufacturers of solar absorbers and to engineers and scientists developing new sources of energy. see N76-24696
(patent)

M-FS-22943 9/74

REMOTE SUNFALL MONITOR, A CONCEPT. Lollar, R.B.; Mandt, R.R. International Business Machines Corp., Huntsville, AL (Federal Systems Div.). AVAIL: Marshall Space Flight Center, AT01. NAS8-1400.

B74-10149

Monitor is proposed as spectral monitor system design to record digital data simultaneously from two types of sensors, mounted on both stationary assembly and tracking assembly. Both direct and total values of solar radiation are recorded. System may measure solar energy collector efficiencies for three main conversion technologies. See N76-10444
IBM-74W-00001
(patent)
IBM-73W-00253,
Vol. 1

M-FS-23057 1/75

SELF-REGENERATING DESICCANT SYSTEM. Anthony, K.G.; Herndon, E.P. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B74-10266

Compact system uses inherent diurnal cyclic airflow in system and energy of sun as drying heat. System requires no power for operation, has no moving parts to wear out, requires no blowers or manifolds, and is relatively inexpensive to produce.

(patent application)

M-FS-23062 2/75

MECHANICAL SOLAR MOTOR, A CONCEPT. Hein, L.A.; Myers, W.N. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B74-10292

Motor is proposed to convert radiation from sun directly into mechanical energy. Motor utilizes thermal expansion of liquid, heated by sun, as driving force. Unlike most thermally powered systems it does not require that liquid be converted into vapor.

see N77-12402
(patent)

M-FS-23128 3/76

PRINTED-CIRCUIT SOLAR-CELL ARRAY. Currier, R F.; Palmer, W.L. Lockheed Missiles and Space Co., Sunnyvale, CA. AVAIL: Marshall Space Flight Center, AT01.

B76-10007

Flexible solar-cell array is made thinner and lighter by placing array on substrate which is a lamination of two sheets of plastic film with etched electrical connector for cells between films.

M-FS-23138

PRINTED-CIRCUIT SOLAR-CELL ARRAY. Currier, R.F.; Palmer, W.L. Lockheed Missiles and Space Co., Sunnyvale, CA. AVAIL: Marshall Space Flight Center, AT01.

A flexible solar-cell array has been made thinner and lighter than previous solar arrays. The array is placed on a substrate, which is a lamination of two sheets of plastic film with an etched electrical connector for the cells between the films. Thus, the substrate mechanically supports the cells and interconnects them electrically.

M-FS-23167 6/75

LARGE-SCALE SOLAR THERMAL COLLECTOR CONCEPTS. Brantley, L. W. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B75-10098

Thermal collector could be used ultimately to power steamplant to produce electricity. Collector would consist of two major subsystems (1) Series of segmented tracking mirrors with two major subsystems (2) Absorber mounted on centrally located tower.

M-FS-23195 8/75

ZENNER-REGULATED SOLAR ARRAY/BATTERY POWER SYSTEM. Eliason, J.T. Sperry Rand Corp., Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01. NAS8-21812.

B75-10162

Zenner-diode limits solar cell voltage used to charge battery. System improves life and reliability of solar cells.

(patent application)

M-FS-23260 8/75

SOLAR RESIDENTIAL HEATING AND COOLING SYSTEM. Melton, D.E.; Humphries, W.R. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B75-10165

System has been placed in operation to verify technical feasibility of using solar energy to provide residential heating and cooling. Complete system analysis was performed to provide design information.

see N75-22903
N75-24107
SHC-5001

M-FS-23272 12/75

LOW-COST HOT-AIR SOLAR COLLECTOR. Herndon, E.P.; Anthony, K.G. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B75-10301

System has only three components per cell. Cell parts are fabricated from readily available materials and, following a construction procedure which requires use of only simple handtools, can be mounted in place by one person.

(patent application)

M-FS-23349 8/76

HORIZONTALLY-MOUNTED SOLAR COLLECTOR. Black, D.H. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B76-10256

Systems consists of three major components: vertical deflector assembly, stationary reflector, and motor driven tracking mechanism. Deflector assembly directs incident incoming energy to a vertical direction, using series of horizontally mounted vanes. Energy is then redirected via reflector to fixed collector.

M-FS-23403 8/76

PROPOSED LOW-TEMPERATURE SOLAR ENGINE. Peoples, J.A.; Kearns, G.B. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B76-10254

Engine, proposed for conversion of sun's heat to motion without need for heat pumps and associated equipment, uses expansion and contraction of aluminum rod to drive two out-of-phase windlasses. Linear displacement of 0.076 cm in rod will exert sufficient force to drive pumps, generators, and compressors.

M-FS-23420 8/76

COATING FOR SOLAR PANELS. Gumbs, R.W. R. Gumbs Assoc., Newark, NJ. AVAIL: Marshall Space Flight Center, AT01. NAS8-31626.

B76-10195

Inexpensive composition with high energy-absorptivity and low emissivity requires no primers for adhesion to aluminum, copper, and stainless steel and uses commercially available materials.

M-FS-23428 8/76

SOLAR CONCENTRATOR/ABSORBER. von Tiesenhausen, G.F. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B76-10253

Collector/energy converter, consisting of dual-slope optical concentrator and counter-flow thermal energy absorber, is attached to multiaxis support structure. Efficient over wide range of illumination levels, device may be used to generate high temperature steam, serve as solar powered dryer, or power absorption cycle cooler.

M-FS-23432 8/76

SOLAR HEATING AND COOLING PERFORMANCE. Littles, J.W.; Cody, J.C. Marshall Space Flight Center, Huntsville, AL. AVAIL: Marshall Space Flight Center, AT01.

B76-10235

Study describes technique developed for comparison of devices to determine if conventional energy resources may be saved.

see N76-14606

M-FS-23505

UNIVERSAL SOLAR-CELL TERMINAL. Bashin, S.; Kelley, F.G. TRW Inc., AVAIL: Marshall Space Flight Center, AT01.

The universal solar-cell terminals use the dissimilar material bonding properties (metal-to-glass and/or ceramics) of an iron-nickel-cobalt alloy in conjunction with standard termination. Loop receptacles replace the conventional connector posts.

A77-10913 10/76
PHOTOVOLTAIC AND THERMAL ENERGY CONVERSION FOR SOLAR POWERED SATELLITES. von Tiesenhausen, G.F. Marshall Space Flight Center, Huntsville, AL.

International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, CA, Oct. 10-16, 1976, 11 p.

A summary is provided concerning the most important aspects of present investigations related to a use of solar power satellites (SPS) as a future source of terrestrial energy. General SPS characteristics are briefly considered, early work is reviewed, and description of current investigations is presented. System options presently under study include a photovoltaic array, a thermionic system, and a closed Brayton cycle. Attention is given to system reference options, basic building blocks, questions of system analysis and engineering, photovolatic conversion, and the utility interface. It is concluded that an SPS may be cost effective compared to terrestrial systems by 1995.

A76-31378 1975
STATUS OF MARSHALL SPACE FLIGHT CENTER SOLAR HOUSE. Humphries, W.R. Marshall Space Flight Center, Huntsville, AL.

In: Application of solar energy; Proceedings of the First Southeastern Conference, Huntsville, AL, March 24-26, 1975. (A76-31376 14-44) Huntsville, AL, UAH Press, 1975, p. 15-30.

The Marshall Space Flight Center (MSFC) solar facility is described herein, and test results obtained from late May 1974 to September 1974 are discussed. This facility was assembled to provide operational experience in the utilization of solar energy for heating and cooling buildings. The major subsystems are the solar collector, the energy storage tank, the simulated living space, the air conditioning and heating subsystems, and the controls. These subsystems are described with emphasis placed on major results and conclusions. A cursory evaluation of the system for cooling is given from energy and power consumption viewpoints. This data evaluation indicates the current system is capable of supply 50 percent of the thermal energy required to drive the air conditioner. A preliminary evaluation of winter data indicates that more than 90 percent of the heating required can be provided by the solar system.

A75-24194 1974
CURRENT TECHNOLOGY FOR DEVELOPMENT OF LOW SOLAR ABSORPTANCE/HIGH EMITTANCE COATINGS - SPACECRAFT THERMAL CONTROL SURFACE MATERIALS. Gilligan, J.E.; Harada, Y.; Gates, D.W. IIT Research Institute, Chicago, IL; Marshall Space Flight Center, Huntsville, AL.

In: Evaluation of the effect of the space environment on materials; International Conference, Toulouse, France, June 17-21, 1974, Proceedings. (A75-24160 09-18) Paris, Centra National D'Etudes Spatiales, 1974, p. 567-589. NASA-supported research.

A comprehensive program to develop low solar absorptance/high emittance coatings, to be successful, must coordinate basic materials preparation, coatings technology, environmental simulation, production, and flight-test evaluation. The prime criteria for "white" thermal-control coatings are low solar

absorptance and, most importantly, solar-absorptance stability. Many variables affect the solar absorptance and its stability. These effects must be discerned and evaluated. The factors involved, however, are not entirely independent; accordingly, the present paper emphasizes the major variables, the relationships among them, and how important they are in improving the properties and performance of the coatings.

A75-14012 10/74

SOLAR ENERGY RECORDER – FOR CONVERTER SITE SELECTION. NAS8-14000. Lollar, R.B.; Mandt, R.R. IBM Corp., Huntsville, AL.

Solar Energy, Vol. 16, Oct. 1974, p. 73-80.

A serious obstacle to the large-scale terrestrial application of solar energy lies in the scarcity of reliable data on the amount of solar energy at candidate converter sites. This paper describes a system designed to monitor and record, automatically, the values of the direct and total (sun and sky) solar radiation which would be seen by either tracking or fixed-type solar converters. A further pressing need addressed by the system is the means for efficiency testing and evaluation of solar cells, solar collectors and solar concentrator systems, under outdoor exposure to natural sunlight and weather conditions for extended periods. The design was accomplished in support of the Marshall Space Flight Center, NASA, where design concepts and materials for large-scale terrestrial solar energy converters are currently being evaluated.

NASA-CASE-MFS-21628-1 9/9/75
SOLAR ENERGY POWER SYSTEM – USING FREON. Davis. B.K. Marshall Space Flight Center, Huntsville, AL. AVAIL: U.S. Patent Office. N75-32581

A solar energy vapor (freon) powered system for generating electrical energy is described in which a portion of the heat absorbed from the sun in daylight is stored for use during darkness by a thermal capacitor. A mass of pyrone, having a high thermal capacity, liquifies when heat is applied to it and goes through a solidification process to provide a heat output. A highly efficient solar boiler is constructed utilizing an anodized titanium surface and a particular combination of shaped boiler tubes and complementary reflectors. The overall efficiency of the system is further improved by a unique arrangement of heat recovery devices.

NASA-CASE-MFS-21628-2 5/18/76
SOLAR ENERGY POWER SYSTEM. Davis, B.K. Marshall Space Flight Center, Huntsville, AL. AVAIL: U.S. Patent Office. N76-23675

A solar energy vapor (freon) powered system is described for generating electrical energy in which a portion of the heat absorbed from the sun in daylight is stored for use during darkness by a thermal capacitor in which a mass of pyrone, having a high thermal capacity, liquifies when heat is applied to it and goes through a solidification process to provide a heat output. A highly efficient solar boiler is constructed utilizing an anodized titanium surface and a particular combination of shaped boiler tubes and complementary reflectors. The overall efficiency of the system is further improved by a unique arrangement of heat recovery devices.

NASA-CASE-MFS-22458-1 10/5/76
PHOTOVOLTAIC CELL ARRAY. Eliason, J. T. Sperry Rand Corp., Huntsville, AL. AVAIL: U.S. Patent Office. N77-10635

A photovoltaic cell array consisting of parallel columns of silicon filaments is described. Each fiber is doped to produce an inner region of one polarity type and an outer region of an opposite polarity type to thereby form a continuous radial semiconductor junction. Spaced rows of electrical contacts alternately connect to the inner and outer regions to provide a plurality of electrical outputs which may be combined in parallel or in series.

NASA-CASE-MFS-22562-1 11/18/75
PANEL FOR SELECTIVELY ABSORBING SOLAR THERMAL ENERGY AND THE METHOD OF PRODUCING SAID PANEL. Lowery, J.R. Marshall Space Flight Center, Huntsville, AL. AVAIL: U.S. Patent Office. N76-14595

A panel is described for selectively absorbing solar thermal energy comprised of a metallic substrate, a layer of bright metallic material carried on the substrate, and a solar thermal energy absorbing coating carried on the bright metallic material. A layer of zinc is interposed between the metal substrate and the layer of bright material or the metallic substrate can be anodized for receiving the layer of bright metallic material. Also disclosed is the method for producing the coating which selectively absorbs solar thermal energy.

NASA-CASE-MFS-22743-1 4/20/76
SOLAR ENERGY ABSORBER. Brantley, L.W., Jr. Marshall Space Flight

Center, Huntsville, AL. AVAIL: U.S. Patent Office. N76-22657

A solar energy absorber is described, which includes a tubular absorber surface through which a fluid passes for transferring thermal energy from the absorber to other devices. Positioned above the tubular absorber surface are spaced glass layers. Positioned between an upper layer and the next layer is a vacuum, or air for minimizing thermal energy losses through convection. A clear liquid passes between two intermediate layers of glass for transferring the thermal energy absorbed by either the initial passage of the visible spectrum of electromagnetic rays or by infrared radiation from an absorber positioned below.

NASA-CASE-MFS-22744-1 5/25/76
SOLAR ENERGY TRAP. Brantley, L.W., Jr. Marshall Space Flight Center, Huntsville, AL. AVAIL: U.S. Patent Office. N76-24696

An apparatus is described for trapping solar energy for heating a fluid that could be subsequently used in turbines and similar devices. The apparatus includes an elongated vertical light pipe having an open end through which the visible spectrum of electromagnetic radiation from the sun passes to strike a tubular absorber. The light pipe has a coated interior surface of a low absorptivity and a high reflectivity at the visible wavelengths and a high absorptivity/emissivity ratio at infrared wavelengths. The tubular absorber has a coating on the surface for absorbing visible wavelengths to heat the fluid passing through. Infrared wavelengths are radiated from the tubular absorber back into the light pipe for heating fluid.

NASA-CASE-MFS-23051-1 11/14/75
AN IMPROVED ROTATABLE MASS FOR A FLYWHEEL. Weyler, G.M., Jr. Marshall Space Flight Center, Huntsville, AL. AVAIL: NTIS.

An improved rotatable mass adapted to be used as a flywheel in energy storage devices is reported. The flywheel is characterized by a plurality of coaxially aligned, contiguous disks mounted on a spin shaft. Each disk is formed of a plurality of woven fibers disposed in a plane transversely related to an axis of rotation with the fibers of alternate disks being continuous throughout their length. The midportion of the fibers of the remaining disks is removed for defining annular voids concentrically related to the spin shaft.

NASA-CASE-MFS-23062-1 10/26/76
MECHANICAL THERMAL MOTOR. Hein, L.A.; Myers, W.N. Marshall Space Flight Center, Huntsville, AL. AVAIL: U.S. Patent Office. N77-12402

An apparatus is described for converting thermal energy such as solar energy into mechanical motion for driving fluid pumps and similar equipment. The thermal motor comprises an inner concentric cylinder carried by a stationary core member. The core member has a cylindrical disc plate fixed adjacent to a lower portion and extending radially from it. An outer concentric cylinder rotatably carried on the disc plate defining a space between the inner and outer concentric cylinders. A spiral tubular member encircles the inner concentric cylinders and is contained within the space between the inner and outer cylinders. One portion is connected to the inner concentric cylinder and a second portion connected to the outer concentric cylinder. A heated fluid is conveyed through the tubular member and is periodically cooled causing the tubular member to expand and contract. This causes the outer concentric cylinder to reciprocally rotate on the base plate accordingly. The reciprocating motion of the outer concentric cylinder is then utilized to drive a pump member in a pump chamber.

NASA-CASE-MFS-23167-1 8/31/76

THERMAL ENERGY STORAGE SYSTEM – OPERATING ON SUPERHEATING OF LIQUIDS. Brantley, L.W., Jr. Marshall Space Flight Center, Huntsville, AL. AVAIL: U.S. Patent Office

N76-31667

A thermal energy storage system is described for converting a fluid such as water into a superheated vapor for driving a turbine and it also includes an energy storage device for storing thermal energy from the vapor to be utilized should the pressure of the vapor fall below a predetermined value. The energy storage device includes a storage tank having a plurality of stacked vertical compartments containing metallic spheres filled with metal alloy for storing the thermal energy therein and a fluid reservoir below the stacked compartments. Diagrams of the system are shown.

NAS-CR-120668 9/75

ECASTAR: ENERGY CONSERVATION; AN ASSESSMENT OF SYSTEMS, TECHNOLOGIES AND REQUIREMENTS, FINAL REPORT. Auburn Univ., Auburn, AL. NGT-01-003-344. AVAIL: NTIS.

N76-21686

A methodology for a systems approach display and assessment of the potential for energy conservation actions and the impacts of those actions was presented. The U.S. economy is divided into four sectors: energy industry, industry, residential/commercial and transportation. Each sector is assessed with respect to energy conservation actions and impacts. The four sectors are combined and three strategies for energy conservation actions for the combined sectors are assessed. The three strategies (national energy conservation, electrification and diversification) represent energy conservation actions for the near term (nor to 1985), the mid term (1985 to 2000) and the far term (2000 and beyond). The assessment procedure includes input/output analysis to bridge the flows between the sectors, and net economics and net energetics as performance criteria for the conservation actions. Targets of opportunity for large net energy savings and the application of technology to achieve these savings are discussed.

NASA-CR-129012 9/73

TERRASTAR: TERRESTRIAL APPLICATION OF SOLAR TECHNOLOGY AND RESEARCH, FINAL REPORT. Auburn Univ., Auburn, AL. (School of Engineering). NGT-01-003-044. AVAIL: NTIS.

N74-12674

The application of solar energy to the energy crisis of the 70's and beyond is discussed in the context of energy consumption in the U.S., energy resources in the U.S., and the state-of-the-art of solar energy applications. Solar energy application concepts, such as solar farms (a term used to describe vast fields of concentrators collecting solar energy for the generation of steam to drive power turbines), an orbiting solar power station, and the conversion of solar energy into solar power for heating and cooling of individual buildings on the Earth, are discussed. The report emphasizes the application of solar energy to the heating and cooling of buildings since this application seems to be more promising in the near term as far as research and development are concerned. The importance of initiating research and development on all solar application concepts is stressed as an important step in pursuing the use of solar energy. Immediate steps leading to the application of solar energy to heating and cooling of buildings are outlined to insure appreciable energy displacement through the use of solar energy by the year 2020.

NASA-CR-142728 4/4/75

THE DEVELOPMENT OF A SOLAR RESIDENTIAL HEATING AND COOLING SYSTEM. Marshall Space Flight Center, AL. AVAIL: NTIS. M-TU-75-3

N75-24107

The MSFC solar heating and cooling facility was assembled to demonstrate the engineering feasibility of utilizing solar energy for heating and cooling buildings, to provide an engineering evaluation of the total system and the key subsystems, and to investigate areas of possible improvement in design and efficiency. The basic solar heating and cooling system utilizes a flat plate solar energy collector, a large water tank for thermal energy storage, heat exchangers for space heating, and an absorption cycle air conditioner for space cooling. A complete description of all systems is given. Development activities for this test system included assembly, checkout, operation, modification, and data analysis, all of which are discussed. Selected data analyses for the first fifteen weeks of testing are included, findings associated with energy storage and the energy storage system are outlined, and conclusions resulting from test findings are provided. An evaluation of the data for summer operation indicates that the current system is capable of supplying an average of fifty percent of the thermal energy required to drive the air conditioner. Preliminary evaluation of data collected for operation in the heating mode during the winter indicated that nearly one hundred percent of the thermal energy required for heating can be supplied by the system.

NASA-CR-144006 4/30/75
SUNFALL MONITOR CALIBRATION PLAN. Lollar, R.B. International Business Machines Corp., Huntsville, AL. NAS8-31309. AVAIL: NTIS. IBM-75W-00061 N76-10444

The initial on-site, and subsequent periodic calibration and adjustments are described for the pyroheliometer, pyranometer, equatorial mount, and the data management system.

NASA-CR-144081 11/75
THERMAL ENERGY STORAGE – BY MEANS OF CHEMICAL REACTIONS. Grodzka, P.G. Lockheed Missiles and Space Co., Huntsville, AL, (Research and Engineering Center). NAS8-31100. AVAIL: NTIS. LMSC-HREC-TR-D496600 N76-13592

The principles involved in thermal energy storage by sensible heat, chemical potential energy, and latent heat of fusion are examined for the purpose of evolving selection criteria for material candidates in the low (0 C) and high (100 C) temperature ranges. The examination identifies some unresolved theoretical considerations and permits a preliminary formulation of an energy storage theory. A number of candidates in the low and high temperature ranges are presented along with a rating of candidates or potential candidates. A few interesting candidates in the 0 to 100C region are also included. It is concluded that storage by means of reactions whose reversibility can be controlled either by product removal or by catalytic means appear to offer appreciable advantages over storage with reactions whose reversability cannot be controlled. Among such advantages are listed higher heat storage capacities and more favorable options regarding temperatures of collection, storage, and delivery. Among the disadvantages are lower storage efficiencies.

NASA-CR-144110 9/75
SOLAR HEATING AND COOLING TECHNICAL DATA AND SYSTEMS ANALYSIS PROGRESS REPORT, OCT. 1974 – AUG. 1975. Christensen, D.L. University of Alabama, Huntsville, AL. (Center for Environmental and Energy Studies). NAS8-31293. AVAIL: NTIS. N76-15587

The solar energy research is reported including climatic data, architectural data, heating and cooling equipment, thermal loads, and economic data. Lists of data sources presented include selected data sources for solar energy heating and cooling; bibliography of solar energy, and other energy sources; sources for manufacturing and sales, solar

energy collectors; and solar energy heating and cooling projects.

NASA-CR-144111 NAS8-31293
SOLAR HEATING AND COOLING TECHNICAL DATA AND SYSTEMS ANALYSIS. PRESENTATION CHARTS (BRIEFING TO NASA 17 SEPTEMBER 1975). University of Alabama, Huntsville, AL, (Center for Environmental and Energy Studies). NAS8-31293. AVAIL: NTIS. N76-15588

An interim status briefing concerning the solar energy research is presented. Systems planning, methodology and procedures, which might be applied to tne current program are included.

NASA-CR-144234 11/28/75
DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR CONDITIONER FINAL SUMMARY REPORT. AiResearch Mfg. Co., Torrance, CA. NAS8-30758. AVAIL: NTIS. N76-20632

The initial objective of the program was the optimization (in terms of cost and performance) of a rankine cycle mechanical refrigeration system which utilizes thermal energy from a flat solar collector for aric conditioning residential buildings. However, feasibility investigations of the adsorption process revealed that a dessicant-type air conditioner offers many significant advantages. As a result, limited efforts were expended toward the optimization of such a system.

NASA-CR-144265 1/76
DESIGN, FABRICATION, TESTING AND DELIVERY OF A SOLAR COLLECTOR, FINAL REPORT. Sims, W.H.; Ballheim, R.W.; Bartley, S.M.; Smith, G.W. Chamberlain Corp., Waterloo, IA. NAS8-31326. AVAIL: NTIS. C8092-PR-012 N76-22671

A two phase program encompassing the redesign and fabrication of a solar collector which is low in cost and aesthetically appealing is described. Phase one work reviewed the current collector design and developed a low-cost design based on specific design/performance/cost requirements. Throughout this phase selected collector component installation, maintainability and durability. The resultant collector design was composed of an absorber plate, insulation, frame, cover, dessicant and sealant. In phase two, three collector prototypes were fabricated and evaluated for both nonthermal and thermal characteristics. Tests included static load tests of covers, burst pressure tests of absorber plates, and tests for optical characteristics of selective absorber plate coatings. The three prototype collectors were shipped to Marshall Space Flight Center for use in their solar heating and cooling test facility.

NASA-CR-144312 7/26/76
INTERCONNECT AND BONDING TECHNOLOGIES FOR LARGE FLEXIBLE SOLAR ARRAYS FINAL REPORT. Lockheed Missiles and Space Co., Sunnyvale, CA. (Space Systems Div.). NAS8-31016. AVAIL: NTIS LMSC-D492654 N76-32653

Thermocompression bonding and conductive adhesive bonding are developed and evaluated as alternate methods of joining solar cells to their interconnect assemblies. Bonding materials and process controls applicable to fabrication of large, flexible substrate solar cell arrays are studied. The primary potential use of the techniques developed is on the solar array developed by NASA/MSFC and LMSC for solar electric propulsion (SEP) and shuttle payload applications. This array is made up of flexible panels approximately 0.7 by 3.4 meters. It is required to operate in space between 0.3 and 6 AU for five years with limited degradation. Materials selected must be capable of enduring this space environment, including outgassing and radiation.

NASA-CR-144314 3/76

DEVELOPMENT OF A SOLAR POWERED RESIDENTIAL AIR CONDITIONER (GENERAL OPTIMIZATION) FINAL REPORT. Lowen, D.J. Chrysler Corp., Cape Canaveral, FL. NAS8-31437. AVAIL: NTIS.

N76-24702

A commercially available three ton residential lithium bromide (LiBr) absorption air conditioner was modified for use with lower temperature solar heated water. The modification included removal of components such as the generator, concentration control chamber, liquid trap, and separator; and the addition of a Chrysler designed generator, an off-the-shelf LiBr-solution pump. The design goal of the modified unit was to operate with water as the heat-transfer fluid at a target temperature of 85C (185F), 29.4C (85F) cooling water inlet, producing 10.5 kw (3 tons) of cooling. Tests were performed on the system before and after modification to provide comparative data. At elevated temperatures (96C, 205F), the test results show that lithium bromide was carried into the condenser due to the extremely violent boiling and degraded the evaporator performance.

NASA-CR-149785 2/29/76

INHIBITOR ANALYSIS FOR A SOLAR HEATING AND COOLING SYSTEM, FINAL REPORT. Tabony, J.H. Southern Univ., Baton Rouge, LA. (Dept. of Mechanical Engineering). NSG-8025. AVAIL: NTIS. N77-75716

Cooling Systems/Corrosion Prevention/Inhibitors/Solar Heating/Aluminum/Copper/Electrochemical Corrosion/Pitting/Steels.

NASA-CR-149928 6/76

IMPROVEMENT OF BLACK NICKEL COATINGS – PRODUCT DEVELOPMENT FOR USE IN SOLAR COLLECTORS, FINAL REPORT. Peterson, R.E.; Lin, J.H. Honeywell, Inc., Minneapolis, MN (Systems and Research Center). NAS8-31545. AVAIL: NTIS.

N76-28404

Selectively absorbing black nickel coatings are among the most optically efficient low cost coatings for use on flat plate solar collectors. However, a current Ni-Zn-S-O coating in use is quite susceptible to a humid environment, degrading badly in less than ten days at 38°C (100°F) at 95 percent relative humidity. Therefore, a black nickel formula was developed which can withstand such exposures with no loss of optical efficiency, solar absorption of 0.92 and an infrared emittance (at 100°C) of 1.00 were still present after 14 days of humidity exposure. This compares to a solar absorptance of only 0.72 for the previous formula after a similar time period. The electroplating bath and conditions were changed to obtain the more stable coating configuration. The effects of bath composition, temperature, pH, and plating current density and time on the coating composition, spectral optical properties and durability were investigated systematically.

NASA-CR-149971 11/22/74

DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR CONDITIONER, DESIGN REQUIREMENTS AND TRADE-OFF PARAMETERS. AiResearch Mfg. Co., Los Angeles, CA. NAS8-30758. AVAIL: NTIS. AIRESEARCH-74-10996(2) N76-30654

Data basic to the design, characterization, comparison, and evaluation of solar-powered residential air conditioner concepts are presented.

NASA-CR-149972 1/13/75

DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR CONDITIONER. AiResearch Mfg. Co., Los

Angeles, CA. NAS8-30758. AVAIL: NTIS. AIRESEARCH-74-10996(3) N76-30656

An extensive review of the literature was conducted which was concerned with the characterization of systems and equipment that could be applicable to the development of solar-powered air conditioners based on the Rankine cycle approach, and the establishment of baseline data defining the performance, physical characteristics, and cost of systems using the LiBr/H20 absorption cycle.

NASA-CR-144973 4/8/75
DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR CONDITIONER. PROGRAM REVIEW. AiResearch Mfg. Co., Los Angeles, CA. NAS8-30758. AVAIL: NTIS. AIRESEARCH-74-10996(5) N76-30665

Progress in the effort to develop a residential solar-powered air conditioning system is reported. The topics covered include the objectives, scope and status of the program. The results of state-of-art, design, and economic studies and component and system data are also presented.

NASA-CR-149974 7/25/75
DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR CONDITIONER. SCREENING ANALYSIS. AiResearch Mfg. Co., Los Angeles, CA. NAS8-30758. AVAIL: NTIS. AIRESEARCH-74-10996(7) N76-30659

Screening analysis aimed at the definition of an optimum configuration of a Rankine cycle solar-powered air conditioner designed for residential application were conducted. Initial studies revealed that system performance and cost were extremely sensitive to condensing temperature and to the type of condenser used in the system. Consequently, the screening analyses were concerned with the generation of parametric design data for different condenser approaches; i.e., (1) an ambient air condenser, (2) a humidified ambient air condenser, (3) an evaporating condenser, and (4) a water condenser (with a cooling tower). All systems feature a high performance turbocompressor and a single refrigerant (R-11) for the power and refrigeration loops. Data were obtained by computerized methods developed to permit system characterization over a broad range of operating and design conditions. The criteria used for comparison of the candidate system approaches were (1) overall system cop (refrigeration effect/solar heat input), (2) auxiliary electric power for fans and pumps, and (3) system installed cost or cost to the user.

NASA-CR-149975 11/7/75
DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR CONDITIONER, SYSTEM OPTIMIZATION PRELIMINARY SPECIFICATION.
Rousseau, J.; Hwang, K.C. AiResearch Mfg. Co., Los Angeles, CA. NAS8-30758. AVAIL: NTIS. AIRESEARCH-74-10996(8) N76-30660

Investigations aimed at the optimization of a baseline Rankine cycle solar powered air conditioner and the development of a preliminary system specification were conducted. Efforts encompassed the following: (1) investigations of the use of recuperators/regenerators to enhance the performance of the baseline system, (2) development of an off-design computer program for system performance prediction, (3) optimization of the turbocompressor design to cover a broad range of conditions and permit operation at low heat source water temperatures, (4) generation of parametric data describing system performance (cop and capacity), (5) development and evaluation of candidate system augmentation concepts and selection of the optimum approach, (6) generation of

auxiliary power requirement data, (7) development of a complete solar collector-thermal storage-air conditioner computer program, (8) evaluation of the baseline Rankine air conditioner over a five day period simulating the NASA solar house operation, and (9) evaluation of the air conditioner as a heat pump.

NASA-CR-149976 3/28/75
DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL AIR CONDITIONER, ECONOMIC ANALYSIS. AiResearch Mfg. Co., Los Angeles, CA. NAS8-30758. AVAIL: NTIS. AIRESEARCH-74-10996(4) N76-30653

The results of investigations aimed at the development of cost models to be used in the economic assessment of Rankine-powered air conditioning systems for residential application are summarized. The rationale used in the development of the cost model was to (1) collect cost data on complete systems and on the major equipment used in these systems; (2) reduce these data and establish relationships between cost and other engineering parameters such as weight, size, power level, etc.; and (3) derive simple correlations from which cost-to-the-user can be calculated from performance requirements. The equipment considered in the survey included heat exchangers, fans, motors, and turbocompressors. This kind of hardware represents more than 2/3 of the total cost of conventional air conditioners.

NASA-CR-150006 6/76
SOLAR HEATING AND COOLING TECHNICAL DATA AND SYSTEMS ANALYSIS PROGRESS REPORT, SEP. 1975–JUN. 1976. Christensen, D.L. University of Alabama, Huntsville, AL. (Center for Environmental and Energy Studies). NAS8-31293. AVAIL: NTIS. N76-32650

The acquisition and processing of selected parametric data for inclusion in a computerized data base using the Marshall Information Retrieval and Data System (MIRADS) developed by NASA-MSFC is discussed. This data base provides extensive technical and socioeconomic information related to solar energy heating and cooling on a national scale. A broadly based research approach was used to assist in the support of program management and the application of a cost-effective program for solar energy development and demonstration.

NASA-CR-150032 10/76
DESIGN, FABRICATION, TESTING, AND DELIVERY OF A SOLAR ENERGY COLLECTOR SYSTEM FOR RESIDENTIAL HEATING AND COOLING. Holland, T.H.; Borzoni, J.T. Honeywell Inc., Minneapolis, MN. (Energy Resources Center). NAS8-31327. AVAIL: NTIS. N77-10638

A low cost flat plate solar energy collector was designed for the heating and cooling of residential buildings. The system meets specified performance requirements, at the desired system operating levels, for a useful life of 15 to 20 years, at minimum cost and uses state-of-the-art materials and technology. The rationale for the design method was based on identifying possible material candidates for various collector components and then selecting the components which best meet the solar collector design requirements. The criteria used to eliminate certain materials were performance and durability test results, cost analysis, and prior solar collector fabrication experience.

NASA-CR-150064 7/76
LISTING OF SOLAR RADIATION MEASURING EQUIPMENT AND GLOSSARY. Carter, E.A.; Greenbaum, S.A.; Patel, A.M. University of Alabama, Huntsville, AL. (Center for Environmental and Energy Studies). NAS8-31293. AVAIL: NTIS. ERDA/NASA-31293-76/3 N77-12507

An attempt is made to list and provide all available information about solar radiation measuring equipment which are being manufactured and are available on the market. The list is in tabular form and includes sensor type, response time, cost data and comments for each model. A cost code is included which shows ranges only.

NASA-CR-150171 5/26/76
SPACE-BASED POWER CONVERSION AND POWER RELAY SYSTEMS: PRELIMINARY ANALYSIS OF ALTERNATE SYSTEMS, INTERIM REPORT, 7/8/75-5/26/76. Boeing Aerospace Co., Seattle, WA. NAS8-31628. AVAIL: NTIS. N77-16447

The results are presented of nine months of technical study of nonphotovoltaic options for the generation of electricity for terrestrial use by satellite power stations (SPS). A concept for the augmentation of ground-based solar power plants by orbital sunlight reflectors was also studied. Three SPS types having a solar energy source and which used nuclear reactors were investigated. Data derived for each included (1) configuration definition, including mass statement; (2) information for use in environmental impact assessment; (3) energy balance (ratio of energy produced to that required to achieve operation); and (4) development and other cost estimates. Cost estimates were dependent upon the total program (development, placement and operation of a number of satellites) which was postulated. This postulation was based upon an analysis of national power capacity trends and guidelines received from MSFC.

NASA-CR-150146 6/30/76
SPACE-BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS STUDY, VOLUME I: EXECUTIVE SUMMARY, INTERIM REPORT. Hazelrigg, G.A., Jr. ECON, Inc., Princeton, NJ. NAS8-31308. AVAIL: NTIS. REPT-76-145-2-VOL-1
N77-15494

The technical and economic aspects of satellite solar power systems are presented with a focus on the current configuration 5000 MW system. The technical studies include analyses of the orbital system structures, control and stationkeeping, and the formulation of program plans and costs for input to the economic analyses. The economic analyses centered about the development and use of a risk analysis model for a system cost assessment, identification of critical issues and technologies, and to provide information for programmatic decision making. A preliminary economic examination of some utility interface issues is included. Under the present state-of-knowledge, it is possible to formulate a program plan for the development of a satellite solar power system that can be economically justified. The key area of technological uncertainty is man's ability to fabricate and assemble large structures in space.

NASA-CR-150147 6/30/76
SPACE-BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS STUDY. VOLUME 2: ENGINEERING ANALYSIS OF ORBITAL SYSTEMS, INTERIM REPORT. Grumman Aerospace Corp., Bethpage NY. NAS8-31308. AVAIL: NTIS. REPT-76-145-2-VOL-2
N77-15495

Program plans, schedules, and costs are determined for a synchronous orbit-based power generation and relay system. Requirements for the satellite (PRS) are explored. Engineering analysis of large solar arrays, flight mechanics and control, transportation, assembly and maintenance, and microwave transmission are included.

NASA-CR-150148 6/30/76

SPACE-BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS STUDY. VOLUME 3: ECONOMIC ANALYSIS OF SPACE-BASED SOLAR POWER SYSTEMS, INTERIM REPORT. Hazelrigg, G.A., Jr. ECON, Inc., PRINCETON, NJ. NAS8-31308. AVAIL: NTIS. REPT-76-145-2-VOL-3 IR-2 N77-15496

A variety of economic and programmatic issues are discussed concerning the development and deployment of a fleet of space-based solar power satellites (SSPS). The costs, uncertainties and risks associated with the current photovoltaic SSPS configuration, and with issues affecting the development of an economically viable SSPS development program are analyzed. The desirability of a low earth orbit (LEO) demonstration satellite and a geosynchronous (GEO) pilot satellite is examined and critical technology areas are identified. In addition, a preliminary examination of utility interface issues is reported. The main focus of the effort reported is the development of SSPS unit production, and operation and maintenance cost models suitable for incorporation into a risk assessment (Monte Carlo) model (RAM). It is shown that the key technology area deals with the productivity of man in space, not, as might be expected, with some hardware component technology.

NASA-CR-150176 12/76

OPTIMIZATION OF ABSORPTION AIR-CONDITIONING FOR SOLAR ENERGY APPLICATIONS, FINAL REPORT 9/1/74-10/31/76. Perry, E.H. Memphis State Univ., TN (Dept. of Mechanical Engineering). NAS8-31189. AVAIL: NTIS. N77-17560

Improved performance of solar cooling systems using the lithium bromide water absorption cycle is investigated. Included are computer simulations of a solar-cooled house, analyses and measurements of heat transfer rates in absorption system components, and design and fabrication of various system components. A survey of solar collector convection suppression methods is presented.

NASA-CR-150177 11/76

SOLAR RADIATION OBSERVATION STATIONS WITH COMPLETE LISTINGS OF DATA ARCHIVED BY THE NATIONAL CLIMATIC CENTER, ASHEVILLE, NORTH CAROLINA AND INITIAL LISTING OF DATA NOT CURRENTLY ARCHIVED. Carter, E.A.; Wells, R.E.; Williams, B.B.; Christensen, D.L. University of Alabama, Huntsville, AL; Energy Research and Development Administration, Washington, D.C. (Center for Environmental and Energy Studies). NAS8-31293. AVAIL: NTIS. N77-17987

A listing is provided of organizations taking solar radiation data, the 166 stations where observations are made, the type of equipment used, the form of the recorded data, and the period of operation of each station. Included is a listing of the data from 150 solar radiation stations collected over the past 25 years and stored by the National Climatic Center.

NASA-CR-150209 3/21/77

SYSTEMS DEFINITION SPACE BASED POWER CONVERSION SYSTEMS, FINAL REPORT-EXECUTIVE SUMMARY. Boeing Aerospace Co., Seattle, WA. NAS8-31628. AVAIL: NTIS.

This study investigated potential space-located systems for the generation of electrical power for use on Earth. These systems were of three basic types: (1) systems

producing electrical power from solar energy; (2) systems producing electrical power from nuclear reactors; (3) systems for augmenting ground-based solar power plants by orbital sunlight reflectors. Systems (1) and (2) would utilize a microwave beam system to transmit their output to Earth. Configurations implementing these concepts were developed through an optimization process intended to yield the lowest cost for each. A complete program was developed for each concept, identifying required production rates, quantities of launches, required facilities, etc. Each program was costed in order to provide the electric power cost appropriate to each concept.

NASA-CR-150268 5/18/77
SYSTEMS DEFINITION SPACE BASED POWER CONVERSION SYSTEMS (FINAL REPORT, DETAILED TECHNICAL REPORT). Boeing Aerospace Co., Seattle, WA. NAS8-31628. AVAIL: NTIS.

The purpose of this study was the investigation of potential space-located systems for the generation of electrical power for use on Earth. These systems were of three basic types: (1) systems producing electrical power from solar energy; (2) systems producing electrical power from nuclear reactors; (3) systems for augmenting ground-based solar power plants by orbital sunlight reflectors. Systems (1) and (2) would utilize a microwave beam system to transmit their output to Earth. Configurations implementing these concepts were developed through an optimization process intended to yield the lowest cost for each. A complete program was developed for each concept, identifying required production rates, quantities of launches, required facilities, etc. Each program was costed in order to provide the electric power cost appropriate to each concept.

NASA-TM-X-3509
SOLAR ABSORPTION CHARACTERISTICS OF SEVERAL COATINGS AND SURFACE FINISHES FOR SOLAR ENERGY COLLECTORS. Lowery, J.R. Marshall Space Flight Center, Alabama, AVAIL: NTIS 77N20567

Solar absorption characteristics are established for several films potentially favorable for use as receiving surfaces in solar energy collectors. Included in the investigations were chemically produced black films, black electrodeposits, and anodized coatings. It was found 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 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 films studied.

NASA-TM-X-53925 9/16/69
THE THERMAL STRUCTURE OF THE SUN. Schocken, K. Marshall Space Flight Center, Alabama. AVAIL: NTIS. MSFC-R-RP-INT-67-3 70N37563

Mathematical Models/Solar Energy/Solar Temperature/Solar Flux/Solar Protons/Solar Radiation/Solar Simulation

NASA-TM-X-53930 9/16/69
THE HEAT PIPE EXPERIMENT. Shelton, R.D. Marshall Space Flight Center., Alabama. AVAIL: NTIS. MSFC-R-SSL-INN-67-10 70N37575

Pipes (Tubes)/Radiant Heating/Solar Heating/Absorbers (Material) Heat/Heat Sinks/Radiant Heat Transfer

NASA-TM-X-60765 5/6/62
DEVELOPMENT OF TECHNIQUES FOR FORMING SEGMENTS OF A PARABOLIC SOLAR CONCENTRATOR. Schuerer, P.H. Marshall Space Flight Center, Alabama. AVAIL: NTIS. MTP-ME-62-1 68N81707

Manufacturing/Parabolic Bodies/Production Engineering/Segments/Solar Collectors

NASA-TM-X-62639 8/5/68
PROCEEDINGS OF THE THIRD SOUTHEASTERN SEMINAR ON THERMAL SCIENCES. Atkins, H.L.; Vachon, R.I. Auburn University and Marshall Space Flight Center, Alabama. AVAIL: NTIS. MISC-SSL-69-1 70N18686

Aerodynamic Heating/Conferences/Fluid Mechanics/Heat Shielding/Heat Transfer/Space Flight/Spacecraft Environments/Blunt Bodies/Energy Conversion/Helium/Hydrogen/Low Temperature Physics/Mass Transfer/Mathematical Models/Polymer Physics/Rheology/Thermal Protection/Thermodynamic Properties/Thermophysical Properties.

NASA-TM-X-64757 5/7/73
TERRESTRIAL ENVIRONMENT (CLIMATE) CRITERIA GUIDELINES FOR USE IN AEROSPACE VEHICLE DEVELOPMENT. Daniels, G.E. Marshall Space Flight Center, Alabama. AVAIL: NTIS. 74N16292

Guidelines are provided on probable climatic extremes and terrestrial environment data applicable to space vehicle and associated equipment design and development. Operational criteria for ground support sites are emphasized.

NASA-TM-X-64924 9/74
SOLAR RESIDENTIAL HEATING AND COOLING SYSTEM DEVELOPMENT TEST PROGRAM Humphries, W.R.; Melton, D.E. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS. 75N22903

A solar heating and cooling system is described, which was installed in a simulated home at Marshall Space Flight Center. Performance data are provided for the checkout and initial operational phase for key subsystems and for the total system. Valuable information was obtained with regard to operation of a solar cooling system during the first summer of operation. Areas where improvements and modifications are required to optimize such a system are discussed.

NASA-TM-X-64940 6/75
FLUID MANIFOLD DESIGN FOR A SOLAR ENERGY STORAGE TANK. Humphries, W.R., Hewitt, H.C., and Griggs, E.I. Marshall Space Flight Center, Huntsville, Alabama. Tennessee Technological University. AVAIL: NTIS. 75N27562

A design technique for a fluid manifold for use in a solar energy storage tank is given. This analytical treatment generalizes the fluid equations pertinent to manifold design, giving manifold pressures, velocities, and orifice pressure differentials in terms of appropriate fluid and manifold geometry parameters. Experimental results used to corroborate analytical predictions are presented. These data indicate that variations in orifices can cause deviations between analytical predictions and actual performance values.

NASA-TM-X-64958 2/28/75
INTERIM PERFORMANCE CRITERIA FOR COMMERCIAL SOLAR HEATING AND COMBINED HEATING/COOLING

SYSTEMS AND FACILITIES. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS. DOC-98M10001 75N32585

Air Conditioning/Solar Energy Conversion/Heat Transfer/Solar Collectors/Solar Heating/Technology Assessment. Superseded by NBSIR 76-1187

NASA-TM-X-64969 5/11/74
CONSIDERATIONS FOR PERFORMANCE EVALUATION OF SOLAR HEATING AND COOLING SYSTEMS. Littles, J.W., Cody, J.C. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS 76N14606

One of the many factors which must be considered in performance evaluation of solar energy is the relative merit of a given solar energy system when compared to a standard conventional system. Although initial and operational costs will be dominant factors in the consideration in system selection, sufficient data are not yet available for a definitive treatment of these variables. It is possible, however, to formulate relationships between the nonsolar energy requirements of the solar energy systems and the energy requirements of a conventional system in terms of the primary performance parameters of the systems. Derivations of such relationships, some parametric data for selected ranges of the performance parameters, and data with respect to limiting conditions are presented.

NASA-TM-X-70089 10/5/74
THE DEVELOPMENT OF A SOLAR-POWERED RESIDENTIAL HEATING AND COOLING SYSTEM. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS. M-TU-74-3 74N26504

ABS efforts to demonstrate the engineering feasibility of utilizing solar power for residential heating and cooling are described. These efforts were concentrated on the analysis, design, and test of a full-scale demonstration system which is currently under construction at the National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Alabama. The basic solar heating and cooling system under development utilizes a flat plate solar energy collector, a large water tank for thermal energy storage, heat exchangers for space heating and water heating, and an absorption cycle air conditioner for space cooling.

NASA-TM-X-71199 11/74
ANALYTICAL DESCRIPTION OF THE MODERN STEAM AUTOMOBILE. Peoples, J.A. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS. M-TU-74-7 75N14134

The sensitivity of operating conditions upon performance of the modern steam automobile is discussed. The word modern has been used in the title to indicate that emphasis is upon miles per gallon rather than theoretical thermal efficiency. This has been accomplished by combining classical power analysis with the ideal pressure-volume diagram. Several parameters are derived which characterize performance capability of the modern steam car. The report illustrates that performance is dictated by the characteristics of the working medium, and the supply temperature. Performance is nearly independent of pressures above 800 psia. Analysis techniques were developed specifically for reciprocating steam engines suitable for automotive application. Specific performance charts have been constructed on the basis of water as a working medium. The conclusion and data interpretation are limited within this scope.

NASA-TM-X-73333 8/76

AN ANALYTICAL AND EXPERIMENTAL EVALUATION OF A FRESNEL LENS SOLAR CONCENTRATOR. Hastings, L.J.; Allums, S.A.; Cosby, R.M. Ball State University and Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS. 76N33011

An analytical and experimental evaluation of line focusing Fresnel lenses with application potential in the 200 to 370°C range was studied. Analytical techniques were formulated to assess the solar transmission and imaging properties of a grooves down lens. Experiment was based on a 56 cm wide, F/1.0 lens. A sun tracking heliostat provided a nonmoving solar source. Measured data indicated more spreading at the profile base than analytically predicted, resulting in a peak concentration 18 percent lower than the computer peak of 57. The measured and computed transmittances were 85 and 87 percent, respectively. Preliminary testing with a subsequent lens indicated that modified manufacturing techniques corrected the profile spreading problem and should enable improved analytical experimental correlation.

NASA-TM-X-73344 6/11

SATELLITE POWER SYSTEM ENGINEERING AND ECONOMIC ANALYSIS SUMMARY. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS. 77N15486

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. Anticipated technology related to manufacturing, construction, and maintenance operations is described. Fuel consumption, environmental effects, and orbital transfer are investigated. Space shuttles, local space transportation, and the heavy lift launch vehicle required are also discussed.

NASA-TM-X-73355 9/76

A PERFORMANCE EVALUATION OF VARIOUS COATINGS, SUBSTRATE MATERIALS, AND SOLAR COLLECTOR SYSTEMS. Dolan, F.J. Marshall Space Flight Center, Huntsville, Ala. AVAIL: NTIS. 77N15489

An experimental apparatus was constructed and utilized in conjunction with both a solar simulation and actual sunlight to test and evaluate various solar panels 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 test. Test data are presented as are schematics and pictures of test equipment and test hardware.

NASA-TM-X-73392 4/77

AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF A 1.8 BY 3.7 METER FRESNEL LENS SOLAR CONCENTRATOR. Hastings, J.; Allums, L.; and Jensen, S. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS.

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 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 54 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 was 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 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 of 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.

NASA-TN-D-6828 6/72

ULTRASONIC INVESTIGATIONS OF THE SUPERCONDUCTING PROPERTIES OF THE NB-MO SYSTEM. Lacy, L.L. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS.
72N26433

The superconducting properties of single crystals of NB and two alloys of NB with MO were investigated by ultrasonic techniques. The results of measurements of the ultrasonic attenuation and velocity as a function of temperature, MO composition, crystallographic direction, and ultrasonic frequency are reported. The attenuation and small velocity changes associated with the superconductivity of the samples are shown to be dependent on the sample resistivity ratio which varied from 4.3 for NB-9% MO to 6500 for pure NB. The ultrasonic attenuation data are analyzed in terms of the superconducting energy gap term of the BCS theory. A new model is proposed for the analysis of ultrasonic attenuation in pure superconductors with two partially decoupled energy bands. To analyze the attenuation in pure superconducting NB, the existence of two energy gaps was assumed to be associated with the two partially decoupled energy bands. One of the gaps was found to have the normal BCS value of 3.4 and the other gap was found to have the anomalously large value of 10. No experimental evidence was found suggesting that the second energy gap had a different transition temperature. The interpretation of the results for the NB-MO alloys is shown to be complicated by the possible existence of a second superconducting phase with a transition temperature of 0.35 of the transition temperature of the first phase. The elastic constants of NB-MO alloys are shown to be approximately independent of MO composition to nine atomic percent MO. These results do not agree with the current microscopic theory of transition temperature for the transition elements.

NASA-TN-D-8409 2/77

CORROSION INHIBITORS FOR SOLAR HEATING AND COOLING SYSTEMS. Humphries, T.S.; Deramus, G.E., Jr. Marshall Space Flight Center, Huntsville, Alabama. AVAIL: NTIS.
77N17198

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 anti-freeze 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 most likely the type to be employed. Several inhibitors show promise for this application.

Effectiveness of corrosion inhibiting solutions containing sodium compounds for aluminum and mild steel sheets at room temperatures and elevated temperatures; variables include degree of chemical attack, corrosive characteristics, solution pH, length to first visual attack, weight loss, and temperature effects; no figures and 6 tables include numeric data.

SUBJECT INDEX

ADHESIVE BONDING: K75-10164, NASA-CR-144312

AIR CONDITIONING: A76-31378, K75-10205, K75-10225, K75-10612, K75-10650, K75-10925, K75-11328, K76-11070, K76-11336, K76-11493, M-FS-22563, M-FS-23057, M-FS-23260, M-FS-23432, NASA-CR-142728, NASA-CR-144110, NASA-CR-144111, NASA-CR-144234, NASA-CR-144314, NASA-CR-149785, NASA-CR-149971, NASA-CR-149972, NASA-CR-149973, NASA-CR-149974, NASA-CR-149975, NASA-CR-149976, NASA-CR-150006, NASA-CR-150032, NASA-CR-150176, NASA-TM-X-64924, NASA-TM-X-64958, NASA-TM-X-64969, NASA-TM-X-70089, NASA-TN-D-8409

CALIBRATING: NASA-CR-144006

COATINGS: A75-24194, M-FS-14706, M-FS-22562, M-FS-23420, NASA-CASE-MFS-22562-1, NASA-CR-149928, NASA-CR-150032, NASA-TM-X-3509, NASA-TM-X-73355

DATA ACQUISITION: NASA-CR-150177

ECONOMIC ANALYSIS: K75-10225, K75-12132, NASA-CR-149976, NASA-TM-X-73344

ELECTRICAL RESISTIVITY: K77-10207

ENERGY ABSORPTION FILMS: K75-10551, K75-10650, M-FS-23420

ENERGY CONSERVATION: K75-10205, NASA-CR-120668

ENERGY CONVERSION: K75-10225, K75-10551, K75-10650, K75-10925, K75-11328, K75-11454, K76-10736, K76-11919, M-FS-21628, M-FS-22743, M-FS-22744, M-FS-23062, M-FS-23195, M-FS-23403, NASA-CASE-MFS-23062-1, NASA-TM-X-62639, NASA-TM-X-72199

ENERGY POLICY: A75-14012

ENERGY REQUIREMENTS: NASA-CR-120668, NASA-CR-129012

ENERGY STORAGE: K74-11130, M-FS-22563, M-FS-23260, NASA-CASE-MFS-23051-1

ENERGY SOURCES: NASA-CR-129012

ENERGY TRANSFER: M-FS-21927, NASA-CASE-MFS-22743-1

ENGINES: M-FS-23403

FLYWHEELS: NASA-CASE-MFS-23051-1

FREON: NASA-CASE-MFS-21628-1

HEAT STORAGE: K74-11130
K76-11922
M-FS-23167
NASA-CASE-MFS-22744-1
NASA-CASE-MFS-23167-1
NASA-CR-144081
NASA-TM-X-64940

HEAT TRANSFER: M-FS-21628
M-FS-22743
M-FS-22744
NASA-TM-X-62639

LENSES: K76-11313
K76-11314
NASA-TM-X-73333
NASA-TM-X-73392

MOLYBDENUM: NASA-TN-D-6828

MOTORS: M-FS-23062
NASA-CASE-MFS-23062-1

PAINTS: M-FS-14706

PHOTOVOLTAIC CELLS: NASA-CASE-MFS-22458-1

RADIATION MEASURING INSTRUMENTS: K75-10554
NASA-CR-144006
NASA-CR-150064

RECORDING INSTRUMENTS: A75-14012

ROTATING BODIES: NASA-CASE-MFS-23051-1

SATELLITE POWER TRANSMISSION TO EARTH: A77-10913
NASA-CR-150146
NASA-CR-150147
NASA-TM-X-73344

SATELLITE SOLAR ENERGY CONVERSION: K76-12132
NASA-CR-150146
NASA-CR-150171

SATELLITE SOLAR POWER STATIONS: K76-12132
NASA-TM-X-73344

SOLAR ARRAYS: K75-10164
K77-10207
M-FS-23138
NASA-CR-144312

SOLAR CELLS: K75-10164
K75-11454
K76-12132
K77-10207
M-FS-21328
M-FS-23138
M-FS-23195
NASA-CASE-MFS-22458-1

SOLAR COLLECTORS: K75-10164
K75-10205
K75-10225
K75-10551
K75-10554
K75-10612
K75-10650
K75-10925
K76-10736
K76-11313
K76-11922
M-FS-21927
M-FS-22562
M-FS-22743
M-FS-22744
M-FS-22943
M-FS-23057
M-FS-23167
M-FS-23260
M-FS-23272
M-FS-23349
M-FS-23420
M-FS-23428
NASA-CR-144265
NASA-CR-149928
NASA-CR-150032
NASA-TM-X-3509
NASA-TM-X-60757
NASA-TM-X-73333
NASA-TM-X-73335

SOLAR ELECTRIC PROPULSION: K75-11454

SOLAR ENERGY CONVERSION: K75-10205
K75-10225
K75-10551
K75-10650
K75-10925
K75-11328
K75-11454
K76-10736
K76-11313

SOLAR ENERGY CONVERSION: (Concluded)
M-FS-23428
M-FS-23432
M-FS-23349
NASA-CASE-MFS-21628-2
NASA-CR-144110
NASA-CR-144111
NASA-CR-149971
NASA-CR-149972
NASA-CR-149973
NASA-CR-149974
NASA-CR-149975
NASA-CR-149976
NASA-CR-150006
NASA-CR-150147
NASA-CR-150148
NASA-CR-150176
NASA-TM-X-64958
NASA-TM-X-64969
NASA-TM-X-70089

SOLAR ENERGY ABSORBERS:
K75-10164
K75-10650
M-FS-22743
M-FS-22744
M-FS-23349
M-FS-23420
M-FS-23428
NASA-CASE-MFS-22562-1
NASA-CASE-MFS-22743-1
NASA-CASE-MFS-22744-1
NASA-CR-150032

SOLAR HEATING:
K75-10612
K75-10650
K75-11328
K76-11070
K76-11336
K76-11932
M-FS-21927
M-FS-22563
M-FS-23432
NASA-CR-144314
NASA-CR-149785
NASA-TM-X-53930
NASA-TM-X-64924
NASA-TM-X-73355

SOLAR RADIATION:
K75-10554
NASA-CR-150064
NASA-CR-150177
NASA-TM-X-53925

SOLAR TEMPERATURE:
NASA-TM-X-53925

SPACECRAFT POWER SUPPLIES:
NASA-CASE-MFS-21628-2

SUNLIGHT:
K75-10554
K76-11313

THERMAL ENERGY:
K74-11130
K75-10225
NASA-CASE-MFS-23167-1

☆ U.S. GOVERNMENT PRINTING OFFICE 1977—740-049/381 REGION NO. 4

APPROVAL

SOLAR ENERGY BIBLIOGRAPHY

Compiled by Stephen Gargus

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.

This document has also been reviewed and approved for technical accuracy.

J. T. SHEPHERD
Director, Administration and Program Support