NASA SP-7043(13)

ENERGY

A CONTINUING BIBLIOGRAPHY

WITH INDEXES

APRIL 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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DOCUMENT	*DATE*	*COVERAGE*
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NASA SP-7043(03)	February 1975	July 1, 1974 – September 30, 1974
NASA SP-7043(04)	May 1975	October 1, 1974 – December 31, 1974
NASA SP-7043(05)	August 1975	January 1, 1975 – March 31, 1975
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NASA SP-7043(13)

ENERGY

A Continuing Bibliography

With Indexes

Issue 13

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from January 1 through March 31, 1977 in

- *Scientific and Technical Aerospace Reports (STAR)*
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INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(13)) lists 1036 reports, journal articles, and other documents announced between January 1, 1977 and March 31, 1977 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

Five indexes -- subject, personal author, corporate source, contract number, and report number -- are included. The indexes are of the cumulating type throughout the year, with the fourth quarterly publication containing abstracts for the fourth quarter and index references for the four quarterly publications.

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GENERAL AVAILABILITY

All publications abstracted in this bibliography are available to the public through the sources as indicated in the *STAR Entries* and *IAA Entries* sections. It is suggested that the bibliography user contact his own library or other local libraries prior to ordering any publication inasmuch as many of the documents have been widely distributed by the issuing agencies, especially NASA. A listing of public collections of NASA documents is included on the inside back cover.

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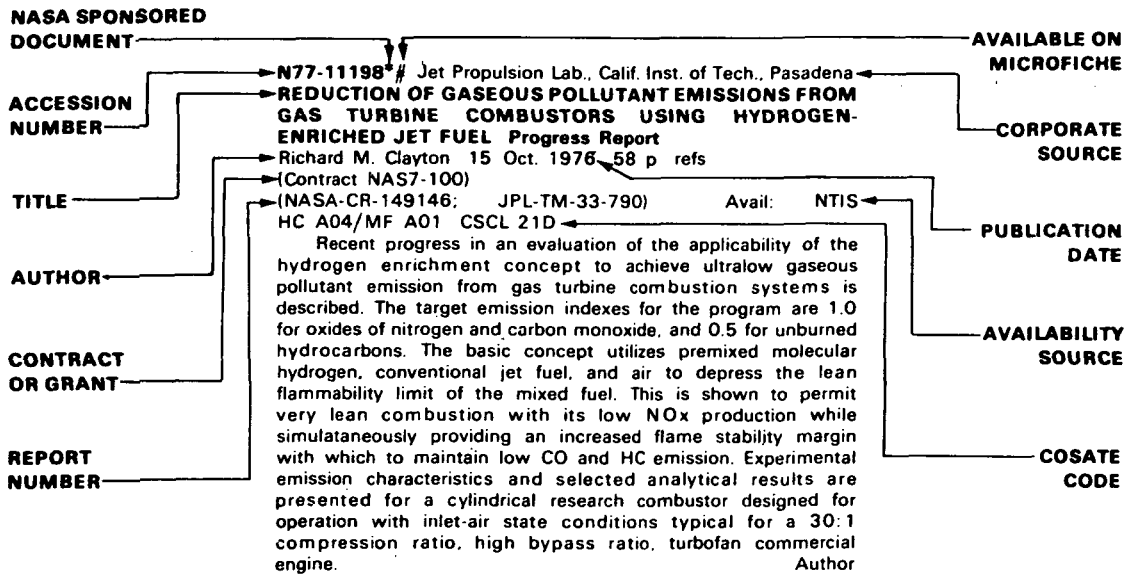
TABLE OF CONTENTS

IAA Entries 1
STAR Entries 83

Subject Index A-1
Personal Author Index B-1
Corporate Source Index C-1
Contract Number Index D-1
Report/Accession Number Index E-1

TYPICAL CITATION AND ABSTRACT FROM *STAR*



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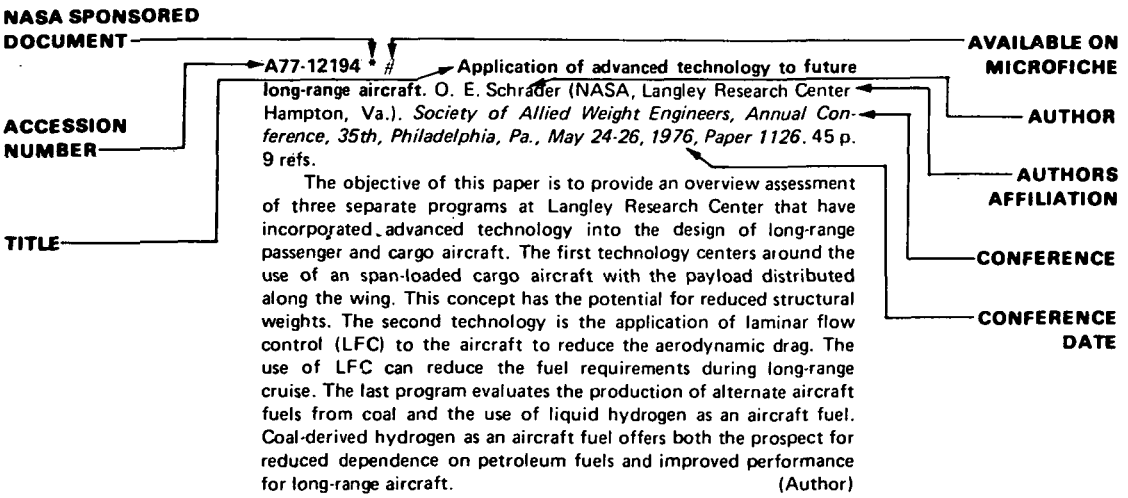

A Listing of Energy Bibliographies Contained In This Publication:

Heat transfer – A review of 1975 literature	p0002	A77-10615
Cost aspects of solar energy – Selective and critical bibliography	p0054	A77-15799
Survey of alcohol fuel technology, Volume 2	p0112	N77-13233
Inventory of energy research and development (1973— 1975), volume 1	p0113	N77-13525
Inventory of energy research and development (1973— 1975), volume 2	p0113	N77-13526
Inventory of energy research and development (1973— 1975), volume 3	p0113	N77-13527
Inventory of energy research and development (1973— 1975), volume 4	p0113	N77-13528
Bibliography on Liquefied Natural Gas (LNG) safety	p0127	N77-15208

ENERGY

A Continuing Bibliography (Issue 13)

APRIL 1977

IAA ENTRIES

A77-10121 * **Thermographic mosaic of Yellowstone National Park.** R. S. Williams, Jr. (U.S. Geological Survey, Reston, Va.), P. G. Hasell, Jr. (Michigan, Environmental Research Institute, Ann Arbor, Mich.), A. N. Sellman (NASA, Goddard Space Flight Center, Greenbelt, Md.; Michigan, Environmental Research Institute, Ann Arbor, Mich.), and H. W. Smedes (U.S. Geological Survey, Denver, Colo.). *Photogrammetric Engineering and Remote Sensing,* vol. 42, Oct. 1976, p. 1315-1324. 28 refs.

An uncontrolled aerial thermographic mosaic of Yellowstone National Park was assembled from the videotape record of 13 individual thermographs obtained with linescan radiometers. Post mission processing of the videotape record rectified the nadir line to a topographic map base, corrected for v/h variations in adjacent flight lanes, corrected for yaw and pitch distortions, and distortions produced by nonlinearity of the side-wise scan. One of the purposes of the thermographic study was to delineate the areas of thermal emission (hot springs, geysers, etc.) throughout the Park, a study which could have great value in reconnaissance surveys of geothermal areas in remote regions or regions of high relief. B.J.

A77-10174 **MIS silicon solar cells.** E. Fabre (Laboratoire d'Electronique et de Physique Appliquée, Limeil-Brevannes, Val-de-Marne, France). *Applied Physics Letters,* vol. 29, Nov. 1, 1976, p. 607-610. 16 refs. Research supported by the Délégation Générale à la Recherche Scientifique et Technique.

A careful analysis of I-V curves under illumination makes it possible to characterize the different parameters leading to an increase of the open-circuit voltage of MIS silicon solar cells with respect to classical Schottky barrier solar cells. The separate influence of the effective barrier height and of the quality factor of the diode upon open-circuit voltage is emphasized. An over-all conversion efficiency over 8 percent under AM1 illumination is reported for a large-area (2.5 sq cm) MIS cell. (Author)

A77-10202 # **Performance theory of diagonal conducting wall MHD generators.** Y. C. L. Wu (Tennessee, University, Tullahoma, Tenn.). *AIAA Journal,* vol. 14, Oct. 1976, p. 1362-1368. 19 refs. Contract No. E(49-18)-1760.

Performance characteristics of diagonal conducting wall (DCW) generators including the Faraday mode are investigated theoretically. Governing equations with current-depending effective voltage drop are derived. Performance diagrams are presented and comparisons of different generators are made. The performance diagrams in the current density plane are found to be spiral-like, constructed by two half-circles of different radii. One half-circle corresponds to the short circuit condition, whereas the other represents the open circuit condition. The operating curve of DCW generators at given Hall parameters are straight lines drawn from the two half-circles. (Author)

A77-10318 **The options for using the sun.** J. B. Goodenough (Oxford University, Oxford, England). *Technology Review,* vol. 79, Oct.-Nov. 1976, p. 63-71.

Several seriously proposed schemes for solar-energy utilization are discussed. The exploitation of the temperature difference between seawater at the ocean surface and at depths of a thousand meters and the conversion of municipal waste into fuel gas are cited as two illustrative cases of solar-energy utilization. Operational principles and components of solar-heat collectors are described, refrigeration systems powered directly by solar energy are considered, and ways to concentrate sunlight are reviewed. Alternatives for producing electric power from solar energy are summarized, including the use of windmills or hydropower to turn electric generators, direct conversion of solar energy to electric power by means of semiconductors, and indirect conversion by driving conventional turbine equipment with solar-derived heat. The conversion of solar energy into chemical energy is examined in terms of pyrolysis, electrolysis, photolysis, and photoelectrolysis of water. The problem of solar-energy storage is noted. F.G.M.

A77-10324 **Emergency power plant of rapid availability for the Berlin-Tegel airport (Schnellbereitschaftsanlage für Flughafen Berlin-Tegel).** A. Jost. *AEG-Telefunken, Technische Mitteilungen,* vol. 66, no. 5, 1976, p. 205-209. In German.

The regulations of the ICAO specify that, in case of a power failure, the interruption of the power supply for the important installations of the airport, especially the airport lighting system, should not exceed 1 second. An emergency power plant with special characteristics for satisfying this requirement is described. The power plant makes use of a flywheel which is coupled with the generator. During normal operation the generator with the flywheel are maintained in a state of motion with the aid of a asynchronous motor. In case of power failure, the energy stored in the flywheel maintains the motion of the generator until the Diesel engine is capable, after about 1 sec, to provide the motive power. The rapid start of the Diesel engine is made possible by coupling the engine to the flywheel. The design details of the emergency power plant used in Berlin-Tegel are discussed. G.R.

A77-10423 **Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream.** V. V. Kirillov, M. Ia. Panovko, and Iu. N. Sokolov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 14, Jan.-Feb. 1976, p. 179-190.) *High Temperature,* vol. 14, no.

1, July 1976, p. 157-166. 10 refs. Translation.

A77-10424 **Study of the ionization of the additive in MHD installations.** M. S. Pinkhasik, Iu. A. Zakharko, V. D. Cherkas, and G. V. Nabatov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 14, Jan.-Feb. 1976, p. 191-198.) *High Temperature,* vol. 14, no. 1, July 1976, p. 167-173. 11 refs. Translation.

The behavior of a drop of an aqueous K2CO3 solution in the circuit of an MHD generator and its influence on conductivity was investigated. The chemical reactions occurring in the boundary layer during the evaporation of a K2CO3 melt are examined, and the dependency of the relative conductivity of the combustion products on the time that the additive is present in the air-gas tract and on the degree of dispersion of the particles is determined. C.K.D.

A77-10451 * **Risk management of liquefied natural gas installations.** O. H. Fedor (NASA, Kennedy Space Center, Cocoa Beach, Fla.), W. N. Parsons (Boeing Co., Cocoa Beach, Fla.), and J. Coutinho (U.S. Army, Materiel Systems Analysis Activity, Aberdeen Proving Ground, Md.). In: Annual Reliability and Maintainability Symposium, Las Vegas, Nev., January 20-22, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 245-250. 7 refs.

In connection with the construction of four major liquefied natural gas (LNG) facilities in New York City, the New York City Fire Commissioner has asked NASA for assistance. It was decided that the Kennedy Space Center should develop a risk management system (RMS) for the use of the New York Fire Department (NYFD). The RMS provides for a published set of safety regulations by the NYFD. A description of the RMS is presented as an example of an application of aerospace technology to a civilian sector, namely LNG facilities. G.R.

A77-10482 **R&M - Today's heating and cooling vs. solar energy.** C. H. Karr (Westinghouse Research and Development Center, Pittsburgh, Pa.) and G. L. Wagner (Westinghouse Electric Corp., Astronuclear Div., Pittsburgh, Pa.). In: Annual Reliability and Maintainability Symposium, Las Vegas, Nev., January 20-22, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 491-499. 10 refs.

The performance data on conventional heating and cooling components discussed include service-call rates, service-call costs, and failure mode types and frequencies which relate to electric and gas air-conditioners, gas and oil furnaces, and heat pumps. This current reliability performance is then extrapolated to a higher-potential future capability. It is shown that certain known failure modes are capable of significant improvement within the present state of the art. By assuming that these obvious problems have been attended to and greatly reduced, an estimate is obtained of how good conventional systems could be in the near future. The study reveals some interesting comparisons, observations, and conclusions concerning reliability and maintenance costs of present conventional systems, improved conventional systems, and candidate solar energy systems. V.P.

A77-10615 **Heat transfer - A review of 1975 literature.** E. R. G. Eckert, E. M. Sparrow, R. J. Goldstein, C. J. Scott, E. Pfender, S. V. Patankar, and J. W. Ramsey (Minnesota, University, Minneapolis, Minn.). *International Journal of Heat and Mass Transfer,* vol. 19, Nov. 1976, p. 1217-1243. 678 refs.

The paper surveys results that have been published in various fields of heat transfer during 1975. Brief summaries of the basic result of several hundred individual papers on the following topics are given: conduction, channel flow, boundary-layer and external flows, flow with separated regions, transfer mechanisms, natural convection, convection from rotating surfaces, combined heat and mass transfer, change of phase, radiation in participating media, surface radiation, liquid metals, measurement techniques, heat exchange and heat pipes, aircraft and space vehicles, solar energy, general heat-transfer applications, and plasma heat transfer. P.T.H.

A77-10634 **Prospects of generating power with laser-driven fusion.** L. A. Booth, D. A. Freiwald, T. G. Frank, and F. T. Finch (California, University, Los Alamos, N. Mex.). *IEEE, Proceedings,* vol. 64, Oct. 1976, p. 1460-1482. 65 refs. Contract No. W-7405-eng-36.

The present status of the prospects for electric power generation with laser-driven fusion as the primary energy source is reviewed. The fundamentals of laser-fusion reactor design and attendant means of utilizing the thermonuclear energy for commercial electric power generation are discussed. Theoretical fusion-pellet microexplosion energy release characteristics and the requirements for high-energy short-pulse leasers are described. The results of analyses to assess the engineering feasibility of reactor cavities, for which protection of cavity components is provided either by suitable ablative materials, or by diversion of plasmas by magnetic fields, are presented. Two conceptual laser-fusion electric generating stations, based on different laser-fusion reactor concepts, are described. Also the environmental and safety aspects of laser fusion energy systems and alternative means of fusion energy utilization, other than electric power via the conventional heat engine cycle, are briefly reviewed. (Author)

A77-10638 **Superflywheel energy storage and non-synchronous AC/DC/AC electric transmission supplements power system operation.** D. K. Reitan and M. Bahari-Kashani (Wisconsin, University, Madison, Wis.). *IEEE, Proceedings,* vol. 64, Oct. 1976, p. 1543, 1544. 8 refs.

The design and the operation of flywheels for energy storage applications are considered, taking into account the use of such devices in utility networks. During an off-peak period energy is stored in the flywheel. The kinetic energy in the flywheel can be converted into electrical energy when additional power is needed. Attention is given to the characteristics of the electrical system required for a suitable energy conversion. G.R.

A77-10649 **Making electricity from moderate temperature fluids.** J. F. Kunze, J. F. Whitbeck, L. G. Miller (ERDA, Idaho National Engineering Laboratory, Idaho Falls, Idaho), and J. L. Griffith (ERDA, Idaho Operations Office, Idaho Falls, Idaho). *Geothermal Energy,* vol. 4, Oct. 1976, p. 7-16.

There is much more warm water than hot water and steam easily accessible in geothermal drilling; however, if the water is below 350 F, the electricity to be generated will cost too much, since a larger number of wells and larger size of machinery will be needed to produce the same amount of electricity available from hot water. In the present paper, a geothermal program initiated to find ways of economically utilizing moderate-temperature hydrothermal resources is discussed, along with experimental research work being carried out in the Raft River geothermal region. V.P.

A77-10670 **Evolution of atmospheric pollution /high acidity and black fumes/ in France during 1975 (Evolution de la pollution atmosphérique /acidité forte et fumées noires/ en France en 1975).** J. P. Detrie (Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique, Paris, France). *Pollution Atmosphérique,* vol. 18, July-Sept. 1976, p. 223-230. In French.

The paper gives a summary of continuous measurements made during 1975 of high-acidity and black-fume pollution levels in areas around large cities and power plants in France. The annual averages

of high-acidity levels for 1975 are generally 5-10 per cent higher, except in three cities, where the effects of special protection zones and alert zones may be felt. No significant changes in black-fume pollution levels are reported. Energy consumption was reduced in 1975 in France, especially in heavy fuel, but the average sulfur content in heavy fuels used rose from about 2.8 per cent in 1974 to 3.0 per cent in 1975. As for refined fuels, the installation of Claus devices in refineries has resulted in a large drop in the sulfur content of fuels, so that a 10 per cent overall reduction in emitted SO2 is estimated. P.T.H.

A77-10698 **Energy from solid wastes.** P. N. Cheremisinoff (New Jersey Institute of Technology, Newark, N.J.) and A. C. Morresi (Exxon Research and Engineering Co., Linden, N.J.). New York, Marcel Dekker, Inc. (Pollution Engineering and Technology. Volume 1), 1976. 513 p. 167 refs. $35.

The book examines a number of ways in which various types of solid waste can be used for extracting energy. Projects currently in operation or under study are described. These include the St. Louis solid waste demonstration project, the East Bridgewater Eco-Fuel II resource recovery plant, the Baltimore pyrolysis resource recovery system, a 1200 ton-per-day solid waste burning steam-generating plant, European steam producing incinerators, and Japanese and Canadian projects. The basic principles of a number of processes are studied, including the extraction of clean liquid and gaseous fuels from organic wastes, plastics recycling, waste oil treatment, pyrolysis for energy recovery, generation of methane in sanitary landfills, and solid waste separation methods. P.T.H.

A77-10835 **Ideal concentrators for finite sources and restricted exit angles.** A. Rabl (Argonne National Laboratory, Argonne, Ill.) and R. Winston (Chicago, University, Chicago, Ill.). *Applied Optics,* vol. 15, Nov. 1976, p. 2880-2883. 21 refs. ERDA-supported research.

Design procedures for ideal radiation concentrators are described which are applicable to finite sources and/or restricted exit angles. Finite sources are relevant for second stage concentrators which collect and further concentrate radiation from a primary focusing element (mirror or lens) in a manner similar to the field optic element in a telescope. Restricting the exit angle is useful for improving the optical efficiency of solar collectors by eliminating grazing angles of incidence of the absorber. It also serves to extend the useful range of angular acceptance values available from solid dielectric concentrators that function by total internal reflection. Concentrators of this type can be used to construct highly efficient radiation traps (spectrally selective filters). (Author)

A77-10911 # **The fuel approach to control emissions from aircraft.** R. W. Hurn (ERDA Bartlesville Energy Research Center, Bartlesville, Okla.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-111.* 7 p.

Control of fuel composition may provide a means to control or affect the emission of metals, sulfur, smoke, and nitrogen oxides. Metals emissions can be related to the occurrence of metals as trace elements in crude oils and to an erosion of metal engine parts. Sulfur in fuel constitutes the only significant source of that element or its derivatives in turbine exhausts. Suitable approaches for reducing the amount of sulfur and sulfur oxide emissions are considered. G.R.

A77-10913 * # **Photovoltaic and thermal energy conversion for solar powered satellites.** G. F. von Tiesenhausen (NASA, Marshall Space Flight Center, Payload Studies Office, Huntsville, Ala.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-117.* 11 p. 17 refs.

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 a 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, photovoltaic conversion, and the utility interface. It is concluded that an SPS may be cost effective compared to terrestrial systems by 1995. G.R.

A77-10914 # **Satellite power systems for large-scale power generation.** C. R. Woodcock (Boeing Aerospace Co., Seattle, Wash.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-118.* 12 p. 8 refs.

The economic feasibility of satellite power systems (SPS) for large scale industrial applications is investigated. Systems for converting sunlight into electricity can be based on quantum devices or thermal cycles. Approaches utilizing laser radiation or microwaves have been proposed for transmitting the energy from the satellite to a ground receiving station. The employment of microwaves appears currently to be best suited for the energy transmission. Attention is given to the transportation costs for SPS's, aspects of space construction costs, questions of SPS operation, and development issues. G.R.

A77-10931 # **Laser propulsion.** C. Selph and W. Horning (USAF, Rocket Propulsion Laboratory, Edwards AFB, Calif.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-166.* 8 p. 7 refs.

The concept of projecting a high energy laser beam into a rocket in flight for propulsion purposes offers the possibility for a major increase in specific impulse over conventional chemical systems. Some of the payoffs and problems associated with this concept are examined. The design of a suitable converter for the laser energy presents many problems not faced in the design of conventional systems. The various types of proposed energy converters are discussed, including energy coupling mechanisms, and working fluid considerations. Laser propulsion bears some resemblances to solar thermal propulsion, and some comparisons are offered between these two concepts. (Author)

A77-10942 # **Flight results of a cryogenic cooler designed for Meteosat.** A. Rolfo (Centre National d'Etudes Spatiales, Toulouse, France). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-210.* 5 p.

The cryogenic radiative cooler was mounted in a small technological satellite and placed into orbit for a test under operational conditions. The design of the cooler is described and the test data are discussed. It is found that the experimental and computed temperatures, which agree on the day of launching, differ afterwards. The reasons for these discrepancies are investigated. It is pointed out that more than one year after launch the cold stage of the passive cooler mounted on the technological satellite is at a temperature of about 100 K. G.R.

A77-10952 # **Optimisation of current source operation in pulse mode.** Iu. S. Bortnikov, V. M. Vlasov, and S. M. Maniakhin (Akademiia Nauk SSSR, Moscow, USSR). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-255.* 13 p.

It is shown analytically that the performance of an electric

generator operating under a periodic load (pulse mode of operation) is superior to the performance in the case of a static load (continuous mode). The parameters that are necessary to predict performance in the pulse mode are determined. V.P.

A77-10953 # **Uranium zirconium hydride reactor space power systems.** J. H. Van Osdol, W. B. Thomson (Rockwell International Corp., Atomics International Div., Canoga Park, Calif.), and O. S. Merrill (ERDA, Washington, D.C.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-256.* 7 p.

A brief summary of the characteristics of unmanned 10 to 75 kW zirconium hydride reactor space power systems is presented. The power conversion types considered are Brayton, organic Rankine, Stirling, and thermoelectric. Design and performance data for each of the systems is presented at selected power levels as well as parametric information which includes total system weight, radiator area and system size as a function of power level. The systems utilize deployable waste heat rejection radiators which not only result in compact launch configurations, but also yield light-weight systems. The Brayton, organic Rankine, and thermoelectric systems represent near-to-intermediate term technologies. Of these systems, the Brayton system is the smallest and has the lowest mass. These area and mass advantages are offset somewhat by the considerably lower operating temperature of the organic Rankine systems. While not yet developed to an equivalent technology status, Stirling systems represent attractive possibilities for future applications. They are significantly lower in mass and smaller than the Brayton systems.
(Author)

A77-10968 # **Legal and economic prerequisites to space industrialization.** A. M. Dula (Butler, Binion, Rice, Cook, and Knapp, Houston, Tex.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper ISL-76-29.* 10 p. 10 refs.

A survey is conducted regarding the areas of investment which are presently of interest to private industry in connection with space-based manufacturing and research activities. An investigation is carried out concerning the effects of legal regulations, especially tax and intellectual property law, on industry's willingness to invest in space research and manufacturing. It is found that the intellectual property law dramatically affects the willingness of the respondent industries to participate in space industrialization. G.R.

A77-10970 # **Energy - Ecospace.** E. R. Finch, Jr. (American Bar Association, New York, N.Y.). *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper ISL-76-59.* 8 p. 39 refs.

Space law is discussed in relation to solar energy conversion. U.S. and Soviet solar power proposals are considered. The legal aspects of the development of satellite solar power stations are examined. B.J.

A77-10976 # **Evolution of thermal traction - From the diesel engine to the gas turbine (Evoluzione della trazione termica - Dal motore diesel alla turbina a gas).** U. Amodio (Ferrovie Italiane dello Stato, Istituto Sperimentale, Rome, Italy). *Ingegneria Ferroviaria,* vol. 31, Apr. 1976, p. 12-23. 12 refs. In Italian.

It is demonstrated that the gas turbine may present a satisfactory solution to the problem of the demand for greater locomotive performance on light permanent ways. A locomotive gas turbine, derived from an aeronautical engine, is described in its structure, operation, and efficiency, with attention given to problems related to adaptation to railroad use. P.T.H.

A77-11000 **On black solar cells or the tetrahedral texturing of a silicon surface.** F. Frestrepo (SEMI, Inc., Phoenix, Ariz.) and C. E. Backus (Arizona State University, Tempe, Ariz.). *IEEE Transactions on Electron Devices,* vol. ED-23, Oct. 1976, p. 1195-1197. Contract No. E(11-1)-2590.

High-efficiency silicon solar cells have been reported that use a surface alteration to reduce reflection. The process here reported purposely alters the cell surface with an anistropic etching in ternary mixtures of KOH, H2O, and ethyl glycol. Wafers were 'sensitized' with a carbon compound to insure etching uniformity. It is suggested the present paper, a geothermal program initiated to find ways of economically utilizing moderate-temperature hydrothermal resources is discussed, along with experimental research work being carried out in the Raft River geothermal region. V.P.

A77-11022 # **Non-equilibrium MHD power generation using non-seeded argon plasma.** M. Miyata (Keio University, Yokohama, Japan) and Y. Kawamura (Hitachi Co., Ltd., Tokyo, Japan). *JSME, Bulletin,* vol. 19, Aug. 1976, p. 965-972. 11 refs.

Experiments with a shock tunnel non-equilibrium MHD power generator using non-seeded argon plasma are described. A linear generator of constant cross section and a diverging generator of diverging cross section were used. Effects of J x B force on the plasma flow when large powers are extracted from the generator were observed. MHD power generator performance is described by the two-temperature theory with treatment of Coulomb collision, segmentation of electrodes, electrode voltage drops, and J x B force effects. In the linear generator, the reflected shock wave was observed at interaction parameter 5 and the distribution of the steady current was affected by the shock wave. The enthalpy extraction efficiency reached 4% in the linear duct. When this efficiency is above 1%, J x B force effects become appreciable.
(Author)

A77-11026 **Aspects of energy conversion; Proceedings of the Summer School, Lincoln College, Oxford, England, July 14-25, 1975.** Edited by I. M. Blair (Energy Technology, Support Unit, Harwell, Berks., England), B. D. Jones (National Institute for Research in Nuclear Science, Chilton, Oxon, England), and A. J. Van Horn (Harvard University, Cambridge, Mass.). Oxford, Pergamon Press, 1976. 860 p. $35.

The broad topics considered are the fundamentals of energy resources and consumption, fossil fuels, nuclear fuels, alternative energy sources (geothermal, solar, waste energy), transmission and storage of energy, environmental and socio-economic aspects of energy use, and energy analysis. Particular papers are on energy use in industry, energy use in agriculture, domestic energy use and conservation in buildings, and energy use in the coal, oil and gas industries. Also considered are possible energy developments in transportation, total energy systems, the effect of energy use on future industrial processes, energy and the developing countries, and radioactive waste management.
B.J.

A77-11027 **The energy problem and the earth's fuel situation.** G. R. Bainbridge (Newcastle-upon-Tyne, University, Newcastle-upon-Tyne, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 3-25; Discussion, p. 26, 27. 22 refs.

The energy problem is discussed primarily as it affects Britain, with attention given to oil dependence, the relation of fuel and living standards, the implications for the birth rate and the quality of life, and the increasing demand for limited world fossil fuels. Tables summarizing British fuel reserves: coal, oil and gas and the North Sea oil reserves, are presented. New energy technologies are examined

including nuclear fission, fusion, solar, geothermal, deep earth heat, tidal energy, wave energy, and wind energy. B.J.

A77-11028 Energy consumption and conservation in the United States. J. E. Rothberg (Washington, University, Seattle, Wash.). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 49-109; Discussion, p. 110, 36 refs.

Energy consumption patterns in the United States are examined, focusing on the largest consumers of energy and attempting to assess the effect of certain conservation options which can have some impact during the next 10 or 15 years. The energy consumers considered are the residential and commercial sectors, transportation, industry, and the electrical utilities. Three categories which account for nearly 60% of the total US consumption of energy - space heating, automobile use, and industrial low temperature heat and utilities - are the key potential conservation targets. B.J.

A77-11029 Energy use in industry. G. E. H. Newton (Reed Engineering and Development Services, Ltd., Maidstone, Kent, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 111-135; Discussion, p. 135, 136. 17 refs.

Tables and charts are presented on the inland consumption of primary fuels, energy consumption by final users, and an energy flow chart, all for the United Kingdom. Energy use in industry is examined with attention given to an analysis of energy consumption in buildings, and energy consumption in the process industries, the food industry, the packaging industry, and the newspaper printing industry. B.J.

A77-11030 Energy and the coal industry. J. S. Harrison (National Coal Board, Harrow, Middx., England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 187-198; Discussion, p. 199, 200. 11 refs.

The energy resources in the U.K. are examined, taking into utilization of wind power depends on the average wind velocity, the frequency of wind occurrence, the wind uniformity, and the design of the installation. The aerodynamics of the operation of wind power installations is investigated and a description is given of a number of experimental wind power systems in various countries. Attention is also given to wind power plants on the roofs of high buildings for the supply of the buildings with electric power. G.R.

A77-11031 Energy and the oil industry. P. J. Garner (Birmingham, University, Birmingham, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 201-214; Discussion, p. 215. 6 refs.

It is pointed out that at the present time petroleum provides about 70% of the world's energy requirements. Petroleum is also the source of 90% of the world production of organic chemicals and plastics. On the basis of an analysis of petroleum consumption data and information concerning the available petroleum resources, it is concluded that petroleum reserves will be dissipated soon after the year 2000. The building of synthetic oil and gas plants based on coal as raw material is considered. The technology of the use of coal as a source of organic chemicals is also available. After the depletion of coal reserves, abundant nuclear power might provide hydrogen by water electrolysis for synthesizing hydrocarbons with the aid of carbon dioxide obtained from limestone. The use of ammonia as a fuel for gas turbines, diesel-type engines, and fuel cells is also discussed. G.R.

A77-11032 Energy and the gas industry. J. A. Gray (British Gas Corp., London, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 217-236; Discussion, p. 236, 237. 17 refs.

Some of the energy problems and prospects facing the British Gas Corporation are described. Attention is given to the natural gas supply system, load matching (seasonal and diurnal), gas reserves, and the market for gas (domestic and industrial). The development of such technologies as substitute natural gas, oil gasification (catalytic rich gas, gas recycle hydrogenator, and fluidized bed hydrogenator), and coal gasification (the Lurgi process, and the slagging gasifier) is examined. B.J.

A77-11033 Sulphur pollution and emission charges. R. Wilson (Harvard University, Cambridge, Mass.). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 239-264; Discussion, p. 265, 266. 35 refs. ERDA-supported research.

Rough estimates are given of the health hazard produced by sulfur compound (sulfur dioxide, sulfates, sulfuric acid, etc.) pollution. A proposal to reduce such pollution by burning fuel with a low sulfur content during unfavorable meteorological conditions and fuel with high sulfur content during favorable conditions, thus stretching the supply of scarce low polluting fuel is presented. It is suggested that a pollution charge or tax be levied on a polluter burning high-sulfur fuel under unfavorable conditions. B.J.

A77-11034 Fusion power. K. V. Roberts (Atomic Energy Research Establishment, Abingdon, Berks., England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 343-372; Discussion, p. 373. 9 refs.

A large nuclear energy industry is expected to develop during the next few decades, based on a limited number of multinational companies, and it is suggested that in order to avoid balance of payments problems due to excessive imports, many countries will find it necessary to build up their own nuclear technology to the point at which companies are attracted to set up a local plant. Attention is given to a number of technical questions such as fusion reactor size and time scale, fusion energy sources, plasma confinement methods, a classification of magnetic confinement systems, physical factors determining reactor size, and overall reactor structure. B.J.

A77-11035 Geothermal energy. E. R. Oxburgh (Oxford University, Oxford, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 385-402; Discussion, p. 402, 403. 5 refs.

The paper reviews the main features of geothermal power and discusses its possible future development and limitations. Attention is given to geothermal energy supply, heat extraction, exploitation of geothermal areas, and to a number of practical difficulties including transmission and environmental problems. B.J.

A77-11036 The atmosphere and the oceans as energy sources. D. T. Swift-Hook (Central Electricity Generating Board, Marchwood Engineering Laboratories, Southampton, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 405-429; Discussion, p. 430. 17 refs.

Wind power is discussed with emphasis on available power and sites and windmill design. Tidal power is considered with attention given to the design of tidal barrages, and engineering problems. Also considered are thermal sea power, and wave power (wave characteristics, wave power conversion devices, and overall system considerations). B.J.

A77-11037 **Solar energy.** B. J. Brinkworth (University College, Cardiff, Wales). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 431-447; Discussion, p. 447, 448. 27 refs.

The paper reviews the possibilities of the direct use of solar energy. Attention is given to solar energy fluxes, and the design and construction of solar collector. Solar space heating systems are considered together with solar thermal power plants (thermodynamic conversion) and conversion - thermionic, thermoelectric, and photovoltaic - to electricity. Photochemical and photobiological energy conversion systems are also considered. B.J.

A77-11038 **Energy from wastes.** W. Sabel (Oxford Polytechnic, Oxford, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 449-457; Discussion, p. 458.

Suitable approaches of dealing with disposal problems are considered, taking into account domestic and industrial sources of waste. It is found that questions concerning the use of processes which make it possible to obtain energy from wastes depend not only on technology and financial cost factors, but also on a consideration of social costs and benefits. Attention is given to the need for the proper use of food, the economic employment of wastes from animal rearing, and the utilization of fermentation processes. G.R.

A77-11039 **Large-scale electrical power generation and storage.** J. K. Wright (Central Electricity Generating Board, London, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 461-485; Discussion, p. 485, 486. 17 refs.

Various aspects of large central electric power stations are considered with attention given to plant mix, the steam cycle, dual cycles, the gas turbine combined cycle, MHD generation, thermionic generation, freon and potassium vapor engines, nuclear gas turbines, fuel cells, the reject heat, reject to sea or rivers, cooling towers, and district heating. Large scale electrical energy storage is discussed with emphasis on the economics of storage, and pumped-water, compressed-air, superconducting, battery, electrolysis, and heat storage systems. B.J.

A77-11040 **Energy storage.** I. E. Smith (Cranfield Institute of Technology, Cranfield, Beds., England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 507-518. 9 refs.

Questions concerning the quality of storage are considered along with aspects of storage duration and the storage scale. A description is presented of the methods of energy storage, taking into account chemical energy, sensible heat storage, latent heat storage, and the heat of solution and reverse osmosis. An investigation is conducted regarding the most suitable forms of kinetic energy storage. A table listing materials of construction for flywheels is presented. Attention is also given to problems related to the occurrence of energy storage losses. G.R.

A77-11041 **The hydrogen economy.** J. K. Dawson (Energy Technology Support Unit, Harwell, Berks., England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 519-526; Discussion, p. 527, 528. 8 refs.

Approaches for hydrogen production are examined, taking into account the electrolysis of water, water splitting by thermochemical cycles, and biochemical water splitting. Questions related to the distribution of hydrogen are investigated and the problem of transporting hydrogen by pipeline over long distances is considered. It is pointed out that a complex large-bore hydrogen pipeline linking several industrial firms is in operation in the Ruhr and has a length of some 300 km. Attention is given to the use of hydrogen in the chemical and metallurgical industries and the employment of hydrogen as a substitute for hydrocarbons as a transport fuel. G.R.

A77-11042 **Total energy systems.** C. M. D. Peters (Total Energy Co., Ltd., Oxford, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 587-606; Discussion, p. 607, 608. 14 refs.

The total energy concept is defined as power generation with heat recovery. There are three main types of total energy system: (1) based on the diesel engine with internal combustion (gas, gas oil, heavy oil) and a waste heat recovery boiler, (2) based on the gas turbine with internal combustion (gas or gas oil) and a waste heat recovery boiler, and (3) based on the steam turbine with external combustion (coal, heavy oil, refuse, etc.) and a high pressure boiler. Attention is paid to conversion and conservation and to the savings in the consumption of primary fuel resources which can be effected by substituting the total energy approach for the conventional approach. A historical background to the use of the total energy concept in the USA, UK and West Germany is presented. B.J.

A77-11043 **Energy and the developing countries.** P. D. Dunn (Reading, University, Reading, Berks., England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 621-639; Discussion, p. 640, 641. 9 refs.

Energy use in developing countries is discussed with attention given to the overall situation and the implications of increased energy use in the future. The problem of providing power in rural areas is considered taking account of energy resources and conversion. Some specific examples of small power plants in developing countries are described including a simple vertical axis Savonius rotor windmill for wind power generation in Zambia, flat plate solar collectors for water heating in Zambia, and the use of internal combustion liquid piston engines in solar heating systems. B.J.

A77-11044 **Environmental aspects of energy conversion and use.** C.-G. Ducret. In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 645-657; Discussion, p. 658-660. 7 refs.

The paper draws a number of conclusions about the modifications of the environment introduced by energy conversion and utilization. The major conclusions are: (1) energy is a normal constituent of the environment but its excess above the environmental acceptance capacity is detrimental not only to the environment but also to man, (2) most energy sources are more or less clean as long as they are used on a reasonably small scale falling within the

acceptance capacity of the environment, (3) man, motivated by economic considerations, is tending to choose sources of energy which are limited, nonrenewable, and not included in the normal energy flow through the environment, (4) the planet's climatic balance has a limited acceptance capacity and therefore the extent of energy sources not normally included in the energy flow through the environment is necessarily limited, (5) general energy policy should be oriented towards a strategy aimed at using the 1 W/sq m acceptance capacity of the environment wisely. B.J.

A77-11045 **Principles of energy analysis.** P. F. Chapman (Open University, Milton Keynes, Bucks., England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 715-736; Discussion, p. 737. 22 refs.

Energy analysis is contrasted with economic analysis, taking issue with the conventional economic view that all the information needed to resolve a production or consumption choice is contained in prices. Energy analysis is a descriptive method which attempts to describe what will happen to energy consumption if certain choices are made, while economic analysis is a prescriptive (or evaluative) method which attempts to prescribe which options should be chosen. An attempt is made using the principles of energy analysis to show that some of the ideas of economic analysis are counterproductive. B.J.

A77-11046 **Methods of energy analysis.** P. F. Chapman (Open University, Milton Keynes, Bucks., England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 739-757; Discussion, p. 758. 5 refs.

The methodology of energy analysis is examined in detail, focusing on methods used to obtain energy requirements with reference to the particular example of nuclear power stations. A number of methodological problems have to be resolved: (1) definition of the system being examined, (2) attribution of energy requirements to the input of the system, and (3) partitioning energy inputs between outputs of joint production processes. It is shown that while the evaluation of an energy requirement for a commodity can be done relatively objectively, the interpretation of the results requires the addition of certain behavioral assumptions. B.J.

A77-11047 **Energy analysis in modelling.** P. C. Roberts (Department of the Environment, London, England). In: Aspects of energy conversion; Proceedings of the Summer School, Oxford, England, July 14-25, 1975. Oxford, Pergamon Press, 1976, p. 759-770; Discussion, p. 771.

Individual factors which must be taken into account in connection with the modeling of resources are related to questions of technical improvement, substitution, resource depletion, and the consumption profile. If an adequate model of an economy facing progressive resource depletion is to be obtained, it is not enough to know the reserve quantities of metalliferous ores, fossil fuel deposits, and areas of cultivable land. The probable time path of improving efficiencies must also be represented and the continuously changing character of the output must be built into the model. G.R.

A77-11050 **Remote sensing of an underground coal-burn cavity with a wide-band induction system.** E. A. Quincy (Wyoming, University, Laramie, Wyo.) and D. F. Moore (ERDA Laramie Energy Research Center, Laramie, Wyo.). *IEEE Transactions on Geoscience Electronics,* vol. GE-14, Oct. 1976, p. 236-243. 21 refs.

A conducting cavity in an underground coal burn was remotely probed from the surface with a wide-band electromagnetic induction system. The cavity, located near Hanna, WY., was produced by underground gasification of a 30-ft-thick subbituminous-coal seam ranging in depth from 300 to 400 ft. The cavity filled with saline ground water after the burn. The wide-band loop-loop system employed pseudonoise and cross-correlation techniques to produce a transient-time response in the field. Additional computer processing produced normalized 3-dimensional signature maps in both the time and frequency domains. These horizontal profiling maps, corresponding to a 100-Hz-50 kHz passband, demonstrate that a significant anomaly is produced by the cavity as the system is moved across the site. Time-domain maps show nearly a 7-1 change in relative peak-to-peak values, whereas the frequency-domain magnitude response changes as much as 36-1. Results were corroborated using another single-frequency system. These anomalies demonstrate the feasibility of employing induction systems to remotely characterize underground coal-burn cavities filled with conducting fluid. (Author)

A77-11093 **Magnetic suspension densimeter for measurements on fluids of cryogenic interest.** W. M. Haynes, M. J. Hiza, and N. V. Frederick (National Bureau of Standards, Institute for Basic Standards, Boulder, Colo.). *Review of Scientific Instruments,* vol. 47, Oct. 1976, p. 1237-1250. 45 refs. Research sponsored by the British Gas Corp., Chicago Bridge and Iron Co., Columbia Gas Service Corp., et al.

A77-11107 **Performance characteristics of solid lithium-aluminum alloy electrodes.** E. C. Gay, D. R. Vissers, F. J. Martino, and K. E. Anderson (Argonne National Laboratory, Argonne, Ill.). *Electrochemical Society, Journal,* vol. 123, Nov. 1976, p. 1591-1596. 12 refs. ERDA-sponsored research.

To develop negative electrodes that meet the cell performance goals, the effects of a number of variables on the lithium-aluminum electrode performance were determined. Investigations were conducted to determine the effects of volume fraction electrolyte in the electrode, electrode thickness, fabrication technique, lithium concentration in the Li-Al alloy, and current collector in the electrode. Electrochemically formed Li-Al electrodes that are 0.32 cm thick, have an electrolyte volume fraction of 0.2 in the charged state, and contain about 2 weight per cent stainless steel wire current collector have demonstrated the performance goals for the negative electrodes in a Li-Al/FeS2 electric automobile battery. For electrode thickness not less than 0.64 cm, vibratorily loaded pyrometallurgical Li-Al electrodes with porous metallic current collectors have demonstrated the highest lithium utilization and capacity density over a wide range of discharge current densities and have met the performance goals for negative electrodes in a Li-Al/FeS2 off-peak energy storage battery. (Author)

A77-11108 **A multilayer iron-thionine photogalvanic cell.** J. A. Eckert (Exxon Research and Engineering Co., Linden, N.J.), N. N. Lichtin, and P. D. Wildes (Boston University, Boston, Mass.). *Electrochemical Society, Journal,* vol. 123, Nov. 1976, p. 1705-1707. 9 refs. NSF Grant No. SE-AER-72-03579.

Progress in conversion of solar energy directly to electricity by means of the iron-thionine photogalvanic system is examined. Attention is focused on the design and performance evaluation of a novel photogalvanic cell with two transparent semiconductor electrodes. The use of two transparent electrodes has made possible the construction of multilayer photogalvanic devices in which there are several layers of photogalvanically active iron-thionine solutions. An increased efficiency has been obtained with these devices. The spectral response of the photogalvanic device can be broadened by using successive solution layers of photogalvanically active dyes which absorb light at different wavelengths. S.D.

A77-11110 **CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates.** L. C. Burton, T. Hench, G. Storti (Delaware, University, Newark, Del.), and G. Haacke (American Cyanamid Co.,

Stamford, Conn.). *Electrochemical Society, Journal,* vol. 123, Nov. 1976, p. 1741-1744. 14 refs. NSF Grant No. AER-73-07957.

Cadmium stannate (Cd2SnO4) films of 1 ohm per square sheet resistance and 85% average transmissivity (500-650 nm) have been grown by means of RF sputtering onto silica substrates. CdS-Cu2S thin film solar cells with conversion efficiencies greater than 5% for front and rear illumination have been fabricated. The reflection of transmitted light back through the cell has increased the light generated current. Fabrication techniques are described and current-voltage and spectral response measurements are presented for frontwall and backwall modes of operation. (Author)

A77-11162 Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions. H. L. Goldstein and C. W. Siegmund (Exxon Research and Engineering Co., Linden, N.J.). *(American Chemical Society, Chemical Congress of North America, 1st, Mexico City, Mexico, Dec. 4, 1975.) Environmental Science and Technology,* vol. 10, Nov. 1976, p. 1109-1114. 5 refs. Research supported by the Exxon Research and Engineering Co.

Studies determined the influence of fuel composition and combustion conditions on particulate mass loading and size distribution. The fuel composition aspect of this study was concerned with determining the effect of the change from conventional high-sulfur fuel oil (Bunker C) to desulfurized fuel oils that have lower ash and asphaltene (hexane insolubles) contents. Varying operating conditions, such as combustion chamber residence time and excess air, produced notable differences in particulate loading and size distribution. (Author)

A77-11174 # The overcoming of energy deficiencies with the aid of wind power (Mit Windkraft Energielücken schliessen). A. Upmalis. *Energie,* vol. 28, Sept. 1976, p. 262-265. 8 refs. In German.

A comparison of the available resources of fossil fuels and the data of energy consumption shows the approaching exhaustion of these fuel resources. A utilization of inexhaustible energy sources becomes, therefore, imperative. Such an inexhaustible energy source is provided by the wind. The performance of an installation for the utilization of wind power depends on the average wind velocity, the frequency of wind occurrence, the wind uniformity, and the design of the installation. The aerodynamics of the operation of wind power installations is investigated and a description is given of a number of experimental wind power systems in various countries. Attention is also given to wind power plants on the roofs of high buildings for the supply of the buildings with electric power. G.R.

A77-11175 # Controlled tipping of combustion residues (Kontrollierte Deponierung von Verbrennungs-Rückständen). F. U. Alms. *Energie,* vol. 28, Sept. 1976, p. 266-269. 25 refs. In German.

Regulations and procedures of refuse disposal and solid waste management in West Germany are examined and problems related to the tipping of the residue obtained in the burning of refuse are considered. A description is presented of the results which have been obtained in studies concerning the controlled tipping of refuse. Economic factors of solid waste management are also examined and attention is given to the details of operation used by an installation for the burning of refuse. G.R.

A77-11233 Energy: Mathematics and models; Proceedings of the Conference, Alta, Utah, July 7-11, 1975. Conference sponsored by the Society for Industrial and Applied Mathematics and National Science Foundation. Edited by F. S. Roberts (Rutgers University, New Brunswick, N.J.). Philadelphia, Pa., Society for Industrial and Applied Mathematics, 1976. 301 p. $16.

The present papers by mathematicians and energy researchers have the objective to delineate the role of mathematics in energy research and to describe the circumstances under which application of mathematical analysis to the energy problem could be meaningful and useful. The individual papers demonstrate the mathematical tools relevant to the energy problem and examine the amenability of significant problems to mathematical analysis. V.P.

A77-11241 Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology. J. R. Bowden (Conoco Coal Development Co., Stamford, Conn.). *(Society of Petroleum Engineers, Annual Fall Meeting, 50th, Dallas, Tex., Sept. 30-Oct. 1, 1975.) Energy Sources,* vol. 3, no. 1, 1976, p. 1-11.

During the next 20 years, domestic energy consumption will grow at a rate of somewhat less than 3% per year. Coal production can grow 75% in this period, which will increase coal's contribution to our energy budget from 18 to 27%. New technology in mining and processing will play only a modest role in expanded utilization of coal, and that mostly after 1985. Principal opportunities and constraints rest in the political arena as we try to accommodate our social concerns with physical and economic realities. No technical fix is on the horizon which will permit coal to be converted cheaply to our present definition of a clean fuel. For processes other than flue-gas desulfurization, value added during conversion exceeds the basic cost of the energy in coal. All conversion costs lie within the range of uncertainty of the untried processes and no process has emerged as clearly superior. An aggressive federal support program is required for verification of the economics on a small commercial scale of several competing conversion processes so that more intelligent choices can be made for the second generation of conversion plants which will emerge in the late 1980s or early 1990s. (Author)

A77-11242 Low-sulfur coal obtained by chemical desulfurization followed by liquefaction. R. A. Meyers, J. W. Hamersma (TRW Systems and Energy, Redondo Beach, Calif.), R. M. Baldwin, J. G. Handwerk, J. H. Gary, and J. O. Golden (Colorado School of Mines, Golden, Colo.). *Energy Sources,* vol. 3, no. 1, 1976, p. 13-18. 6 refs. Research supported by TRW Systems and Energy; U.S. Department of the Interior Contract No. 14-32-001-1225.

Coal combustion is the largest single source of sulfur oxide air pollution. Two major technologies for the desulfurization of coal prior to combustion, coal liquefaction and the Meyers Process, have been experimentally evaluated. While each process is individually capable of reducing a portion of U.S. coal reserves to an environmentally acceptable sulfur content, neither can meet all U.S. needs. An advantageous combination of the two processes is described which could eliminate a major technical hurdle in the application of liquefaction technology and thus expand the portion of U.S. coal which can be converted to an acceptably low-sulfur fuel. Information regarding the fate of sulfur forms during liquefaction is also presented. (Author)

A77-11243 Catalytic hydrogenation of solvent-refined lignite to liquid fuels. J. Y. F. Low, K. J. Klabunde, N. F. Woolsey, R. J. Baltisberger, V. I. Stenberg (North Dakota, University, Grand Forks, N. Dak.), and M. Govek. *Energy Sources,* vol. 3, no. 1, 1976, p. 19-38. 5 refs. NSF-PHS-supported research; U.S. Department of the Interior Contract No. 14-32-0001-1224.

A study was undertaken to determine the best reducing conditions for converting solvent-refined lignite to light distillable liquid fuels and/or chemical feedstocks. Batch autoclave experiments were performed in the temperature range 375-450 C and a hydrogen pressure range of 1500-4500 psi, with catalysts Ni-Mo-Al2O3, Co-Mo-Al2O3, Ni-W-Al2O3, Ni-W-SiO2-Al2O3, SiO2-Al2O3, Al2O3, SnCl2, and presulfided catalysts Ni-Mo-Al2O3, Co-Mo-Al2O3, and Ni-W-Al2O3. Results were evaluated in terms of the amount of liquids produced, deoxygenation, denitrification, hydrogen-carbon

ratios, aromatic-aliphatic hydrogen ratios, and benzene solubility of unconverted material. Best results were obtained with a presulfided Ni-Mo-Al2O3 catalyst at 450 C and an operating pressure of about 3500 psi with a 1:1 solvent-refined lignite to tetralin solvent ratio.
B.J.

A77-11244 Evaluation of coal liquefaction efficiency based on various ranks. Y.-P. Hsia and T. F. Yen (Southern California, University, Los Angeles, Calif.). *Energy Sources*, vol. 3, no. 1, 1976, p. 39-47. 8 refs. Contract No. E(49-18)-2031.

A method has been developed to calculate the efficiency of coal liquefaction, based on various coal ranks. The assumption is made that the service requirement (both enthalpy and hydrogen) is provided from the same rank of coal when it is being converted to transportation fuel or specialty oils. Results for most coals indicate that in order to upgrade coal to fuels of H/C = 2, the actual fraction of coal used for liquefaction is about 35-45%. (Author)

A77-11245 The influence of the properties of coals on their conversion into clean fuels. A. Davis, W. Spackman, and P. H. Given (Pennsylvania State University, University Park, Pa.). *Energy Sources*, vol. 3, no. 1, 1976, p. 55-81. 19 refs. Research sponsored by the U.S. Department of the Interior and NSF.

Two fundamental controlling factors in the geological histories of coals have determined their physical and chemical characteristics and, consequently, the industrial uses to which they can be put. The first of these is the set of conditions that existed in the original peat swamp, involving the type of vegetation, the nature and extent of the degradative, preservational, and sedimentary processes, and resulting in varying assemblages of organic macerals and inorganic minerals. Certain of these ingredients are beneficial in conversion processes. The second factor is the nature and degree of the metamorphic changes that the peat deposit underwent during burial within the earth's crust. Although coals of lower rank are readily converted into liquid fuels, the highest yields are obtained from coals of high volatile bituminous rank. Microscopic methods of measuring the contribution made by both of the controlling factors (petrographic type and rank) enable workers to compare the conversion potential of American coals. (Author)

A77-11266 The wind and its effect on the heating requirements (Über den Wind und seinen Einfluss auf den Wärmebedarf). E. Mattersdorff. *HLH - Zeitung für Heizung, Lüftung, Klimatechnik*, vol. 27, Mar. 1976, p. 93-96. 12 refs. In German.

Approaches for describing the wind intensity are considered and the geographical aspects of the wind characteristics are examined. An investigation is conducted regarding the effect of the wind characteristics on the required performance of the heating system. The design of a heating system represents generally a compromise between the protection against the environmental conditions and economic factors. An absolute protection in the case of extreme wind and temperature conditions, which generally occur only during relatively brief time periods, would be economically very expensive. A table and graphs are presented which provide the data for a calculation of the heating requirements in various regions of Germany. G.R.

A77-11267 Plastics for solar-energy collectors. I - General aspects, hot-water collectors, design variants (Kunststoffe für Solarenergie-Kollektoren. I - Allgemeines, Warmwasser-Kollektoren, Konstruktionsvarianten). G. Schenkel (Stuttgart, Universität, Stuttgart, West Germany). *HLH - Zeitung für Heizung, Lüftung, Klimatechnik*, vol. 27, May 1976, p. 151-157. In German.

The characteristics and the amount of solar energy available on earth are examined and the investigations conducted in various countries concerning the utilization of this energy are briefly considered. A description of solar-energy collectors for hot-water supply systems and space heating applications is presented, taking into account solar radiation conditions in Germany, aspects of collector design, suitable materials for the construction of the collectors, and economic considerations related to the cost of the solar-energy system and the savings in fuel costs. Attention is given to a solar-energy system which, in Central Europe, can provide warm water for a swimming pool. The operational efficiency of a number of different solar-energy collector designs is investigated. G.R.

A77-11268 Optimal thermal insulation as an investment-computational problem (Die optimale Wärmedämmung als investitionsrechnerisches Problem). K.-D. Däumler (Kiel, Fachhochschule, Kiel, West Germany). *HLH - Zeitung für Heizung, Lüftung, Klimatechnik*, vol. 27, June 1976, p. 203-205. In German.

Approaches for reducing the primary energy requirements are considered. It is pointed out that about 40% of the entire energy consumption in the Federal Republic of Germany is related to heating requirements. An investigation is conducted concerning the possibilities to reduce the heating-energy requirements by means of an improved thermal insulation of buildings. A description is given of an approach for the evaluation of the economic advantages of an improved thermal insulation of a building. Attention is given to the costs of the insulation measures and the savings obtained on account of the reduced energy consumption. G.R.

A77-11269 Plastics for solar-energy collectors. II - Typical operational data and model parameters, functional diagrams, optimization of layer thicknesses (Kunststoffe für Solarenergie-Kollektoren. II - Typische Betriebsdaten und Modellkennzahlen, Funktionsdiagramme, Optimierung der Schichtdicken). G. Schenkel (Stuttgart, Universität, Stuttgart, West Germany). *HLH - Zeitung für Heizung, Lüftung, Klimatechnik*, vol. 27, June 1976, p. 206-211. In German.

The stagnation temperatures of an absorber with insulation under a 0.15 mm cover of cellulose acetate butyrate and the stagnation temperatures of an absorber without insulation under a 1.0 mm cover of PVC are presented in graphs. Thermal component processes and the transversal temperature profile of solar-energy collectors are shown along with the temperature profiles of heat exchangers and solar energy absorbers. Attention is also given to functional diagrams of various solar-energy collector designs and the optimization of cover plate and air layer thickness. G.R.

A77-11270 The assurance of the heat supply with respect to the primary energy use in the case of heating and air conditioning installations (Sicherheit der Wärmeversorgung von Heizungs- und Klimaanlagen im Hinblick auf den Primärenergieeinsatz). H. Börner (Niedersächsische Staatshochbauverwaltung, Fachbereich Elektro- und Maschinentechnik, West Germany). *HLH - Zeitung für Heizung, Lüftung, Klimatechnik*, vol. 27, July 1976, p. 241-245. In German.

A classification of the priority levels concerning the supply of buildings with fuel and energy in emergencies is considered. The general supply situation in the Federal Republic of Germany with regard to fuel and energy is examined, taking into account coal, lignite, mineral oil, fuel gas, and electric energy. The economical and technological characteristics of a use of electric energy and natural gas are investigated and a description is presented of the various factors which are related to an employment of different types of primary energy. G.R.

A77-11271 Compilation of an inventory for particulate emissions in Belgium. M. Demuynck (Gent, Rijksuniversiteit, Ghent, Belgium). *Water, Air, and Soil Pollution*, vol. 5, Oct. 10, 1975, p. 3-10. Research supported by the Nationaal Centrum voor Studies vom de Luchtverontreiniging door Verbranding.

Using production and consumption data of different raw

materials in Belgium during 1972, a particulate emission inventory was calculated. The discharges were computed by means of emission factors cited in the literature. The relative contribution of the different sources was compared to a worldwide inventory. Whereas on a global scale combustion appears to be the major source, it only accounts for 21% of the particulate emissions in Belgium. The iron and steel industries on the other hand account for nearly 44% of the particulate discharges. Because only a minor fraction of the emitted particulate material can remain airborne, a second inventory was calculated also taking into account the size distribution of the emissions. Of the particulate material smaller than 10 microns, only 18% originates from the steel mills, while nearly 33% appears to be combustion derived. (Author)

A77-11275 **Energy: A radical redirection.** M. Gravel (U.S. Senate, Washington, D.C.). *Journal of Energy and Development,* vol. 1, Spring 1976, p. 191-200.

Suitable approaches for a national energy policy are discussed, taking into account the goal of energy self-sufficiency for the U.S. Current commitments in regard to energy policy are critically examined. It is concluded that the preferential treatment of the breeder reactor in the allocation of funds at the expense of solar energy options cannot be justified. The proposal is made to place greater emphasis on the development of approaches for the utilization of solar energy. Attention is given to solar heating and cooling of buildings, wind energy, and bioconversion to fuels. Difficulties concerning a use of solar cells are related to their high price. It is recommended to provide government support in assuring a market which would make a lowering of the production costs possible. G.R.

A77-11298 **Dutchess County, NY moves towards pyrolysis.** R. M. Bodner (Martin and Martin, Inc.). *Waste Age,* vol. 7, Sept. 1976, p. 48, 50, 51, 74.

A description is given of developments leading to the use of a pyrolysis process in connection with the solid waste management problems of Dutchess County in the state of New York. The reasons for the selection of the pyrolysis process are related to a projection of the economical competitiveness of the process, its environmental soundness, the production of a medium BTU fuel gas which could be burned in a utility boiler, the feasibility to pipe the gas across the Hudson River to a power plant, and the possibility to fire a gas turbine generator with the gas and produce electricity. The pyrolysis process uses a vertical shaft furnace. Refuse is admitted into the top of the furnace, while high-purity oxygen is admitted into the bottom of the furnace to form a combustion zone. G.R.

A77-11301 # **Experience in putting the Kiskore hydroelectric power plant on line (A Kiskorei Vizeromu uzembehelyezesi tapasztalatai).** G. Laki (Ganz Mavag, Budapest, Hungary). *Energia es Atomtechnika,* vol. 29, Jan. 1976, p. 8-18. In Hungarian.

The article concentrates on safety measures, equipment installation schedules and sequencing, equipment startup procedures, and preventive and emergency shutdown procedures in putting the Kiskore hydropower plant in central SE Hungary on line. Cooperation between French and Hungarian factories, which enterprises handled manufacture and installation of turbine, switchgear, electrical machinery, or retaining structures, and data on turbine and shaft seals are included. Damming of the Tisza, canal building, water deviation for irrigation of low-precipitation areas, affluent level in normal-load periods, control of boat traffic over canal locks, and output in years of average water level (106 million kWh) are discussed, along with run-in of bearings, inspection and checkouts, and procedures for running turbine and associated equipment up to full power. R.D.V.

A77-11302 # **Air cleanup and energy management (A levegotisztasag es energiagazdalkodas).** G. Koranyi (Nehezipari Miniszterium, Budapest, Hungary). *Energia es Atomtechnika,* vol. 29, Mar. 1976, p. 101-104. 5 refs. In Hungarian.

Air pollution problems are broached from the angles of form of energy production and manner of energy use, with attention also given to emissions and energy economies. Close attention is given to control of sulfur-containing emissions and high-sulfur flue gas, scrubbing of off-gases for desulfurization, comparison with U.S. plant data and compatibility of air cleanup measures with conditions in Hungary. The increasing role of gaseous and liquefied fuels, increasing domestic use of fuel oil, industrial use of coking coals, fly-ash separation, dust control and filtration at coal mines and plants, and exhaust emissions from automotive vehicles (with lead and ethylation problems) are dealt with. The Borsod basin area is viewed as the most heavily air-polluted under the V and VI five-year plans for industrial development. R.D.V.

A77-11303 # **Clean air protection and industrial development (A levegotisztasag-vedelem es a muszaki fejlesztes kapcsolata).** J. Francia (Orszagos Muszaki Fejlesztesi Bizottsag, Budapest, Hungary). *Energia es Atomtechnika,* vol. 29, Mar. 1976, p. 105-108. In Hungarian.

Separation and utilization of industrial fly-ash, ore treatment in metallurgy, and automotive emissions are emphasized. Savings possible from use of modernized equipment for handling off-gas dust loads in hydrometallurgical work, ore comminution pelletizing, and conglomeration are discussed in relation to particulate pollution. Separators, filters, and precipitators for fly-ash are discussed along with utilization of fly-ash as filler in cements, fly-ash blocks for construction, fly-ash gravel, and gas silicate composites. Fly-ash use in soil melioration, particularly of soda-rich soils common in parts of Hungary, is dealt with. Factors influencing pollution from automotive exhausts and the need for a computerized pollution monitoring network are mentioned. Some fly-ash separators on stream in Hungarian industry (wet separators, fabric filters, bag filters, electrostatic precipitators) are mentioned. R.D.V.

A77-11315 **Estimating wind power feasibility.** W. K. Widger, Jr. *Power Engineering,* vol. 80, Aug. 1976, p. 58-61.

A description is given of a method which makes it possible to obtain wind power feasibility estimates for an area on the basis of average wind speed data. The method appears particularly useful, when applied to climatological average wind speed data, and for initial feasibility assessments. Attention is given to data needs and sources, relationships between wind speeds, the nominal average wind power, and a technique evaluation. G.R.

A77-11316 **The availability of fuels for power plants.** F. C. Olds. *Power Engineering,* vol. 80, Sept. 1976, p. 42-49.

Questions of fuel availability are examined, taking into account the existing coal reserves in the world and in the U.S., the feasibility of deep open pit mining, questions concerning the possibility of maintaining a high energy growth rate, and the plight of the nonoil developing countries. Attention is also given to a global energy projection, the global energy use rate, and alternative fuels. G.R.

A77-11322 **Submarine geothermal resources.** D. L. Williams (U.S. Geological Survey, Denver, Colo.). *Journal of Volcanology and Geothermal Research,* vol. 1, June 1976, p. 85-100. 49 refs.

The paper considers submarine geothermal resources, which are indicated by hydrothermal discharge from young rocks adjacent to active seafloor-spreading centers and submarine volcanic areas. Evidence for the existence and importance of submarine hydrothermal heat loss is discussed, and the magnitude of such heat loss is estimated to be roughly equivalent to humanity's present gross energy-consumption rate. Probable characteristics of submarine geothermal temperature gradients, the location and dimensions of reservoirs, and their permeability and porosity. It is shown that the

geothermal reservoirs are examined, emphasizing hot-water volume, distribution of permeability and porosity is of primary importance in determining the magnitude of submarine geothermal resources. The possible geothermal potential of the northern Gulf of California is evaluated, and it is suggested that the electrical generating potential would be approximately 180,000 MW for 30 years. F.G.M.

A77-11324 ERDA's gas turbine development program for the next decade. W. M. Crim, W. W. Bunker, and G. B. Manning. *Gas Turbine International,* vol. 17, Sept.-Oct. 1976, p. 24-27.

Overall aspects of the ERDA gas turbine development program are outlined. A combination of two conversion systems (open cycle gas turbine (OCGT) + steam turbine, closed cycle gas turbine (CCGT) + steam/organic/alkali metal vapor (AMV)/other turbine) is seen as necessary to achieve coal-to-busbar conversion efficiencies upwards of 40%. Greatest promise is seen in the OCGT, CCGT, and AMVGT methods. Major technical hurdles in the way are: materials compatibility, high-temperature turbine (HTT) cooling for OCGT systems, heat exchanger components for CCGT, bearings, seals, and accessories for both OCGT and CCGT, efficient low-cost hot gas cleanup for OCGT. Coal-fired OCGT in combined cycle configuration is emphasized in the article. Three phases of the HTT technology program are spelled out, and four contracts for phase I are discussed. Development programs for ceramics and combustors are discussed. R.D.V.

A77-11334 Higher electric power use reduces energy consumption for same gross national product (Le rendement élevé de l'énergie électrique à l'utilisation réduit la consommation d'énergie pour un même produit national brut). F. Felix (Société Internationale de Technologie, Paris, France). *Revue de l'Energie,* vol. 27, Feb. 1976, p. 96-101. In French. (Translation).

A statistical study covering the specific place of conversion of power to electrical energy in 84 countries encompassing the entire range of populations, area, and levels of industrial development argues for most efficient utilization of energy by those countries, large or small, that have undergone most intense electrification. Data on population growth rates and increased use of electric power (per GNP), annual electric power production on a world scale projected to 50 years ahead, fuel costs for electric power producers, and worldwide production of crude oil are presented in graphical form. Assumptions entertained in the statistical comparison are stated. More intense electrification is recommended for energy conservation, and arguments for cutbacks in energy use are rejected. R.D.V.

A77-11335 Primary energy sources for hydrogen production. C. Marchetti (International Institute of Applied Systems Analysis, Laxenburg, Austria). *Revue de l'Energie,* vol. 27, Feb. 1976, p. 102-112. 6 refs. In English and French.

Various blue-sky approaches to production of hydrogen by novel low-cost thermodynamically efficient processes with ecological compatibility are put forth. Tapping of hydrogen stored in trees by using genetically engineered microflora and suitable collectors, secondary recovery of coal, an energy-island concept of using nuclear fission reactors in hydrogen production at terawatt levels, hydrogen extraction from thermonuclear plasma, tapping solar energy by developing photothermal chemistry techniques and appropriate semiconductors and solid electrolytes, and tapping melting glacier ice and ocean thermal gradients are considered. The storability, transportability, flexibility, and ecological compatibility of hydrogen and the ecological safety of associated electrolytic processes are pointed out. R.D.V.

A77-11336 A word on worldwide petroleum resources (A propos des ressources mondiales de pétrole). M. Grenon. *Revue de l'Energie,* vol. 27, Feb. 1976, p. 113-116. In French.

Techniques for elaborating estimates or well-educated guesses on occurrences and reserves of petroleum, and other hydrocarbons, on large-area scales are compared and evaluated briefly. Some recent estimates of resources and reserves are tabulated. The methods are grouped under four headings: (1) extrapolation of past trends; (2) methods based on geological analogy, including offshore extensions of proven petroliferous provinces; (3) methods utilizing experience and know-how (or hunches) of geologists; (4) statistical techniques or qualitative models. Cautious optimism is ventured on the reliability of techniques being developed further and novel approaches. R.D.V.

A77-11337 The mysteries of nuclear programs (Les mystères des programmes nucléaires). L. Gouni (Electricité de France, Paris, France). *Revue de l'Energie,* vol. 27, Mar. 1976, p. 138-153. 20 refs. In French.

Present structure and future trends in the electroenergy supply and consumption system for France are discussed with special attention to the contribution of nuclear energy sources. Particular features of the electroenergy economics are examined, and the impossibility of stocking electricity is pointed out. A simplified method based on the probability approach is used to calculate long-term energy balance. The optimization problem for electroenergy production is considered, and reliability of fossil fuel and nuclear power plants is assessed comparatively, taking into account the hazard of critical changes in the production conditions (e.g., considerable increase in the cost of fuel). The analysis shows that the part of nuclear sources in the total electricity generated by the French thermal plants will reach about 85 per cent by 1985. It is concluded that construction of new nuclear power plants not only presents economic advantages for the future energy production, as compared to conventional thermal power plants, but even at the present time, the nuclear plants can well compete economically with the existing fossil fuel power plants. S.N.

A77-11338 Electricity and heat production - Energy efficiency versus cost efficiency. M. P. A. Lingard (East Midlands Electricity Board, England). *Revue de l'Energie,* vol. 27, Mar. 1976, p. 154-164. In English and French.

The paper examines for the United Kingdom the problem of possible long-term energy savings by combining electricity and heat for public energy supply. Taking into account that the temperature of the waste water in the conventional electric power plants does not exceed 20 C (as a result of the efficient use of the steam for electricity generation), two other fossil fuel-based energy production systems are comparatively assessed: a system generating only heat, and a combined heat/electric system, yielding water at 100 C. A 45% saving in heat is shown to be obtained through use of the heat/electric system. The correlation between the cost efficiency of heat/electricity production and variations in energy demand is analyzed, and possible ways of achieving an adequate production/consumption balance are discussed. Considering the heat distribution problems, it is concluded that the use of smaller heat/electric stations is more promising. Possibilities of resolving the contradiction between the fuel savings and the enhanced capital costs of heat/electric power plants are analyzed. S.N.

A77-11339 Concerning world oil resources. II - Statistical logistic models /King Hubbert's models/ (A propos des ressources mondiales de pétrole. II - Modèles statistiques logistiques /modèles de King Hubbert/). M. Grenon. *Revue de l'Energie,* vol. 27, Mar. 1976, p. 165-174. In French.

A promising but highly controversial approach to mathematical modeling of the resource problem (in particular, for ultimate oil resources), proposed by King Hubbert by the end of the 1950s, is discussed. One of the Hubbert's methods is based on the analysis of the production curves for fossil fuels, assuming that this production has already reached the advanced phase, and using independent data

(evaluations) concerning ultimate production values. Some numerical predictions obtained by means of the Hubbert's model show a surprisingly good agreement with the observed values. Another method developed by King Hubbert in 1967 uses statistical data and curves of discovered oil resources per linear unity of exploration boring. The values of the ultimate oil resources for the 48 continental states of the U.S., obtained by the two methods are nearly coinciding (170 and 172 billions of barrels) and coincide with the value predicted recently by the U.S. Geological Survey experts with the aid of a completely different method. S.N.

A77-11340 Characteristic aspects of the evolution of the French electric balance in 1975 (Aspects caractéristiques de l'évolution du bilan électrique français en 1975). J. Laigroz (Electricité de France, Paris, France). *Revue de l'Energie,* vol. 27, Apr. 1976, p. 219-225. In French.

A77-11341 World oil resources. III - The geological analogy method (A propos des ressources mondiales de pétrole. III - La méthode d'analogie géologique). M. Grenon. *Revue de l'Energie,* vol. 27, Apr. 1976, p. 226-231. In French.

The paper describes developments of the geological analogy method for estimating total oil reserves in a large region. The method began with Zapp in 1962, who arrived at a figure of 590 billion barrels for total U.S. reserves by assuming constant drilling yields in time and space for operating wells, probable economical discoveries, and non-economical discoveries. Hendricks modified the method in 1965 by considering the total oil in the earth rather than just recoverable oil, and assuming that the probability of oil existing in the regions considered will vary between 0 and 1, and arrived at the figure of 400 billion barrels. A recent refinement of the method divides a large explored region such as the U.S. into zones of similar geological features, and assumes that the ratio of oil yield to reserves in that region can be applied to other less explored regions of the world. Finally, another modification calculates undiscovered recoverable resources by assuming that the ratio of their amount to the volume of favorable, unexplored rocks is proportional to the ratio of the amount of known hydrocarbons to the volume of drilled terrain. P.T.H.

A77-11342 World petroleum resources. IV - Probabilistic methods (A propos des ressources mondiales de pétrole. IV - Les méthodes probabilistes). M. Grenon. *Revue de l'Energie,* vol. 27, June 1976, p. 316-325. In French.

The paper gives a general description of the method of petroleum zones or 'play' for estimating the probability of oil deposits attaining certain levels in unexplored petroleum zones in a given basin. Basically the method consists in surveying experts regarding their opinions on the probability of parameters attaining given values in the zone. Such parameters might be, for example, the surface area of traps to be tested, the mean thickness of deposits or thickness of rocks with porosity above a certain minimum, gas/oil ratio, recovery rate for oil, and recovery rate for gas. The procedure used by Odell and Rosing (1975) to estimate the productivity of the North Sea basin over twenty years of drilling is examined. P.T.H.

A77-11343 The world's oil resources. V - Recovery rates (A propos des ressources mondiales de pétrole. V - Les taux de récupération). M. Grenon. *Revue de l'Energie,* vol. 27, July-Aug. 1976, p. 372-377. In French.

The rate of recovery of oil resources is estimated to be about 30 percent, i.e., for each ton of oil produced, at least two tons are left in the earth. The paper describes a number of methods of tertiary (improved assisted) recovery of oil reserves which can augment the recovery rate. The methods discussed are classified into three categories: (1) methods based on the injection of soluble gaseous compositions, (2) methods based on the injection of water modified with polymers, microemulsions, caustics, etc., and (3) thermal methods such as in situ combustion with or without water, drainage using water vapor, and cyclic stimulation using vapor ('huff and puff'). B.J.

A77-11347 # Problems involved in improving the industrial fuel and energy balance (Problemy sovershenstvovaniia toplivno-energeticheskogo balansa promyshlennosti). E. A. Nitskevich (Institut Chermetinformatsiia). *Promyshlennaia Energetika,* Aug. 1976, p. 30-35. In Russian.

Some aspects of the concept of using organic fuels and nuclear energy in industrial technology and power engineering are discussed. Problems associated with the production and use of synthetic fuels, in particular of production of gas from coal, are examined. The advantages and drawbacks of switching the industry from natural gas and fossil fuels to nuclear energy and synthetic fuels are assessed, and the need for large nuclear-energy, synthetic-fuel and heat generating centers is indicated. V.P.

A77-11468 Muon catalysed fusion for pellet ignition. W. P. S. Tan (Glasgow, University, Glasgow, Scotland). *Nature,* vol. 263, Oct. 21, 1976, p. 656-659. 10 refs.

The paper proposes the use of muon-catalyzed fusion reactions to provide the energy needed for the ignition of ordinary fusion reactions in an inertially confined DT pellet. According to this scheme, the pellet is first compressed to around 1000 times solid density and preheated to about 1000 eV by a relatively low-power laser or electron beam acting as a prepulse. Simultaneously, or shortly beforehand, a pulse of muons is injected into the pellet with a muon energy distribution such that most of the muons are deposited in the pellet core. The muon catalytic reaction is outlined, the mechanism of muon-catalyzed fusion is analyzed, and reaction rates are considered for catalytic fusion. The overall energy output and input are evaluated for different combinations of pellet size and other fusion parameters. Possible muon production and storage facilities are discussed. F.G.M.

A77-11492 * Energetics of the midlatitude thermosphere. R. S. Stolarski (NASA, Goddard Space Flight Center, Greenbelt, Md.). *Journal of Atmospheric and Terrestrial Physics,* vol. 38, Aug. 1976, p. 863-868. 9 refs.

Thermospheric energetics is examined from the point of view of atomic and molecular processes which convert solar EUV radiative energy into kinetic energy of the ambient electron, ion, and neutral gases. The energy flow from photon to photoelectron-ion pair through energy loss and ion-molecule transfer to eventual electron-ion recombination is traced in detail. Upper and lower bounds are placed on the efficiency of conversion of radiative to thermal energy. Implications for the question of consistency of measured solar EUV fluxes and ionospheric models are discussed. (Author)

A77-11496 The utility of waters from the high-temperature areas in Iceland for space heating as determined by their chemical composition. S. Arnorsson (National Energy Authority, Reykjavik, Iceland) and S. Sigurdsson (University of Iceland, Reykjavik, Iceland). *Geothermics,* vol. 3, Dec. 1974, p. 127-141. 16 refs.

A brief account of the compositional characteristics of geothermal waters from high-temperature areas on the Reykjanes peninsula in southwestern Iceland is given with particular reference to those dissolved compounds which affect the quality of hot water for space heating and domestic use. These compounds include sodium chloride, silica, hydrogen sulfide, carbon dioxide, and calcites. Results are discussed for tests of a heat-exchange pilot plant constructed in a high-temperature area in order to devise a method of transferring thermal energy from the high-temperature geothermal water to exploitable fresh water. The results show that suitable water

for space heating can be produced by mixing steam flashed from the geothermal water directly with fresh ground water preheated to 110-130 C and that the quality of the resulting hot water depends on the H2S and CO2 contents of the steam as well as the pH and total carbonate content of the fresh water. The pH of the steam-heated water and its CO2 and H2S contents are calculated from the compositions of the fresh water and the steam. F.G.M.

A77-11497 Isotopic composition of steam samples from Lanzarote, Canary Islands. V. Araña (Consejo Superior de Investigaciones Científicas, Departamento de Petrología y Geoquímica, Madrid, Spain) and C. Panichi (CNR, Istituto Internazionale per le Ricerche Geotermiche, Pisa, Italy). *Geothermics,* vol. 3, Dec. 1974, p. 142-145. 12 refs.

Isotopic analysis of steam samples collected in the geothermal area of Lanzarote show that the values of deuterium variations are practically constant, while those of O-18 vary over a range of 17 per cent, reaching a maximum of plus 14.7 per cent versus the SMOW standard. This composition can be explained as a consequence of isotope exchange at high temperature between limestones and a mixture of marine and local meteorological waters. This interpretation agrees with previous geological and geophysical studies which suggest that a promising geothermal field could exist in Lanzarote. (Author)

A77-11498 Locating interesting geothermal areas in the Tuscany region /Italy/ by geochemical and isotopic methods. R. Fancelli and S. Nuti (CNR, Istituto Internazionale per le Ricerche Geotermiche, Pisa, Italy). *Geothermics,* vol. 3, Dec. 1974, p. 146-152. 13 refs.

Results are reported for a geochemical and isotopic survey of hot-water springs in the area of the Italian province of Siena lying to the east of the well-known geothermal areas in the Tuscany region. The geology of the surveyed area is described, and possible geothermal zones are delineated. Isotopic compositions and underground temperatures estimated from Na-K-Ca geothermometer readings are given for 22 thermal springs in the area of interest. Only the zones surrounding four of the springs are found to have underground temperatures that are high enough to warrant further exploration. Oxygen and deuterium isotopic analyses of two of these springs indicate oxygen-isotope exchange between water and rock as well as possible mixing of local waters with geothermal steam. F.G.M.

A77-11499 Results of some geothermal studies in Singhbhum thrust belt, India. R. U. Rao and G. V. Rao (National Geophysical Research Institute, Hyderabad, India). *Geothermics,* vol. 3, Dec. 1974, p. 153-161. 12 refs.

Temperature, conductivity, and heat-flow measurements are reported for two sites along the Singhbhum thrust belt, a Precambrian metamorphic belt in the peninsular shield of India. Temperatures were measured with a thermistor probe in a number of bore holes, thermal conductivity was measured in about 80 core samples, and heat flow was evaluated taking account of anisotropy in conductivity. Water flows were encountered in many of the bore holes, and rocks along the thrust belt were found to have high concentrations of U, Th, and K. The results indicate that the entire thrust belt appears to be characterized by a uniform heat flow of about 61 mW/sq m, which is almost the same as the global average but much higher than the mean value quoted for shields. F.G.M.

A77-11523 The economics of coal supply - The state of the art. R. L. Gordon (Pennsylvania State University, University Park, Pa.). *Energy* (UK), vol. 1, Sept. 1976, p. 283-289. 14 refs. Research supported by the Electric Power Research Institute.

Basic concepts in coal supply cost analysis are reviewed. Emphasis is on the work undertaken by the US Bureau of Mines Process Evaluation Group at Morgantown, West Virginia, which remains the model for other supply analyses. Alternative models of the determinants of coal mining costs at a particular time are described together with the handling of cost changes over time, and efforts to assign reserves to cost categories. Weaknesses in all aspects of coal supply evaluation undertaken up to this point have been indicated, with key defects being essentially problems of insufficient data. B.J.

A77-11524 Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/. P. L. Auer (Electric Power Research Institute, Palo Alto, Calif.; Cornell University, Ithaca, N.Y.), A. S. Manne (Electric Power Research Institute, Palo Alto; Stanford University, Stanford, Calif.), and O. S. Yu (Electric Power Research Institute, Palo Alto, Calif.). *Energy* (UK), vol. 1, Sept. 1976, p. 301-313. 7 refs.

A model is developed concerning the options by which the United States can move away from its dependence on oil and gas to a more diversified energy economy based on nuclear power and/or coal. The energy supply options considered are: direct generation of electricity from coal combustion, coal conversion to synthetic fuels, the limited petroleum, natural gas, and shale oil resources, nuclear energy from light water reactors and fast breeder reactors, hydrogen via electrolysis, and such advanced technologies as solar power and fusion. Each energy source is examined with respect to its cost and the probable date of its commercial introduction. It is found that if a nuclear moratorium prohibiting the construction of additional nuclear power plants throughout the US were to come into effect, the direct cost to the US economy would be about $300 billion at a 10% discount rate and $2500 billion at a 5% rate. B.J.

A77-11532 Prospects for solar energy utilization in Iran - Photothermal methods. G. A. Mansoori (Illinois, University, Chicago, Ill.). *Iranian Journal of Science and Technology,* vol. 5, no. 2, 1976, p. 55-73. 49 refs.

The paper reviews the state of the art of photothermal methods of solar energy utilization and examines the technical and economic feasibility of adopting photothermal methods in Iran. Attention is given to the following methods: space and water heating, agricultural crop and vegetable drying, water desalinization and distillation; cooking, heat actuated heat pumps; space cooling and heating, water pumping in arid areas, conventional steam turbines for power generation, dissociation of water for the production of hydrogen, advanced MHD and gas turbine processes, solar furnaces, and thermoelectric and thermionic converters. B.J.

A77-11536 Energy recovery from saline water by means of electrochemical cells. B. H. Clampitt (Gulf Oil Chemicals Co., Houston Research Laboratory, Houston, Tex.) and F. E. Kiviat (Gulf Science and Technology Co., Pittsburgh, Pa.). *Science,* vol. 194, Nov. 12, 1976, p. 719, 720. 7 refs.

An electrochemical concentration cell is proposed as a means of extracting the energy released from the mixing of freshwater with seawater. In order to obtain the maximum power from such a cell, a small amount of seawater must be added to the freshwater prior to its introduction into the cell in order to lower the internal resistance of the cell. The work available from the electrochemical concentration cell is of the same order of magnitude as the work derived from the use of an osmotic pump to extract energy from seawater. Both of these saline water techniques should be considered when unconventional, long-range power sources are evaluated. (Author)

A77-11568 # Stratospheric heating due to absorption of solar radiation by NO2. P. C. Beadle (British Aircraft Corp., Bristol, England) and S. R. Mattingly (Meteorological Office, Bracknell, Berks., England). *Royal Meteorological Society, Quarterly Journal,* vol. 102, Oct. 1976, p. 918-923. 28 refs.

The relative importance of ozone and NO2 in the heat balance of the stratosphere is studied to determine whether the effect of

NO2-induced ozone reduction on the stratospheric heat balance may be mitigated by increased absorption of solar radiation by NO2. Absorption of fluorescence photons by NO2 is neglected in the analysis, and stratospheric heating rates for the Northern Hemisphere in winter and spring are computed by assuming that the contributions of NO2 concentrations to the total solar heating in the stratosphere are about twice those of CO2 at 1 mb. It is concluded that the role of NO2 in the heat budget of the stratosphere must be seriously considered if rather more NO2 is found to be present than is assumed in these calculations; otherwise, NO2 must be regarded as a minor contributor. F.G.M.

A77-11591 **A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs.** S. Paul (Paris VIII, Université, Paris, France), J. P. Gibert (Paris XI, Université, Orsay, Essonne, France), L. Pontier, C. Dechambenoy, and L. Menenger (CNRS, Laboratoire de Météorologie Dynamique, Palaiseau, Essonne, France). *Remote Sensing of Environment,* vol. 5, no. 3, 1976, p. 177-190. 10 refs. Délégation Générale à la Recherche Scientifique Contracts No. 73-7-1322; No. 74-7-1375.

In the course of an aerial survey mission with an infrared scanning radiometer (10.5-12.5 microns) performed in 1974 over an area of eruptive volcanic rocks, a surface thermal anomaly has been detected in the vicinity of Chaudes-Aigues, France. Its amplitude, 2-3 C, is close to the one produced by hyperthermal springs at Chaudes-Aigues. The existence of this anomaly has been confirmed by in-situ surface temperature measurements performed in 1975. This paper reports on the method by which a surface temperature anomaly was confirmed by ground measurements, using contact thermometers and a hand-held Barnes PRT-6 radiometer. An isopleth map of surface thermal anomalies has been produced which is based on airborne thermal infrared imagery (aerial thermography). (Author)

A77-11600 # **Intermetallic compounds - Background and results of twenty years of research.** J. H. N. van Vucht (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). *Philips Technical Review,* vol. 36, no. 5, 1976, p. 136-146. 22 refs.

An overview of research on intermetallic compounds emphasizing work done at Philips, is presented. Intrinsic and extrinsic properties and phase relations are characterized, and varied practical results and outgrowths of work on getters for thermionic tubes, superconductors, and permanent magnets based on intermetallic compounds are covered. Analyses are presented of the phenomena of polytypism (of close-packed AB3 compounds), shape hysteresis of close-packed AB compounds, and hydrogen storage by LaNi5 and other 'hydrogen sponge' intermetallic compounds. Applications of these compounds in hydrogen storage, cryogenerators, rechargeable batteries, thermocompressors, hydrogenation catalysis, pressure buffering in batteries, and hydrogen purification are mentioned. R.D.V.

A77-11761 **Reducing grain-boundary effects in polycrystalline silicon solar cells.** T. L. Chu (Southern Methodist University, Dallas, Tex.). *Applied Physics Letters,* vol. 29, Nov. 15, 1976, p. 675, 676. NSF-supported research.

Solar-cell structures were prepared by depositing successively p- and n(+)-type silicon layers on low-resistivity p-type polycrystalline silicon substrates. The characteristics of the solar cells are limited predominately by the grain boundaries in the deposited p layer. The effects of grain boundaries can be reduced by increasing the dopant concentration in the p layer, and solar cells of lower series resistance and higher conversion efficiency have been obtained. (Author)

A77-11762 **Operation of ITO/Si heterojunction solar cells.** T. Mizrah and D. Adler (MIT, Cambridge, Mass.). *Applied Physics Letters,* vol. 29, Nov. 15, 1976, p. 682-684. 10 refs. Research supported by the Cabot Solar Energy Fund.

The paper reports the fabrication of solar cells by RF sputtering of transparent conducting films of indium-tin oxide (ITO) onto epitaxial wafers of both n/n(+) and p/p(+) single-crystal Si. The I-V characteristics in the dark as well as in sunlight of a device consisting of ITO RF-sputtered at 35 W onto a 5.3-micron-thick 5.1-ohm cm n/n(+) Si substrate are illustrated, and the band diagram of the device is constructed. The ITO/n-Si device is shown to be similar to a Schottky diode because the current is carried primarily by majority carriers on both sides of the junction, at least under low-injection conditions. Negligible photovoltaic conversion efficiencies of cells with ITO layers deposited at high sputtering powers are attributed to the recombination of photoexcited holes in the Si with photoexcited electrons in the Si conduction band, the effect of which will depend strongly on the density of interface states in the Si. F.G.M.

A77-11818 * **Microwave transmission system for space power.** R. M. Dickinson (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Raumfahrtforschung,* vol. 20, Sept.-Oct. 1976, p. 238-241. 10 refs. Contract No. NAS7-100.

A small total system model and a large subsystem element similar to those that could be eventually used for wireless power transmission experiments in space have been successfully demonstrated by NASA. The short range, relatively low-power laboratory system achieved a dc-to-dc transmission efficiency of 54%. A separate high-power-level receiving subsystem, tested over a 1.54-km range at Goldstone, California, has achieved the transportation of over 30 kW of dc output power. Both tests used 12-cm wavelength microwaves. (Author)

A77-11916 **Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells.** T. M. Golovner, E. V. Zhidkova, A. K. Zaitseva, and L. B. Kreinin (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). *(Geliotekhnika,* no. 1, 1976, p. 3-8.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 1-5. 12 refs. Translation.

The influence of the thickness of the diffused region, the resistance of this region, the built-in electrostatic field, and surface recombination velocity on the collection efficiency and spectral response of photovoltaic solar energy converter cells is studied experimentally. It is shown that recombination in the surface layer has a decisive influence on the short-wave sensitivity of photocells. V.P.

A77-11917 **Thermoelectric power of pseudoternary solid solutions.** A. Z. Kuliev, K. S. Kakhramanov, E. S. Sagatov, and I. Tukhtasinov (Akademiia Nauk Azerbaidzhanskoi SSR, Institut Fiziki, Baku, Azerbaidzhan SSR). *(Geliotekhnika,* no. 1, 1976, p. 15-17.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 11-13. Translation.

A study of the thermoelectromotive force in PbS-PbSe-PbTe solid solutions showed that the thermoelectromotive force in solid solutions containing 5 to 20% PbSe increases more rapidly with increasing temperature than in n-PbS and in PbS-PbSe and PbS-PbTe solid solutions with identical contents of the second component and identical electron concentrations. The effect becomes more pronounced as the content of the second component and the electron concentration are increased. V.P.

A77-11918 **Isothermal surface in a radiation field.** A. I. Rogulev. *(Geliotekhnika,* no. 1, 1976, p. 18-21.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 14-17. Translation.

Solar thermal energy devices exhibit the best characteristics in the case of an isothermal heat supply surface. The equation of an

isothermal surface in a radiation field is derived under some simplifying assumptions conventionally used in radiative transfer theory. An integrodifferential form of the equation is proposed. Numerical solutions of this equation can be used to optimize the shape of the irradiated surface. V.P.

A77-11919 Design of a tracking system for a solar-energy installation. A. A. Simoniants, Ia. T. Shermazanian, and A. V. Vartanian. *(Geliotekhnika,* no. 1, 1976, p. 22-26.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 18-21. Translation.

The optimal time lag of an automatic sun-tracking system is calculated, and the principles of operation of the system are discussed. The optimal gear ratios of the actuator reduction gears are also obtained. V.P.

A77-11920 Radiant-vector distribution in the radiant field of a parabolocylindric concentrator. G. Ia. Umarov, R. A. Zakhidov, and A. Sh. Khodzhaev (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *(Geliotekhnika,* no. 1, 1976, p. 27-32.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 22-26. 9 refs. Translation.

Formulas are proposed for calculating the energy density distribution over collectors of arbitrary shape. The energy density distribution curves of plane and cylindrical collectors are plotted with allowance for the shading produced by the collector. The influence of longitudinal defocusing on the irradiance of a collector is assessed. V.P.

A77-11921 *Calculations on an optimized faceted solar* concentrator. I. V. Baum, A. Ch. Bairiev, and N. Saiylov (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *(Geliotekhnika,* no. 1, 1976, p. 33-39.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 27-32. Translation.

The positioning of facets over a parabolic surface is calculated for facets of trapezoidal planform and variable curvature. The facets are not strict trapezoids, but rather equal parts of circular strips (of identical width) of the paraboloid surface. The number of facets and the flare angle of the paraboloid are determined for a given collector efficiency, followed by the determination of the paraboloid area and other parameters, on the basis of which the final number of facets is computed. Certain functions which facilitate the calculation of the collector parameters are tabulated. V.P.

A77-11922 Design principles for solar and wind power installations. R. B. Salieva (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR). *(Geliotekhnika,* no. 1, 1976, p. 51-57.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 41-45. 15 refs. Translation.

A systems analysis approach is proposed for planning and designing solar- and wind-energy systems whose operation involves natural, engineering, and human factors. Such relatively complex systems are characterized by the presence of control, functional objectives, a hierarchical system structure, and a continuously changing state of subsystems and elements. Computer-aided solutions to the problems of optimizing the system structure, the system parameters, and the system modes of operation are presented. V.P.

A77-11923 Optimization criteria for solar and wind power systems. R. B. Salieva (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR). *(Geliotekhnika,* no. 1, 1976, p. 58-63.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 46-49. 7 refs. Translation.

It is shown that in order to design efficient solar- and wind-energy systems, it is necessary to define a goal function and to optimize the system with respect to two optimality criteria. One criterion is economic efficiency in the sense of least national-economy expenditures; the other is reliability in the sense of flawless performance probability. V.P.

A77-11924 Some features of the operation of a solar installation acting as a low-temperature source of heat for a heat pump. O. L. Shvaleva and R. R. Avezov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *(Geliotekhnika,* no. 1, 1976, p. 64-66.) *Applied Solar Energy,* vol. 12, no. 1, 1976, p. 50, 51. Translation.

A 'hot box' type solar energy system operating in combination with a heat pump is discussed. The effectiveness of water heating for the heat pump is analyzed for the period from October to March, assuming a water temperature of 35 C. The superiority of the system over a system without a heat pump is demonstrated. V.P.

A77-11947 * Near-uv photon efficiency in a TiO2 electrode - Application to hydrogen production from solar energy. J.-L. Desplat (NASA, Ames Research Center, Moffett Field, Calif.; Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). *Journal of Applied Physics,* vol. 47, Nov. 1976, p. 5102-5104. 8 refs.

An n-type (001) TiO2 electrode irradiated at 365 nm was tested under anodic polarization. A saturation current independent of pH and proportional to light intensity has been observed. Accurate measurements of the incident power lead to a 60 per cent photon efficiency. A photoelectrochemical cell built with such an electrode, operated under solar irradiation without concentration, produced an electrolysis current of 0.7 mA/sq cm without applied voltage. (Author)

A77-12059 Energy in the household - Comparison of heating costs and prognosis concerning the consumption of energy until 1985 (Energie im Haushalt - Heizkostenvergleich und Energieverbrauchsprognose bis 1985). G. Kammholz, H. Frohnert (VEBA-Chemie AG, Gelsenkirchen-Scholven, West Germany), and W. Lührmann (VEBA AG, Düsseldorf, West Germany). *Energiewirtschaftliche Tagesfragen,* vol. 26, Oct. 1976, p. 567, 568, 570 (5 ff.). 8 refs. In German.

An investigation is conducted regarding the costs of various heating systems for residential applications, taking into account conditions in West Germany for a large city, a city of medium size, and a rural area. A use of natural gas, oil, coking coal, and a coal of a grade used for power plants is considered. Attention is given to primary energy costs, costs related to material conversion and storage, distribution costs, and costs related to the installation of suitable heating equipment and storage devices in the residential area. New developments in the sector of residential heating are discussed, taking into account conditions for the time period from 1975 to 1985. G.R.

A77-12061 The solution of the garbage problem: New proposals for the utilization of refuse - Proposals and suggestions (Den Müll im Griff: Neue Vorschläge zur Müllverwertung - Vorschläge und Anregungen). R. Rupp. *Energiewirtschaftliche Tagesfragen,* vol. 26, Oct. 1976, p. 596, 597. In German.

A description is given of a new approach for the solution of the garbage disposal problem. This approach makes it possible to overcome the difficulties which are connected with an employment of the conventional refuse disposal methods. The approach requires an area of 1200 x 600 m for the establishment of the various facilities needed. Residential housing with recreational areas for the employed personnel and their families is also provided. The described installation will employ about 700 persons. The refuse processing

methods employed make a utilization of the collected materials for a number of applications possible. G.R.

A77-12062 A methodical approach concerning energy supply problems (Probleme einer zielbewussten Energieversorgung). H. G. Mebuss. *Energiewirtschaftliche Tagesfragen*, vol. 26, Oct. 1976, p. 604, 605. In German.

A first evaluation of the various forms of energy available for the satisfaction of the cultural and technological requirements of a nation will take into account only the cost factors involved. It is, however, advisable to consider also other factors related to an assurance of the availability of the selected form of energy for the present time and the future. The development of suitable approaches with respect to the solution of energy supply problems is difficult and requires the cooperation of highly qualified experts from various areas including science, economics, technology, and the political sector. G.R.

A77-12114 Concorde - Endurance flights results (Concorde - Résultats des vols d'endurance). P. Lebouc (La Concorde, Toulouse, France). *L'Aéronautique et L'Astronautique*, no. 60, 1976, p. 10-15. In French.

Data are presented and tabulated on Air France Concordes run through endurance tests to date. Data on each aircraft tested, on the flights executed, the routes traveled, amount of fuel consumed, amount of fuel taken on board, flight profiles, prescheduled detours, and test facilities placed on board for the endurance tests are included. Time out of service during this period is compared to figures for subsonic large aircraft. It is concluded that Concorde has proved itself as an operationally viable passenger aircraft. R.D.V.

A77-12125 # Coming - Solar power plants. L. M. Murphy and A. C. Skinrood (Sandia Laboratories, Livermore, Calif.). *Mechanical Engineering*, vol. 98, Nov. 1976, p. 26-32. 9 refs.

The system designs proposed by Honeywell, Martin Marietta, and McDonnell Douglas for the 10 MW(e) pilot plant and its heliostat concepts are examined. Calculations indicate that roughly 2000 heliostats, each with about 40 sq m of reflective surface, would be required for such a plant. Annual solar energy of approximately 2.0 MWhr/sq m of mirror area can be redirected to a receiver from a heliostat array located in a favorable location. Each of the designs examined requires approximately 100 acres of land for the 10-MW plant, but less than 40% of the land will be actually covered by mirrors. Both Honeywell and McDonnell Douglas envision a tower surrounded by a flat heliostat field. The Martin Marietta approach is to locate the tower on the southern edge of either a horizontal or sloped field. Evaluation of the different systems will not start until 1977. Preliminary studies, however, indicate that the designs proposed are workable. V.P.

A77-12150 Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine. S. D. Hires (Ford Motor Co., Dearborn, Mich.), A. Ekchian, J. B. Heywood, R. J. Tabaczynskii, and J. C. Wall (MIT, Cambridge, Mass.). *Society of Automotive Engineers, Automotive Engineering Congress and Exposition, Detroit, Mich., Feb. 23-27, 1976, Paper 760161*. 30 p. 18 refs. Research supported by the Ford Motor Co.

The development of a cycle simulation model for the jet ignition prechamber stratified charge engine is described. Given the engine geometry, load, speed, air-fuel ratios and pressures and temperatures in the two intakes, flow ratio and a suitable combustion model, the cycle simulation predicts engine indicated efficiency and NO emissions. The relative importance of the parameters required to define the combustion model are then determined, and values for ignition delay and burn angle are obtained by matching predicted and measured pressure-time curves. The variation in combustion parameters with engine operating variables is then examined. Predicted and measured NO emissions are compared, and found to be in reasonable agreement over a wide range of engine operation. The relative contribution of the prechamber NO to total exhaust NO is then examined, and in the absence of EGR, found to be the major source of NO for overall air-fuel ratios leaner then 22:1. (Author)

A77-12181 # Estimating procedures associated with aircraft modifications. J. A. Knagg (E-Systems, Inc., Dallas, Tex.). *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1101*. 11 p.

Modification of existing or obsolescent aircraft is discussed from the viewpoint of the weight engineer. Several examples of modified aircraft are described, and a general modification methodology is outlined. Consideration is given to the use of micromodules in aircraft electronic systems, antenna miniaturization, and effects of modification programs on fuel requirements and management. F.G.M.

A77-12192 * # Air transportation energy efficiency - Alternatives and implications. L. J. Williams (NASA, Ames Research Center, Moffett Field, Calif.). *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1124*. 25 p. 14 refs.

Results from recent studies of air transportation energy efficiency alternatives are discussed, along with some of the implications of these alternatives. The fuel-saving alternatives considered include aircraft operation, aircraft modification, derivative aircraft, and new aircraft. In the near-term, energy efficiency improvements should be possible through small improvements in fuel-saving flight procedures, higher density seating, and higher load factors. Additional small near-term improvements could be obtained through aircraft modifications, such as the relatively inexpensive drag reduction modifications. Derivatives of existing aircraft could meet the requirements for new aircraft and provide energy improvements until advanced technology is available to justify the cost of a completely new design. In order to obtain significant improvements in energy efficiency, new aircraft must truly exploit advanced technology in such areas as aerodynamics, composite structures, active controls, and advanced propulsion. V.P.

A77-12194 * # Application of advanced technology to future long-range aircraft. O. E. Schrader (NASA, Langley Research Center, Hampton, Va.). *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1126*. 45 p. 9 refs.

The objective of this paper is to provide an overview assessment of three separate programs at Langley Research Center that have incorporated advanced technology into the design of long-range passenger and cargo aircraft. The first technology centers around the use of an span-loaded cargo aircraft with the payload distributed along the wing. This concept has the potential for reduced structural weights. The second technology is the application of laminar flow control (LFC) to the aircraft to reduce the aerodynamic drag. The use of LFC can reduce the fuel requirements during long-range cruise. The last program evaluates the production of alternate aircraft fuels from coal and the use of liquid hydrogen as an aircraft fuel. Coal-derived hydrogen as an aircraft fuel offers both the prospect for reduced dependence on petroleum fuels and improved performance for long-range aircraft. (Author)

A77-12195 # The next-generation subsonic transport. D. P. Marsh (Douglas Aircraft Co., Long Beach, Calif.). *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1127*. 8 p.

The design approach used at McDonnell Douglas to satisfy the market requirements and operating economics for a next-generation commercial subsonic transport is discussed. The principal near-term design objectives are reduced fuel consumption and the development

of a configuration, to satisfy this goal, on the basis of wing geometry studies, advanced technology applications, and fuselage and engine configuration studies. The results of the configuration development studies, marketing reports, and airline inputs indicate that the next-generation transport will incorporate the following features: all-new wing design with higher aspect ratios for reduced drag; advanced high-lift systems for reduced noise and wing area; incorporation of such advanced technologies as supercritical wing, composite materials, and relaxed static stability to reduce fuel consumption and weight; reduced passenger capacity over current wide-body transports to meet market requirements; reduced cruise speed for minimum operating costs; and commonality with existing transport aircraft to reduce development costs. V.P.

A77-12233 Photosynthesis as a resource for energy and materials. M. Calvin (California, University, Berkeley, Calif.). *American Scientist,* vol. 64, May-June 1976, p. 270-278. 38 refs. ERDA-supported research.

Possible ways of using the natural photosynthetic mechanisms in some plants to construct large-scale synthetic systems serving as renewable sources of materials (plastics, fibers) and fuel are examined. The processes of photosynthetic quantum collection in green plants are discussed with special attention to the photosynthetic potential of such plants as sugarcane, kelp, and the rubber tree. The possibilities of controlling natural processes in these plants and improving their energetic efficiency are analyzed. The photochemical quantum conversion in synthetic systems is then considered as a promising mechanism for direct fuel production (H2, CH4, etc). Recent studies concerning catalysts for these processes are reviewed. Particular attention is given to the problem of creating photochemical cell-membrane, in which hydrogen might be evolved on one side of the membrane and oxygen on the other. A conceptual design of such a membrane analogous to the natural chloroplast membranes is proposed. S.N.

A77-12234 Nuclear power - Compared to what. D. J. Rose (MIT, Cambridge, Mass.), L. L. Leskovjan (Florida Power and Light Co., Miami, Fla.), and P. W. Walsh. *American Scientist,* vol. 64, May-June 1976, p. 291-299. 31 refs. NSF Grant No. ST-40016000.

The paper is concerned with long-term decisions which will affect electric power generation towards the end of the century. Petroleum and natural gas being scarce at that time, the real choices will be among nuclear fission (with breeder reactors in prospect), controlled nuclear fusion, solar power, and coal. These major alternatives are comparatively assessed from economic, environmental and societal points of view. An analysis of US available fuel resources leads to the conclusion that the only near-term alternatives are nuclear fission and coal power. Health hazards of nuclear fission power including those from mining, radio activity, reactor accidents and nuclear waste disposal are discussed, as well as health effects of coal-generated power arising from mining, direct burning, and the conversion of coal through gasification and liquefaction. Particular attention is given to the environmental impact of coal burning products, such as sulfur oxides, nitrogen oxides, particulates, and trace metals. For the long term, controlled fusion and solar power are briefly discussed. It is concluded that the nuclear fission appears to be the most acceptable technology from all the discussed points of view. S.N.

A77-12236 Synthetic fuels - Prices, prospects, and prior art. O. H. Hammond and R. E. Baron (MIT, Cambridge, Mass.). *American Scientist,* vol. 64, July-Aug. 1976, p. 407-417. 29 refs.

An overview of the development of synthetic fuel technologies is followed by a comparative description of the naturally occurring carbonaceous raw materials (lignite, coals, oil shales, and tar sands), their chemical composition and relative abundance. Basic methods available for conversion of natural raw materials into fuel are discussed, including hydrogenation by pyrolysis and by direct reaction with hydrogen, and indirect hydrogenation using water as a source of hydrogen. Application of these methods to coal gasification, coal liquefaction, and processing of tar sands is examined. Attention is also given to the in-situ processing of raw materials. Economic problems related to synthetic fuel industrial development are analyzed and prospects of synthetic fuels are tentatively assessed. S.N.

A77-12237 The long-range prospects for solar energy. W. G. Pollard. *American Scientist,* vol. 64, July-Aug. 1976, p. 424-429.

An attempt is made to evaluate the long-range potential of various ways of using solar energy. Assuming the technology to be successfully established, the question is posed whether solar energy systems can be commercially feasible as a practical component of the nation's energy system in competition with alternative energy sources. In discussing direct uses of solar radiation, including solar heating and solar electricity systems, the energy conversion efficiency, problems related to low intensity and intermittency of solar energy are analyzed, as well as land requirements for solar-electric power plants. The major trends and prospects of wind power plants, and the Ocean Thermal Energy Conversion (OTEC) system are examined as examples of indirectly used solar energy. Attention is also given to space-based solar electric systems. It is concluded that neither direct nor indirect solar energy (other than hydroelectric) can make a substantial contribution to the nation's large-scale energy needs. Potential of solar energy is found to be significant only for small self-contained total energy systems for rural homes and farms, or in remote locations where the cost factor is not important. S.N.

A77-12240 The long-range prospects for solar-derived fuels. W. G. Pollard. *American Scientist,* vol. 64, Sept.-Oct. 1976, p. 509-513. 10 refs.

Solar-derived fuels are considered to be those produced annually by photosynthesis in currently growing plant material. The paper examines the potential of fuels derived from the sun through photosynthesis from the standpoint of their commercial conversion as an integral part of the world energy system in the long-range future when reserves of fossil fuels, especially petroleum and natural gas, have been depleted. Attention is focused on the pyrolysis of biomass to produce solid fuel and methanol, as well as on the production of liquid and gaseous fuels by appropriate techniques. It is shown that the long-range prospect for the use of solar energy through photosynthesis to produce solid, liquid, and gaseous fuel seems reasonably well assured. The technology for such fuels is already well developed and their extensive use awaits a favorable price level for delivered biomass and a major shift in agricultural and silvacultural practice. S.D.

A77-12246 # The shaping of our needs in mineral raw materials and sources for meeting those needs (Asvanyi nyersanyagszuksegletunk alakulasa es a kielegites forrasai). J. Fulop (Foldtani Hivatal, Hungary). *Energia es Atomtechnika,* vol. 29, Oct. 1976, p. 433-439. 20 refs. In Hungarian.

World energy production history and Hungary's own energy production history are compared, and new possibilities for exploitation of Hungary's mineral resources opened up by new processes and methods and by the higher prices on imported petroleum and natural gas are examined. Denudation of forests at the outset of the industrial revolution led to reliance on the originally less efficient coal. Petroleum and natural gas took the lead, on a world scale and in Hungary eventually, not because of exhaustion of coal reserves (which are still plentiful), but because they were cheaper, more versatile, less labor-consuming. Hungary's ample coal reserves and prospects for exploiting Hungarian geothermal sources are discussed, energy sources and reserves are extrapolated to 2000 AD, and the outlook for domestic production of alumina, Cu, Mn, Pb, Zn, artificial fertilizer, rock salt, and other ores, minerals, and products is evaluated optimistically. R.D.V.

A77-12247 # **The significance of coal in the future energy picture (A szen jelentosege a jovo energetikajaban).** L. Heller. *Energia es Atomtechnika,* vol. 29, Oct. 1976, p. 445-448. In Hungarian.

Presently feasible solutions for producing energy efficiently, ways of cutting specific investment costs, and the outlook for coal utilization in contrast to other energy sources are emphasized. More promise is seen in power plants exploiting a combination of steam turbine and gas turbine, the use of electric power to generate space heat and process heat, pressurized boilers, and the use of multiple working fluid systems (with processes incorporating high flash point fluids such as molten Hg, molten K, or cold fluids such as ammonia) than in systems relying on solar energy, wind energy, geothermal energy, tidal energy, hydrothermal temperature differences, or MHD, with their high specific investment costs. Combination coal-fired nuclear-fueled plants are also recommended. Ecologically beneficial aspects of the recent petroleum price rise are pointed out. Investment policies, heat insulation, and corporate consolidation are also discussed. R.D.V.

A77-12256 # **Use of radar in geology.** H. C. MacDonald (Arkansas, University, Fayetteville, Ark.). *Remote Sensing of the Electro Magnetic Spectrum,* vol. 3, July 1976, p. 93-104.

In some areas of the world where the collection of photogeological data is constrained by adverse weather conditions, side-looking airborne radar (SLAR) imaging systems are a primary tool for geological reconnaissance. A number of applications of SLAR imagery to geological surveying are discussed including general geological interpretation, mineral, petroleum, and groundwater exploration, and geological mapping. B.J.

A77-12282 Off-shore oil scenarios - Method and results (Les scénarios du pétrole off-shore - Une méthode, des résultats). M. Godet and O. Ruyssen (Société d'Economie et de Management, Montrouge, Hauts-de-Seine, France). *Revue de l'Energie,* vol. 27, Oct. 1976, p. 484-491. In French.

The SMIC variant of a scenario projection technique for assessing possible futures facing off-shore oil development and exploitation on an international scale is presented and exemplified. Branching trees for a unique and uncertain future and for a multiple indeterminate future are presented, and SMIC selection of final images and calculation techniques are presented. Principal factors weighed include: continuing American leadership, solidarity of the OPEC nations, maintenance of big-power hegemony, increased hydrocarbon reserves in non-OPEC territories, step-ups in off-shore exploration, development and exploitation, and fixing of a floor price on crude oil ($7-$8 per barrel). SMIC advantages in keeping track of variables masked by other models, in yielding results agreeing with and at variance with intuition, and in weighing probabilities of rival scenarios, are pointed out. R.D.V.

A77-12361 # **Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies (Anomal'nye vol't-ampernye kharakteristiki, nabliudaemye pri reaktornykh ispytaniiakh mnogoelementnykh termoemissionnykh sborok).** V. V. Siniavskii, A. S. Karnaukhov, E. S. Bekmukhambetov, V. I. Berzhatyi, A. A. Dzhaimurzin, I. M. Kuznetsov, V. A. Maevskii, and V. K. Morozov. *Zhurnal Tekhnicheskoi Fiziki,* vol. 46, Sept. 1976, p. 1895-1900. 5 refs. In Russian.

A77-12401 Law and solar energy systems - Legal impediments and inducements to solar energy systems. R. L. Robbins (Lake Michigan Federation, Chicago, Ill.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 5, 1976, p. 371-379. NSF Grant No. APR-74-21034.

Local and state law impediments as well as institutional constraints that have severely limited the change to solar energy systems for heating and cooling purposes are reviewed. Emphasis is placed on the activities that can take place in state and local governments to encourage use of solar energy. The areas of legal change include improving the access to solar insolation, optimizing the location of solar energy collectors, improving the public economics of solar energy systems, improving the operation and design of systems through feasible energy backup and utility concern with solar energy, removing potential construction and maintenance problems, financing solar energy systems, and allocating rights to solar insolation. Solutions that can be adapted to the problems of most states are recommended, although the suggestions still need to be matched to local conditions and legal precedent. S.D.

A77-12402 Developments in solar energy utilisation in the United Kingdom. J. C. McVeigh (Brighton Polytechnic, Brighton, England). *Solar Energy,* vol. 18, no. 5, 1976, p. 381-385. 19 refs.

The paper outlines the main lines of research and development currently being undertaken in the United Kingdom for solar energy applications. A brief discussion of the radiation climate is included, along with a review of activities in the photovoltaic, photochemical, and photobiological fields. Wind power is also receiving renewed interest. A major conclusion is that many workers believe solar energy can make a significant contribution to the energy requirements of the country, although this is not as yet the official government viewpoint. S.D.

A77-12403 The solar water heater industry in South Florida - History and projections. J. E. Scott (Delaware, University, Newark, Del.). *Solar Energy,* vol. 18, no. 5, 1976, p. 387-393. 6 refs. NSF-supported research.

Recent developments in energy prices and availability have produced an economic environment more promising to a resurgence of solar water heating in South Florida. The paper presents the results of an examination of the experience with solar water heaters in South Florida and assesses the likelihood of developing future demand. Included is a discussion of the solar heater used and the factors underlying the growth and subsequent decline of new water heater installations. Prospects for increasing use of solar water heating are evaluated. Although the discussion is centered around solar water heating, the results provide substantial insights into other uses of solar energy such as heating and cooling of single family residences. S.D.

A77-12404 A cylindrical blackbody solar energy receiver. D. A. Boyd, R. Gajewski, and R. Swift (American Science and Engineering, Inc., Cambridge, Mass.). *(International Solar Energy Society, Meeting, Fort Collins, Colo., Aug. 1974.) Solar Energy,* vol. 18, no. 5, 1976, p. 395-401. 8 refs.

This paper discusses a design for a receiver appropriate for a concentrating collector having potential application at moderate working temperatures (near 100 C) as well as at high temperatures (above 300 C). The receiver consists of an annular cylindrical tube with an aperture parallel to the axis of the cylinder. The aperture is illuminated by means of a focusing concentrator, such as a lens, and the radiation energy is scattered inside the cavity, absorbed by the walls and transmitted, as heat, to the working fluid flowing axially inside the annulus. To reduce radiative losses the tube is surrounded by a layer of a thermal insulator. Principal advantages of this design lie in exclusive use of commonly-available materials and current fabrication technology. Thermal losses are controlled by the configuration of the receiver assembly containing the working fluid, without the use of special surface coatings, vacuum enclosures, or other complex features. Projected performance of the collector is compared with other designs. A theoretical performance analysis is presented, and two specific examples pertinent to moderate and high-temperature applications, are discussed. (Author)

A77-12405 **Accelerated response of thermopile pyranometers.** B. J. Brinkworth and T. D. R. Hughes (University College, Cardiff, Wales). *Solar Energy,* vol. 18, no. 5, 1976, p. 403, 404.

Thermopile pyranometers are the most commonly used instruments for solar energy research and for routine measurement by national monitoring services. In many of these, the sensing element is attached to a blackened metal disk, forming the receiving surface; the additional thermal capacity of the disk, however, gives these instruments a rather slow response to changes in the incident radiation flux. The requirement for making repeated observations at intervals of a few seconds necessitated the use of a compensation network. It is shown that a simple compensation network is capable of accelerating the response of a thermopile pyranometer by a factor of about ten. When it is used with the Kipp solarimeter, the response to a step change in irradiation is substantially completed in about 2.3 sec, and fluctuations are satisfactorily resolved at frequencies up to about 0.12 Hz. S.D.

A77-12406 **Solar water pump for lift irrigation.** D. P. Rao and K. S. Rao (Birla Institute of Technology and Science, Pilani, India). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 5, 1976, p. 405-411.

A77-12407 **Thermal evaluation of a house using a movable-insulation heating and cooling system.** P. W. B. Niles (California Polytechnic State University, San Luis Obispo, Calif.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 5, 1976, p. 413-419. 7 refs. U.S. Department of Housing and Urban Development Grant No. H-22026R.

A full-size house utilizing a heating and cooling system composed of roof water-bags intermittently covered with insulation was designed and tested in Atascadero, California (35 N lat.). Twenty centimeters of water sealed in plastic bags with inflatable covers rested on the metal ceiling which covered the 102 sq m living space. The movement of the 5 cm thick polyurethane insulation panels were automatically controlled to maximize the heating and cooling potentials of the system. With family occupancy, the house remained comfortable in both the heating and cooling seasons which were typified by daily average outdoor temperatures of 8 C and 22 C, respectively. No auxiliary heating or cooling systems were employed during the 9-month test. Operating characteristics were favorable. Design parameters and performance data are given. (Author)

A77-12408 **A method of testing for rating solar collectors based on thermal performance.** J. E. Hill and E. R. Streed (National Bureau of Standards, Thermal Engineering Section, Washington, D.C.). *(International Solar Energy Society, International Solar Energy Conference and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 5, 1976, p. 421-429. 28 refs. NSF-ERDA-supported research.

Basic approaches are presented for testing and experimentally determining the thermal efficiency of solar collectors. A proposed standard test procedure is described. The test apparatuses and major components are prescribed so that a liquid or air can be used as the transfer fluid. The limitation in determining the thermal efficiency of the collector accurately is primarily affected by the accuracy by which the incident solar energy can be measured by commercially available pyranometers. The importance of evaluating the angular and transient response characteristics of the collector in such a standard test procedure is discussed. S.D.

A77-12409 **Optimal control of flow in low temperature solar heat collectors.** M. Kovarik and P. F. Lesse (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering and Div. of Building Research, Highett, Victoria, Australia). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 5, 1976, p. 431-435. 5 refs.

Solar energy collection plants with uniform flat plate collectors are classified according to the mode of operation and the type of performance criterion. The problem of optimal control of flow through the collector is formulated under simplifying assumptions and conditions for the existence of an optimal control of the system are stated for certain elements of the above classification. A numerical process for the optimal solution is described and an example of solution given. A simple control policy is given, applicable to those elements of the above classification where a continuous solution of the problem does not exist. This policy consists of alternate switching between zero and maximum available flow. A direction for further research into some aspects of the optimal control problem is suggested. (Author)

A77-12410 **Performance analysis of a cylindrical parabolic focusing collector and comparison with experimental results.** M. W. Edenburn (Sandia Laboratories, Albuquerque, N. Mex.). *(International Solar Energy Society, International Solar Energy Congress and Exposition, Los Angeles, Calif., July 28-Aug. 1, 1975.) Solar Energy,* vol. 18, no. 5, 1976, p. 437-444. ERDA-sponsored research.

The efficiencies for focusing collectors which consist of a cylindrical parabolic reflector and a collector tube surrounded by a transparent envelope and which heat a fluid flowing through the collector tube have been predicted using heat transfer analytical methods. The analysis considers visible radiation transfer, IR radiation exchange, conductive and convective losses and energy transferred to a fluid flowing through the collector tube. The collector may have a tilted north-south axis, an east-west axis or it may fully track the sun, and geometric parameters associated with tracking the sun are considered. Predicted results are in excellent agreement with recent collector performances measured using Sandia Laboratories' collector test facility. (Author)

A77-12411 **Grain drying in stationary bins with solar heated air.** G. Roa and I. C. Macedo (Campinas, Universidade Estadual, Campinas, Brazil). *Solar Energy,* vol. 18, no. 5, 1976, p. 445-449. 7 refs. Research supported by the Financiadora de Estudos e Projetos.

A77-12412 **A method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds.** M. L. Wesely and R. C. Lipschutz (Argonne National Laboratory, Argonne, Ill.). *Solar Energy,* vol. 18, no. 5, 1976, p. 467-473. 10 refs. ERDA-supported research.

The amount and type of cloud prevailing at a given time and location largely determine the amount and type of solar radiation received at the earth's surface. It is conventional to consider the total shortwave irradiance (visible plus some near infrared) at a horizontal rather than inclined surface and to express the irradiance as consisting of a diffuse component D and a direct component I where D + I is the solar energy input relevant to considerations of local energy balances at the earth's surface. The paper describes a simple procedure for estimating values of D and I that can be used in comparisons of the theoretical performances of solar collectors of different designs. The amounts and types of cloud cover are examined with regard to hourly averages of the magnitudes of D and I when small zenith angles of the sun and partly cloudy skies prevail. Also investigated are cloud-induced transients in the direct-beam irradiance. S.D.

A77-12413 **A forced circulation system for solar water heating.** G. J. Parker (Canterbury, University, Christchurch, New Zealand). *Solar Energy,* vol. 18, no. 5, 1976, p. 475-479. 7 refs.

Results are presented for a study designed to examine the possibility of using a forced circulation system for solar water heating, which is also operated by solar energy via solar photovoltaic cells. The cost of such a device could be offset primarily by savings in using the existing ground level storage tank. The discussion covers the characteristics of solar cells, estimation of the power requirement for a typical installation, and the design and performance of a motor-pump unit which would meet some of the requirements. Results of testing the unit in a simple solar water heating circuit demonstrate the feasibility of using solar cells in conjunction with a

pump unit to produce forced circulation in a solar water heating system. S.D.

A77-12502 Equation solution accuracy in calculating jet engine characteristics. A. M. Akhmedzianov, S. Kh. Aksel'rod, and Kh. S. Gumerov. *(Aviatsionnaia Tekhnika,* vol. 19, no. 1, 1976, p. 5-10.) *Soviet Aeronautics,* vol. 19, no. 1, 1976, p. 1-5. 5 refs. Translation.

The calculation of engine characteristics is conventionally reduced to ensuring an accurate selection of the position of the operating point on the characteristic curve of the compressor. In the present paper, a method is proposed for determining the accuracy to which the selection conditions are satisfied for solving a system of equations in the computation of the characteristics of a turbojet engine. It is shown that to achieve convergence of the solution to this system of equations by computer-aided selection (at a prescribed accuracy of such output parameters as thrust and fuel consumption), a specific relation must be used to determine the error in the selection conditions. This relation must be precisely satisfied in the computer-aided determination of the turbojet engine characteristics. V.P.

A77-12528 Heat-pipe regenerator for gas turbine engine. V. K. Shchukin, I. I. Mosin, N. V. Lokai, and I. I. Fedorov. *(Aviatsionnaia Tekhnika,* vol. 19, no. 1, 1976, p. 172-175.) *Soviet Aeronautics,* vol. 19, no. 1, 1976, p. 140-143. Translation.

The principles of operation of gas-turbine-engine regenerator of a fundamentally new design are discussed. The device is essentially a recuperative (fixed) heat exchanger which uses heat pipes to offset the intrinsic drawbacks of recuperative heat exchangers, such as a low recovery factor and high hydraulic pressure losses along the hot gas duct. V.P.

A77-12650 # New electrochemical current sources (Novye elektrokhimicheskie istochniki toka). V. S. Bagotskii. *Akademiia Nauk SSSR, Vestnik,* no. 7, 1976, p. 41-52. In Russian.

Several types of voltaic cells and electrochemical batteries capable of directly converting chemical energy to electrical energy are reviewed and compared as possible sources of power for electrically powered lightweight vehicles and in terms of high-efficiency cold combustion processes comparable to biochemical analogs. Devices with spatially separated combustion reactions, nonaqueous organic solvents, nonporous solid electrolytes, liquid or gas electrolytes, fuel cells, electrocatalytic reactions, and gas diffusion electrodes or liquid diffusion electrodes are discussed. Modified Grenet cells, iron-air batteries, zinc-air batteries, Ni-H batteries, Na-S batteries, Ni-Zn batteries, and cells with propylene carbonate solvent, sodium oxide + alumina electrolyte, or RbAg4I5 solid electrolyte are considered. R.D.V.

A77-12657 # Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance (K metodike ucheta neopredelennosti iskhodnoi informatsii pri optimizatsii regional'nogo toplivno-energeticheskogo balansa). Sh. Ch. Chokin, E. E. Loiter, T. S. Sartaev, and S. Zh. Tashenev. *Akademiia Nauk Kazakhskoi SSR, Vestnik,* Sept. 1976, p. 43-48. In Russian.

An attempt is made to compute the ambiguity of some initial-information elements in the perspective optimization of the fuel/energy balance of Kazakhstan. Such a regional optimization is understood to mean the solution of a host of problems associated with the most effective distribution of fuel among the users, the selection of the optimal type of fuel for each user, and the determination of the optimal means of fuel transportation. The block diagram of an algorithm developed for calculating the perspective amounts of natural gas required to satisfy the long-term needs of Kazakhstan is given and discussed, along with the minimization of the economical 'risk' involved. V.P.

A77-12662 Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volumes 1 & 2. Conference sponsored by AIChE, ANS, SAE, ACS, AIAA, ASME, and IEEE. New York, American Institute of Chemical Engineers, 1976. Vol. 1, 1007 p.; vol. 2, 1011 p. Price of two volumes, members, $75.; nonmembers, $90.

Discussed topics are related to the areas of advanced auto propulsion, advanced concepts, alternative fuels, biomedical power, Brayton cycles and expanders, coal and oil shale utilization, electric vehicles, electrochemical power, energy conservation and storage, geothermal energy, heat pipes, and hydrogen energy systems. Attention is also given to MHD and other topping cycles, nuclear power, Rankine cycle power, solar power, space power, Stirling cycle engines, thermoelectrics, thermionics, urban energy management, and wind power. G.R.

A77-12663 * Onboard hydrogen generation for automobiles. J. Houseman and D. J. Cerini (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 6-16. 14 refs. Contract No. NAS7-100.

Problems concerning the use of hydrogen as a fuel for motor vehicles are related to the storage of the hydrogen onboard a vehicle. The feasibility is investigated to use an approach based on onboard hydrogen generation as a means to avoid these storage difficulties. Two major chemical processes can be used to produce hydrogen from liquid hydrocarbons and methanol. In steam reforming, the fuel reacts with water on a catalytic surface to produce a mixture of hydrogen and carbon monoxide. In partial oxidation, the fuel reacts with air, either on a catalytic surface or in a flame front, to yield a mixture of hydrogen and carbon monoxide. There are many trade-offs in onboard hydrogen generation, both in the choice of fuels as well as in the choice of a chemical process. Attention is given to these alternatives, the results of some experimental work in this area, and the combustion of various hydrogen-rich gases in an internal combustion engine. G.R.

A77-12664 The fuel efficiency potential of a flywheel hybrid vehicle for urban driving. A. A. Frank, N. H. Beachley, T. C. Hausenbauer, and P. Ting (Wisconsin, University, Madison, Wis.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 17-24. 5 refs. U.S. Department of Transportation Contract No. OS-30112.

The concept of a flywheel energy management power plant (FEMP) for automobiles, consisting of an internal combustion engine, an energy-storage flywheel, and a continuously-variable transmission (CVT), has been found to have the potential of greatly increasing fuel economy in urban driving. The improvement occurs because of two factors: (1) The engine is only run at or near its highest efficiency, and (2) the system allows efficient regenerative braking. The design details of an experimental flywheel vehicle currently under construction are discussed. This vehicle is projected by a complete simulation to achieve a 58% improvement in fuel economy over the EPA-CVS city driving cycle. With further research and development, however, it is felt that a 100% improvement is feasible. The flywheel concept has been found very sensitive to component efficiencies, with the CVT being the most critical item in this regard. (Author)

A77-12665 Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system. M. Balasubramaniam (TRW, Inc., Energy Systems Planning Div., McLean, Va.), A. Lowi (Terraqua, Inc., San Pedro, Calif.), G. L. Schrenk (Pennsylvania, University, Philadelphia, Pa.), and J. C. Denton (American Technological University, Killeen, Tex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 25-32. 19 refs.

An organic fluid engine cooling system combined with a novel

jet-vapor-compression automotive air-conditioning system is considered as an alternative to conventional belt driven vapor compression systems added on to the water cooled power plant. The energy significance of accessory dead weight and engine drag is evaluated and the value of shifting from a prime shaft driven system to a waste heat recovery system is derived. Based on a single model year fleet equipped with the hypothetical heat recovery system it is shown that the annual energy cost of automotive air-conditioning usage could be reduced by more than 70%. The salient features of this novel Rankine bottoming cycle approach and some of its eccentricities are also described. (Author)

A77-12666 * Photoassisted electrolysis of water - Conversion of optical to chemical energy. M. S. Wrighton, J. M. Bolts, S. W. Kaiser (MIT, Cambridge, Mass.), and A. B. Ellis. In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 35-42. 42 refs. Research supported by the Massachusetts Institute of Technology and NASA.

A description is given of devices, termed photoelectrochemical cells, which can, in principle, be used to directly convert light to fuels and/or electricity. The fundamental principles on which the photoelectrochemical cell is based are related to the observation that irradiation of a semiconductor electrode in an electrochemical cell can result in the flow of an electric current in the external circuit. Attention is given to the basic mechanisms involved, the energy conversion efficiency, the advantages of photoelectrochemical cells, and the results of investigations related to the study of energy conversion via photoelectrochemical cells. G.R.

A77-12667 Energy conversion via photoelectrolysis. A. J. Nozik (Allied Chemical Materials Research Center, Morristown, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 43-50. 26 refs.

Photoelectrolysis represents an approach for the decomposition of water into hydrogen and oxygen by means of photoelectrochemical processes. According to this approach light is absorbed in semiconducting electrodes. The electron-hole pairs produced in connection with the absorption process are subsequently separated by the semiconductor-electrolyte junction and injected at the cathode and anode to produce reduction and oxidation reactions, respectively. Photoelectrolysis is attractive as a solar energy conversion scheme because it converts solar energy into chemical energy which can be stored much more easily than either electricity or heat. The maximum theoretical efficiency for the conversion of solar energy into hydrogen is estimated to be about 40-45%, using p-n type photoelectrolysis cells. G.R.

A77-12668 The Osmotic power plant. S. Loeb, F. van Hessen, J. Levi, and M. Ventura (Negev, University, Beersheba, Israel). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 51-57. Research supported by the United States-Israel Binational Science Foundation.

An investigation is conducted concerning the feasibility to utilize the osmotic pressure to produce power by means of a hydroturbine-generator set. The principle of pressure-retarded osmosis (PRO) involved in the proposed process is discussed and the application of PRO to continuous power production is considered. Possibilities regarding the use of Dead Sea brine as the brine source are examined, taking into account the permeate-receiver side, the permeate-donor side, and details concerning the power conversion system. Attention is also given to the use of solid salt as the brine source, test permeators, the parameters which control energy cost, the test procedure, experimental results, and energy costs. G.R.

A77-12669 An energy center in Sri Lanka. H. J. Allison, S. R. Southerland, and C. E. Gordon (Oklahoma State University, Stillwater, Okla.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 58-63. Research sponsored by the United Nations Environment Program.

In connection with the United Nations Environment Program (UNEP) effort to install rural energy centers in developing nations throughout the world, a model energy center is designed and installed in Sri Lanka (formerly Ceylon). The system will derive its input from a mix of solar, wind, and biogas energy, and produce electricity at power levels up to 30 to 50 kilowatts. Windmills will be used to generate electricity and pump water. A solar energy system is also to be employed. The electrical components of the solar and wind energy system will be connected to a storage system to insure an uninterrupted supply of energy. The solar energy component of the system consists of a moderate temperature solar collector which drives a Rankine Cycle engine that produces direct current for charging a battery bank. G.R.

A77-12671 Solar SNG - Large-scale production of SNG by anaerobic digestion of specially grown plant matter. M. D. Fraser (InterTechnology Corp., Warrenton, Va.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 83-90. 13 refs. Research supported by the American Gas Association; Grant No. DACA23-74-C-009.

The considered concept represents a systematic approach to produce a practical and economic fuel from plant matter on a large scale. The required plants are to be grown on 'energy plantations' purposely and optimally for their renewable fuel value. A process involving the conversion of plant matter into synthetic natural gas (SNG) by anaerobic fermentation is discussed, taking into account the anaerobic digestion of woody plant material. Attention is given to preferred plant species for SNG production on energy plantations, the pretreatment of deciduous woody material, the annual costs of an SNG plant, optimality considerations, and the potential of the proposed process. G.R.

A77-12672 Solar energy collection by bioconversion. O. C. Sitton and J. L. Gaddy (Missouri-Rolla, University, Rolla, Mo.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 91-97. 21 refs.

The leaf system, or canopy, of a particular plant serves as a solar energy collecting surface. Efficiencies as high as 30.0 percent have been reported for the conversion of incident radiation into energy in the form of biomass. U.S. land availability for biomass production is considered, taking into account the North Central cropland, crop wastes, and range and forest land. Attention is given to biomass as an energy mechanism, the processing of the biomass to obtain large quantities of methane for distribution in existing natural gas pipelines, and questions of process economics. It is found that bioconversion of plant matter to methane gas is economically attractive at today's fossil fuel energy prices. Technology and land areas are available to employ this process on a large scale today. G.R.

A77-12673 * A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics. R. W. Graham, T. W. Reynolds, and Y.-Y. Hsu (NASA, Lewis Research Center, Hampton, Va.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 98-104. 17 refs.

An estimate is obtained of the yearly supply of organic material for conversion to fuels, the energy potential is evaluated, and the fermentation and pyrolysis conversion processes are discussed. An investigation is conducted of the estimated cost of fuel from organics and the conclusions of an overall evaluation are presented. It is found that climate, land availability and economics of agricultural production and marketing, food demand, fertilizer shortage, and water

availability combine to cast doubts on the feasibility of producing grown organic matter for fuel, in competition with food, feed, or fiber. Less controversial is the utilization of agricultural, industrial, and domestic waste as a conversion feedstock. The evaluation of a demonstration size system is recommended. G.R.

A77-12676 A conceptual design study of closed Brayton cycle gas turbines for fusion power generation. S. C. Kuo (United Technologies Research Center, East Hartford, Conn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 184-191. 8 refs. Research supported by the Electric Power Research Institute.

This paper presents the results of a conceptual design study of closed Brayton cycle gas turbine power conversion systems suitable for integration with advanced-concept Tokamak fusion reactors (such as UWMAK-III) for efficient power generation without requiring cooling water supply for waste heat rejection. A baseline cycle configuration was selected and parametric performance analyses were made. Based on the results of the parametric analysis and trade-off and interface considerations, the reference design conditions for the baseline cycle were selected. Conceptual designs were made of the major helium gas turbine power system components including a 585-MWe single-shaft turbomachine, (three needed), regenerator, precooler, intercooler, and the piping system connecting them. Structural configuration and significant physical dimensions for major components are illustrated, and a brief discussion on major advantages, power control and crucial technologies for the helium gas turbine power system are presented. (Author)

A77-12678 * Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly. P. Aller, W. Saylor, G. Schmidt, and D. Wein (General Electric Co., Space Div., Valley Forge, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 208-215. 6 refs. Contract No. NAS3-18541.

The Mini-Brayton Heat Source Assembly (HSA) consists of a radioisotope fueled heat source, a heat exchanger, a multifoil thermal insulation blanket, and a hermetically sealed housing. The thermal insulation blanket is a multilayer wrap of thin metal foil separated by a sparsely coated oxide. The objectives of the insulation blanket are related to the effective insulation of the HSA during operation, the transfer of the full thermal inventory to the housing when the primary coolant is not flowing, and the transfer of the full thermal inventory to the housing in the event of a flow stoppage of the primary coolant. A description is given of the approaches which have been developed to make it possible for the insulation blanket to meet these requirements. G.R.

A77-12679 Steam station repowering - A near-term method of energy conservation. R. D. Lessard, S. J. Lehman, and F. L. Robson (United Technologies Research Center, East Hartford, Conn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 216-221. 9 refs.

A description is presented of the potential of steam station repowering for future electric utility power generation. In steam station repowering, the gas turbine generates power and exhausts to a new waste-heat recovery boiler which replaces the old steam powerplant boiler. Steam from the new boiler drives the existing steam turbine. In process repowering the steam produced in the waste-heat boiler is used for process application. Attention is given to the performance potential of steam station repowering, the cost savings potential, a market analysis, and an evaluation of fuel savings. G.R.

A77-12683 Catalytic coal gasification for SNG production. W. R. Epperly and H. M. Siegel (Exxon Research and Engineering Co., Baytown, Tex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 249-253. 5 refs.

The catalytic coal gasification process of Exxon for the production of substitute natural gas (SNG) is described. The alkali carbonate catalyst increases the rate of steam gasification, prevents agglomeration when gasifying caking coals, and promotes gas phase methanation equilibrium. The process uses a low gasifier temperature of 650-750 C along with separation of synthesis gas (CO and H2) from the product methane and recycling of the synthesis gas to the gasifier. The only net products of gasification are CH4, CO2, and small quantities of H2S and NH3, and the overall gasification step is essentially thermoneutral. B.J.

A77-12684 Comparative economics for the Arthur D. Little extractive coking process. S. A. Reber, R. M. Nadkarni, R. W. Hyde, and A. H. Schutte (Arthur D. Little, Inc., Cambridge, Mass.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 254-261. 13 refs.

Direct coal-liquefaction processes are reviewed, and the cited process (referred to as the ADL process) is described in detail. The key step in the ADL process is the use of delayed coking to effect a clean separation of the liquids from the unreacted coal and ash. The yield structure of liquid, gas, and unreacted coal from this process is evaluated, an experimental program conducted to verify the yield predictions is outlined, and the process design employed for preliminary economic analysis is discussed. Results of a preliminary economic analysis are presented for a plant with a capacity of 10,000 tons of coal per day. The economics of the ADL process is compared with those of the H-Coal and Synthoil processes. F.G.M.

A77-12685 Solids gasification for gas turbine fuel 100 and 300 Btu gas. W. B. Crouch (Texaco, Inc., Montebello, Calif.) and R. D. Klapatch (Turbo Power and Marine Systems, Inc., Farmington, Conn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 268-274. 14 refs.

A development program has demonstrated that low and medium Btu gas can be burned efficiently in a gas turbine. Experimental operation and typical results of gasification of a variety of solid and liquid materials by the Texaco synthesis gas generation process and Texaco coal gasification process are described. Operating performance data for a gas turbine combustor fired on both 100 and 300 Btu/scf fuel gas produced by Texaco gasification technology are reported, including NOx and CO emissions data. The effect of steam injection for NOx reduction when burning low-Btu gas is assessed. A method is described for efficient conversion of fuels with a high nitrogen content to electrical power with minimal NOx emissions. S.D.

A77-12686 Recovery of inaccessible coal reserves by in situ gasification. R. C. Forrester, III (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 275-279. 14 refs. ERDA-sponsored research.

The technology challenge of in-situ or underground coal gasification is examined as a potential tool to recover the energy contained by many deposits inaccessible by present surface and deep-mining techniques. In-situ coal gasification involves injection of oxygen or air with or without steam into a coal seam whose permeability has been previously enhanced by explosives, high-pressure liquid injection, or some other means. It is shown that in-situ coal gasification is an economical alternative to conventional extraction/surface gasification techniques and their relatively adverse impacts on both the environment and industrial health and safety.

Preliminary experiments suggest that costs will be competitive with those for surface processing techniques and that new technology requirements are realizable. S.D.

A77-12687 Low-Btu gasification of coal by Atomics International's molten salt process. W. V. Botts, A. L. Kohl, and C. A. Trilling (Rockwell International Corp., Atomics International Div., Canoga Park, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 280-285.

The molten salt coal gasification process is essentially based on partial oxidation and complete gasification of coal at a temperature of 1700 to 1800 F and a pressure of 10 to 20 atm by reaction with air in a bed of molten sodium carbonate, the sulfur and ash of the coal being retained in the melt. The low-Btu gas produced has a heating value of about 150 Btu/scf. Attention is focused on the process development unit (PDU) and further research and development. The PDU program is aimed at demonstrating the performance of a complete integrated system and providing design data for process scale-up and evaluation. The optimum power generation system appears to be a combined cycle involving gasification with air under pressure, combustion of the product gas in a gas turbine, and operation of a waste heat boiler system on the turbine exhaust gas. S.D.

A77-12688 Hydrogen production by the steam-iron process. P. B. Tarman and D. V. Punwani (Institute of Gas Technology, Chicago, Ill.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 286-293. 9 refs. Research sponsored by the American Gas Association and ERDA.

The production of hydrogen-rich gases from coal or coal char is a key step in the production of synthetic gas or oil from coal. This paper describes the use of the steam-iron process for this purpose. The process incorporates a multi-stage, fluidized-bed reactor with iron solids recirculation between beds. Solids recirculation allows continuous hydrogen production at the elevated pressures needed for coal gasification and liquefaction. The effects of temperature, residence time, and solids recirculation rate on the production rate and concentration of hydrogen are discussed. An empirical correlation was developed for predicting the fluidized-density of iron solids as a function of particle size, gas velocity, and system properties. The use of this information in the design of a large pilot-plant steam-iron reactor is also discussed. (Author)

A77-12689 Operation of the Westinghouse Coal Gasification Process Development Unit. R. D. Shah, P. J. Margaritis, L. K. Rath, P. Cherish, and L. A. Salvador (Westinghouse Research Laboratories, Waltz Mill, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 294-299. ERDA-supported research.

The objective of the Westinghouse Coal Gasification Program is the development of an integrated process which gasifies caking, high-sulfur coals to a low-Btu fuel gas which is combusted and expanded through a combined-cycle generating plant. The purpose of work performed as part of the pilot scale work on the PDU is to demonstrate the feasibility of the basic concepts comprising the gasification, devolatilization, desulfurization and waste removal processes, and to demonstrate the system performance and operability. The test results reported herein are evaluations of the devolatilizer reactor system using a variety of coal feedstocks under a range of operating conditions and are a demonstration of the basic feasibility and operability of the devolatilizer system with its recirculating fluidized bed concept. (Author)

A77-12690 A preliminary engineering assessment of jet fuel production from domestic coal and shale derived oils. C. D. Kalfadelis, H. Shaw, and W. F. Taylor (Exxon Research and Engineering Co., Linden, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 315-319. Contract No. F33615-74-C-2036.

A pilot plant program was recently completed that demonstrated that specification JP-4 and Jet A can be produced from domestic shale oils and coal liquids. Three shale oils and two coal liquids were evaluated in this study. All crude oil samples received were analyzed in our laboratories. The kerosene range (IBP-570 F/300 C) fraction was utilized as feed to our coal and shale hydrogenation (CASH) unit. Experimental runs with synthetic crudes have been made at liquid hourly space velocities (LHSV) of 0.5 to 1.0 at 700 F (370 C), using Ni/Mo or Co/Mo catalysts with target inlet hydrogen rate equivalent to 4000 SCF per barrel of liquid feed. Operations have been conducted at total pressures of 1500 psig (normal severity), 800 psig (low severity), and 2200 psig (high severity). (Author)

A77-12691 Design of a 100 BPD pilot plant to convert methanol to gasoline using the Mobil process. N. Daviduk, J. Maziuk, and J. J. Wise (Mobile Research and Development Corp., Princeton and Paulsboro, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 320-324. Contract No. E(49-18)-1773.

The paper discusses the design of a 100 BPD skid-mounted pilot plant to convert methanol to high octane gasoline and a stoichiometric quantity of water using the recently announced Mobil process. The conversion of methanol to gasoline and a small quantity of hydrocarbon gases is accomplished catalytically in one integrated step at about 650 F and 300 psig. The reaction is highly exothermic. A recycle system is used to control reactor temperature. The process is 95.5% thermally efficient based on the net heating value of the methanol compared to the net heating value of the products. The cost of conversion in a commercially sized plant is estimated at less than 5 cent per gallon of gasoline. (Author)

A77-12692 Hydrocarbon fuels from oil shale. F. C. Schora, P. B. Tarman, H. L. Feldkirchner, and S. A. Weil (Institute of Gas Technology, Chicago, Ill.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 325-330. Research sponsored by the American Gas Association.

A new process based on controlled countercurrent heating of oil shale in the presence of hydrogen at moderate pressure levels is described for producing substitute natural gas and/or middle distillate type oils from oil shale. Before testing in large-scale experimental equipment, extensive testing was conducted in laboratory thermobalance to determine the effects of primary process variables on the rate and ultimate extent of kerogen removal measured as organic carbon removal. Moving-bed hydrogasification test were then performed in a 10-cm diam bench-scale reactor to obtain results in large-scale equipment. Organic carbon recoveries as high as 95% were obtained at shale flow rates of up to 57 kg/hr. Temperature is found to be the most significant operating variable in the range of shale space velocities studied. S.D.

A77-12693 Oil shale development. P. Wellman (Ashland Oil, Inc., Ashland, Ky.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 331-335. 7 refs.

The almost fourfold increase in the world oil prices over the last three years and the growing dependence of the U.S. on oil imports (a 58% increase in oil imports in 1976 alone) makes an urgent development of alternate energy sources imperative. The paper examines the potential and possible ways of development for one of those sources, commercial U.S. oil shale deposit exploitation. According to the United States Geological Survey estimates, only in

the Piceance Creek oil shale basin (Western Colorado) the total in-place reserves of oil assaying 15 gallons or more per ton is 1.8 trillion barrels or about three times the proven world reserves of oil. The major problems confronting oil shale industry development are discussed, including economic and financial, environmental political aspects, including those connected with the OPEC oil price politics, prospects for new discoveries of oil shale, conservation problems, technological problems, and social impact of the oil shale industry development. Government support is considered necessary for oil shale development in the near future. S.N.

A77-12694 In situ recovery of oil and minerals from Piceance Creek Basin oil shale. J. O. Cowles and E. M. Boughton (TRW, Inc., Energy Systems Group, McLean, Va.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 336-340. 9 refs.

This paper discusses an in situ process for recovering shale oil from the salt capped shale deposit at the depocenter of the Piceance Creek Basin in Colorado. The operations in this process are tailored to this specific deposit. The deposit lies beneath a thick overburden and cannot be economically recovered by conventional mining and surface retorting. The formation is gas tight, free of aquifers and rich in soluble salts, making it a likely candidate site for a successful demonstration of in situ recovery techniques. The salt capped region is estimated to contain over 50 billion barrels of oil in place. The potential oil recovery by this process is 10-20 billion barrels of oil. In addition substantial by-product soda ash and aluminum ore are recovered. The paper further describes in some detail a proposed development program designed to assess the commercial feasibility of the process. (Author)

A77-12695 In situ combustion of Michigan oil shale - Current field studies. W. N. Musser and J. H. Humphrey (Dow Chemical Hydrocarbons and Energy Research Laboratory, Midland, Mich.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 341-348. 7 refs.

Eastern oil shales, though having a considerably lower oil content than that of their western counterpart, represent a vast hydrocarbon resource (2.5 trillion barrels in place only for Michigan's known deposits). Geological and chemical characteristics of the eastern (Devonian) and western (Eocene) shales are examined comparatively. In developing an in situ shale combustion technology utilizing borehole techniques appropriate for deep, low-grade Michigan oil shale deposits, a field combustion experiment was carried out. The in situ combustion of the shale with air was performed in a zone fractured by the simultaneous detonation of 21 tons of chemical explosive (a metalized ammonium nitrate slurry) divided between two wells drilled 60 feet apart. The basic steps of the experiment program are discussed, including site selection, drilling, fracturing the formation, ignition, and controlling combustion so as to maximize resource recovery. The experiment proved to be only partially successful. The difficulties encountered and the problems to be solved are analyzed. S.N.

A77-12696 Retorting of single oil shale blocks with nitrogen and air. E. T. S. Huang (Gulf Research and Development Co., Pittsburgh, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 349-354. 8 refs.

Experiments on retorting single oil shale blocks were carried out to investigate the anomalous fast internal heating phenomenon. Two 0.156 liters/kg (37.5 gal/ton) oil shale polyhedral blocks (approximate diameter of 18 cm or 7.1 inches) having almost identical organic content and lithological properties were heated at atmospheric pressure to 500 C with a carrier gas flow rate of 60 liters/hr. Carrier gas for one test was air and the other was nitrogen, while all the other experimental parameters were the same. The experimental results showed that the thermal behavior was the same for both runs and no anomalous fast internal heating was observed. A third run with air at a higher flow rate (173 liters/hr) also showed no sign of fast heating. Production of oil and gas was essentially completed in 5 hours under the heating mode of this study. Oil recovery efficiency ranged between 80 to 91% Fischer assay. (Author)

A77-12698 Small electric vehicle considerations in view of performance and energy usage. M.-C. Yew and D. E. McCulloch (General Motors Corp., Warren, Mich.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 363-368. 5 refs.

Present and relevant future technology of electric batteries for vehicle propulsion, drive systems, packaging, and accessories are discussed. Energy consumption by a lightweight electric vehicle and comparable internal combustion engine vehicles is compared. The performance and range of electric vehicles with Zn-Ni oxide batteries, at the present state of the art and at current prices, is evaluated and found still rather modest. But use of electric vehicles with Zn-Ni oxide batteries could be feasible for personal transportation over 40 to 75 km radius trips in the near future, particularly if no substantial new petroleum reserves or other source of low-cost fuels or synthetic fuels should become available in the future. Battery characteristics, experience with test vehicles, motor and controller efficiency, and efficiency in the production of gasoline and electricity are discussed. R.D.V.

A77-12700 An analysis of electric vehicle mission, design, energy impact and cost. M. Klein (Energy Research Corp., Danbury, Conn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 377-381.

Vehicle performance is assessed against mission requirements and battery capabilities for an electrically rechargeable vehicle capable of a 75-mile range on a metropolitan driving cycle. The vehicle's energy consumption per mile is analyzed as a function of driving cycle, vehicle total weight (including battery weight), range, and battery energy density. The energy consumption of the electric vehicle is then compared with that of an internal-combustion vehicle in the cases where the primary fuel of the latter is crude petroleum, coal, and nuclear fuel (hydrogen). An attempt is made to evaluate the cost of operating the electric vehicle and the internal-combustion vehicle in each case considered. F.G.M.

A77-12701 Load leveling with electric vehicles in the urban environment. E. C. Jerabek (GE Research and Development Center, Schenectady, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 382-389. 14 refs.

Forecasts of vehicle populations and degree of electrification have been made with respect to the urban environment. Also, electrical load curves, for the two seasons of summer and winter have been forecast upon which vehicle recharge has been superimposed. It is shown that unless very significant changes in mass transit occur, the personal automobile will dominate any load-leveling effect a city might experience. By 1990, this paper forecasts 52 percent conversion of personal cars to electric propulsion. The study shows the possibility of increasing the daily load factor or low/high power ratio by 10-20 percentage points which could cause a reduction in the production cost of electricity since the most efficient units are used. However, this does not require the addition of new generation capacity since the need comes during off-peak hours and would not seriously exceed, if at all, daytime peaks, at least through 1990. (Author)

A77-12702 Selection of driving cycles for electric vehicles of the 1990's. A. W. Liles and G. P. Fetterman, Jr. (Exxon

Enterprises, Inc., Florham Park, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 390-395. 7 refs.

Three types of electric vehicles intended to operate in an urban environment are considered in order to select appropriate driving cycles for anticipated traffic patterns of the 1990s. The vehicles include a limited-performance introductory passenger electric vehicle, a light duty van, and a fully competitive urban electric vehicle. The driving cycles evaluated are the EPA urban cycle, the SAE urban and electric-vehicle cycles, and the Scott urban cycle. Computer-simulation cycle tests are run to determine the peak acceleration and power requirement of each vehicle through the cycle speed range and the energy requirement per kilometer. Based on the analysis, the more severe EPA cycle is selected to typify the operation of an electric vehicle on urban streets and freeways, while a less severe SAE electric-vehicle cycle is selected for vehicles limited to urban streets only. The relative efficiency of an advanced ac motor-controller system and a conventional dc series motor/chopper controller system is compared for the three vehicles operated over their appropriate driving cycles. F.G.M.

A77-12703 Application of a shunt motor and a 2 cylinder gasoline engine as a hybrid drive for an automobile. E. A. Ulbrich (Creative Automotive Research, Whittier, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 396-403.

The application of a shunt motor and a 2 cylinder gasoline engine as a hybrid drive for an automobile is described. A drawing of the drive train and the control system is presented. The operation of the vehicle is described from a theoretical and an empirical view point. Test results are presented from a mileage, pollution, and public opinion point of view. Failures and hazards are described. Extensions to future vehicles are made. (Author)

A77-12704 * Baseline test data for the EVA electric vehicle. W. C. Harhay (Electric Vehicle Associates, Parma, Ohio) and J. Bozek (NASA, Lewis Research Center, Hampton, Va.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 404-410.

Two electric vehicles from Electric Vehicle Associates were evaluated for ERDA at the Transportation Research Center of Ohio. The vehicles, loaded to a gross vehicle weight of 3750 pounds, had a range of 56.3 miles at a steady speed of 25 mph and a 27.4 miles range during acceleration-deceleration tests to a top speed of 30 mph. Energy consumption varied from 0.48 kw-hr/mi. to 0.59 kw-hr/mi. (Author)

A77-12706 Ambient temperature electric vehicle batteries based on lithium and titanium disulfide. L. H. Gaines, R. W. Francis, G. H. Newman, and B. M. L. Rao (Exxon Research and Development Co., Linden, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 418-423. 11 refs.

A77-12707 Electric vehicle performance with alternate batteries. S. Sudar and W. Thomson (Rockwell International Corp., Atomics International Div., Canoga Park, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 424-429.

Atomics International has made a preliminary study of the performance of electric vehicles in support of their research and development program on advanced electric storage batteries. The electric vehicles studied were an 1134 kg commuter car and a 3175 kg van. Each was considered as an all-electric vehicle and also as a hybrid. Performance data calculated were range, acceleration, gradeability, and top speed. Advanced batteries having energy densities from 1.19 to 5.95 x 10 to the 5th J/kg were considered. Two such advanced batteries were considered in this study. One was a lithium-iron sulfide design while the other was a zinc-nickel oxide design that features a rotating shutter. (Author)

A77-12708 Energy saving potential of engine-electric vehicular drives. L. E. Unnewehr, R. L. Bailey, H. L. Stadler, and A. H. Turner (Ford Motor Co., Dearborn, Mich.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 430-437. 24 refs. NSF Grants No. C-805; No. AER-73-07199.

The hybrid powertrain - combining a conventional internal combustion engine with an energy storage system - has the potential for a significant reduction of fuel consumption in vehicles during metro driving. The overall energy savings possible through the use of hybrid powertrains in a variety of vehicle types is calculated and analyzed. Comparisons are made with all-electric and conventional powertrains and the parallel on/off hybrid is found to be superior in fuel economy during metro/highway driving to both of these powertrains. (Author)

A77-12709 Electrochemical power and hydrogen generation from high temperature electrolytic cells. M. S. S. Hsu and T. B. Reed (MIT, Lexington, Mass.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 443-446. 6 refs. USAF-sponsored research.

A planar bipolar high-temperature cell stack using stabilized zirconia is described. Direct stacking of cells achieves series connections without external connectors, and consequently, reduces electrical losses. The design uses the pressure contacts for gas seals and electrical contacts to avoid unreliable ceramic/metal joints for the cyclic operations of the system. The cell components are currently under test. Four reactions involving SO3, H2O, CO2, and watergas shift have been found to possess the proper characteristics for electrochemical cycle operation. The cycle, consisting of high and low temperature electrochemical components, is capable of efficient conversion of high temperature heat to electricity in a topping arrangement. Water electrolysis and the watergas shift reaction at high temperature are promising processes for the efficient production of hydrogen. Mixed conductors that conduct ions as well as electrons have special applications for power generation and hydrogen production. They operate in a self-driven mode and eliminate the need for electrodes. (Author)

A77-12710 Advances in component technology for nickel-zinc cells. A. Charkey (Energy Research Corp., Danbury, Conn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 452-456.

Progress in Ni-Zn cell electrode design improvements, separator system cell construction, and cell cycle life is reported, and problems unresolved are delineated. The development program emphasizes development of: inexpensive nonsintered Ni electrodes, long-life Zn electrodes, stable separators, and 300 Ah size cells. Encouraging results are reported along all of these lines, and in the study of cell failure mechanisms including loss of Ni electrode capacity by ZnO poisoning and graphite oxidation or by the Zn electrode drying out. Cycle life better than 800 cycles is reported for nonsintered Ni electrodes, and better than 500 cycles for Zn electrodes. R.D.V.

A77-12713 Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells. E. C. Gay, T. D. Kaun, and F. J. Martino (Argonne National Laboratory, Argonne, Ill.). In: Intersociety Energy Conversion Engineering Conference,

11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 477-484. 14 refs. ERDA-sponsored research.

A number of electrode designs and fabrication techniques have been evaluated in order to identify the most suitable electrodes to meet the Li-Al/iron sulfide battery performance goals for off-peak energy storage in utility networks and for electric-vehicle propulsion. This paper describes several positive and negative electrode designs and fabrication procedures that have been sufficiently successful to warrant further development. A major effort is being directed to the development of pressed and carbon-bonded iron sulfide electrodes. The carbon-bonded electrode was formed from a three component paste of active material, volatile substance, and carbon cement. After heating and driving off the volatile, a structure is formed in which the active material is held in a porous carbon lattice. Pressed electrodes were formed by hot- or cold-pressing mixtures of active material and electrolyte on a metal current collector. Investigations of charged and uncharged Li-Al/iron sulfide cells indicate that the performance goals can be met with several electrode designs. The final choice of electrodes is based on the ease of manufacture and component costs. (Author)

A77-12714 Development status of lithium-silicon-iron sulfide load-leveling batteries. L. R. McCoy and L. A. Heredy (Rockwell International Corp., Atomics International Div., Canoga Park, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 485-490. 10 refs. ERDA-supported research.

A77-12715 Development of compact lithium/iron disulfide electrochemical cells. J. S. Dunning, T. G. Bradley, and E. J. Zeitner (GM Research Laboratories, Warren, Mich.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 491-496. 6 refs.

The design and testing of two compact Li alloy/FeS2 cells are discussed. These cells operated at 425 C-500 C, delivered up to 130 W-h/kg and 59 W/kg during separate cycles. The best performance was obtained using an 80 a/o lithium-silicon negative electrode in a cell weighing 823 g and having a capacity of about 80 A-h. This cell operated for 1700 h and 77 cycles. The other cell, using a lithium-aluminum alloy negative electrode, is still operating after 7800 h and 445 cycles. Reference electrodes were used to determine the voltage traces of each electrode during charge and discharge. Voltage plateaus were correlated with specific regions of the phase diagram of the negative electrodes and the reaction mechanism of the positive electrodes. (Author)

A77-12716 Development of sodium/sulfur-cells. R. Bauer, W. Fischer, W. Haar, H. Kleinschmager, R. Langpape, and G. Weddigen (Brown, Boveri et Cie AG, Heidelberg, West Germany). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 497-502. 9 refs. Bundesministerium für Forschung und Technologie Contract No. NT-4471.

The state of the development of Na/S-cells at Brown Boveri is described. The solid electrolyte used is magnesia doped beta-alumina having an electrical conductivity of 0.2-0.3/(ohm-cm) at 300 C. In Na/Na-cells tubular electrolytes have attained life times of more than 3.500 Ah/sq cm. After preliminary corrosion tests stainless steels look promising as container materials. Several refractory materials exhibited nearly no corrosion in Na2S4. Two types of Na/S-cells having glass and stainless steel containers respectively are used for laboratory tests. Their effective capacity which is usually limited to about 40% of the theoretical value, can be increased by several means, but the stability of performance has still to be improved. (Author)

A77-12717 Sodium/sulphur battery development in the United Kingdom. R. M. Dell (Atomic Energy Research Establishment, Harwell, Oxon, England), J. L. Sudworth (British Railways, Derby, England), and I. W. Jones (Chloride Silent Power, Ltd., Runcorn, Ches., England). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 503-509. 13 refs.

This paper describes recent progress in a coordinated Research and Development Programme on Sodium/Sulphur Batteries in the United Kingdom. A central sulphur cell design has been adopted, which circumvents the longstanding problem of case corrosion in conventional tubular designs, by placing the sulphur electrode inside an electrolyte tube. The design is particularly suited to high rate motive power applications, and over 85% utilization of the sodium and sulphur active materials has been achieved with experimental electrode constructions. (Author)

A77-12722 Production of methane using offshore wind energy. R. B. Young, I. R. Barr (AAI Corp., Baltimore, Md.), and L. R. Marianowski (Institute of Gas Technology, Baltimore, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 541-546. NSF Grant No. C-993.

A study was undertaken to establish the technical and economic feasibility of using offshore wind turbine generators to produce significant quantities of high BTU synthetic natural gas through the electrolysis of seawater and calcining of sea sands. A description of the process and its projected costs are presented. The wind energy potential of two candidate sites is assessed. (Author)

A77-12723 Energy conservation with advanced power generating systems. I. L. Chait (Burns and Roe, Inc., Hempstead, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 547-553. 14 refs.

Plant thermal efficiencies of central power stations have evolved from the low 20's to the high 30's since the 1920's. During the last 20 years, a downward trend has developed due to a combination of environmental regulations, more severe operating conditions and the need to move away from the use of petroleum fuels to nuclear, coal and lower grade fuels. Fossil-fired power generating plants based on advanced power conversion systems - such as magnetohydrodynamics, fuel cells and advanced steam and gas turbines in various configuration - have the potential for regaining some of the lost thermal efficiency. Significant gains in energy conservation can be anticipated from efforts to optimize the balance-of-plant power requirements from improvements and application of more efficient auxiliary equipment and systems in plants using advanced power generating cycles. (Author)

A77-12724 Energy conservation potential of Modular Integrater Utility Systems /MIUS/. W. R. Mixon and C. L. Segaser (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 554-558. 8 refs. Research supported by the U.S. Department of Housing and Urban Development.

The Modular Integrated Utility Systems (MIUS) program is directed toward the development, demonstration, and ultimate widespread application of integrated systems to provide all the utility services of new housing developments or communities. Results relating to energy conservation are presented for a series of evaluation studies on the major components and subsystems of utility technologies applicable to MIUS. Analytical comparisons are made between the fuel energy consumption of MIUS and five model conventional utility systems, all serving a 720-unit garden apartment complex. It is found that MIUS are significantly more efficient than

the other systems in the utilization of input fuel energy over a wide range of climate, with an average overall fuel-energy saving of 30%. The use of thermal energy storage and solid-waste incineration in MIUS is also evaluated. F.G.M.

A77-12725 Diversification as an energy conservation strategy. R. I. Vachon (Auburn University, Auburn, Ala.) and J. H. Morehouse (Texas A & M University, College Station, Tex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 559-564. 12 refs.

Diversification is an energy conservation policy whose primary thrust is to maximize the total number of viable energy system types in every sector, implementing conservation through substitution for scarce energy resources. One approach to the assessment of diversification strategies involves the determination of the requirements for both individual energy resources and those combinations of energy resources concurrently implemented. Another approach is to investigate the supply of a requirement which is needed by several of the proposed energy sources, illustrated here by the assessment of water requirements. The role of Congress and ERDA in developing a diversification policy is discussed as are the ECASTAR (Energy Conservation: an Assessment of Systems, Technologies, and Requirements) analysis of coal gasification and the analysis of ERDA diversification strategy by the Office of Technology Assessment. B.J.

A77-12726 Modeling residential energy use. E. Hirst, W. Lin, and J. Cope (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 573-577. 10 refs. ERDA-sponsored research.

This paper describes a comprehensive engineering-economic computer model used to simulate energy use in the residential sector from 1970 to 2000. The purpose of the model is to provide an analytical tool with which to evaluate a variety of conservation policies, technologies, and strategies for their impacts on residential energy use and fuel expenditures over time. The present version of the model deals with energy use at the national level for four fuels, six end uses, and three housing types. (Author)

A77-12727 Compressed air energy storage - A near term option for utility application. J. B. Bush, Jr. (General Electric Co., Schenectady, N.Y.), G. C. Chang (ERDA, Div. of Energy Storage Systems, Washington, D.C.), and N. F. Sather (Argonne National Laboratory, Argonne, Ill.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 578-585. 13 refs. ERDA-supported research.

Results of an economic and technical feasibility study of compressed air energy storage (CAES) of off-peak energy are reported, with a description of the associated turbomachinery, system simulation problems, cost estimates, underground storage problems, and design of aquifer reservoirs to receive the compressed air. CAES in depleted oil and gas fields, in aquifers, solution-mined caverns, igneous rock formations, and conventionally mined caverns is studied and compared, with underground natural gas/hydrocarbons storage technology taken into account. Differences with natural gas storage include differences in fluid viscosity and flow through porous media and differences in the charge/discharge cycle. Heat rejected through the CAES compressor system intercoolers and aftercooler is identified as the greatest loss mode. No serious technical impediments to economic implementation of CAES for meeting peak-intermediate demand are foreseen. R.D.V.

A77-12728 Underground storage of off-peak power. S. L. Ridgway and J. L. Dooley (R & D Associates, Marina del Rey, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 586-590.

Underground storage of pressurized hot water to back up a steam power plant by providing economical peak power storage is probed as an alternative to pumped hydroelectric storage. Steam flashed from the hot water is routed to peaking turbines, while surplus steam is condensed in the hot water for system recharge when load demand is low. Advantages of underground hot water storage are stated (high heat capacity and low cost, high energy recovery, rapid response to rapid load changes, compatibility with typical geology of power plant sites, water as working fluid and storage medium with no need for heat exchangers, acceptance of water by the power industry and by the general public). Cavity excavation problems (grouting, bolting, lining, sealing, compression mechanics) and costs are discussed, and a system flowchart is presented. R.D.V.

A77-12729 Thermal energy storage applied to residential heating systems. T. M. Gresko and D. R. Glenn (General Electric Co., Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 591-597.

This paper assesses the role of thermal energy storage (TES) as a means to maximize the overall daily and seasonal operating efficiency of a residential, fossil-fired space and hot water heating system. Conventional residential heating systems and inherent thermal losses are defined. Several conceptual approaches for providing integrated space heating and hot water heating using TES are presented and evaluated. System performance requirements are specified leading to a finalized system design. Economic factors and a cost profile of ownership are also included and contrasted to conventional systems. (Author)

A77-12730 Storage in oil of off-peak thermal energy from large power stations. E. W. Nicholson (Exxon Enterprises, Inc., New York, N.Y.) and R. P. Cahn (Exxon Research and Engineering Co., Linden, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 598-605. 5 refs.

A novel method of storing and recalling off-peak thermal energy from large power stations using a high-boiling refined oil as storage medium is described, and the economics of the system are developed and compared with competitive energy storage techniques. The effect of storage medium cost is analyzed, and potential methods of improving the economics of the overall system are outlined. Specific applicability to various nuclear reactor types is discussed, and other potential uses of the method are presented. (Author)

A77-12731 Thermal energy storage for solar power plants. H. V. Venkatesetty and R. T. LeFrois (Honeywell, Inc., Minneapolis, Minn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 606-612.

Experimental techniques and results obtained for a number of promising phase-change materials for the thermal energy storage subsystem of a central receiver solar thermal power pilot plant are presented. Nine inorganic eutectic compositions with melting points between 220 and 290 C were studied with two of them; NaNHO3-NaOH and NaCl-NaNO3-NaSO4, chosen for further investigation. The thermal stability and phase characteristics of the latter eutectic were examined as were the effects of thermal cycling on the stability and heats of fusion of both eutectics. Engineering model experimentation results associated with latent heat storage dynamic processes are also described with attention given to vaporizer heat transfer, and solid salt removal and settling. B.J.

A77-12732 Thermal energy storage considerations for solar-thermal power generation. N. Lior, P. S. Ayyaswamy, J. O'Leary, K. W. Kauffman, H. Yeh (Pennsylvania, University,

Philadelphia, Pa.), and H. G. Lorsch (Franklin Institute Research Laboratories, Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 613-622. 32 refs.

The problem of thermal energy storage for solar-thermal power generation is examined. Major conceptual systems for thermal storage are proposed and described. Storage modes through sensible heat, latent heat (phase change), and thermochemical energy are reviewed and proposed. A survey of applicable materials for thermal storage, which includes available thermophysical properties, compatibility with containing and heat transfer interfaces, and economics, is presented. The energy storage related parameters (such as temperatures, heat fluxes and quantities) of two major conceptual systems for solar-thermal power generation are identified for a power station size of 100 MWe. Mathematical details relevant to transient analyses of thermal storage have been developed and discussed. (Author)

A77-12733 Industrial energy conservation through integration of thermal energy storage into process energy dynamics. D. R. Glenn, R. L. McCarthy, and J. D. Schelkopf (General Electric Co., Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 623-627.

The potential for the integration of Thermal Energy Storage (TES) into the industrial process stream in order to capitalize on energy conservation opportunities is examined. Two examples are presented to illustrate the energy conservation potentials of industrial TES systems: waste heat from a periodic kiln in a brick plant (variation of energy supply with time) and process steam requirements for batch digestors and pulpers in a paper pulp mill (variation of energy demand with time). B.J.

A77-12734 Seasonal storage of thermal energy in water in the underground. E. B. Qvale (Technical University of Denmark, Lyngby, Denmark). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 628-635.

Studies of the Danish energy supply-and-demand picture show that substantial amounts of money and primary energy resources could be saved by introduction of underground thermal-energy storage reservoirs. Consequences of widespread use of thermal energy for district heating applications through storage of warm water in aquifers are examined. Theoretical and practical aspects of underground thermal energy storage are discussed, with special emphasis on the energy expenses of thermal energy storage. Geological structures suitable for underground thermal energy storage are identified. S.D.

A77-12735 The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements. J. A. C. Kentfield (Calgary, University, Calgary, Alberta, Canada) and J. A. Barnes (Imperial College of Science and Technology, London, England). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 636-643. 16 refs.

A description is given of a device, termed a pressure divider, which can be used to reduce the pumping energy requirements of natural gas distribution networks by extracting work from gas flowing out of a branch point, or tee, in a high pressure line into a portion of the system at a lower pressure. The work so obtained is employed to compress the remaining gas flowing on, past the branch point, in the high pressure line. Several types of machine are considered for this task and it was concluded that pressure exchangers have substantial, and unique, advantages over turbocompressor units or positive-displacement machines. The working principles of pressure exchangers are described and predicted performances of pressure-exchanger dividers are compared with experimental results. The design requirements of pressure-exchanger dividers for natural-gas pipe-line usage are considered. Attention is also paid to their installation and to their potential economic advantages. (Author)

A77-12736 Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations. L. E. Donovan, J. G. Keller, and J. F. Kunze (Idaho National Engineering Laboratory, Idaho Falls, Idaho). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 644-651. 12 refs.

A77-12737 Design analyses of a methane-based chemical heat pipe. H. B. Vakil and P. G. Kosky (General Electric Co., Schenectady, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 659-664. 6 refs. Contract No. E(11-1)-2676.

Methanation reaction is referred to as a chemical heat pipe because it is used to transport heat in the same sense as does a heat pipe. A related chemical reaction pair is termed a chemical heat pump because it can be used to convert low-grade heat to high-grade heat as does a heat pump. There are several design choices to make which impinge strongly on the First and Second Law efficiencies of the process. The most crucial step is the method whereby the suprastoichiometric steam content is handled. The elements of the chemical heat pipe represent some extension of existing power plant or chemical plant engineering. Some of the outstanding difficulties of implementing the methane-based chemical heat pipe are discussed. S.D.

A77-12738 Thermochemical energy storage systems. E. W. Schmidt (Rocket Research Corp., Seattle, Wash.) and P. A. Lowe (ERDA, Washington, D.C.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 665-672. 21 refs.

A thermochemical energy storage system is based on a reversible chemical reaction which consumes heat when proceeding in one direction and releases heat when proceeding in the opposite direction. The paper presents an overview of chemical reactions which can be used in a thermochemical energy storage (CES) system. Selection criteria for candidate CES systems are presented. Emphasis is on thermal storage in solar energy systems for power plants, space heating, and industrial or agricultural applications. CES systems without solid constituents and with solid constituents are described. These include the sulfuric acid/water system, the sulfuric acid dissociation system, the sulfur trioxide system, the ammonia dissociation system, the methanation reaction, the nitrosyl chloride photolysis, and systems with solid constituents such as the ammino complexes. Analytical studies are in progress to quantify the relative advantages of one system over another for selected CES and phase change systems combinations. S.D.

A77-12739 An evaluation of the use of metal hydrides for solar thermal energy storage. G. G. Libowitz and Z. Blank (Allied Chemical Materials Research Center, Morristown, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 673-680. 26 refs.

The basic properties of metal hydrides relevant to their application for storing solar thermal energy are reviewed. Several schemes are discussed and evaluated in which the enthalpy of formation of a primary hydride is used to provide heat and a secondary hydride or compressed gas is utilized for hydrogen storage. The results show that, with present technology, a metal hydride-based system is considerably more expensive than sensible heat or

phase change material storage. The advantages of a metal hydride-based system are discussed, and technological advances are suggested which would make such a system economically competitive with other thermal storage systems. (Author)

A77-12740 HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides. D. M. Gruen, R. L. McBeth, M. Mendelsohn, J. M. Nixon, F. Schreiner, and I. Sheft (Argonne National Laboratory, Argonne, Ill.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 681-687. 16 refs.

The use of metal hydrides in an integrated system for thermal storage, space conditioning and refrigeration as well as for power production is described. Details of the various functions of the two metal hydride concept are presented with the help of heat transfer fluid and hydrogen gas flow diagrams. Thermodynamic analyses of the cooling and energy conversion cycles are given. Special features associated with the use of metal hydrides in solar energy applications are pointed out. (Author)

A77-12741 Geothermal energy in Hawaii - Hydrothermal systems. J. W. Shupe, R. M. Kamins, and P. C. Yuen (Hawaii, University, Honolulu, Hawaii). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 696-703. 13 refs. Research supported by the Hawaiian Electric Co., Water Resources International, ERDA, and NSF.

A candidate that shows good promise for early power generation at commercial levels in Hawaii is geothermal energy. An overview is presented of the exploratory geophysical survey program in the Hawaii Geothermal Project, with supporting activity in engineering, socioeconomic, and environmental programs, with special emphasis on the research drilling program. The discussion covers heat and mass transfer in volcanic island geothermal reservoirs, geothermal power plant design, environmental baseline studies, and economic considerations. The potential of geothermal development in Hawaii is also assessed. Arrangements are under way to install a slotted liner and proceed with well testing. S.D.

A77-12742 Geothermal studies in northern Nevada. H. A. Wollenberg (California, University, Berkeley, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 704-710. 15 refs. ERDA-supported research.

A77-12743 Application of the Stretford process for H2S abatement at the Geysers geothermal power plant. J. Laszlo (Pacific Gas and Electric Co., San Francisco, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 724-730.

The Stretford process used for reduction of H2S emissions originating from a geothermal power plant is examined. H2S abatement is necessary because H2S emissions are malodorous and potentially in violation of air pollution regulations. Since a significant modification of the power plant's condensate and cooling water systems is required, the Stretford process is not practical for use with existing units. A modified system cycle for using surface condensers is proposed for significant reduction of total H2S emissions. S.D.

A77-12744 Economic optimization of binary fluid cycle power plants for geothermal systems. R. A. Walter and S. W. Wilson (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 731-738.

An analytical model called GEOCOST has been constructed and used to study the design, performance and cost of geothermal power plants using the binary fluid cycle. The GEOCOST computer program simulates all the major components of a geothermal system and calculates the cost of energy production by equating the present worth of revenues and expenses including investment return over the economic life of the plant and/or reservoir. The characteristics of the binary fluid cycle power plant are determined for a variety of geothermal resources, working fluids, and cycle types. An optimization technique based upon the maximum use of available energy in the geothermal fluid is generated, and results of this optimization technique are compared with computed cost data for a variety of binary power plants. (Author)

A77-12745 * Economic and engineering implications of the Project Independence 1985 geothermal energy output goal and the associated sensitivity analysis. A. K. Mukhopadhyay (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 739-746. Contract No. NAS7-100.

A77-12746 Investigation of heat exchanger flow arrangement on performance and cost in a geothermal binary cycle. W. H. Giedt (California, University, Davis and Livermore, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 747-753. 8 refs. ERDA-sponsored research.

The performance of an idealized geothermal binary-fluid-cycle energy conversion system is shown to be a function of the temperatures of brine and working fluid leaving the heat exchanger. System power output, heat exchanger area required and initial well and heat exchanger costs are determined for counterflow, single and multi-pass parallel-counterflow exchangers. Results are presented graphically as functions of the brine and working fluid exit temperatures from the exchanger. Use of the system analysis developed is illustrated by showing quantitatively the advantage of the counterflow over the other flow arrangements considered. (Author)

A77-12747 Direct contact heat exchangers for geothermal power plants. R. Boehm, H. Jacobs, R. Bliss, and D. Kelly (Utah, University, Salt Lake City, Utah). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 754-760. 12 refs. Contracts No. E(11-1)-2601; No. E(11-1)-1523.

Several details relating to the design considerations for geothermal power plants using direct contact heat exchangers are given. Primary emphasis is given here to boiler and turbine parameters. Reports are outlined of tests of various types of heat exchangers in our laboratory and at the Raft River Geothermal Well. Also discussed are various parameters that affect the operation of turbines that utilize a mixture of two vapors. (Author)

A77-12748 Fluidized bed heat exchangers for geothermal applications. C. A. Allen, E. S. Grimmett, and K. L. Wagner (Allied Chemical Corp., Idaho Falls, Idaho). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 761-767. 9 refs.

Bench-scale liquid-fluidized bed heat exchangers used with geothermal water prevented fouling and nearly doubled the rate of heat transfer compared to identical tube and shell arrangements. A six-inch pressurized unit operated at the Raft River geothermal site near Malta, Idaho verified these results. Horizontal and vertical configurations and other design considerations are discussed. Insufficient data currently exists to make valid correlations for scale-up

for demonstration or commercial size units. An experimental program is in progress to correct this deficiency. (Author)

A77-12749 The economic generation of electricity from moderate temperature geothermal resources. J. F. Kunze, J. F. Whitbeck, and R. H. Dart (Idaho National Engineering Laboratory, Idaho Falls, Idaho). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 768-770.

A77-12750 * Comparison of geothermal power conversion cycles. D. G. Elliott (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 771-777. 8 refs. Contract No. AT(04-03)-1086.

Geothermal power conversion cycles are compared with respect to recovery of the available wellhead power. The cycles compared are flash steam, in which steam turbines are driven by steam separated from one or more flash stages; binary, in which heat is transferred from the brine to an organic turbine cycle; flash binary, in which heat is transferred from flashed steam to an organic turbine cycle; and dual steam, in which two-phase expanders are driven by the flashing steam-brine mixture and steam turbines by the separated steam. Expander efficiencies assumed are 0.7 for steam turbines, 0.8 for organic turbines, and 0.6 for two-phase expanders. The fraction of available wellhead power delivered by each cycle is found to be about the same at all brine temperatures: 0.65 with one stage and 0.7 with four stages for dual stream; 0.4 with one stage and 0.6 with four stages for flash steam; 0.5 for binary; and 0.3 with one stage and 0.5 with four stages for flash binary. (Author)

A77-12751 Power production from high temperature geothermal waters. I. Sheinbaum (I. Sheinbaum Co., Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 778-785. 111 refs.

The adaptability, efficiency, and relative costs of the Direct Contact Binary Cycle for the conversion of high temperature geothermal resources into power are examined and compared with those for the Multistage Steam Flash Cycle and the Multistage Binary Cycle. Two types of hot geothermal waters are evaluated: high temperature, low salinity, and no condensables; and high temperature, high salinity, with condensables. Three important parameters are discussed: cycle efficiencies, the effect of the salinity levels, and the effect of noncondensables in the brine. B.J.

A77-12752 Preliminary analysis of electric generation utilizing geopressured geothermal fluids. J. Gault, J. W. Hall (Brown and Root, Inc., Houston, Tex.), J. S. Wilson, H. Michael, B. P. Shepherd (Dow Chemical Co., Freeport, Tex.), G. Underhill, and L. Rios-Castellon (Texas, University, Austin, Tex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 790-797. 11 refs.

An investigation is conducted concerning the feasibility to utilize for electric power generation the overpressured, elevated-temperature water-bearing deep sands lying along the Texas and Louisiana Gulf Coast. A model production reservoir is developed. The model considers wells which produce moderate salinity, 163 C water containing methane gas. This brine is used in the operation of a 25 MW(e) geothermal power plant. Two types of power plant are considered, including a two-stage, flash steam plant with a geohydraulic turbine and an isobutane secondary working fluid plant with a geohydraulic turbine. G.R.

A77-12753 Pressure drawdown and buildup analyses in geothermal reservoirs. L. F. Rice (Systems, Science and Software, La Jolla, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 798-801. Research supported by Systems, Science and Software; NSF Grant No. AER-75-14492.

A description is given of a number of computational examples which demonstrate that the calculated behavior of the reservoir agrees very closely with the classical single-phase interpretation if only a single phase is present. However, it is also found that the classical interpretation is no longer adequate to predict the reservoir behavior if there is multiphase flow. These results show that it is vital to employ in the study of geothermal reservoirs a simulator with multiphase flow capabilities. G.R.

A77-12754 Geothermal powered heat pumps to produce process heat. D. T. Neill (Idaho State University, Pocatello, Idaho) and W. P. Jensen (Idaho National Engineering Laboratory, Idaho Falls, Idaho). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 802-807. 12 refs.

The heat pump coupled to a geothermal source offers an alternative to fossil fuel for at least moderately high temperature needs. The principles involved in the operation of such a heat pump are examined and aspects of working fluid selection are considered, taking into account organic working fluids and steam. A description of a geothermal powered heat pump system is presented. Steam generated by direct flashing of the geothermal fluid is used both as the working fluid supplied to the compressor and as the steam to spin a turbine which is directly coupled to the compressor. Attention is also given to economic considerations. G.R.

A77-12755 Direct applications of geothermal energy. R. C. Schmitt, R. J. Schultz (Idaho National Engineering Laboratory, Idaho Falls, Idaho), J. L. Griffith (ERDA, Idaho Falls, Idaho), and W. S. Brown (Utah, University, Salt Lake City, Utah). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 815-821. 6 refs. ERDA-sponsored research.

The historical background of the utilization of geothermal energy is examined and technical aspects concerning such a utilization are investigated. Attention is given to the ERDA development and technology transfer program which is designed to assist industry in accelerating geothermal energy development. A description is presented of the Boise space heating demonstration project, taking into account the background of the project, the environmental program for the project, resource definition studies, plans for converting state buildings to geothermal heat, and details concerning the distribution and discharge system. The Raft River direct applications demonstration project is also discussed. G.R.

A77-12756 The utilization and economics of low temperature geothermal water for space heating. J. W. Lund (Oregon Institute of Technology, Klamath Falls, Ore.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 822-827. 15 refs.

A77-12757 Extracting energy from hydraulically-fractured geothermal reservoirs. R. D. McFarland and H. D. Murphy (California, University, Los Alamos, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 828-835. 7 refs. ERDA-sponsored research.

It has been proposed that man-made geothermal energy reservoirs can be created by drilling into relatively impermeable rock to a depth where the temperature is high enough to be useful; creating a large hydraulic fracture; and then completing the circulation loop by

drilling a second hole to intercept the hydraulic fracture. An inlet and an outlet pipe are used to introduce and withdraw water. The energy in the hot water withdrawn from the fracture is employed for generating electrical power or for other uses. Attention is given to reservoir features and expected performance, the governing equations for the process, the solution procedure, the calculated flow patterns, and the pressure relations. G.R.

A77-12758 The use of program GEOTHM to design and optimize geothermal power cycles. H. S. Pines and M. A. Green (California, University, Berkeley, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 836-842. 8 refs. ERDA-supported research.

A77-12759 * Electric utility companies and geothermal power. D. S. Pivirotto (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 843-849. Contract No. NAS7-100.

The requirements of the electric utility industry as the primary potential market for geothermal energy are analyzed, based on a series of structured interviews with utility companies and financial institution executives. The interviews were designed to determine what information and technologies would be required before utilities would make investment decisions in favor of geothermal energy, the time frame in which the information and technologies would have to be available, and the influence of the governmental politics. The paper describes the geothermal resources, electric utility industry, its structure, the forces influencing utility companies, and their relationship to geothermal energy. A strategy for federal stimulation of utility investment in geothermal energy is suggested. Possibilities are discussed for stimulating utility investment through financial incentives, amelioration of institutional barriers, and technological improvements. S.N.

A77-12760 The potential national benefits of geothermal electrical energy production from hydrothermal resources in the West. C. H. Bloomster and R. L. Engel (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 853-859. 11 refs.

A77-12761 Prerequisites for military/civilian geopressured geothermal resource development. F. R. Krause, R. E. Schmidt, and G. L. McKown (National Space Technology Laboratories, Bay St. Louis, Miss.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 860-866. 9 refs.

The applicability of geopressured geothermal energy resources in the U.S. Gulf Coast region to demands of federal installations has been examined. Energy demands for selected NASA and Department of Defense facilities are determined and compared to potential supplies from geopressured formations. A system emphasizing hydrocarbon recovery is proposed, some advantages of offshore development are discussed, and a case is presented for federal involvement in resource exploration and utilization technology during early stages of development. (Author)

A77-12762 An engineering feasibility study of using low temperature geothermal sources in Colorado. L. W. Nannen, F. Kreith, and R. E. West (Colorado, University, Boulder, Colo.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 867-872. 13 refs. Research supported by the Colorado Energy Research Institute.

The technical and economic feasibility of using low temperature geothermal sources in Colorado was investigated. It was projected that several of the known sources could be used to heat buildings and water in district-type projects at costs between 2 and 5 dollars per Gj delivered. The technology necessary to use geothermal sources for low temperature applications exists. Not enough is known about the thermal, chemical and geological characteristics of the several geothermal sources in Colorado to determine whether or not they are suitable for electric power generation. Nonetheless, several should be suitable for applications which can reduce the demand for power and natural gas. It is recommended that an exploratory well and demonstration heating project be undertaken at Glenwood Springs, CO. (Author)

A77-12763 The potential of the heat pipe in coal gasification processes. W. A. Ranken (California, University, Los Alamos, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 876-882. 11 refs. ERDA-sponsored research.

Design concepts for incorporation of heat pipes (HP) into indirect coal gasification units, methanators, and energy recovery units are presented, with a discussion of promising HP working fluids, and problems to be overcome in research and development. Complete physical separation of process streams, ability to handle several process streams in a single unit, heat removal at near-constant temperature, high heat recovery efficiency, low operating costs, no reliance on auxiliary power, and relative ease of cleaning are singled out as requirements for HP heat transfer units in effective coal gasification applications. Designs of a fluidized-bed HP indirect coal gasifier, a three-chamber heat recuperator for preheating methanator feedstock with product gas stream, a ceramic HP are described, and the suitability of Hg, K, and S as working fluids is assessed. R.D.V.

A77-12764 Heat pipes for fluid-bed gasification of coal - Metallurgical condition of heat pipes after tests in process environment. J. S. Mei (ERDA, Morgantown, W. Va.) and E. S. Keddy (California, University, Los Alamos, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1.
New York, American Institute of Chemical Engineers, 1976, p. 883-886. 5 refs.

A77-12765 Heat pipe heat exchanger design considerations. K. T. Feldman and D. C. Lu (New Mexico, University, Albuquerque, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 887-892. 17 refs. NSF Grant No. ENG-74-018062.

Typical heat pipe heat exchangers (HPHX) are described, along with their advantages, uses, and some problems in HPHX design, and a computer HPHX analysis program is discussed with required input data. The computer program is being developed for analysis of heat exchange performance by finned-tube HPHX and thread-puddle-artery heat pipes. Copper-water heat pipes and carbon steel-Dowtherm A heat pipes are analyzed. Crucial parameters for improving HPHX performance are: maximum pipe length, staggered finned pipes, pipe diameter, fin height, maximum number fins per unit length, and fin thickness tolerated for allowable pressure drop. Applications for HPHX include: recuperators in heating and ventilating systems, gas turbines, steam power plants, and heat recovery in process industries. R.D.V.

A77-11766 Higher eigenstates in boundary-layer stability theory. D. Corner, D. J. R. Houston, and M. A. S. Ross (Edinburgh, University, Edinburgh, Scotland). *Journal of Fluid Mechanics*, vol. 77, Sept. 9, 1976, p. 81-103. 21 refs.

Using the Orr-Sommerfeld equation with the wavenumber as the eigenvalue, a search for higher eigenstates in the stability theory of the Blasius boundary layer has revealed the existence of a number of

viscous states in addition to the long established fundamental state. The viscous states are discrete, belong to two series, and are all heavily damped in space. Within the limits of the investigation the number of viscous states existing in the layer increases as the Reynolds number and the angular frequency of the perturbation increase. It is suggested that the viscous eigenstates may be responsible for the excitation of some boundary-layer disturbances in the free stream. (Author)

A77-12767 VBP heat pipes for energy storage. A. Basiulis (Hughes Aircraft Co., Electron Dynamics Div., Torrance, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 901-904.

Different techniques to operate heat pipes against gravity were evaluated. The VBP heat pipe was found to be the most promising for application in energy storage systems. The external power requirements could be very low, system efficiency is potentially very high, and high-volume fabrication costs could be very low. Experiments with prototype heat pipes support the prediction that VBP heat pipes can be operated against gravity and, with optimum design, can be very efficient. (Author)

A77-12768 * Benefits of hydrogen production research. R. Manvi, T. Fujita, W. Rossen, and C. Jacobs (California Institute of Technology, Jet Propulsion Laboratories, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 907-914. Contract No. NAS7-100.

An economic analysis of total monetary benefits arising from increased volume and efficiency of hydrogen production from various primary energy sources is carried out. The analysis is based on NASA's projections of future hydrogen demand in terms of both established industrial-chemical uses and new energy system applications, along with the mix of primary energy sources needed to meet this demand. A cost methodology model is worked out with the basic cost elements being plant construction costs, feedstock and energy costs, and operating and labor-related costs. A computer simulation technique was developed and a set of model calculations was performed. Some representative outputs of the computer analysis are displayed and conclusions are drawn on major factors determining the overall savings possible in hydrogen production and on its technological and economic impact. S.N.

A77-12769 The commercial production of hydrogen by the K-T process. R. Wintrell and H. F. Leonard (Koppers Co., Inc., Pittsburgh, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 915-919.

The K-T gasification process, a commercial operation, is discussed in full detail. The process gasifies the complete range of solid, liquid and gaseous hydrocarbon fuels. The process is discussed from coal grinding through drying and pulverization, to transfer to the storage and feed bins at the gasifier. From the feed bins, the process is described through the screw feeders to entrainment at the mixing head and transfer to the burner. Within the gasifier, the thermal and equilibrium reactions, together with the benefits of high temperature operation on the final gas composition, are discussed. Gas cooling and recovery of the sensible heat in the gas is proven to maintain high process efficiencies. The process and equipment for removal of the particulate matter in the gas is commented on regarding its efficiency and effectiveness. The paper discusses the processes utilized by the K-T process for sulfur removal prior to the CO shift and hydrogen generation. (Author)

A77-12770 Hydrogen separation and compression through hydride formation and dissociation by low-level heat. D. Gidaspow and Y. Liu (Institute of Gas Technology, Chicago, Ill.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 920-925. 11 refs. Research supported by the Gas Association.

A process making it possible to effect hydrogen separation from methane and compression of hydrogen into hydrides, using low-level heat (waste heat, or solar energy from flat plate collectors) and eliminating an expensive cryogenic separation step, is described. The hydrogen product stream can be delivered at pressures up to 1000 psig, with methane, CO2, and N2 removed. Alloys of Fe-Ti, Fe-Ti-Ni, and LaNi5 are proposed as sorbents in the separation step. Hydrogen production from biomass partially oxidized with air is considered, as well as hydrogen removal from methane-hydrogen mixtures resulting in coal gasification processes or from coal gases produced by in situ coal gasification processes, for production of pipeline quality gas without a cryoseparation step. R.D.V.

A77-12771 Hydrogen from solar energy via water electrolysis. K. E. Cox (New Mexico, University, Albuquerque, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 926-932. 13 refs. Research supported by the University of New Mexico.

Hydrogen production from solar energy alleviates the two major problems associated with solar energy as a primary energy source, storage and the intermittency of solar radiation. An attractive and simple method to produce hydrogen is by the electrolysis of water. Power for the electrolysis cells is supplied by an array of silicon solar photovoltaic cells. Experiments have been conducted with a 12 watt (peak power) array wired directly to an electrolyzer. Initial results, though not optimum, have shown that hydrogen is produced at efficiencies of up to 10%. An average efficiency of 4.5% was obtained in daily tests. (Author)

A77-12772 Experimental demonstration of an iron chloride thermochemical cycle for hydrogen production. J. Gahimer, M. Mazumder, and J. Pangborn (Institute of Gas Technology, Chicago, Ill.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 933-939. 16 refs. Research supported by the American Gas Association.

A77-12773 Energy transmission from ocean thermal energy conversion plants. A. Konopka, A. Talib, B. Yudow, N. Biederman (Institute of Gas Technology, Chicago, Ill.), and B. Winer (Arthur D. Little, Inc., Cambridge, Mass.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 940-948. 26 refs. ERDA-NSF-supported research.

This paper compares the transmission, by barge and pipeline, of gaseous hydrogen, liquid hydrogen, and ammonia, as energy carriers, with transmission of electricity in submarine cables from an ocean-thermal energy conversion (OTEC) plant. Because hydrogen energy and electrical energy are not equivalent, comparison requires assuming the outputs are converted to a common form. Thus, the delivered cost and overall energy efficiency of hydrogen, ammonia, and electricity are presented as well as a discussion of the equipment, costs and efficiencies of converting hydrogen and ammonia into electricity, and OTEC mechanical energy into hydrogen and ammonia. Converting electricity to chemical commodities and energies was not assessed. (Author)

A77-12774 Energy storage via calcium hydride production. L. Green, Jr. (Mitre Corp., McLean, Va.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 949-953. 14 refs.

An energy storage approach based on continuous production of low-quality low-cost calcium hydride as a by-product of the Dow magnesium process is described. A dual-purpose high-temperature gas-cooled nuclear reactor (HTGR) comprises the energy source yielding high-temperature process heat and electric power. The hydrogen is obtained via electrolysis of water, and is heated to about 500 C by heat exchange with the primary-loop coolant (helium), which in turn heats pellets of lime and Mg powder to about 400 C to initiate the main reduction reaction. The CaH2 provides safe efficient H2 storage until the hydrogen fuel is required to meet peak power loads (hydride + water yields calcium hydroxide + H2 + heat). A process flowchart and a diagram of a moving-bed hydriding reactor are included. R.D.V.

A77-12775 Metal hydrides of improved heat transfer characteristics. M. Ron. In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 954-960. 16 refs.

The poor heat transfer response of a bed of powdered metal hydride is a considerable constraint on the design of a hydrogen storage device. Metal hydrides consolidated in a highly porous metallic matrix are shown to have improved heat transfer features. A preliminary evaluation of thermal conductivity and heat transfer characteristics is given. The beneficial effects of these materials on the heat transfer of hydrogen storage devices are discussed for vehicle, secondary battery and hydrogen compressor applications. (Author)

A77-12776 Some useful relationships between the physical and thermodynamic properties of metal hydrides. C. E. Lundin, F. E. Lynch, and C. B. Magee (Denver, University, Denver, Colo.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 961-964. 14 refs.

The sizes of the interstitial tetrahedral holes in intermetallic compound crystal lattices are shown to correlate well with the stability of hydrides formed from these compounds. Both AB5 (hexagonal, CaCu5 type) and AB (body-centered cubic, CsCl type) alloys are considered. This correlation is of practical significance in the design of metal hydride systems for the storage of hydrogen gas. (Author)

A77-12777 Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage. G. D. Sandrock (International Nickel Co., Inc., Paul D. Merica Research Laboratory, Suffern, N.Y.), J. J. Reilly, and J. R. Johnson (Brookhaven National Laboratory, Upton, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 965-971. 16 refs. ERDA-supported research.

Hydriding alloys based on the intermetallic compound FeTi have potential for the safe and convenient storage of hydrogen, both for mobile and stationary applications. Optimum technical and economic use of these alloys requires an understanding of the physical metallurgy of the system and its relation to the hydriding behavior. This paper provides an introduction to some of the metallurgical factors that affect hydriding behavior in FeTi and related alloys. Properties considered are hydrogen storage capacity, activation, decrepitation (particle size breakdown) and hydride stability (dissociation pressure). (Author)

A77-12778 Survey of hydrogen energy application projects. R. E. Billings (Billings Energy Corp., Provo, Utah). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 972-977. 17 refs.

Contemporary U.S. hydrogen application research projects are reviewed. Specific emphasis is placed on aircraft, industrial and domestic applications, electrical generation and storage, vehicles, and farms. Although the study does not attempt to evaluate the technical feasibility or status of individual projects, some prognostications are made as to future hydrogen energy applications. (Author)

A77-12779 A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines. F. B. Simpson, D. R. Swope, J. H. Lofthouse (Idaho National Engineering Laboratory, Idaho Falls, Idaho), and D. L. Henriksen (Billings Energy Research Corp., Provo, Utah). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 978-984. 14 refs.

An outline for the design and maintenance of engines burning hydrogen fuel, and for conversion of engines to hydrogen fuel, is presented. Properties of hydrogen as engine fuel are examined (low ignition energy, high ignition temperature, high heating value, and air displacement) and the behavior of H2 in engine systems are analyzed, along with efficient forms of H2 storage (compressed gas, liquefied cryo medium, and metallic hydride pellets) and H2 engine processes. Ways of preventing oxygen in-leakage and H2 out-leakage, seal design, and prevention of hydrogen embrittlement of engine materials are mentioned. Use of lean mixtures, exhaust gas recirculation, and water induction (injection) are techniques described. Backflash suppression and other aspects of hydrogen engine operation are outlined, along with engine break-in, engine tuning and ignition timing, and maintenance (periodic preventive and trouble-shooting). R.D.V.

A77-12780 The performance of hydrogen-injected reciprocating engines. R. F. McAlevy, III (Stevens Institute of Technology, Hoboken, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 985-991. 13 refs. Contract No. N00014-75-C-0220.

Due to economic and operational problems demonstrated with H2-fueled, naturally-aspirated gasoline engines, and the inability of unmodified diesel engines to run successfully on H2 it appears that a hybrid engine, called the CFI engine, will have to be developed if H2 is to become an alternative automotive fuel of significance. The CFI-cycle is analyzed on the basis of the air-standard-cycle approximation, and its performance characteristics are predicted. Published data from an experimental, single-cylinder, laboratory version of a CFI engine support the prediction. Considering the promise of the CFI engine for advancing the penetration of H2 into the automotive fuel market, development of a practical H2 CFI engine should start immediately. (Author)

A77-12781 Performance of a hydrogen-powered transit vehicle. R. L. Woolley (Billings Energy Corp., Provo, Utah). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 992-996. 7 refs.

In-service test data for a 19-passenger, hydrogen-powered bus is presented. Included is a description of the engine as modified for hydrogen operation, the metal hydride storage system, and the control system. Performance characteristics are described for vehicle operation over an established service route. Also included is a description of two safety demonstrations involving metal hydride storage of hydrogen. (Author)

A77-12782 MHD power generation - 1976 Status Report. W. D. Jackson, R. V. Shanklin (ERDA, Washington, D.C.), P. S. Zygielbaum (Electric Power Research Institute, Palo Alto, Calif.), H. R. Graham, and J. E. Scheppan (TRW Energy Systems, McLean, Va.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical

Engineers, 1976, p. 1006-1014. 12 refs.

This paper addresses the three-phased development of an MHD power-system program. The near-term (1985) and mid-term (1990) objectives which support the national energy goals are presented. The current approach to the national program strategy is described. Comparative economic-analysis results of the potential of several advanced power plants using coal and coal-derived fuels are given. System engineering considerations are established for the development logic and design criteria for an open-cycle MHD system. A brief description of the development problems associated with the critical components is presented. National program milestones, development status, and technical issues are discussed. (Author)

A77-12783 Investigation of direct coal-fired MHD power generation. J. B. Dicks, K. E. Tempelmeyer, Y. C. L. Wu, and L. W. Crawford (Tennessee, University, Tullahoma, Tenn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1015-1019. 6 refs. Contract No. E(49-19)-1760.

Various experiments were carried out in a direct coal-fired MHD power generation facility. It was found that the generator's overall performance is not affected by the presence of coal slag in the generator channel. However, the erosion/corrosion is greatly reduced by the slag. Seed/slag interaction investigation showed that at 1300 K, up to 90% of potassium can be easily recovered by simple methods. The recovery efficiency can be improved by carrying out the separation at higher temperatures and using a bag house or other apparatus for removal of smaller particulates. Analysis of slag taken from the generator does not show diffusion of copper. (Author)

A77-12784 * Liquid-metal magnetohydrodynamic system evaluation. R. R. Holman and T. E. Lippert (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1020-1076. 7 refs. Contract No. NAS3-19407.

The present study emphasizes a direct coal-fired design using a bubbly two-component flow of sodium and argon in the MHD generator and a Rankine steam-bottoming plant. Two basic cycles were studied, corresponding to argon temperatures of 922 and 1089 K at the duct inlet. The MHD duct system consisted of multiple ducts arranged in clusters and separated by iron magnet pole pieces. The ducts, each with an output of about 100 MW, were parallel to the flow, but were connected in series electrically to provide a higher MHD voltage. With channel efficiencies of 80%, a pump efficiency of 90%, and a 45% efficient steam-bottoming plant, the overall efficiency of the 1089 K liquid-metal MHD power plant was 43%. (Author)

A77-12785 Liquid-metal MHD - Cycle studies and generator experiments. E. S. Pierson, A. R. Brunsvold, G. Fabris, R. G. Hantman, and R. L. Cole (Argonne National Laboratory, Argonne, Ill.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1027-1032. 7 refs.

A continuing study of the two-phase liquid-metal MHD (LMMHD) concept coupled to a coal-fired fluidized-bed combustor was conducted. The LMMHD concept is briefly described, and results obtained to date are summarized. The main component unique to this LMMHD concept is the two-phase LMMHD generator. A diverging-channel generator with gas injection along the insulating walls was built and placed in operation. The expected significant improvement in performance of this generator over the previous generator was not obtained. Experiments to investigate this lack of improvement demonstrated that the gas injection was not operating as expected. The gas injection ports were removed, and substantial improvement was obtained in generator performance. (Author)

A77-12786 * System studies of coal fired-closed cycle MHD for central station power plants. B. Zauderer (GE Space Sciences Laboratory, Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1033-1039. 20 refs. Contract No. NAS3-19406.

This paper presents a discussion of the closed-cycle MHD results obtained in a recent study of various advanced energy-conversion power systems. The direct coal-fired MHD topping-steam bottoming cycle was established as the current choice for central station power generation. Emphasis is placed on the background assumptions and the conclusions that can be drawn from the closed-cycle MHD analysis. It is concluded that closed-cycle MHD has efficiencies comparable to that of open-cycle MHD. Its cost will possibly be slightly higher than that of the open-cycle MHD system. Also, with reasonable fuel escalation assumptions, both systems can produce lower-cost electricity than conventional steam power plants. Suggestions for further work in closed-cycle MHD components and systems are made. (Author)

A77-12787 * Thermionic topping for central station power plants. E. J. Britt and G. O. Fitzpatrick (Rasor Associates, Inc., Sunnyvale, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1040-1045. 6 refs. ERDA-NASA-supported research.

This paper describes recent results of the second phase of system analyses on the thermionic topping cycle. A comparison is made among various thermionic heat-exchanger (THX) geometries. Two methods of transferring electric power are considered. In the first, power is provided at relatively high voltages by coupling it out inductively via transformers built into the THX modules. In the second method, converter cells are series-connected within a THX module and external power conditioning is used. The results show that the use of a thermionic topping cycle can result in significant improvements in overall system efficiency. (Author)

A77-12788 PULSAR, an unconventional topping stage. W. K. Tucker, W. B. Leisher, M. Cowan, D. L. Wesenberg, and E. C. Cnare (Sandia Laboratories, Albuquerque, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1046-1049. 7 refs. ERDA-supported research.

This paper describes a new topping stage which could perform the intended role of conventional MHD and which has several apparent advantages. It is based on a linear reciprocating flux-compression generator, called PULSAR. The primary difference between PULSAR and the more conventional MHD stage is that PULSAR uses one moving part (a metallic armature) which produces magnetic-flux compression. The PULSAR thermodynamic cycle is similar to that of a free-piston diesel engine. The exhaust gases serve as a heat source for steam production. Preliminary calculations show that for a conventional-plant overall thermal efficiency of 35%, addition of the PULSAR stage can easily increase overall thermal efficiency to 49%. (Author)

A77-12789 Thermionic topping of a steam power plant. G. Miskolczy and T. O. P. Speidel (Thermo Electron Corp., Waltham, Mass.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1050-1055. 11 refs. Contract No. E(11-1)-3056.

Thermionic topping of steam power plants can significantly improve efficiency by using the thermodynamic availability between the heat-source temperature and the conventional utilization temperature. Studies of incorporating thermionic converters to top fossil-fuel power plants have been performed with the goal of minimum perturbation to conventional power-plant practice. The

thermionic converters generate electricity while receiving the combustion heat by radiation. The reject heat from the thermionic converter is transferred via the combustion air into the steam cycle. Acyclic motors are used to condition the dc thermionic output into high voltage dc. The plant efficiencies range from 47 to 50% (corresponding to air preheat temperatures of 600 C and 1150 C, respectively). A cost analysis of a 250-watt converter assembly resulted in an estimated delivery price of about $250 per kilowatt. The performance and cost projections indicate that thermionic conversion is a viable candidate for topping steam power plants. (Author)

A77-12790 **Nuclear power for the production of synthetic fuels and feedstocks.** M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1086-1094. 13 refs.

Nuclear power not only can provide the stationary thermal and electrical power backbone in the United States but can also be of great assistance in supplying premium synthetic carbonaneous fuels and feedstocks (SCFF). The process concept consists of generating hydrogen and oxygen by the electrolytic decomposition of water using nuclear-generated power. The oxygen is used to gasify reduced carbonaceous raw material, and the hydrogen is used to make synthetic gas. The latter is combined thermocatalytically to produce methanol, which is in turn dehydrated to synthetic gasoline. Coal, municipal solid waste, and agri- and aqua-cultural material (biomass) can be converted to methanol and synthetic gasoline with an approximately 50% increase in yield of synthetic product, utilizing the nuclear-electrolytic hydrogen and oxygen concept. Estimates of SCFF production costs and capital outlays indicate competitive situations with future escalated costs of new oil supplies. (Author)

A77-12791 * **Nuclear driven water decomposition plant for hydrogen production.** G. H. Parker, L. E. Brecher, and G. H. Farbman (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1095-1101. Contract No. NAS3-18934.

The conceptual design of a hydrogen production plant using a very-high-temperature nuclear reactor (VHTR) to energize a hybrid electrolytic-thermochemical system for water decomposition has been prepared. A graphite-moderated helium-cooled VHTR is used to produce 1850 F gas for electric power generation and 1600 F process heat for the water-decomposition process which uses sulfur compounds and promises performance superior to normal water electrolysis or other published thermochemical processes. The combined cycle operates at an overall thermal efficiency in excess of 45%, and the overall economics of hydrogen production by this plant have been evaluated predicated on a consistent set of economic ground rules. The conceptual design and evaluation efforts have indicated that development of this type of nuclear-driven water-decomposition plant will permit large-scale economic generation of hydrogen in the 1990s. (Author)

A77-12792 **Current status of the magnetic fusion program.** J. M. Williams and S. L. Bogart (ERDA, Div. of Magnetic Fusion Energy, Washington, D.C.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1110-1117.

The state of the art of fusion physics and engineering in key problem areas is reviewed. The objectives of the Fusion Power Program are discussed, along with the technical program and timetables for reaching these objectives. The primary objective is to develop fusion power as a safe, reliable, and economic source of electric power before the year 2000. Optimism that this objective can be achieved is supported by encouraging results from recent physical experiments. It is seen that the engineering problems, in spite of their difficulty, are tractable and should be solved within the time schedules. Fusion reactor concepts are discussed, with particular reference to schemes for converting fusion energy into useful power. V.P.

A77-12793 **PACER - A practical fusion power concept.** H. W. Hubbard and R. P. Hammond (R & D Associates, Marina del Rey, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1118-1122. 7 refs.

A practical method of converting the energy of nuclear fusion to electricity makes use of the fully developed technology for burning deuterium in a nuclear explosive. Recent theory and testing show that repetitive firings can be safely and reliably contained in deep underground cavities. Steam at high pressure in such cavities would be heated by the charges and used to drive conventional turbine-electric generators on the surface. In addition to harnessing the heat of fusion, neutrons produced in the reaction can also be utilized to convert the plentiful fertile element thorium to a safe nontoxic nonexplosive fuel for ordinary reactors. Studies to date indicate that the concept is suitable for rapid development and deployment and that the economic, conservation, and safeguards potentials are enormous. (Author)

A77-12794 **The migma high energy advanced fuel direct conversion fusion power plant.** B. C. Maglich, M. Mazarakis, R. A. Miller, J. Nering, J. Ferrer, J. E. Golden, S. Menasian (Fusion Energy Corp., Princeton, N.J.), S. Channon (Rutgers University, New Brunswick, N.J.), R. Ho (Princeton University, Princeton, N.J.), and C. Powell (Stevens Institute of Technology, Hoboken, N.J.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1123-1129. 5 refs.

The migma concept of controlled fusion is discussed, and the advantages which accrue from the use of advanced fuels are pointed out. A migma reactor is discussed in terms of direct conversion of fusion products, the energy gain from such a reactor, and the amount of heat the reactor may be expected to reject to the environment. The prerequisites to the fulfillment of the migma power plant R & D program are: demonstration that 'Migma' can be made; demonstration of the quadratic law that the fusion output is proportional to the square of the power input; and demonstration that electrons can be introduced into migma without destroying its ordered configuration. V.P.

A77-12795 **Radiolytic hydrogen production from a laser fusion system.** V. C. Rogers, R. Baird (Ford, Bacon and Davis Utah, Inc., Salt Lake City, Utah), and G. M. Sandquist (Utah, University, Salt Lake City, Utah). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1130-1135. 16 refs.

The direct radiolytic production of hydrogen utilizing a laser-fusion system is examined. In the operation of typical proposed laser-fusion systems, small deuterium-tritium pellets are repeatedly imploded, causing fusion with an energy yield composed of 14.1-MeV neutrons (77%), fusion-product debris (15%), alphas (7%), and X-rays (1%). The neutrons can be used for the production of hydrogen by radiolysis. Optimization of the hydrogen yield is subject to constraints, such as breeding and recovery of tritium, minimizing thermal energy production, maximizing the G(H2) factor (i.e., number of hydrogen atoms released per 100 eV of energy absorbed), and minimizing radioactive materials entrained in the produced hydrogen. The addition of additives to the aqueous feedstock to suppress the recombination of hydrogen species and increase the LET of the primary radiation can improve the effective G(H2). Factors necessary for economic feasibility have been identified. (Author)

A77-12796 **Isotope heat source for dynamic power systems.** A. Schock (Fairchild Space and Technology Co., Germantown, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1136-1138.

A design is described for automatically limiting the temperature excursion of an isotope heat source following loss of cooling in dynamic space power systems. Its purpose is to keep the resultant temperature rise small enough and brief enough to prevent fuel capsule degradation; i.e., not merely to avoid meltdown, but also to retain adequate capsule ductility to ensure fuel retention in case of subsequent reentry and earth impact. Applications of the concept in designs of heat-source assemblies for Brayton, Rankine, and Stirling cycle power systems are illustrated. (Author)

A77-12797 * **Heat pipe nuclear reactor for space power.** D. R. Koening (California, University, Los Alamos, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1139-1144. 20 refs. ERDA-NASA-supported research.

A heat-pipe-cooled nuclear reactor has been designed to provide 3.2 MWth to an out-of-core thermionic conversion system. The reactor is a fast reactor designed to operate at a nominal heat-pipe temperature of 1675 K. Each reactor fuel element consists of a hexagonal molybdenum block which is bonded along its axis to one end of a molybdenum/lithium-vapor heat pipe. The block is perforated with an array of longitudinal holes which are loaded with UO2 pellets. The heat pipe transfers heat directly to a string of six thermionic converters which are bonded along the other end of the heat pipe. An assembly of 90 such fuel elements forms a hexagonal core. The core is surrounded by a thermal radiation shield, a thin thermal neutron absorber, and a BeO reflector containing boron-loaded control drums. (Author)

A77-12798 **Solar powered organic Rankine cycle engines - Characteristics and costs.** R. E. Barber (Barber-Nichols Engineering Co., Arvada, Colo.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1151-1156. 8 refs.

The technical and cost aspects of the organic Rankine cycle and its interaction with the solar collector as a power system are examined. It is shown that collector temperatures of 200, 300-400, and 600 F are optimum operating conditions for flat plate, concentrators, and tracking concentrators, respectively, with the peak solar conversion efficiencies of these systems, approximately 5, 10 and 11%. The dominant factor in system cost is shown to be the collector cost. It is estimated that the Rankine cycle cost will be about one third of the total system cost with two thirds going to the collector component. It is also estimated that the installed cost mass-produced solar power systems would be about 1600-2500 dollars/peak kw output. B.J.

A77-12799 **A unique Rankine-cycle heat pump system.** F. R. Biancardi and M. D. Meader (United Technologies Research Center, East Hartford, Conn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1157-1162. Contract No. E(11-1)-2824.

Feasibility of operating a Rankine-cycle turbocompressor air conditioning system at temperature levels consistent with present-day flat-plate solar collectors has been convincingly demonstrated. During testing of the demonstration system, more than four tons of cooling and in excess of sixty hours of safe reliable operation were obtained at performance levels consistent with prior predicted levels. In this system, thermal energy is used to vaporize a refrigerant working fluid which is expanded through a turbine to produce mechanical power. In the current program, modifications have been made to the demonstration system to permit the further characterization of the performance potential of the turbocompressor concept over a wide range of operating conditions. Extensive operation of the system has been achieved at condenser temperatures suitable for both water and air cooling and at equivalent turbine-inlet temperatures below 160 F and in excess of 220 F. Results of recent testing are presented. (Author)

A77-12800 **Solar-powered Rankine-cycle heat pump system.** J. Rousseau and J. C. Noe (AiResearch Manufacturing Company of California, Los Angeles, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1163-1168.

This paper presents an evaluation of solar energy systems designed for heating and cooling residences and buildings. The system designs cover a range from 3 to 75 tons in the cooling mode and up to 2 million Btu/hr for heating. Low-temperature flat-plate collectors are used in conjunction with an electrically augmented turbocompressor heat pump. These systems were evaluated in terms of fossil-fuel savings and life-cycle cost benefits. By comparison with conventional systems, solar heating and cooling systems offer the potential for a 75 percent yearly reduction in energy requirements. Also, a cost benefit amounting to 90 percent of the initial added investment over the life of the system can be realized even at present-day energy costs. (Author)

A77-12801 **Alternate fuel capability of Rankine cycle engines.** R. D. Burtz (Steam Power Systems, Inc., San Diego, Calif.) and T. E. Duffy (International Harvester Co., Solar Div., San Diego, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1192-1197.

The paper describes a Rankine cycle steam engine for automotive applications which has surpassed the ultimate Federal emissions standards and demonstrated low emissions characteristics on a broad range of petroleum based and on non-petroleum fuels. Results of continued development of this engine with alternate fuels are presented. Emissions with coal derived fuel oil and methanol are characterized across a wide range of fuel flows. The rotating cup fuel injection system is found to have excellent characteristics with a wide range of liquid fuel types. Extension of the fuel injection technology to powdered solid fuel in a water slurry or directly for powder slinger injection appears practical. B.J.

A77-12803 * **Comparative performance of solar thermal power generation concepts.** L. Wen and Y. C. Wu (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1209-1215. 5 refs. Contract No. NAS7-100.

A performance comparison is made between the central receiver system (power tower) and a distributed system using either dishes or troughs and lines to transport fluids to the power station. These systems were analyzed at a rated capacity of 30 MW of thermal energy delivered in the form of superheated steam at 538 C (1000 F) and 68 atm (1000 psia), using consistent weather data, collector surface waviness, pointing error, and electric conversion efficiency. The comparisons include technical considerations for component requirements, land utilization, and annual thermal energy collection rates. The relative merits of different representative systems are dependent upon the overall conversion as expressed in the form of performance factors in this paper. These factors are essentially indices of the relative performance effectiveness for different concepts based upon unit collector area. These performance factors enable further economic tradeoff studies of systems to be made by comparing them with projected production costs for these systems. (Author)

A77-12804 * Solar thermal electric power plants - Their performance characteristics and total social costs. R. S. Caputo and V. C. Truscello (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1216-1223. 7 refs. Contract No. NAS7-100.

The central receiver (power tower) concept as a thermal conversion approach to the conversion of solar energy into electricity is compared to other solar power plant designs which feature distributed solar collection and use other types of solar collector configurations. A variety of solar thermal storage concepts are discussed and their impacts on system performance are assessed. Although a good deal of quantification is possible in a comparative study, the subjective judgments carry enormous weight in a socio-economic decision, the ultimate choice of central power plant being more a social than an economic or technical decision. Major elements of the total social cost of each type of central plant are identified as utility economic costs, R&D funds, health costs, and other relevant social impacts. S.D.

A77-12805 Solar energy prospects for electric power generation in Brazil. D. Magnoli (Centro de Tecnologia Promon, Rio de Janeiro, Brazil). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1224-1231. 15 refs.

A review of the energy prospects for electric power generation in Brazil indicates that hydraulic resources offer the best possibilities. However, Brazil's hydroelectric potential, both known and assumed, lies in the north, which is far away from the country's developed centers and where settlement is difficult. Exploitation of other resources for electric power generation is necessary before 1990. The discussion covers electric power in the northeast region, prospects of the use of solar energy in the northeast region, configuration of helio-electric systems in prospect, and capacity of the Brazilian industry for manufacture of solar power plant components and applied research programs. There is sufficient R&D basis for installation of small power plants based on biomass energy. Installation of large-scale solar power plants would require applied research programs regarding processes, materials, and development of adequate equipment. S.D.

A77-12806 Central station solar electric power using liquid metal heat transport. T. H. Springer and W. B. Thomson (Rockwell International Corp., Atomics International Div., Canoga Park, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1232-1238.

A study has been made of a 100 MWe solar thermal electric power station using the tower concept in which liquid sodium is used to transport heat from the receiver on the tower to steam generators on the ground. The advantages of using sodium are: (1) the ability to accept a severe heat flux at the receiver, (2) a dense, single-phase coolant with no inherent flow instabilities, (3) an inherently low receiver coolant pressure, (4) sodium reheat can be used in the cycle, and (5) sodium technology has advanced sufficiently to be successfully applied in such a power station. Conceptual design data for the mirror system, receiver, sodium heat transport system, steam system, and heat rejection system are presented. Thermal storage is discussed. Data on the present state of liquid sodium technology are given. (Author)

A77-12807 * Economic optimization of the energy transport component of a large distributed solar power plant. R. H. Turner (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1239-1243. 9 refs. Contract No. NAS7-100.

A solar thermal power plant with a field of collectors, each locally heating some transport fluid, requires a pipe network system for eventual delivery of energy power generation equipment. For a given collector distribution and pipe network geometry, a technique is herein developed which manipulates basic cost information and physical data in order to design an energy transport system consistent with minimized cost constrained by a calculated technical performance. For a given transport fluid and collector conditions, the method determines the network pipe diameter and pipe thickness distribution and also insulation thickness distribution associated with minimum system cost; these relative distributions are unique. Transport losses, including pump work and heat leak, are calculated operating expenses and impact the total system cost. The minimum cost system is readily selected. The technique is demonstrated on six candidate transport fluids to emphasize which parameters dominate the system cost and to provide basic decision data. Three different power plant output sizes are evaluated in each case to determine severity of diseconomy of scale. (Author)

A77-12808 Windowed versus windowless solar energy cavity receivers. P. O. Jarvinen (MIT, Lexington, Mass.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1244-1252. 13 refs. Research supported by the Massachusetts Institute of Technology and U.S. Air Force.

A model for a windowed, high-temperature cavity receiver of the heated-air type is developed and used to evaluate the greenhouse effect as a method for obtaining high receiver operating efficiencies. The effects on receiver efficiency of varying the window cutoff wavelength, the amount of absorption in the window pass-band, the cavity operating temperature, and the number of windows are determined. Single windowed cavities are found to offer theoretical efficiencies comparable to windowless ones, while multiple windowed units are found to suffer from low operating efficiencies due to losses resulting from reflections at each window/air interface. A 'first order' examination is made of the feasibility of air cooling the window to assure its survival. This appears possible if a proper combination of cooling technique and window material characteristics is selected. (Author)

A77-12809 The role of simulation in the development of solar-thermal energy conversion systems. G. L. Schrenk (Pennsylvania, University, Philadelphia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1256-1263. 10 refs.

The design of a solar-thermal energy conversion system depends on a large number of parameters that relate to the characteristics of the solar concentrator and absorber. Only part of these parameters are amenable to experimental determination. A comprehensive balanced experimental-mathematical simulation procedure for the solar-thermal subsystem is described, and is shown to be capable of quantitative evaluation of the variables critical to the design of a realistic solar-thermal energy conversion system. A unique feature of the work discussed is the realization that we deal with an extended finite-sized source and that the resultant radiation transfer must be analyzed using cones, either infinitesimal or finite, rather than optical rays as the basic vehicle for energy transfer. V.P.

A77-12810 Transient performance characteristics of a high temperature distributed solar collector field. D. L. Black and J. F. Ellis (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1264-1271. 5 refs.

A mathematical model of a high temperature distributed solar collector field was used on a hybrid computer to study the transient

performance characteristics. The heat transfer system consists of a series of reflector/absorber energy concentrating devices using Therminol 66 coolant operating between a minimum cold storage temperature of 242 C and a hot storage temperature of 315 C. Control strategies were tested and controllers were developed which would maximize the daily energy delivered while maintaining a rigid tolerance of + or - 1 C on its temperature. The results for different strategies included cold startup, sudden change in insolation, and malfunctions such as loss of pump. Continuous storage bypass and startup only were evaluated through the use of a high temperature auxiliary bypass accumulator loop. Analog flow controllers were developed from a model frequency response at the noon period operating conditions for the fall season. (Author)

A77-12811 Collector field optimization for a solar thermal electric power plant. C. R. Easton, J. E. Raetz (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.), and L. L. Vant-Hull (Houston, University, Houston, Tex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1272-1277.

A procedure for optimizing a central receiver solar thermal electric power plant is presented. Key parameters of the optimization are identified and examined to show the degree of interdependence and to derive a secondary set of variables more amenable to optimization. The procedure is detailed with numerical examples, and the results for a 100-MWe commercial plant are shown. (Author)

A77-12812 Development of compound parabolic concentrators for solar-thermal electric and process heat applications. N. Levitz, J. Allen, A. Rabl, K. Reed, R. Rush, W. Schertz, A. Wantroba, and R. Winston (Argonne National Laboratory, Argonne, Ill.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1278-1283. ERDA-supported research.

Development of solar collectors based upon the compound parabolic concentrator (CPC) concept is in progress. Two collectors are described, one with a tenfold (10x) concentration, the other a 3x unit, both aimed at establishing their potential for power applications. These units will be operating in the range 149-232 C. An efficiency in the range 35-40% is considered necessary for practical consideration. The 10x collector has 3.7 sq m of aperture and comprises two mirrored troughs, each 9.1 m long. The receivers are of extruded aluminum; one has a flat-black finish, the other a selective-coated (black chrome) finish for comparative testing. The 10x unit is built as five 1.8 m (6 ft) modules, coupled together and mounted on a tilting platform for daily-cycle testing. The assembly of the 10x CPC and early results of testing are described. The 3x CPC emphasizes the use of low-cost materials and mass-producible construction techniques to form the reflector surfaces and evacuated tube receivers. (Author)

A77-12813 * A fixed collector employing reversible vee-trough concentrator and a vacuum tube receiver for high temperature solar energy systems. M. K. Selcuk (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1284-1290. 17 refs. Contract No. NAS7-100.

A solar heat collection system employing non-tracking reflectors integrated with a fixed vacuum tube receiver which achieves modest year-round concentration (about 2) of the sunlight at low capital costs is discussed. The axis of the vee-trough reflector lies in a east-west direction and requires reversal of the reflector surfaces only twice a year without disturbing the receiver tubes and associated plumbing. It collects most of the diffuse flux. The vacuum tube receiver with selective absorber has no convection losses while radiation and conduction losses are minimal. Significant cost reductions are offered since the vee-trough can be fabricated from inexpensive polished or plastic reflector laminated sheet metal covering 2/3 of the collection area, and only about 1/3 of the area is covered with the more expensive vacuum tube receivers. Thermal and economic performance of the vee-trough vacuum tube system, year-round variation of the concentration factor, incident flux, useful heat per unit area at various operation temperatures and energy cost estimates are presented. The electrical energy cost is estimated to be 77 mills/kWh, and the system construction cost is estimated to be $1140/kWe. (Author)

A77-12814 Calorimetry of large solar concentrators. D. Waddington (Martin Marietta Aerospace, Denver, Colo.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1291-1295.

The development of large focusing heliostats to concentrate solar energy on a boiler or central receiver demands a method of measuring the concentration efficiency. A flat plate calorimeter, using the temperature rise in water at a measured flow rate, has been employed to test a 22.3-square-meter heliostat focused at a distance of 31 meters. These measurements represent the first tests of large-area concentrating heliostats in this country. This paper presents the calorimeter design, defining absorptance of the flat plate coating, the instrumentation, and the capabilities for calibration and error correction. Typical tests are discussed and data are included. Evaluation data taken with an AGA thermovision infrared scanner confirm flux distribution on the calorimeter receiver plate. The prototype calorimeter has successfully measured solar fluxes of 47,307 W/sq m and total fluxes of 14,650 watts. (Author)

A77-12815 The ERDA Photovoltaic Systems Definition Project. D. G. Schueler (Sandia Laboratories, Albuquerque, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1297-1299. ERDA-supported research.

The ERDA Photovoltaic Systems Definition Project is aimed at identifying the most promising applications for terrestrial photovoltaic power systems and optimizing their reliability and cost-effectiveness. Various system concepts and candidate applications are currently being studied. (Author)

A77-12816 Performance and cost analysis of photovoltaic power systems for on-site residential applications. A. Kirpich, N. F. Shepard, Jr., and S. E. Irwin (General Electric Co., Space Div., Valley Forge, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1300-1307.

Results are presented for the performance analysis of an on-site residential photovoltaic power system, both with and without energy storage. For systems with energy storage, a direct (or float) charge system implementation with a lead-acid battery was selected, whereas for systems without energy storage a maximum power tracking dc/ac inverter was used to provide the interface between the solar array and the utility. The system performance sensitivity to the number of solar cells in the array and to the solar roof slope angle is discussed. The results of system performance calibrations for the battery and no-battery cases are used as a basis for a modified present worth cost analysis to determine the preferred system sizing associated with the minimum cost of energy supplied. Major conclusions are that for average size all-electric houses on-site residence photovoltaic systems with energy storage can achieve energy displacements varying from 38 to 80% for the range of U.S. weather conditions, and that systems without energy storage can achieve energy displacements ranging from 51 to 98%.

A77-12817 New concepts in solar photovoltaic electric power systems design. E. F. Federmann, R. R. Ferber, P. F. Pittman, and C. R. Chowaniec (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th,

State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1308-1315.

Results are presented for a study of three types of viable solar photovoltaic electric power systems. The first is an on-site residential power system with an output ranging from 1 to 10 kW; the second is an intermediate power system with an output in the range 100 kW to 10 MW for location near an industrial or commercial load; and the third is a central power system with an output varying between 50 and 1000 MW to be located remote from urban areas. The residential power system is discussed relative to system description and application, system evaluation elements, energy balance program, and system potential. The intermediate power system is examined in terms of system description, utility ownership, and proprietor-ownership. The central power system is an inseparable part of a total utility system. If one assumes that cost objectives for the photovoltaic materials are achieved, that there is an effective pre-commercialization phasse, that there are rising energy costs, and that institutional problems are resolved, then the result would be widespread acceptance of all three types of systems. S.D.

A77-12818 An integrated photovoltaic/thermal High Intensity Solar Energy System /HISES/ concept for residential applications. B. L. Sater and C. Goradia (Cleveland State University, Cleveland, Ohio). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1316-1323. 20 refs.

An integrated photovoltaic/thermal High Intensity Solar Energy System (HISES) concept is presented for residential application. The design of a 36 sq m HISES which can supply almost the entire energy for the heating, air conditioning, hot water and electrical needs of an 1800 sq.ft model home in Albuquerque, N. M. is discussed in detail. It appears that the HISES concept can be implemented in the very near future and that it is cost effective in terms of both dollar value and energy payback. At an installation rate of about 500,000 HISES per year, a 36 sq m HISES is estimated to cost less than $4,500, while providing over 45,000 KWHr/yr of thermal energy at $0.0072/KWTHr and over 10,000 KWHr/yr of electrical energy at $0.02/KWeHr, and resulting in an equivalent fuel savings of over 30 million barrels of oil total per year. (Author)

A77-12819 * Alternative strategies for implementing silicon-ribbon technology for photovoltaic applications. A. Kran (IBM East Fishkill Laboratories, Hopewell Junction, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1324-1329. ERDA-sponsored research; Contract No. NAS7-100.

Interactive computer models are being designed to support the development of technological and economic data required to define the potential of silicon sheet growth for large scale photovoltaic applications. Technology projection and sensitivity analysis suggest that single-ribbon growth systems offer the best potential for achieving low-cost silicon sheet material within the shortest period of time. Such systems must be highly reliable, be capable of near unattended growth, and feature automatic melt replenishment. Processing-technology improvement, such as the following, are the key elements for reducing the cost of silicon sheet material: (i) increasing ribbon width; (ii) speeding up the growth rate; and (iii) decreasing ribbon thickness. Such tasks should be pursued in that order to minimize sheet material cost. One interesting finding is that significant reductions in sheet material cost are achievable in the near future by increasing ribbon width to 5 cm. (Author)

A77-12821 A summary of solar heating and cooling of buildings /SHACOB/ - Phase I demonstration planning studies. A. D. Cohen (General Electric Co., Space Div., King of Prussia, Pa.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1338-1344. Contract No. E(11-1)-2683.

Results are presented for a study designed to provide an assessment of the number of commercial and residential projects required to accelerate the application of solar technology for the heating and cooling of buildings. A life cycle cost effectiveness technique is used to analyze potential solar demonstration projects. Future SHACOB market penetration achieved as a result of the recommended demonstrations is evaluated to the year 2000. Analyses are performed through the development of a decision-making model to provide quantitative results. Major conclusions are that a total of 800 demonstration projects (buildings) is recommended, a market of 16 million buildings is predicted to be solar equipped by the year 2000, and that savings equivalent to 233 barrels of oil could be saved annually by the year 2000. S.D.

A77-12822 Long term performance prediction of residential solar energy heating systems. J. M. Nash, J. C. Bartlett, N. J. Caiola, and J. E. Irby (IBM Corp., Huntsville, Ala.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1345-1348. 8 refs.

An automated technique to provide long term performance predictions of residential solar energy heating systems has been developed. Implementation of this interactive computer program requires inputs of generic system description, operational site characteristics, subsystem characteristics, application characteristics, and modifications (if any) to baseline generic design factors. With these inputs, either as single values or iterated over ranges of characteristics, the program outputs long term system performance as percent of total heating load satisfied by solar energy as a function of solar collector area. This report presents initial results of application of this program considering ranges of collector performance and residential construction for representative regions of the United States. Specific discussion is presented on the general utility of long term performance prediction, availability of prediction methods, details of the method selected, results from automating this technique for a national level application, and suggested future application possibilities. (Author)

A77-12823 Experimental evaluation of the University of Florida solar powered ammonia/water absorption air conditioning system. E. A. Farber, C. A. Morrison, and H. A. Ingley (Florida, University, Gainesville, Fla.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1349-1353. 7 refs.

This paper presents a review of the experimental work conducted with an ammonia/water absorption air conditioning system at the University of Florida, Solar Research Residence. This unit was designed and constructed by the Solar Energy and Energy Conversion Laboratories at the University for daily operation from a solar collection and storage system installed at the residence. Data are presented illustrating the efficiency and effectiveness of the air conditioning unit. The importance of the EER (Energy Efficiency Ratio) and the COP (Coefficient of Performance) of solar air conditioning systems is documented and discussed. A data base formed over the years at the Solar Residence taken under actual living conditions provides for a comparison of the cost of operating a conventional cooling system and a solar cooling system. (Author)

A77-12824 Short and long term comparison of solar absorption air-conditioning system performance using real and synthetic weather data. D. K. Anand, R. W. Allen, and E. O. Bazques (Maryland, University, College Park, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1354-1361. 7 refs. Contract No. E(40-1)-4976.

A77-12825 * SEP solar array technology development. R. V. Elms, Jr. (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.) and L. E. Young (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1372-1378. Contract No. NAS8-31352.

A technology development program is in progress to define a detail design of a lightweight 25 KW solar array for Solar Electric Propulsion (SEP) and to demonstrate technology readiness for fabrication, testing and flight of the large area solar array system. The requirements and baseline design for the 66 W/kg are discussed. The requirement for operation at 0.3 to 6.0 AU heliocentric distance presents a wide range of temperature environments as well as severe combined thermal/vacuum/UV radiation environments. The specific technology deficient areas are defined and the technology development program is presented. The program includes design and design evaluation testing on a component level followed by the fabrication and test of a developmental full-scale solar array wing. The results of the design studies and test program underway are presented. The test program covers the areas of fabrication testing, design support evaluation testing, zero-gravity array fold-up testing, full-scale array wing testing, and NDT development testing. (Author)

A77-12828 Ultralightweight solar array for Naval Sea Control Systems. W. Luft (TRW Defense and Space Systems Group, Redondo Beach, Calif.) and H. Crecraft (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1395-1399.

A 10-kW solar array to power the propulsion system of a high altitude (18-21 km) super pressure balloon has been designed. The solar array is attached to the top of the 23,000 cu m balloon in station and is folded with a portion of the balloon during launch, when it is subjected to the most severe stresses due to wind turbulence. Sound design, low cost and low weight were the main requirements. This was achieved using 25.6 sq cm solar cells, 200-micron thick, attached to a 13-micron Kapton substrate. The 176 sq m solar array contains 34,560 solar cells and weighs 54 kg, yielding 185 W/kg. A bypass diode is used for every six solar cells to achieve 0.95 reliability for launch and 3 months mission. Verification testing has included wind tunnel tests at 29 m/s air velocities on 16-cell 0.1 sq m test coupons attached to balloon skin material in a folded configuration. No power degradation resulted from such tests, which represented more high-velocity turbulence than is expected during launch from Cape Kennedy. (Author)

A77-12829 * Transportation options for solar power satellites. G. R. Woodcock and E. E. Davis (Bell Aerospace Co., Seattle, Wash.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1400-1407. Contract No. NAS9-14323.

Advantages of solar power satellites compared to ground-based solar power installations are related to an almost continuous exposure to sunlight and to a much smaller collector area. An investigation of the transportation cost problem is conducted. Transportation systems based on presently understood technology are considered for the deployment of solar power satellites at potentially competitive costs. It is found that the cost of placement in a geosynchronous orbit is reducible to the range from $500 to $1000/kW. Approaches for achieving dramatic cost reductions are discussed. G.R.

A77-12831 * The ATS-6 power system - Hardware implementation and orbital performance. T. A. LaVigna (NASA, Goddard Space Flight Center, Greenbelt, Md.) and F. L. Hornbuckle (Fairchild Space and Electronics Co., Germantown, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1414-1421. 5 refs.

The Applications Technology Satellite-6 has performed more than 20 communications, technological and scientific experiments in 2 years of highly successful operation. Contributing substantially to this success has been the flexibility of the power system that allows multiple operation of experiments. The power system, a shunt-boost configuration, uses partial shunt regulation of the solar array and a boost regulator for control of battery power. Regulation is provided for three different operating modes: shunt, charge, and boost. This configuration achieves the highest efficiency of power transfer from the solar array to the loads. The solar array degradation (18.5 percent) has been less than the predicted 20 percent in spite of extreme cycling from -160 C to 60 C. A unique battery cycling regime of discharges varying from 5 percent to 60 percent daily is being encountered. During the second year, noneclipse discharges have occurred twice a day to depths of 35 percent and 45 percent. Battery performance has been good with only a small decrease in end-of-discharge voltage. (Author)

A77-12833 Power source requirements of electric propulsion systems used for north-south stationkeeping of communication satellites. D. Rusta (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1429-1436. 8 refs. Research sponsored by the International Telecommunications Satellite Organization.

This paper reports the results of an analysis of the impact on satellite power source size and weight resulting from the incorporation of an electric propulsion system configured to provide north-south stationkeeping in a geosynchronous equatorial orbit. The study shows that high power thrusting can be performed for most of the systems considered with no increase in battery size if a nickel-hydrogen secondary battery system is used. A review of ground-based nickel-hydrogen battery cycle life test data is presented in support of the analysis. It is also shown that if the solar array is used to power low-thrust systems, the resulting additional array increment will be very small. It is concluded that the integration of electrostatic ion thrusters into a satellite for this purpose will usually result in minimal size and weight penalties to its power sources. (Author)

A77-12835 * Small space station electrical power system design concepts. G. M. Jones and L. N. Mercer (Sperry Rand Corp., Systems Management Div., Huntsville, Ala.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1443-1448. 14 refs. Contract No. NAS8-21812.

A small manned facility, i.e., a small space station, placed in earth orbit by the Shuttle transportation system would be a viable, cost effective addition to the basic Shuttle system to provide many opportunities for R&D programs, particularly in the area of earth applications. The small space station would have many similarities with Skylab. This paper presents design concepts for an electrical power system (EPS) for the small space station based on Skylab experience, in-house work at Marshall Space Flight Center, SEPS (Solar Electric Propulsion Stage) solar array development studies, and other studies sponsored by MSFC. The proposed EPS would be a solar array/secondary battery system. Design concepts expressed are based on maximizing system efficiency and five year operational reliability. Cost, weight, volume, and complexity considerations are inherent in the concepts presented. A small space station EPS based

on these concepts would be highly efficient, reliable, and relatively inexpensive. (Author)

A77-12836 * **Comparison of candidate solar array maximum power utilization approaches.** E. N. Costogue (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and S. Lindena (Electro-Optical Systems, Inc., Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1449-1456. Contract No. NAS7-100.

A study was made of five potential approaches that can be utilized to detect the maximum power point of a solar array while sustaining operations at or near maximum power and without endangering stability or causing array voltage collapse. The approaches studied included: (1) dynamic impedance comparator, (2) reference array measurement, (3) onset of solar array voltage collapse detection, (4) parallel tracker, and (5) direct measurement. The study analyzed the feasibility and adaptability of these approaches to a future solar electric propulsion (SEP) mission, and, specifically, to a comet rendezvous mission. Such missions presented the most challenging requirements to a spacecraft power subsystem in terms of power management over large solar intensity ranges of 1.0 to 3.5 AU. The dynamic impedance approach was found to have the highest figure of merit, and the reference array approach followed closely behind. The results are applicable to terrestrial solar power systems as well as to other than SEP space missions. (Author)

A77-12837 **KIPS - Kilowatt Isotope Power System.** R. C. Brouns (ERDA, Nuclear Research and Applications Div., Washington, D.C.), E. C. Krueger, R. F. McKenna, R. E. Niggemann (Sundstrand Corp., Sundstrand Advanced Technology Group, Rockford, Ill.), and F. A. Russo (Teledyne Energy Systems, Timonium, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1457-1461. ERDA-supported research.

A dynamic space power system designated as KIPS (Kilowatt Isotope Power System) for use in satellites of the 1980s is discussed. The KIPS is a plutonium oxide-fueled, organic Rankine cycle turbine power system producing electric power in a range from 0.5 to 2.0 kW. The discussion covers both the flight system concept design and the ground demonstration system which is being designed and fabricated to prove the feasibility of the flight design. The principal components considered are the energy source, turbo-alternator-pump, bearings, regenerator, jet condenser, and radiator. Interface, integration and trade-off criteria between components are presented. High efficiency to minimize fuel costs and realiability to achieve 60,000 hr unattended operation are the principal design goals. Operation in a satellite, operation on the pad and through launch if desired, and operation in space are considered. (Author)

A77-12838 **The nuclear spinner for Satcom applications.** J. J. Karlin and B. Raab (Fairchild Space and Electronics Co., Germantown, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1462-1470. Contract No. E(49-15)-3063.

In order to avoid the power limitations of the solar-powered spinner satellites, operators of commercial communications spacecraft have turned to three-axis-stabilized designs. Nuclear-powered spacecraft can avoid this limitation, while retaining the desirable weight, stability, and cost advantages of the spinner approach. A nuclear spinner satellite launched on a Delta-3914 can provide enough weight and volume capacity for both C- and Ku-band operation, with a total capacity exceeding 40,000 one-way circuits, almost twice the capacity of present-day solar-three-axis designs. It is shown that, based on the criterion of cost-per-satellite-circuit in orbit, a nuclear spinner Satcom is superior to any present day solar-powered satellite in the Delta-launched class. However, in order to retain this superiority in the face of anticipated advances in solar power technology, a nuclear power system of at least 4 watts(e)/lb specific power is required. (Author)

A77-12840 **SNAP 19 Viking RTG mission performance.** W. M. Brittain (Teledyne Energy Systems, Timonium, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1479-1486. Contract No. AT(49-15)-3069.

The electrical power source for each Viking lander consists of two SNAP 19 radioisotope thermoelectric generators (RTG's). Each RTG will supply a minimum electrical power of 35 watts during the 90-day minimum Mars surface mission. The SNAP 19 Viking RTG consists of three basic assemblies including the housing/radiator assembly, the thermoelectric converter assembly, and the radioisotopic heat source assembly. Attention is given to aspects of RTG design description, questions of thermal/electrical integration, flight RTG acceptance testing, and prelaunch and postlaunch performance. G.R.

A77-12842 **The Stirling engine - Engineering considerations in view of future needs.** R. I. Pedroso (Florida International University, Miami, Fla.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1498-1505. 14 refs.

The efficiency of the Stirling cycle engine can be excellent. The high efficiency of these power converters has been shown on paper as well as proven in the field. Its input energy is in the form of heat, hence it is compatible with nuclear and solar energy sources. The development and application of these engines in the past has been limited. With the low cost of fossil fuels that used to prevail, the Stirling engine was not able to compete with the gasoline internal combustion engine. In due time, scarcity of fossil fuels should shift the balance, and the Stirling engine will find many more applications. It is the purpose of this paper to examine the Stirling engine from an engineering point of view, and to discuss some of its features and components likely to receive most engineering effort in the future. (Author)

A77-12844 **Self-starting, intrinsically controlled Stirling engine.** N. E. Polster (Research Engineering Consultant, Argenta, British Columbia, Canada) and W. R. Martini (Joint Center for Graduate Study, Richland, Wash.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1511-1518. 13 refs.

A unique type of Stirling engine has been built and has shown that it can start itself and run in either direction when the torque control lever is moved. The engine is a four-displacer, four-power piston, horizontally opposed, offset (gamma type) Stirling engine. The machine uses four hypocycloid gear sets to couple the two oscillating displacer shafts and the two oscillating power piston shafts with the rotating output shaft. A spur gear phase changer is used at any time to change the phase angle between the displacers and the power pistons to control torque. This engine appears to be ideal for powering vehicles since it self-starts and has built-in-torque control, reverse, and generative braking. The engine can be permanently connected to a thermal energy storage (TES) reservoir because of its very low heat leak when not in use. An engine and TES conceptual

design and performance prediction is given for a small car power plant. (Author)

A77-12848 Transport theory of 3M high-performance thermoelectric materials. W. C. Mitchell, R. B. Ericson, E. F. Hampl, Jr., R. M. Swinehart, K. C. Thompson, S. J. Thompson, and G. R. Wyberg (3 M Pioneering Laboratory, St. Paul, Minn.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1539-1545. 5 refs. Contract No. E(11-1)-2331.

Copper-silver-selenide and gadolinium-selenide have exhibited high performance as thermoelectric materials, and offer significant improvement in thermoelectric generator efficiency. This paper describes the characteristics of these materials, correlating the observed properties with transport theory. Equations for determining operating characteristics from the more fundamental microscopic constants are presented. (Author)

A77-12850 The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction. J. F. Goff and J. R. Lowney (U.S. Navy, Naval Surface Weapons Center, Silver Spring, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1561-1566. 20 refs. Navy-supported research.

The efficiency of thermoelectric devices can be improved either by raising the operating temperature or by improving the thermoelectric materials used to construct them. Either way requires a better understanding of the intrinsic factors that limit the thermoelectric figure-of-merit. We have reformulated the figure-of-merit in integral form so that it becomes a transport quantity of interest rather than a ratio of other transport quantities. This new formulation has been used to analyse the figure-of-merit data of PbTe. It is possible to calculate the quantitative effect of changes in electrical and lattice parameters of the material. A study of the lattice thermal conduction of PbTe indicates that different approaches are necessary to reduce its magnitude and that there can be another criterion for obtaining improved material performance. It seems reasonable to suggest that device efficiency could be improved by a factor of two or perhaps more. (Author)

A77-12852 Development of a small radioisotopic heat source. G. J. Jones (Sandia Laboratories, Albuquerque, N. Mex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1572-1577. 14 refs.

A radioisotopic heat source has been designed, fabricated and evaluated for use in a 25 mW(e), 25 year thermoelectric generator. This three layer heat source contains approximately 7 grams Pu-238 in the form of PuO2 hydroxide-precipitated shards. A cup/cap type encapsulation configuration was used for ease of fabrication and thermopile mating. The nonvented design led to the requirement that the heat source be able to withstand the internal helium pressures generated during a hypothetical 1 hour, 1273 K fire occurring at the end of generator lifetime. In addition, the heat source is required to survive at 150 m/sec impact into hardened steel at 723 K without breaching. This paper discusses three main areas of concern in obtaining a heat source meeting the safety requirements: (1) materials selection and design, (2) structural testing and (3) compatibility verification. (Author)

A77-12853 * Test and evaluation of the Navy half-watt RTG. F. E. Rosell, Jr., S. D. Lane (U.S. Navy, Naval Nuclear Power Unit, Port Hueneme, Calif.), P. E. Eggers (Ridihalgh and Associates, Columbus, Ohio), W. E. Gawthrop (Battelle Columbus Laboratories, Columbus, Ohio), P. G. Rouklove, and V. C. Truscello (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1578-1585.

The radioisotope thermoelectric generator (RTG) considered is to provide a continuous minimum power output of 0.5 watt at 6.0 to 8.5 volts for a minimum period of 15 years. The mechanical-electrical evaluation phase discussed involved the conduction of shock and vibration tests. The thermochemical-physical evaluation phase consisted of an analysis of the materials and the development of a thermal model. The thermoelectric evaluation phase included the accelerated testing of the thermoelectric modules. G.R.

A77-12855 The low cost high performance generator /LCHPG/. A. R. Lieberman, W. E. Osmeyer, T. E. Hammel (Teledyne Energy Systems, Timonium, Md.), and R. T. Carpenter (ERDA, Washington, D.C.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1591-1598.

The LCHPG program was initiated in 1973 by ERDA as systems effort to create a new generation of space Radioisotope Thermoelectric Generators (RTG's). Significant advances in radioisotope thermoelectric generator performance were achieved. Efficiencies have doubled and specific power has improved by at least 50% over existing systems. Cost projections indicate a potential reduction from $25,000 to $5,000 per watt electrical. Attention is given to flight RTG system studies, a flight LCHPG description, and a ground demonstration system. G.R.

A77-12857 Spherical radioisotope thermoelectric generators - An approach to high specific power devices. P. E. Eggers (Ridihalgh and Associates, Inc., Columbus, Ohio). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1606-1613.

A concept for attaining high specific power radioisotope thermoelectric generators (RTGs) is described which features the close packing of thermoelectric elements around the surface of a spherical heat source, thereby reducing the need for conventional thermal insulation systems. Eliminating thermal insulation allows the thermoelectric element length (and associated thermopile weight) to be reduced without incurring excessive bypass heat losses. One of the design constraints is that the spherical heat source volume must be sized to match the surface heat flux requirements imposed by the thermoelectric converter which envelops the heat source. A preferred embodiment of the spherical RTG concept is described along with component weight breakdowns for output power levels ranging from 250 to 575 watts including weights for the heat source, thermal and impact protection members, thermoelectric converter, outer shell and spring assembly hardware, and radiator. The results of design optimization analyses are described and indicate that specific power levels of four to six watts(e) per pound are attainable using the TPM-217 thermoelectric alloys operating between 225 and 800 C. Also discussed are key engineering problems to realize the benefits of this advanced concept for RTG design. (Author)

A77-12861 ERDA's Bicentennial Thermionic Research and Technology Program. O. S. Merrill (ERDA, Div. of Nuclear Research and Applications, Washington, D.C.) and J. J. Cuttica (ERDA, Div. of Conservation Research and Technology, Washington, D.C.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical

Engineers, 1976, p. 1635-1644.

The principal objectives of the ERDA Thermionic Research and Technology Program are: (1) to provide very high specific power thermionic system for NASA nuclear electric propulsion missions, and (2) by the use of thermionic topping cycles for coal burning steam generating plants, to increase overall plant efficiency. The goals of thermionic technology are: (1) to achieve a low collector work function (about 1.0 eV) stable for long lifetime at design operating temperatures, and (2) to reduce or eliminate plasma arc drop. B.J.

A77-12862 * Advanced thermionic converter development. F. N. Huffman, D. Lieb, T. R. Briere, A. H. Sommer and F. Rufeh (Thermo Electron Corp., Waltham, Mass.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1645-1651. 5 refs. Contracts No. E(11-1)-3056; No. NAS3-19866.

Recent progress at Thermo Electron in developing advanced thermionic converters is summarized with particular attention paid to the development of electrodes, diodes, and triodes. It is found that one class of materials (ZnO, BaO and SrO) provides interesting cesiated work functions (1.3-1.4 eV) without additional oxygen. The second class of materials studied (rare earth oxides and hexaborides) gives cesiated/oxygenated work functions of less than 1.2 eV. Five techniques of oxygen addition to thermionic converters are discussed. Vapor deposited tungsten oxide collector diodes and the reflux converter are considered. B.J.

A77-12863 * NASA thermionic-conversion program. J. F. Morris (NASA, Lewis Research Center, Thermionics and Heat-Pipe Section, Cleveland, Ohio) and J. G. Lundholm (NASA, Office of Aeronautics and Space Technology, Research Div., Washington, D.C.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1652-1655.

The NASA applied research and technology (ART) program for thermionic energy conversion (TEC) is progressing effectively. Current out-of-core emphases allow converter material and design freedoms previously prohibited by in-core nucleonic and geometric restrictions. As a result, potential improvements indicate possibilities for severalfold increases in efficiencies. The new TEC-ART program concentrated initially on low-work-function collectors and inter-electrode-loss reduction and revealed much in a short time. For example, arc-drop studies verified the necessity of stable emitters that operate well with little or no adsorbed cesium. This new emission capability coupled with improved collectors that maintain performance with emitter-vapor deposit accumulations are requisites for efficient, enduring thermionic converters. The accomplishments and contributors in these areas are discussed. (Author)

A77-12864 Detailed geographic analysis of residential energy consumption. T. Alereza, P. McCarthy, H. Bernstein, and M. Miller (Hittman Associates, Inc., Columbia, Md.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1703-1710. 7 refs.

Based on data collected in 10 major cities in the U.S., representative versions of the single-family, townhouse, and low-rise residential buildings are presented. The representative buildings illustrate the regional variations in building materials use, layout, and construction practices in the 10 geographic areas. The hourly heating and cooling loads are calculated using the time-response method, for each characteristic building type in each of the 10 locations considered (Atlanta, Boston, Chicago, Denver, Houston, Los Angeles, Miami, Minneapolis, St. Louis, and San Francisco). These heating and cooling loads are calculated and presented for a typical weather year in each location. Load calculations enable the comparison of heating and cooling load values for variations in geographic location and construction practices. (Author)

A77-12865 Siting of wind driven apparatus. F. C. Radice, Jr. (Hooker Chemicals and Plastics Corp., Niagara Falls, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1736-1740.

An important consideration when employing wind driven power conversion devices is selecting a suitable site. Two important factors influencing site selection are wind power and location relative to power user. Based on these criteria, the optimum site location would be one with high wind power and in close proximity to a large number of users and/or several large users. Wind power, i.e., the amount of energy available to a wind driven power conversion device, increases as the cube of wind velocity. Therefore, the wind speed distribution and not the average wind velocity is needed to determine the power available. By using wind distribution data, wind power contour maps were constructed. Population density maps were also constructed. By assigning appropriate values to the wind power and population, an optimal site selection map for the continental United States was drawn. (Author)

A77-12866 The consumer's cost of electricity from windmills. B. Quinn (USAF, Office of Scientific Research, Bolling AFB, Washington, D.C.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1746-1753. 8 refs.

An investigation is conducted of the consumer's cost of converting the kinetic energy of the wind to the electrical energy that satisfies his standard of living. The demand for energy is considered and aspects of energy storage are examined. Questions of capital investment are discussed, taking into account generator costs, expenses for rotors and controls, the dollar cost of all peripheral electrical equipment, costs for storage devices, and the cost of structural steel towers. It is found that storage costs contribute far more than other costs to the price of the consumer's electricity. The obtained costs of wind power electricity are about four times the five cents per kWh charged by public utilities in the Boston area. G.R.

A77-12867 Operational, cost, and technical study of large windpower systems integrated with existing electric utility. R. T. Smith, R. K. Swanson, C. C. Johnson (Southwest Research Institute, San Antonio, Tex.), C. Ligon (Southwest Public Service Co., Amarillo, Tex.), J. Lawrence, and D. Jordan (Texas Tech University, Lubbock, Tex.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1754-1760. Contract No. E(11-1)-2621.

A study was conducted concerning the feasibility of the use of windpower generating systems as supplemental energy sources on existing electric utilities. Wind duration, power density, and annual energy density data were calculated and computations regarding the conversion of the kinetic wind energy to useful busbar energy were carried out. Questions of energy storage are considered, taking into account the use of a compressed air storage-depleted potash mine, an employment of petroleum reservoirs, and a utilization of pumped-hydro storage. Attention is also given to cost goals, technical and operational requirements, institutional considerations, and wind generator system cost estimates. G.R.

A77-12868 A new generation scheme for large wind energy conversion systems. S. R. Yadavalli and T. S. Jayadev (Wisconsin, University, Milwaukee, Wisc.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2.
New York, American Institute of Chemical Engineers, 1976, p. 1761-1765. 5 refs. NSF Grant No. AER-75-000653.

In this paper a new generation scheme is proposed for large wind energy conversion systems. The scheme which utilizes the principle of an induction generator and which supplies power to the grid from both stator and rotor of an induction machine, is described in detail.

Theoretical evaluation of the performance of this system is presented. A comparison is made with conventional induction generators in terms of overall efficiency and annual energy collection. Based on this study, it is concluded that the proposed generation scheme could provide an economic and efficient method to convert wind energy to electrical energy. (Author)

A77-12869 Wind driven field modulated generator systems. R. Ramakumar (Oklahoma State University, Stillwater, Okla.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1766-1772. 23 refs. NSF Grant No. AER-75-00647.

Wind driven field modulated generator systems allow the aeroturbine rotational speed to vary optimally with wind to maintain a high coefficient of performance for the aeroturbine and enable the extraction of a part of the energy spilled by constant-speed constant-frequency (CSCF) Systems. After briefly surveying the various variable-speed constant-frequency (VSCF) schemes proposed for harnessing wind energy, this paper describes the system under development at Oklahoma State University. Schemes to integrate such system with conventional utility grids are presented. Economic aspects of VSCF and CSCF approaches are studied. The paper concludes with a brief discussion of the experimental research program underway. (Author)

A77-12870 Vortex kinetic energy concentrator. R. Huq and J. L. Loth (West Virginia University, Morgantown, W. Va.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1773-1778. 12 refs.

This paper describes the aerodynamic performance of a non-rotating Vortex Kinetic Energy Concentrator, a vertical high lift finite wing which is oriented into the wind. As the wing develops lift, the trailing vortex sheet rolls up to form a single vortex of significant strength. The core of the vortex is subject to low static pressure due to the centrifugal effects. The azimuthal motion in this vortex provides the core with concentrated rotational kinetic energy which can be harnessed by an appropriate rotor placed coaxially with the vortex core. As a result of this augmentation the power harnessed per unit rotor area can be increased up to five fold, thereby permitting a corresponding reduction in rotor size. The theoretical aspects of concentrating kinetic energy in the trailing wing tip vortex behind a high lift wing has been reported. Specific design criteria for the required wind turbines have been developed. The energy concentration ratio for various rotor sizes and wing loading characteristics has been computed. Significant concentration ratios are obtainable with this technique. (Author)

A77-12871 Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines. P. G. Migliore, J. B. Fanucci, and W. Squire (West Virginia University, Morgantown, W. Va.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1779-1786. 14 refs.

A numerical procedure is developed for determining the unsteady lift and moment characteristics of cross-flow wind turbines. The method employs a force-free wake model, accounts for wake/blade interaction, reflects transient aerodynamics and accommodates time varying winds. Introduction of experimental drag data permits calculation of energy extraction capacity for such devices. Typical results are presented for a straight bladed Darrieus turbine and compared to those given by strip theory. Extension of the method to multi-bladed variable pitch turbines is a part of the continuing research. The developed model will aid the systematic investigation of vertical axis wind turbines for cost effective energy conversion. (Author)

A77-12872 Design consideration for the Darrieus rotor. R. W. Thresher and R. W. Wilson (Ohio State University, Corvallis, Ohio). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1787-1794. 20 refs. Research supported by the Oregon People's Utility Districts Directors' Association; Contract No. AT(04-3)-1075.

The objective of this study was to determine the performance, operating and load characteristics of Darrieus wind turbines. The performance of Darrieus Rotors was examined using the flow model of Wilson and Lissaman. The blades of the rotors were assumed to be of a parabolic shape with the vertical height equal to twice the maximum radius. Performance curves and operating envelopes for a family of Darrieus Rotors with diameters ranging from 7.62 to 30.49 meters were determined. Aerodynamic loads are also presented for various blade positions and operating conditions. The rotors have been selected to reach maximum rated shaft power at a wind speed of 8.94 m/s (20 mph) and have a cut-off wind speed of 20.12 m/s (45 mph). A structural analysis of the Darrieus vertical axis wind turbine is also presented. The emphasis was placed on obtaining an estimate for the lead-lag bending-torsion stresses and deformations. To accomplish this task, a rather elementary model was developed where several simplifying assumptions were used; both a maximum stress based design and a maximum deformation based design were developed. (Author)

A77-12873 Operational experience with small wind units. J. Park (Helion Co., Sylmar, Calif.). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1795-1797.

The paper gives a brief review of the development of wind energy conversion systems of 10 kW size and smaller at Helion. Attention is given to generator/windwheel matching through appropriate regulator and governor design, improved equipment and procedures for installation of conversion systems on support towers, and aerodynamic design from steady state considerations. Results of Kedco model 1200 power tests (power output vs wind velocity) are presented. B.J.

A77-12874 An experimental 200 kW vertical axis wind turbine for the Magdalen Islands. R. D. McConnell, J. H. VanSant, M. Fortin, and B. Piché (Hydro-Québec Institute of Research, Varennes, Quebec, Canada). In: Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1976, p. 1798-1802. 9 refs.

A 200 kW vertical axis wind turbine will be installed in the Magdalen Islands power network which has 26 MW of installed diesel generator capacity. The site is located in the Gulf of St. Lawrence and has an average annual wind speed of 8.5 m/s. The wind turbine will be 24 meters in diameter and 37 meters in height. The turbine will be connected to the network in the fall of this year for a one year performance evaluation. The Magdalen Islands power network and the wind turbine will operate as a symbiotic system. The network will start the turbine whenever there is sufficient wind. Power supplied by the wind turbine will reduce diesel fuel consumption. Descriptions of protection and control equipment and method of operation are presented. The power output of the wind turbine is calculated on the basis of wind data acquired on the islands and performance estimates of the wind turbine. An economic evaluation is presented based on fuel costs and estimated costs of production models of the wind turbine. It is shown that the wind turbine system should prove to be economical when used in conjunction with the diesel generating plant on the Magdalen Islands. (Author)

A77-12926 Underground gasification of coal: A National Coal Board reappraisal. 1976. P. N. Thompson, J. R. Mann, and F. Williams. London, National Coal Board, 1976. 72 p. 27 refs. $8.25.

A systematic handbook on underground gasification of coal (UCG) is presented. General topics covered include: methods of UCG application; UCG costs; how the gas is utilized, stored, upgraded; energy balance, extraction efficiency, compression; environmental and safety aspects; UCG compared to other energy sources, and requirements for large-scale UCG implementation. The current situation in UCG research and development, and historical background on UCG and early trial efforts in the USSR, are also covered. Underground working and mine support problems are discussed, in addition to surface gasification, dynamics of reaction fronts, local geological problems (subsidence, faulting), and coalface fracturing techniques (explosive and hydraulic fracturing). The handbook is profusely illustrated. R.D.V.

A77-12928 An advanced energy conservation technology program; Proceedings of the Intersociety Workshop Conference, Airlie House, Va., March 24-26, 1976. Conference sponsored by AIAA, AIChE, ASHRAE, ASME, and ERDA. Edited by J. Grey (American Institute of Aeronautics and Astronautics, New York, N.Y.). New York, American Institute of Aeronautics and Astronautics, Inc., 1976. 96 p. $8.50.

The conference was assembled to consider the processes by which advanced energy conservation engineering knowledge and methods are introduced into practical end-product manufacture and use, and to examine the possibilities for accelerating these processes. Ten major technologies were identified which affect energy conservation and which utilize advanced engineering methods: waste heat recovery, instruments and controls, energy conversion (including combustion and heat transfer), energy transmission and storage, materials (including recycling), analytical methods and modeling, manufacturing processes, basic component design, system integration, and alternative energy sources. The areas of application for some or all of these techniques were grouped into five general categories: transportation, heating and cooling, electric power generation, end-product manufacture, and process industries. B.J.

A77-12933 Is nuclear energy economically viable. L. J. Perl (National Economic Research Association, Inc., New York, N.Y.). *Energy,* vol. 1, Summer-Fall 1976, p. 21-23.

An attempt is made to estimate the cost of electric energy generated both from coal- and nuclear-fired capacity in 1990. Regression equations are used to estimate capital costs for coal and nuclear capacity from 1980 to 1990. Estimated costs in 1990 of energy from the nuclear and coal plants under alternative SO2 control scenarios and at alternative capacity factors are discussed. A table describing coal demand based upon three alternative assumptions of electricity growth, nuclear capacity growth, and growth of solar and geothermal energy is presented. B.J.

A77-12934 COSTEAM: Low-rank coal liquefaction - An updated analysis. H. R. Appell (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.). *Energy,* vol. 1, Summer-Fall 1976, p. 24-26. 11 refs.

COSTEAM is a process under development at the Pittsburgh Energy Research Center of ERDA for converting lignite to a low-sulfur, low-ash industrial fuel oil. The name comes from the use of carbon monoxide (CO) and steam, which react with the lignite and convert it to an oil. This paper reports on research carried out on the substitution of synthesis gas (a mixture of carbon monoxide and hydrogen) for carbon monoxide because of its lower cost, and the achievement of a product of improved fluidity that could also be used as a slurry vehicle for pumping the coal into the high pressure hydrogenation unit. B.J.

A77-12935 Air, water, nuclear power make gasoline. M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.) and S. Baron (Burns and Roe, Inc., Oradell, N.J.). *Energy,* vol. 1, Summer-Fall 1976, p. 27-29.

The production of synthetic carbonaceous fuels using nuclear power, air and water is proposed. Nuclear power is used to generate heat and electricity which, in turn, is used to decompose water thermally and electrolytically to produce hydrogen and oxygen. CO2 is extracted from either or both the atmosphere and water. The hydrogen is combined thermocatalytically with CO2 to produce methanol which is further thermocatalytically dehydrated to synthetic hydrocarbon fuels. Tables are presented listing synthetic hydrocarbon fuel production capacity, methanol plant capital costs, methanol production cost, gasoline production cost, and projections of capacity and capital requirements for methanol fuel. B.J.

A77-12939 # Combination power plants for improved utilization of fossil fuels (Kombi-Kraftwerke für die bessere Nutzung fossiler Brennstoffe). R. Hübner. *Energie* (Zurich), vol. 19, no. 2, 1976, p. 20-22. In German.

The design and operation of combination power plants utilizing both steam turbines and gas turbines in environmentally compatible and efficient energy production, and the design of a fluidized-bed reactor for coal gasification, are described. Advantages in the use of feedstock that is uneconomical or antiecological in other power plants, efficient use of waste heat from the steam turbine by the gas turbine, absence of spent coal refuse dumps, and elimination of thermal pollution of bodies of water deviated for cooling ponds and cooling towers in conventional power plant systems, are emphasized. An American design of a fluidized-bed coal gasifier using process-purified lean gas, and the West German Lurgi gasifier, are contrasted, and data on product stream components from the two gasifier variants are tabulated. R.D.V.

A77-12940 # MHD - Energy transformation by burning coal (MHD - Energieumwandlung auf Kohlebasis). R. Hübner. *Energie* (Zurich), vol. 19, no. 2, 1976, p. 22-25. In German.

Basics of magnetohydrodynamics and MHD generators are reviewed, with a discussion of unresolved problems in MHD engineering, plasmas useful as working fluids, MHD generators based on electric power from coal dust and/or coke gas, hybrid MHD generators utilizing fossil fuels, MHD generators as entry stages to coal-fired or oil-fired power plants, and some working prototypes of MHD power generators. Inert gases, liquid metals, and combustion gases are compared as plasma working fluids. MHD current generators utilizing coal dust or coke gas as working fluid, and an air/oxygen or NO-air mixture as oxidizer, and in some cases aided by laser bombardment of working fluid, are described, and evaluated as potentially competitive with electric power generated by nuclear reactors. A 2 MW pilot facility using carbonization coke, and a USSR facility delivering 25 MW to the power grid, are mentioned as working prototypes. R.D.V.

A77-13030 # UK, T5 ion engine thrust vector control considerations. J. W. Pye (Royal Aircraft Establishment, Farnborough, Hants., England). *American Institute of Aeronautics and Astronautics, International Electric Propulsion Conference, Key Biscayne, Fla., Nov. 14-17, 1976, Paper 76-1064.* 10 p. 18 refs. Research sponsored by the European Space Agency.

An investigation is presented in which the thrust vector control (TVC) requirements for the UK, T5 ion engine were defined, as applied to the north-south station-keeping (nssk) role on present and projected European communication satellite designs. Consideration of the removal of the disturbing influence of nssk thrust vector misalignment torques indicates only small overall mass savings. However, when the principle of TVC is applied to control system momentum off-loading, the subsequent fuel savings are a strong function of the solar array disturbance torques, particularly those experienced by satellites with high power requirements. Alternative ion engine-spacecraft installation schemes, also discussed, highlight other areas where the control of the ion engine thrust vector might also be usefully employed. (Author)

A77-13033 * # NASA electric propulsion program. W. R. Hudson (NASA, Washington, D.C.) and R. C. Finke (NASA, Lewis Research Center, Electric Propulsion Branch, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, International Electric Propulsion Conference, Key Biscayne, Fla., Nov. 14-17, 1976, Paper 76-1068.* 10 p. 18 refs.

Major portions of the NASA electric propulsion technology program have attained the level of maturity required to achieve near-term technology readiness for flight missions for primary and auxiliary propulsion application. Advanced electric propulsion program elements addressing less immediate requirements are in more exploratory stages. This paper will discuss the NASA electric propulsion technology program including - planetary and earth orbit raising applications, attitude control and stationkeeping of geosynchronous satellites, and the research support program. Objectives, requirements, and hardware status are presented for each program. (Author)

A77-13151 # **The U-240 cyclotron (Tsiklotron U-240).** O. F. Nemets'. *Akademiia Nauk Ukrains'koi RSR, Visnik,* vol. 40, July 1976, p. 60-72. In Ukrainian.

The U-240 isochronous cyclotron facility at the Ukrainian SSR Nuclear Research Institute is described, with a review of basic cyclotron physics, isochronic conditions, focusing of particle bunches in the dee, relativistic constraints, synchrocyclotron operation, sector-focused poles, and a table of U-240 basic data. Auxiliary systems, including support systems, data processing, pulse analyzers, and particle extraction with quadrupole lenses, are dealt with. Research experiments (on nuclear reactions, excited states of nuclei, collective models and nucleon cluster models, radiation damage, heavy ion physics) and applications of the machine (IC manufacture using heavy-ion implantation in semiconductors, radioisotope therapy, nucleotherapy of malignancies, manufacture of optoelectronic waveguide using heavy ions) are discussed, in addition to combinations of the U-240 with fission and fusion reactors and with the EGP-20 tandem generator as heavy-ion injector. R.D.V.

A77-13242 # **Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels (Raschet turbulentnogo magnitogidrodinamicheskogo pogranichnogo sloia v kanalakh MGD-generatorov).** A. B. Vatazhin and G. R. Alavidze (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *Teplofizika Vysokikh Temperatur,* vol. 14, May-June 1976, p. 619-628. 17 refs. In Russian.

A differential equation for eddy viscosity is used in the calculation of a turbulent MHD boundary layer in high temperature MHD generator channels. It is shown that the effects of the magnetic field on boundary layer characteristics is evident in the MHD-force and heat sources accounted for in the averaged equations of motion and energy. An approximate model is developed for the effects of Joule heat transfer near the cold electrode wall of the channel. Two cases of MHD boundary layer flow are calculated: constant velocity of the outer flow, and constant pressure. B.J.

A77-13243 # **Study of the properties of heat pipes with liquid-metal heat-transfer agents in low-temperature regimes (Issledovanie kharakteristik teplovykh trub s zhidkometallicheskimi teplonositeliami v nizkotemperaturnykh rezhimakh).** P. I. Bystrov and A. N. Popov. *Teplofizika Vysokikh Temperatur,* vol. 14, May-June 1976, p. 629-637. 18 refs. In Russian.

A method is outlined for the theoretical study of the properties of heat pipes containing liquid-metal heat-transfer agents at low vaporization temperatures. This method takes into account the compressibility and friction of the vapor flow, heat-load nonequilibrium along the length of the vaporization zone, and the temperature dependence of the properties of the heat-transfer agent. It is shown that the capacity of heat pipes in sonic flow regimes depends substantially on the geometric dimensions of the vaporization zone; i.e., the diameter of the vapor duct and the ratio of zone length to diameter. The calculations also indicate that neglect of the friction of the vapor flow leads to errors of 50% or more in determining the sonic limit. The theoretical results are found to be in good agreement with experimental measurements in a vapor duct and with empirical data on the sonic limit of heat transfer. The greatest discrepancy between theory and experiment does not exceed 10%. F.G.M.

A77-13254 # **Evaporation of solution droplets in a high-temperature medium (Isparenie kapli rastvora v vysokotemperaturnoi srede).** A. M. Golovin (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) and V. R. Pesochin (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *Teplofizika Vysokikh Temperatur,* vol. 14, July-Aug. 1976, p. 814-822. 25 refs. In Russian.

The evaporation of an isolated droplet of an aqueous solution of potassium carbonate in combustion products of a fuel gas is analyzed. It is shown that the droplet goes through the following stages: heating; evaporation of water, accompanied by the formation of a saturated solution; evaporation of this solution, accompanied by the formation of a solid phase; heating and melting of the solid phase; and finally heating and evaporation of the liquid potassium carbonate. Semiempirical formulas are proposed for calculating the drag coefficient and Nusselt number in the motion of an evaporating droplet. Evaporation and melting are calculated in a quasi-steady approximation. V.P.

A77-13258 # **Influence of various losses on the characteristics of high-power MHD generators (O vliianii razlichnykh poter' na kharakteristiki moshchnykh MGD-generatorov).** V. A. Bitiurin, P. P. Ivanov, V. I. Kovbasiuk, and G. M. Koriagina (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *Teplofizika Vysokikh Temperatur,* vol. 14, July-Aug. 1976, p. 846-852. 9 refs. In Russian.

The hydrodynamic characteristics of MHD flow are discussed for generators of the type used in 1000 MW open-cycle power plants. Detailed attention is given to the influence on the output characteristics of electrodynamic effects associated with the nonuniformity of the flow in boundary layers, the electrode phenomena, the nonuniformity of conductivity across the channel, the Hall effect in flows with a nonuniform conductivity, and end effects. The analysis is aimed at identifying basic errors in conventional (quasi-one-dimensional) computations of the gasdynamic and electric characteristics of MHD flows, and the causes of the errors. The need to thoroughly analyze the influence of conductivity nonuniformity and to optimize the flow conditions is pointed out. V.P.

A77-13323 **Dependability of wind energy generators with short-term energy storage.** B. Sorensen (Copenhagen, University, Copenhagen, Denmark). *Science,* vol. 194, Nov. 26, 1976, p. 935-937. 9 refs.

Power fluctuations and power duration curves for wind energy generators, including energy storage facilities of a certain capacity, are compared to those of typical nuclear reactors. A storage system capable of delivering the yearly average power output for about 10 hours already makes the dependability of the wind energy system comparable to that of a typical nuclear plant. (Author)

A77-13336 **A hydride compressor (Un compresseur à hydrure).** M. Laguës. *La Recherche,* vol. 7, Nov. 1976, p. 962, 963. In French.

A chemical compressor is proposed as a link in an improved power generation cycle adaptable to existing power plants, and utilizing hydrogen (in iron-titanium hydride form) as working fluid. Concepts developed at Philips (Eindhoven) and at Brookhaven are described. The hydrides not only provide compact storage of hydrogen, but rapid and efficient heat release. Small temperature differences become usable, as in low-cost low-calorie sources such as geothermal sites, solar energy, waste-heat recovery. Waste heat volume would be cut down and pollution minimized. Problems associated with the slow kinetics of the reaction, enclosures needed to withstand high hydrogen pressures, supplies of titanium available, and costs effects in a power plant setting are touched upon. R.D.V.

A77-13335 **Noise mechanism separation and design considerations for low tip-speed, axial-flow fans.** R. E. Longhouse (GM Research Laboratories, Warren, Mich.). *Journal of Sound and Vibration,* vol. 48, Oct. 22, 1976, p. 461-474. 5 refs.

A77-13501 **Life-cycle costs and solar energy.** R. Ruegg (National Bureau of Standards, Institute for Applied Technology, Washington, D.C.). *ASHRAE Journal*, vol. 18, Nov. 1976, p. 22-25. 6 refs.

Techniques of life-cycle cost evaluation are examined as prospective means of assessing the cost effectiveness of solar energy systems as compared to rival energy systems. Acquisition costs (including system design, purchase, installation), system repair and replacement costs, maintenance and operating costs, and salvage values are considered in a present-value or annual-value model. Relevant tax policies and clean-energy incentives are also considered. A present-value evaluation model is presented in abbreviated form, incorporating: direct costs (down payment, loan principal and interest), insurance costs, direct cost savings in value of fuel economized, property taxes and sales taxes, tax deductions, and incentives. R.D.V.

A77-13502 **Optimizing solar cooling systems.** A. B. Newton. *(International Institute of Refrigeration, Meeting, Melbourne, Australia, Sept. 6-10, 1976.)* *ASHRAE Journal*, vol. 18, Nov. 1976, p. 26-31.

An approach is developed to aid optimization of a solar energy system used to cool buildings. Relationships between the expected load and the ambient surroundings, the temperature at which the absorption system rejects its heat, the coefficient of performance (ratio of thermal kW cooling effect to thermal kW required to energize), overall energy requirements, and energy savings are examined. Suitable storage systems, the array of flat-plate collectors, and performance of a system using lithium bromide absorber and water refrigerant are discussed. R.D.V.

A77-13503 **Atlanta /Towns/ solar experiment - The lessons we learned.** A. Weinstein, R. T. Duncan, and W. C. Sherbin (Westinghouse Electric Corp., Special Systems Div., Baltimore, Md.). *ASHRAE Journal*, vol. 18, Nov. 1976, p. 32-35.

A rooftop solar heating and cooling plant, with sawtooth arrays of tilted flat plate collectors, was tested with data collected over several months from 60 data points (collector plate temperatures, inlet and exit temperatures of water to collectors, storage tank temperature, flow rates). Collector failure data are reported, and a storage tank farm, flat reflectors, and an absorption chiller are described. Tentative findings are presented on: reflector performance, overall system performance in heating and cooling modes, tank farm costs (piping, fittings, valves), thermodynamic performance of the drain-down system, and comparison of the collectors with expected performance of some new improved collector designs. R.D.V.

A77-13504 **Feasibility of a satellite solar power station /SSPS/.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *ASHRAE Journal*, vol. 18, Nov. 1976, p. 36-40. 8 refs.

Service life, energy conversion efficiencies, costs and revenues, pointing problems, energy conversion options, and earth-side thermal pollution are discussed in relation to the satellite solar power station concept (SSPS) beaming solar energy converted to microwaves to subsatellite points on earth. Solar energy available in space at geostationary orbit (22000 mi) is 4 to 15 times that available anywhere on earth, heat dissipation is no problem for unenclosed microwave devices in space, and earth-side thermal pollution problems are minimal compared to conventional power plants. Long life in orbit and high conversion efficiencies attained or projected, requirements for lifting large structure parts into orbit, dimensions of projected large structures, sunward pointing of the solar cell panels and earthward pointing of the microwave antenna, and earth-side problems (land use, microwave exposure, energy payback, radio interference, ionosphere interactions) are discussed. R.D.V.

A77-13505 **Evaluating a solar energy concentrator.** R. L. Pendleton (South Dakota School of Mines and Technology, Rapid City, S. Dak.). *ASHRAE Journal*, vol. 18, Nov. 1976, p. 47-50.

Studies of the linear Fresnel lens (LFL), as low-level solar energy collector, are outlined, with emphasis on lens symmetry, lens efficiency, and water spotting of the lens. Possible advantages offered by LFL collectors include: low cost, convenient interfacing of air conditioning with flat plate collectors, compatibility with absorption type air conditioners, relaxed tolerances on lens precision, modest concentration of LFL needed for applications in heating of hot water and room space (houses and barns). Test data on four LFL are reported. Rotation of LFL specimens was also studied. R.D.V.

A77-13506 **The Shenandoah Community Center - A total solar design concept.** S. F. Bruning and M. S. George (Newcomb and Boyd, Atlanta, Ga.). *ASHRAE Journal*, vol. 18, Nov. 1976, p. 53-56. 7 refs.

Various aspects of the solar heating and cooling (SH/C) system are described. Space heating/cooling and hot water supply are handled by the SH/C system featuring 10,584 sq. ft reflector-augmented flat plate collectors, a 200-ton LiBr absorption chiller, 20,000 gal. hot water storage and 60,000 gal. chilled storage. The piping system, hot water storage tank, load-bearing supports for the collectors, structure and design of the collectors, and handling of working fluids expansion are described. Cooling loads and operating modes for summer and winter service and with insufficient, sufficient, or excess insolation, are described. Computer simulation studies of the SH/C installation are mentioned. R.D.V.

A77-13509 **Schottky solar cells on thin epitaxial silicon.** W. A. Anderson, S. M. Vernon, P. Mathe, and B. Lalevic (Rutgers University, New Brunswick, N.J.). *Solid-State Electronics*, vol. 19, Dec. 1976, p. 973, 974. 6 refs. Research supported by the Exxon Co. and NSF.

Schottky solar cells fabricated on 10, 20 and 30 micron epitaxial silicon produce a current density ranging from about 10-22 mA/sq cm, depending on Si thickness and orientation, in close agreement with theoretically predicted data. These results are also in close agreement with recent data on p-n solar cells, using thin epitaxial silicon. Data reported herein predict that 10% efficient Schottky solar cells could be produced using about 20 microns of silicon on a suitable substrate. A 7.6% efficient Schottky solar cell on epitaxial silicon has been recently fabricated and tested using AM1 sunlight (100mW/sq cm). (Author)

A77-13538 * **Stage efficiency in the analysis of thermochemical water decomposition processes.** W. L. Conger, J. E. Funk, R. H. Carty, M. A. Soliman (Kentucky, University, Lexington, Ky.), and K. E. Cox. *International Journal of Hydrogen Energy*, vol. 1, Oct. 20, 1976, p. 245-250. 7 refs. Grant No. NGR-18-001-086.

The procedure for analyzing thermochemical water-splitting processes using the figure of merit is expanded to include individual stage efficiencies and loss coefficients. The use of these quantities to establish the thermodynamic insufficiencies of each stage is shown. A number of processes are used to illustrate these concepts and procedures and to demonstrate the facility with which process steps contributing most to the cycle efficiency are found. The procedure allows attention to be directed to those steps of the process where the greatest increase in total cycle efficiency can be obtained. (Author)

A77-13539 **A new hydrogen storage electrode.** G. Bronoel, J. Sarradin, M. Bonnemay (CNRS, Laboratoire d'Electrolyse, Meudon, Hauts-de-Seine, France), A. Percheron, J. C. Achard, and L. Schlapbach (CNRS, Laboratoire des Terres Rares, Meudon, Hauts-de-Seine, France). *International Journal of Hydrogen Energy*, vol. 1, Oct. 20, 1976, p. 251-254. 6 refs.

This paper presents experimental evidence that it is possible to use a cathodic charge to store hydrogen on compounds such as LaNi5. Using an alkaline medium (KOH 5N) in an unpressurized system at 20 C, the mass capacity was found to be approximately 330 mAH/g (5H/mol LaNi5). Comparison of these results with the solid-gas isotherms indicated that the hydrogen is held in a nonequilibrium state. The influence of temperature, stoichiometry and substitution in the LaNi5 on the capacity are presented. (Author)

A77-13540 **Hydrogen production using solar radiation.** T. Ohta (Yokohama National University, Yokohama, Japan) and T. N. Veziroglu (Miami, University, Coral Gables, Fla.). *International Journal of Hydrogen Energy*, vol. 1, Oct. 20, 1976, p. 255-263. 31 refs.

Various water-splitting methods using solar energy are reviewed and compared to each other. Direct thermal method has the highest efficiency, however it poses difficulties because of the need for heat-resisting materials. Thermochemical method becomes promising if corrosion-resisting materials are found. Electrolytic method is straightforward and conventional. However, a hybrid system combining electrolytic method with thermochemical and/or photochemical methods looks promising and is believed to result in optimum conversion efficiencies in the near future. Photolysis and biochemical methods are environmentally most acceptable, but are of low conversion efficiencies presently. (Author)

A77-13541 * **Hydrogen production via thermochemical cycles based on sulfur chemistry.** M. A. Soliman, W. L. Conger, R. H. Carty, J. E. Funk (Kentucky, University, Lexington, Ky.), and K. E. Cox. *International Journal of Hydrogen Energy*, vol. 1, Oct. 20, 1976, p. 265-270. 14 refs. Grant No. NGR-18-001-086.

A77-13543 **Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant.** A. H. Beaufrere, F. J. Salzano, R. J. Isler, and W. S. Yu (Brookhaven National Laboratory, Upton, N.Y.). *International Journal of Hydrogen Energy*, vol. 1, Oct. 20, 1976, p. 307-319. 5 refs. ERDA-sponsored research.

Work is in progress at the Brookhaven National Laboratory for the development of bulk storage techniques for hydrogen using iron-titanium. The program consists of a variety of activities which include engineering analysis and design of a large bulk hydrogen storage facility, engineering-scale tests, work on the selection and development of suitable iron-titanium alloys, and the construction of a large prototype energy storage system. Based on these engineering studies, a preliminary plant design and cost estimate is presented for a 26 MW(e) hydrogen storage peaking electric power plant, with hydrogen production via water electrolysis, iron-titanium metal hydride hydrogen storage beds and hydrogen-air fuel cells for reconversion to electricity. Cost estimates of a similar plant incorporating advanced technology components are made and compared with allowed costs for such systems. Description of R & D requirements to achieve these goals is discussed. (Author)

A77-13589 # **The nature and characteristics of the distribution of helium and argon isotopes in the geothermal waters of the Kuril Islands and Kamchatka (O prirode i zakonomernostiakh raspredeleniia izotopov geliia i argona v termal'nykh vodakh Kuril'skikh Ostrovov i Kamchatki).** L. K. Gutsalo (Akademiia Nauk Ukrainskoi SSR, Institut Geologii i Geokhimii Goriuchikh Iskopaemykh, Lvov, Ukrainian SSR). *Geokhimiia*, June 1976, p. 886-895. 28 refs. In Russian.

A77-13624 **Windmills stage a comeback.** T. S. Jayadev (Wisconsin, University, Milwaukee, Wis.). *IEEE Spectrum*, vol. 13, Nov. 1976, p. 44-49.

Technical and economic problems in practical harnessing of wind power to generate electric power are surveyed, with various types of wind-responsive rotors contrasted, cost items examined, and direct coupling to the power grid examined. Total system costs are stressed, options of large rotors and a windmill farm with small rotors are considered, and problems with random inputs, damping out sharp transients, handling resonant frequencies, and rotor pitch control for constant output are discussed. Investment costs, costs of dc-ac conversion and rectification, costs of conversion from random-frequency to constant-frequency power, thyristor costs, microprocessor control, and generator costs are dealt with. Wind power is taken as proportional to the cube of wind velocity, and an estimate of several million MW recoverable useful power from the world's 100 trillion MW wind power is ventured. R.D.V.

A77-13643 # **Transport of the future and the tasks of science (Transport budushchego i zadachi nauki).** D. P. Velikanov. *Akademiia Nauk SSSR, Vestnik*, no. 8, 1976, p. 10-26. In Russian.

The prospects of the development of transportation into the relatively distant future (into the twenty first century) are examined in the context of scientific and technological progress, neglecting social, economic and political factors. Attention is given to future developments in air transportation, surface rapid transit (rail, ground-effect, magnetic levitation, etc.), urban passenger transportation (e.g., subways), automobiles, and freight transportation. Problems of transportation energy are considered. B.J.

A77-13648 * # **Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1.** J. D. Friedman, D. M. Preble, and S. Jakobsson. *U.S. Geological Survey, Journal of Research*, vol. 4, Nov.-Dec. 1976, p. 645-659. 22 refs. Research sponsored by the Icelandic Museum of Natural History, U.S. Geological Survey, and NASA.

The net geothermal flux through palagonitized basaltic tephra rims of the Surtur I and Surtur II craters at Surtsey, Iceland, in 1972, is estimated at 780 plus or minus 325 microcal/sq cm/s, indicating a decline since 1969 when a flux of 1500 microcal/sq cm/s was estimated. Heat flux in this range characterizes the postvolcanic environment on Surtsey in which the subaerial palagonitization of basaltic tephra is associated with mass transfer of hydrothermal vapor, either of meteoric or sea-water origin, only a few years after cessation of eruptive activity. The flux estimation is the result of the Surtsey data-relay experiment via Landsat-1 which was carried out in several phases. Temperature data were transmitted for a 38-day period in November and December 1972. A near-surface vertical gradient of 69.4 C/m was obtained, suggesting a mixed mechanism of heat transfer, partitioned between conduction and convection. (Author)

A77-13704 # **Dual optimum aerodynamic design for a conventional windmill.** H. J. Stewart (California Institute of Technology, Pasadena, Calif.). *AIAA Journal*, vol. 14, Nov. 1976, p. 1524-1527.

The theoretical possibility of designing the blading of a conventional windmill so as to match the optimum loading for maximum output at two different operating conditions (i.e., at two different values of the ratio of tip speed to wind speed) is investigated using the vortex blade element theory. The theory of optimum loading is developed, including the effect of profile drag. For the range of parameters considered, it is shown that the effect of profile drag on blade loading is quite small, although the effect on efficiency is significant. The simpler theory, neglecting profile drag, and first presented by Glauert, then is used to design three sets of blading which match the Glauert loading conditions at two conditions, tip speed ratios of 4 and 5. The first design is for fixed blading and the other two involve pitch changes of 1.5 deg and 2 deg between the two conditions, the latter two showing a moderate degree of taper and being more desirable from a structural design point of view. It is concluded that the possibility of designing blading having high efficiency over a considerable range of operating conditions exists and can be used. (Author)

A77-13711 # **Boundary-layer separation from the electrode wall of an MHD generator.** C. C. P. Pian and W. F. H. Merck (Eindhoven, Technische Hogeschool, Eindhoven, Netherlands). *AIAA Journal*, vol. 14, Nov. 1976, p. 1585-1588. 15 refs.

The compressible, laminar boundary-layer separation from the finitely segmented electrode wall of an MHD generator has been investigated, using a simplified model in order to obtain a quick physical understanding of the particular influence of the segmentation upon the separation process. Calculations, using an implicit finite-difference scheme, were carried out for a variety of externally imposed conditions, for two different electrical conductivity models, and for different kinds of wall boundary conditions in the solution of the energy equation. Results showed that any variations in the externally imposed parameters which tend to increase the Ohmic heating in the duct, to increase the magnitude of the axial Lorentz force, or to decrease the inertia of the fluid elements in the near-wall

region will favor earlier separation. In the cases where the wall temperature is specified a priori, separation was found to be nearly independent of the two electrical conductivity models used in the calculations. Separation is also favored in situations where the duct walls are incapable of conveying away the excess Joule heating in the boundary layers. (Author)

A77-13728 # **Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/.** S. Ikeda, T. Masuda, Y. Kusaka, T. Honda, and Y. Aiyama (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). *AIAA Journal*, vol. 14, Nov. 1976, p. 1655, 1656. 6 refs.

Experimental conditions and results of a power generating experiment on a Al2O3 coated peg-wall type MHD generator with a large-scale superconducting magnet are described. This generator features a superconducting magnet, a cold wall Faraday type generating channel, and a combustor (25 MW thermal input) for investigating generating characteristics in a strong magnetic field. Predicted gas temperatures are compared to empirical values, geometrical parameters of the arrangement are reported, and experimental and theoretical distributions of heat flux, static pressure, and current (open-voltage and short-circuit) are plotted. Maximum output 482 kW and total short-circuit current 2820 A were obtained at 3 kg/sec mass flowrate. The cooling time (by various methods) and field raising time of the magnet are reported, along with output power extraction. R.D.V.

A77-13736 **Electric vehicle batteries - Opportunities for materials improvement.** E. W. Brooman and J. E. Clifford (Battelle Columbus Laboratories, Columbus, Ohio). *SAMPE Journal*, vol. 12, Jan.-Feb. 1976, p. 4-10. 51 refs.

Materials problems exist with both active and inactive battery components. These problems are identified for the battery systems in contention for electric vehicle propulsion, and fall under the general categories of (1) low ratio of practical to theoretical energy density, (2) active component capacity losses, (3) corrosion of inactive components, (4) inadequate separator materials, (5) unavailability of hermetic seals, and (6) restricted availability or high cost of certain materials. Current research to solve some of these materials problems is outlined, and opportunities for materials improvement are suggested. (Author)

A77-13739 **Some material considerations involved in the application of solar energy to electric power generation.** R. L. Gervais, H. Taketani, H. W. Babel, and G. F. Pittinato (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). *SAMPE Journal*, vol. 12, Mar.-Apr. 1976, p. 12-19. 14 refs.

A progress report is made on two basic approaches to generating electrical power using solar energy: local absorption system and central absorption system. The main difference between the two approaches is that the central absorption relies upon optical transportation of energy while the local absorption relies upon piping of thermal energy. The activities and issues associated with the formation of noncondensable gases in water heat pipes are discussed, along with some of the activities and issues for material selection and some considerations for the solar concentrator. The technical issues all appear to be resolvable with current technology. Innovative concepts, however, are required to make solar electric power competitive. S.D.

A77-13743 **Practical aspects of solar heating - A review of materials use in solar heating applications.** D. P. Grimmer and S. W. Moore (California, University, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.). *SAMPE Journal*, vol. 12, June-Aug. 1976, p. 12-17. 18 refs.

A review of materials use in solar heating of buildings is presented with the emphasis on outlining important criteria for selecting materials for a particular application. The most important criteria to consider in solar-heating materials applications are durability and cost-effectiveness. In the area of active solar heating systems, materials use in flat-plate collectors is discussed for the various collector components. In addition, materials use is presented for the area of passive solar systems (sun-tempered buildings). (Author)

A77-13811 # **The conservation of air purity and its effect on the energy economy (Die Luftreinhaltung und ihre Auswirkungen auf die Energiewirtschaft).** K. Kny (Dresden, Hygieneinstitut, Dresden, East Germany) and P.-J. Hentschel (VEB Energiekombinat Ost, East Germany). *Wissenschaftliche Zeitschrift*, vol. 25, no. 4, 1976, p. 851-854. In German.

Questions concerning the importance of air purity conservation are examined, taking into account general objections of antipollution regulations, air pollution sources and their effect on the environment, and air hygiene requirements. An investigation is conducted regarding the approaches which in the German Democratic Republic can be used to satisfy environmental requirements with respect to air purity. Attention is given to the employment of suitable fuels, operational and investment costs, and an economical evaluation of the measures for the conservation of air purity. Procedures for the implementation of optimal solutions are also discussed. G.R.

A77-13831 # **A 2-MW electric arc generator with porous cooling of the interelectrode insert (Elektrodugovoi generator s poristym okhlazhdeniem mezhelektrodnoi vstavki moshchnost'iu 2 MgVt).** A. B. Karabut, V. N. Korshunov, Iu. V. Kurochkin, A. V. Pustogarov, and M. N. Supronenko. *Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskikh Nauk*, June 1976, p. 10-13. 6 refs. In Russian.

Performance tests were conducted on a linear arc generator of plasma with air cooling of the interelectrode insert through a porous wall. Tests were conducted in the arc power range of 100-2000 kW and an air mass flow rate of 0.05-1.0 kg/s. Volt-ampere characteristics of the arc were examined and thermal efficiency and mean temperature were studied as a function of arc power at different flow rates of the injected air. The thermal efficiency of the generator was found to be 90-95%. B.J.

A77-14261 **New modes of operation for avalanche diodes - Frequency multiplication and upconversion.** P.-A. Rolland, J. L. Vaterkowski, E. Constant, and G. Salmer (Lille I, Université, Villeneuve-d'Ascq, Nord, France). *IEEE Transactions on Microwave Theory and Techniques*, vol. MTT-24, Nov. 1976, p. 768-775. 20 refs. Research supported by the Délégation Générale à la Recherche Scientifique et Technique.

The nonlinear properties of avalanche diodes can be exploited for use as frequency multipliers and upconverters. Among the various possible modes of avalanche device operations, the two mentioned above evoke great interest because of their high conversion efficiency. Basic principles, theoretical predictions, and experimental results are outlined in some detail and indicate both the present state of development as well as the performance achieved using avalanche devices operated in this manner. (Author)

A77-14319 # **Diffuse thermal model of electrode erosion for MHD generators (Diffuzionno-teplovaia model' erozii elektrodov MGD generatora).** V. N. Soshnikov. *Inzhenerno-Fizicheskii Zhurnal*, vol. 31, Sept. 1976, p. 437-442. 7 refs. In Russian.

The diffusion/heat conduction model proposed is based on relating the erosion and the arc-spot lifetime to the decrease in time of the vapor concentration of electrode materials at the surface of the erosive cavity. For sufficiently strong transverse plasma flows, the vapor concentration is determined from a quasi-steady diffusion equation for the erosive cavity. The temperature/radius relationship is found from a heat equation at a given empirical heat flux to the spot, while the time behavior of the radius is defined by the evaporation rate. The model is used to evaluate the characteristic lifetimes of cathode arc spots and the erosion of graphite, copper, iron, and chromium electrodes under conditions of MHD-generator operation. The appreciable influence of the geometrical shape of the erosive cavity on the erosion rate is pointed out. V.P.

A77-14321 # **Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks (Issledovanie teplofizicheskikh kharakteristik nizkotemperaturnykh teplovykh trub s metallovoloknistymi fitiliami).** M. G. Semena, A. G. Kostornov, A. N. Gershuni, V. K. Zaripov, and A. L. Moroz (Kievskii Politekhnicheskii Institut; Akademiia Nauk Ukrainskoi SSR, Institut Problem Materialovedeniia, Kiev, Ukrainian SSR). *Inzhenerno-Fizicheskii Zhurnal,* vol. 31, Sept. 1976, p. 449-455. 5 refs. In Russian.

The heat transfer capacity and thermal resistance of heat pipes employing copper-fiber wicks were studied experimentally. It is shown that heat tubes with such wicks are characterized by a low thermal resistance and a high heat-transfer capacity, and that they function satisfactorily at any orientation in a gravitational field. V.P.

A77-14326 # **Structural heat conductivity of fiber metal wicks for heat pipes (Karkasnaia teploprovodnost' metallovoloknistykh fitilei teplovykh trub).** M. G. Semena, A. G. Kostornov, V. K. Zaripov, A. L. Moroz, and M. S. Shevchuk (Kievskii Politekhnicheskii Institut; Akademiia Nauk Ukrainskoi SSR, Institut Problem Materialovedeniia, Kiev, Ukrainian SSR). *Inzhenerno-Fizicheskii Zhurnal,* vol. 31, Oct. 1976, p. 581-586. 13 refs. In Russian.

The effective heat conductivity in direction normal to the fiber plane was determined by a stationary comparison technique for sintered monodisperse wicks prepared of copper, nickel, stainless steel, and Nichrome fibers measuring 20, 30, 40, 50, and 70 microns in diameter. The conductivity is studied as a function of the fiber material, the porosity (ranging from 20 to 96%), and the fiber diameter. V:P.

A77-14327 # **Investigation of gas-controlled heat pipes with reservoirs of constant and variable volume (Issledovanie gazoreguliruemykh teplovykh trub s ballonami postoiannogo i peremennogo ob'ema).** V. V. Barsukov (Odesskii Tekhnologicheskii Institut Kholodil'noi Promyshlennosti, Odessa, Ukrainian SSR). *Inzhenerno-Fizicheskii Zhurnal,* vol. 31, Oct. 1976, p. 587-593. 5 refs. In Russian.

The performance characteristics of gas-controlled heat pipes is analyzed for pronounced fluctuations of the temperatures of the heat release area and the medium about the reservoir. An expression which can be used to evaluate the possibility of using a heat pipe with a hot reservoir of constant volume under various conditions is derived, along with an equation for calculating heat pipes with a reservoir of variable volume. V.P.

A77-14328 # **Gas release during long-term operation of heat pipes (K voprosu gazovydeleniia pri dlitel'noi rabote teplovykh trub).** V. V. Gil', E. N. Minkovich, and A. D. Shnyrev (Akademiia Nauk Belorusskoi SSR, Institut Teplo- i Massoobmena, Minsk, Belorussian SSR). *Inzhenerno-Fizicheskii Zhurnal,* vol. 31, Oct. 1976, p. 594-600. 9 refs. In Russian.

Gassing processes are analyzed for low-temperature heat pipes employing hydrogen-containing heat transfer agents. The influence of noncondensing gases on the service life of low-temperature heat pipes is examined. It is shown that the mass of the released gas is defined by thermal dissociation, chemical dissolution, and electrochemical dissociation, the latter usually playing the principal part. A method of calculating gassing is developed on the basis of theoretical considerations. V.P.

A77-14530 **An alternative fuel for cars.** J. S. Chatterjee and P. Som (Jadavpur University, Calcutta, India). *Electronics and Power,* vol. 22, Aug. 1976, p. 528, 529.

The paper is concerned with an effective solution of easy and inexpensive production and safe storage of hydrogen for use as a fuel for automobiles. The discussion covers raw materials and chemistry, total power requirements, payload comparisons, and system layout, with particular reference to electrolysis of sodium hydroxide and sodium chloride. The hydrogen tank at 2 atm serves only as a buffer to start the engine and maintain the engine cycle until the generation of hydrogen from the reaction chamber reaches the engine. The reaction chamber will ultimately be filled with sodium hydroxide, which can be recovered for the recycling process. The total electrical energy required for running the car by recycling sodium hydroxide is 24,000,000 MWh. S.D.

A77-14531 **Wind-power generation on a large scale - A design idea.** T. Mensforth. *Electronics and Power,* vol. 22, Aug. 1976, p. 530-532.

The Orkney windmill project developed around 1950 is shown to suffer from design faults. Failure of the project is attributed to design unsuitability for rough local conditions, inadequacy of dampers, weakness of the rotor/blade system, oil contamination in the control gear, corrosion by salt-laden air, and site remoteness. Instead, the paper proposes a 10 MW windmill design which is within the practical experience of constructional engineers and ship builders. The design employs an aluminum rotor with 24 blades supported at the hub (roots), tips and intermediately. The rotor is 183 m in diameter with 15 m tip to ground clearance and rotates at 8 rpm. The rotor is carried by four drive rollers and two guide rollers, all 3 m steel-treaded and with rubber backing for silence, each drive roller driving directly a low-speed induction generator. Braking is by dc injection to the generators and friction pads on the roller track. Preset pitch adjustment is desirable for tuning and possible changes in wind regimes. The major costs are in the structure and mechanical parts, as the rotor is estimated to weigh about 700 tons. S.D.

A77-14559 # **Aerodynamics of the Darrieus rotor.** R. E. Wilson, S. N. Walker (Oregon State University, Corvallis, Ore.), and P. B. S. Lissaman (Aero Vironment, Inc., Pasadena, Calif.). *Journal of Aircraft,* vol. 13, Dec. 1976, p. 1023, 1024. 8 refs. NSF Grant No. AER-74-04014A03.

To analyze a Darrieus type crosswind-axis wind turbine, the forces on the system are expressed by a momentum analysis of the wake and by an airfoil theory at the lifting surface. Equating wake and wing forces yields equations for determining induced flows. Some available experimental data on rotor power and thrust coefficients are compared with theoretical results of Wilson and Lissaman (1974). P.T.H.

A77-14560 **Energy and environment post-2000 (Energie et environnement après l'an 2000).** R. Gibrat. *Sciences et Techniques,* Nov. 1976, p. 5-14. 17 refs. In French.

General environment and energy resources and disposal problems extrapolated to the next century are surveyed, with focus on: hydrogen/electricity economy, global climatology and CO2 disposal, long-term climatological changes and predictions of interglacial era duration, and applications of topology and catastrophe theory to environment and climatology problems. Projections on population level, energy needs and resources, and a population of 12 billion using 60 TW energy are considered for the year 2000 and beyond. The basics of Thom (1970) catastrophe theory and possible applications are outlined. Disposal of waste heat and excess CO2 generated by industry in the waters of the Antarctic (Weddell sea) is weighed, favorably, in the light of oceanographic data. R.D.V.

A77-14561 **Energy consumption in various modes of transportation (Consommation d'énergie des divers modes de transports).** P. Le Vert (Commission des Comptes des Transports de la Nation, France). *Sciences et Techniques,* Nov. 1976, p. 26-29. In French.

Comparisons are made between amounts of petrochemical products consumed by various types of vehicles (private automobiles, trucks, large trucks, aircraft, railways, subways, ships) in Europe or in France in particular, and of passenger utilization of various means of transportation, particularly in the wake of the recent fuel crisis. Ways in which work is done by vehicles consuming energy are outlined and compared for different types of vehicles, along with data on ton-kilometers of cargo moved and seat-kilometers of passengers moved. Some slight slackening in the use of private transportation with the fuel crisis is noted, with subsequent resumption more than making up for the decrease, and passenger

preference for public transportation is shown to depend more on the conveniences and quality of those services than on fuel prices. R.D.V.

A77-14562 Evolution of the concept of the automobile from the standpoint of saving energy (L'évolution de la conception de l'automobile en vue d'économiser l'énergie). R. Choulet (Société SARE-Charles Deutsch, France). *Sciences et Techniques,* Nov. 1976, p. 31-33. In French.

Ways of cutting manufacturing costs and associated energy consumed in the fabrication of automobiles, approaches to reducing work done by the vehicle in overcoming resistances on the road, comparisons and analysis of various modes of automotive engine output, and a comparison of electrically powered and fuel-burning automobiles are presented. Modes of automobile performance discussed include: thermodynamic performance, shape of thermodynamic cycle, how the fuel is utilized, and mechanical performance. Power transmission efficiency, effect of the weight of the vehicle, air drag, and tire rolling friction are also discussed. A national policy to spur fuel savings and offer incentives for economizing on energy use is recommended. R.D.V.

A77-14563 Air transportation and fuel consumption (Transport aérien et consommation d'énergie). J.-C. Wanner (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *Sciences et Techniques,* Nov. 1976, p. 34-36. In French.

Various options available in present technology for reducing fuel consumption and holding air travel costs down are examined. Improvements in thermodynamic efficiency by altering specific fuel consumption and bypass ratio, and two ways of raising the temperature upstream of the turbine, are considered. The advantages of the delta sweepback wing and supercritical airfoils are outlined, in addition to possible weight reduction through the use of new advanced materials (more Ti, less steel, more composites) and optimized dimensional design of aircraft by finite element methods. Control configured vehicle approaches to aeronautical design are outlined briefly, and the outlook for reliance on liquid hydrogen as fuel is sketched. R.D.V.

A77-14564 Energy recovery in railway and road transportation (La récupération de l'énergie dans les transports ferroviaires et routiers). P. Patin (Régie Autonome des Transports Parisiens, Paris, France). *Sciences et Techniques,* Nov. 1976, p. 37-44. In French.

The outlook for recovery and re-use of the energy expended in braking, control, and turning in the handling of tracked and free-wheeling vehicles is surveyed. Only electrical energy recovery systems for railway transportation have been implemented, efforts with steam engines have been dropped long ago, and there is no record of such work on Diesel systems. System interactions are discussed, and various dc and ac systems for energy recovery are outlined, along with inertial (flywheel) energy storage and release systems for subways and suburban lines. Requirements for energy recovery in roadway vehicles, and some suggestions advanced for designing vehicular energy recovery systems (including inertial steering wheels), are presented. R.D.V.

A77-14578 # Characteristics of a system for transmitting concentrated solar radiation (Osobennosti sistem peredachi kontsentrirovannogo solnechnogo izlucheniia). V. K. Baranov (Gosudarstvennyi Opticheskii Institut, Leningrad, USSR). *Geliotekhnika,* no. 5, 1976, p. 15-25. 5 refs. In Russian.

The paper examines a system for transmitting concentrated solar energy over various distances, which uses hollow optical waveguides to gather rays in the output pupil after reflection from the waveguide walls. The relations between transmission capacity and the ratios of concentrator to waveguide diameter and waveguide length to concentrator geometry are investigated. The reflection coefficient of several waveguide materials (Cu, Al, and Ag) is studied. B.J.

A77-14579 # Energetic calculation of the concentrating capacity of paraboloidal facets (Energeticheskii raschet kontsentriruiushchei sposobnosti paraboloidnykh fatset). R. A. Zakhidov and A. Sh. Khodzhaev (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 5, 1976, p. 26-30. In Russian.

The distribution of radiant vectors in the concentration field of long-focal paraboloidal mirrors (facets) of solar concentrators at different angles of incidence is studied. Formulas are obtained for the distribution of radiant flux density on planes perpendicular to the incident rays. B.J.

A77-14580 # Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up (Termodinamicheskii analiz i vybor optimal'nykh parametrov dinamicheskogo preobrazovatelia dlia solnechnoi energoustanovki). G. Ia. Umarov, B. B. Orunov, Iu. E. Kliuchevskii, I. A. Tursunbaev, and V. S. Trukhov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 5, 1976, p. 31-34. In Russian.

A77-14581 # Calculation of the radiation entering a 'hot box' type solar set-up (Raschet radiatsii, vkhodiashchei v gelioustanovku tipa 'goriachii iashchik'). O. L. Shvaleva and R. R. Avezov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 5, 1976, p. 35-39. In Russian.

The paper calculates a number of parameters of a solar heating set-up with southern orientation including: the total solar radiation input, the useful heat obtained, and the energy conversion efficiency. The analysis of these data indicates that vertical solar set-ups are more advantageous than oblique set-ups for heating, a conclusion confirmed by an increase of the total solar radiation input from autumn to winter. B.J.

A77-14584 Alternate fuels for road vehicles of the future (Alternativ-Kraftstoffe für Strassenfahrzeuge der Zukunft). D. Gwinner (Daimler-Benz AG, Stuttgart, West Germany). *VDI-Z,* vol. 118, no. 22, Nov. 1976, p. 1053-1060. In German.

An evaluation of fuels shows that presently only methanol and hydrogen can be considered as possible substitutes for gasoline and Diesel oil as motor-vehicle fuels. Questions related to a use of methanol and hydrogen for the propulsion of road vehicles are investigated, taking into account the availability of the raw materials for a production of the two fuels, problems of fuel storage on board the vehicle, and aspects of motor operation. It is pointed out that the use of either fuel as a substitute for the currently used fuels for motor vehicles would lead to a significant reduction of air pollution problems. An introduction of methanol as fuel on a relatively short-term basis is possible. A use of hydrogen, however, requires the solution of a number of problems mainly related to the economic production of the gas and its storage on board the vehicle. G.R.

A77-14597 * # Hypersonic technology-approach to an expanded program. D. P. Hearth (NASA, Langley Research Center, Hampton, Va.) and A. E. Preyss (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Astronautics and Aeronautics,* vol. 14, Dec. 1976, p. 20-37. 12 refs.

An overview of research, testing, and technology in the hypersonic range. Military and civilian hypersonic flight systems envisaged, ground testing facilities under development, methods for cooling the heated airframe, and use of hydrogen as fuel and coolant are discussed extensively. Air-breathing hypersonic cruise systems are emphasized, the airframe-integrated scramjet configuration is discussed and illustrated, materials proposed for hypersonic vehicles are reviewed, and test results on hypersonic flight (X-15 research aircraft) are indicated. Major advances and major problems in hypersonic flight and hypersonic technology are outlined, and the need for a hypersonic flying-laboratory research craft is stressed. R.D.V.

A77-14703 # Scientific-technological problems of the development of a fuel-energy complex in the USSR (Nauchno-tekhnicheskie problemy razvitiia toplivno-energeticheskogo kom-

pleksa SSSR). Z. F. Chukhanov. *Akademiia Nauk SSSR, Vestnik,* no. 9, 1976, p. 104-119. 14 refs. In Russian.

The fuel-energy complex is defined as that part of the national economy which is designed to meet the total fuel and thermal and electrical energy needs of the USSR. A brief review is given of the energy crisis outside the USSR. The development of a system of high-speed pyrolysis for the processing of solid fuel is examined with specific attention given to the pyrolytic processing of coals from Kansko-Achinsk and Kabass-Kuzbass. A schematic diagram of a coal processing system is presented. B.J.

A77-14825 Heat pipe theory and practice. S. W. Chi (George Washington University, Washington, D.C.). Washington, D.C., Hemisphere Publishing Corp.; New York, McGraw-Hill Book Co., 1976. 256 p. 67 refs. $25.

The operating principles of heat pipes (HP) are expounded, along with a discussion of different types of HP, and the underlying theory, design, and fabrication of HP. Working fluids, wick configurations, reservoirs, and pipe materials are dealt with, and cleaning, assembly, evacuation, charging, and closure of HP are covered. Capillary action, sonic limitation, entrainment limitation, boiling limitation, interface conditions, startup difficulties, and control and modulation of HP are discussed. Applications discussed include: heat exchangers, space heating, industrial processes, cryosurgery, heating/ventilation/air conditioning systems, de-icing, heat sinks, and thermal energy recovery. Practical numerical design examples are included in the text. R.D.V.

A77-14890 Black magnetic spherule fallout in the eastern Gulf of Mexico. L. J. Doyle, T. L. Hopkins, and P. R. Betzer (South Florida, University, St. Petersburg, Fla.). *Science,* vol. 194, Dec. 10, 1976, p. 1157-1159. 16 refs. Contract No. N00014-75-C-0539.

Large numbers of black metallic spherules ranging in diameter from a few micrometers to over 800 micrometers are raining into the eastern Gulf of Mexico and adjacent areas of western Florida. The composition of the flux, its association with glass spherules and coky particles, and its magnitude point to industrial pollution, probably coal- and coke-burning facilities around the perimeter of the gulf, as the source. Since metallic particles represent only a small fraction of most fly ash, such an influx of large numbers of black magnetic spherules must be symptomatic of a much higher rate of sedimentation of fly ash. The internal microstructures and the general appearance of spherules derived from industrial processes are similar to those of particles derived from cosmic sources. Because of the high potential for contamination in micrometeorite studies, a complete compositional verification of each 'cosmic' particle may be necessary. (Author)

A77-14901 # Satellite solar power stations and energy relay satellites (Sloneczne elektrownie satelitarne /SES/ i satelitarne przekazniki energii /SPE/). M. Subotowicz (Lublin, Uniwersytet, Lublin, Poland). *Postepy Astronautyki,* vol. 9, no. 3, 1976, p. 7-47. 10 refs. In Polish.

After reviewing the basic principles of controlled nuclear fusion, especially the possibility of laser-initiated fusion, the author discusses the feasibility of satellite solar power stations transmitting their energy in the form of microwaves. Problems of mechanical design, antennas, phase front control, transport, and cost related to a satellite solar power station program are discussed. P.T.H.

A77-14928 Effect of optical properties of a surface exposed to solar radiation on the radiation balance (Influence sur le bilan radiatif des propriétés optiques d'une surface exposée au rayonnement solaire). R. Pasquetti, F. Papini, and P. Gallet (Aix-Marseille I, Université, Marseille, France). *Revue Générale de Thermique,* vol. 15, Jan. 1976, p. 13-17. In French.

A solar radiation absorption surface termed a hot selective surface is characterized by the ratio of absorption to emission and by the limiting temperature attainable by the surface. The effect exerted by the optical properties of the surface on the radiation balance is studied for an ideal surface (monochromatic absorption and emission constant throughout the range of interest, well-defined cutoff frequency, sun treated as 5800 K blackbody). The radiation balance (difference of flux absorbed and flux emitted) is calculated from a formula for blackbody spectral power density, (BBSPD), and curves for various BBSPD parameters as functions of operating temperature and cutoff frequency are plotted. R.D.V.

A77-14929 Characteristic equations of unconcentrated flat solar cell panels (Equations caractéristiques des capteurs solaires plans sans concentration). J. F. O. Sacadura (Lyon, Institut National des Sciences Appliquées, Lyons, France). *Revue Générale de Thermique,* vol. 15, Mar. 1976, p. 217-223. In French.

The range of validity of simplified linear equations describing the behavior of an unconcentrated flat solar cell panel is examined, and auxiliary equations are proposed for the range of low flowrates of heat-transfer medium. A threshold radiation level contrasting with that obtained via classical linear equations which lose their validity in the vicinity of the operating threshold is reported. Mass heat flowrate is related to other process variables, and some underlying assumptions are re-examined: loss calculations based on a unique conductivity constant along the panel, uniform absorbed flux distribution, and homogeneous wetting of the equipment by the heat-transfer medium. R.D.V.

A77-14951 # Optimization of the geometry of switching buses for thermoelements in thermoelectric generators (Optimizatsiia geometrii kommutatsionnykh shin termoelementov v termoelektrogeneratorakh). B. A. Kirichenko, N. V. Kolomoets, and V. M. Rzhevskii. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* Sept.-Oct. 1976, p. 78-84. In Russian.

Calculations are made for selecting geometry for thermoelement switching buses in thermoelectric generators which would minimize conversion efficiency loss due to nonideality of the thermoelements, i.e., the presence of thermal and electrical end resistances at the switching buses. Attention is given to the operation of a generator in the regime of constant temperature drop with a thermal battery switched together by p and n type branches with two types of switching buses: plane buses that are optimized with respect to the thickness of the switching plates; and wedge buses that are optimized with respect to wedge angle. B.J.

A77-14957 Energy: Conversion and utilization. J. H. Krenz (Colorado, University, Boulder, Colo.). Boston, Mass., Allyn and Bacon, Inc., 1976. 367 p. 440 refs. $17.95.

The energy crisis is considered along with aspects of energy consumption, the fossil fuel reserves, the solar energy balance of the earth, problems of carbon dioxide generation, atmospheric pollution, thermodynamic limitations, and questions related to the generation of electrical energy from fossil fuels. Topics related to the utilization of nuclear energy are discussed, taking into account the fission chain reaction, thermal neutron reactors, fast neutron breeder reactors, fission wastes and other limitations, requirements for a thermonuclear fusion reaction, magnetically confined plasma fusion devices, and laser induced fusion. Attention is also given to the potential of solar energy, low and high temperature applications of solar energy, photovoltaic solar cells, photosynthesis, hydropower, tidal power, power from ocean temperature gradients, wind power, geothermal power, and questions related to energy usage and the U.S. economy. G.R.

A77-14980 # Thermal explosion of moving reacting fluids of variable viscosity (Teplovoi vzryv dvizhushchikhsia reagiruiushchikh zhidkostei s peremennoi viazkost'iu). P. V. Zhirkov, V. I. Boiarchenko, and S. A. Bostandzhiian (Akademiia Nauk SSSR, Institut Khimicheskoi Fiziki, Chernogolovka, USSR). *Fizika Goreniia i Vzryva,* vol. 12, July-Aug. 1976, p. 511-519. 6 refs. In Russian.

The unsteady-state problem of the flow between two rotating coaxial cylinders of a viscous fluid characterized by a zeroth-order reaction, a first-order reaction, or an autocatalytic reaction is analyzed. Thermal explosion is produced by a heat source of both chemical and mechanical origin. The viscosity depends on the

temperature and on the conversion depth of the substance. Detailed attention is given to the case where a continuous moment is given at the external cylinder. The critical ignition conditions are plotted against the parameters that characterize the intensity of mechanical heat release. The time-dependent characteristics of the thermal explosion are plotted against the chemical and mechanical parameters, and the relationships obtained are analyzed. V.P.

A77-15005 # **Study of cathode spots in the presence of slag films on the electrodes of an open-cycle MHD generator (Issledovanie katodnykh piaten pri nalichii shlakovykh plenok na elektrodakh MGD-generatora otkrytogo tsikla).** V. I. Zalkind, V. V. Kirillov, and A. P. Markina. *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki,* July-Aug. 1976, p. 29-33. 8 refs. In Russian.

A77-15044 * **Thermal alteration of young kerogen in relation to petroleum genesis.** R. Ishiwatari, M. Ishiwatari, I. R. Kaplan, and B. G. Rohrback (California, University, Los Angeles, Calif.). *Nature,* vol. 264, Nov. 25, 1976, p. 347-349. 9 refs. NASA-ERDA-supported research.

Kerogen, humic acid, and lipid material were separated from a young marine sediment and heated in sealed tubes in a nitrogen atmosphere at 150 and 410 C. Gaseous and liquid products generated during heating, and also the residual organic material, were characterized by gas-liquid chromatography, elemental analysis, infrared and electron spin resonance spectroscopy, and X-ray diffraction. P.T.H.

A77-15047 **Can Canada harness the wind.** B. McCallum (Environment Canada, Advanced Concepts Centre, Canada). *Engineering Journal,* vol. 59, Sept.-Oct. 1976, p. 46-48.

Canada's options for wind power and new developments in wind power generator (WPG) technology are discussed. Batteries for power storage account for about 50% of systems costs, require maintenance and possibly backup from a conventional generator in slack-wind periods. A power conversion unit developed by Windworks makes it possible to do without batteries and to convert variable current from a WPG to 60-cycle ac so that load can be shared with the local power grid and excess wind-generated power can be fed into the grid. Possibilities of accommodating larger WPG into such a setup are good, and the outlook for WPG on the order of 10 kW to 100 kW is examined, particularly offshore WPG. Brief data are provided on Canada's windiest regions best suited to WPG use. The Huronemus plan for large WPG on the Great Lakes and western Great Plains, with electrolytically recovered hydrogen as secondary product, is mentioned. R.D.V.

A77-15048 **Transport systems guarantee efficient utilization of energy resources.** R. M. Mathur (Manitoba, University, Winnipeg, Canada). *Engineering Journal,* vol. 59, Sept.-Oct. 1976, p. 54-56.

Various types of electrical urban public transportation are compared for adaptability to congested urban traffic, in terms of energy consumption, braking, local and remote control and power supplies, personal rapid transport, and freight carriage. Intra-urban, suburban, and interurban traffic modes are considered. Chopper and SCR dc electric vehicle systems, rotating ac induction motors, linear ac induction motors, vehicle suspension by wheels-on-rails, air cushions, and magnetic levitation, and regenerative braking schemes are examined. Magnetic suspension or air cushions are seen as unnecessary for most urban transport needs, while magnetic levitation appears better suited, with linear induction motors, for high-speed interurban lines. Rotating machines with wheel drives appear best suited for low transit speeds, in that existing roads and tracks can be utilized without heavy capital outlays in new systems. A comeback for surface rail transportation is envisaged. R.D.V.

A77-15049 **Utilization of solar power - A new departure (L'utilisation de l'énergie solaire - Un nouveau départ).** W. Palz (Centre National d'Etudes Spatiales, Paris, France). *Revue Française de l'Electricité,* vol. 49, 3rd Quarter, 1976, p. 6-13. In French.

Current applications for solar power, and particularly solar energy facilities based on solar photocells, in France, new directions in utilization of solar cells, and the history of solar power utilization along various lines, are discussed. Non-electrical use of solar power in water heaters and residence heating is discussed with its limitations, in addition to solar engines, solar energy power stations, and solar pumps. Direct conversion via photocells, with the advantages of minimal maintenance, no moving parts, and usefulness in cold climates, is stressed, and future applications of solar cells are projected. A breakeven time of 3-5 years for solar power water heaters is reported. R.D.V.

A77-15050 **National Meeting on Air and Space Law, 7th, Universidad Nacional de Córdoba, Córdoba and La Falda, Argentina, August 13-16, 1975, Proceedings (Jornadas Nacionales de Derecho Aeronáutico y Espacial, 7th, Universidad Nacional de Córdoba, Córdoba and La Falda, Argentina, August 13-16, 1975, Proceedings).** Meeting sponsored by the Universidad Nacional de Córdoba. Cordoba, Argentina, Universidad Nacional, 1976. 801 p. In Spanish.

The considered meeting took place in Cordoba, Argentina, in August 1975. International agreements related to the transportation of goods and the consequences of these agreements for civil aviation are examined. Questions concerning a change in the Argentine air law are investigated and ideas for international agreements in the area of space law are discussed. Details concerning the responsibility of the aircraft manufacturer are explored. Attention is also given to international juridical aspects connected with the utilization of solar energy. G.R.

A77-15130 **Satellite communications for off-shore oil operations using WESTAR.** G. L. Sarver (U.S. Federal Communications Commission, Washington, D.C.). In: National Telecommunications Conference, New Orleans, La., December 1-3, 1975, Conference Record. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p. 9-7 to 9-14.

Satellite communications provide a greater degree of reliability than either submarine cable or multiple hop microwave systems, and have the capability and flexibility to extend communications to any off-shore location through the use of transportable earth stations. The paper discusses the capabilities of the WESTAR domestic communications satellite (WESTAR I and WESTAR II) as applied to communications to off-shore oil operations. The satellite has twelve transponders with 40 MHz spacing and includes five communications earth stations and their associated terrestrial microwave interconnect links. Each station is a modular, self-contained, transportable unit employing actively redundant RF and IF equipment and is designed for unattended operation with remote monitoring and control from the WESTAR master control station. Particular attention is given to the Dallas earth station and to fault monitoring and control. S.D.

A77-15237 **Shaping of laser pulses in an amplifying system receiving input signals with a variable spectrum.** Iu. I. Kruzhilin. *(Kvantovaia Elektronika* /Moscow/, vol. 3, July 1976, p. 1564-1569.) *Soviet Journal of Quantum Electronics,* vol. 6, July 1976, p. 847-849. 11 refs. Translation.

The control of the shaping of laser pulses from a system composed of a master oscillator and an amplifier is examined with reference to laser fusion. It is shown that scanning of the spectral line of the input signal in the gain band during pulse generation can be used to vary the output power within a wide range. The spectral-temporal characteristics of an input pulse necessary for obtaining an output pulse of required form in a laser amplifier using neodymium-doped phosphate glass are investigated numerically. B.J.

A77-15301 **Software aspects of super composites.** M. K. Mukherjee (Indian Space Research Organization, Vikram Sarabhai Space Centre, Trivandrum, India). In: International Conference on Composite Materials, Geneva, Switzerland, April 7-11, 1975 and Boston, Mass., April 14-18, 1975, Proceedings. Volume 2. New York, Metallurgical Society of AIME, 1976, p. 96-105.

The term software is associated with computer science and concerns the analysis, theoretical calculations, design and development of a hardware. The paper shows how the software technique can be used to develop super composites with more than two constituents with a view to obtaining numerous properties in addition to load-carrying capabilities. Classes of super composites to be utilized for various applications according to user requirements are identified. Use of super composites for power generation from solar energy using software technology is also discussed. S.D.

A77-15350 Energy research for physicists. G. T. Reynolds (Princeton University, Princeton, N.J.). *Physics Today,* vol. 29, Dec. 1976, p. 34-41. 11 refs.

Challenging problems for physicists probing into exploitation of novel energy resources are reviewed and outlined. Attention is centered on applications of fluid dynamics in harnessing of wind power, solar energy, solar power stored in ocean temperature differentials, and geothermal energy. Advanced design of solar reflectors and concentrators, collection of wind power over a broad area with convection through a vertical stack, difficulties in exploitation of ocean depths as a heat reservoir, and types of geothermal reservoirs are discussed. Stimulating fluid production from presently unproductive hydrothermal reservoirs, working with dry geothermal reservoirs, qualitative advances in drilling techniques, improved water-to-steam conversion, handling of mineralized geothermal fluids, and improved thermodynamic power cycles are considered as examples of intriguing problems for physicists working on tapping geothermal energy. R.D.V.

A77-15625 The potential for application of energy storage capacity on electric utility systems in the United States. I. V. T. Sulzberger and J. Zemkoski (Public Service Electric and Gas Co., Newark, N.J.). *(Institute of Electrical and Electronics Engineers, Winter Meeting and Tesla Symposium, New York, N.Y., Jan. 25-30, 1976.) IEEE Transactions on Power Apparatus and Systems,* vol. PAS-95, Nov.-Dec. 1976, p. 1872-1880; Discussion, p. 1881. 15 refs. Research supported by the Electric Power Research Institute and ERDA.

This paper briefly describes the results of the first phase of the systems analysis part of a research project to assess energy storage systems suitable for use by electric utilities. U.S. electric utility systems load and generation data that were collected and analyzed in order to select a number of systems most representative of the electric utility industry are described. The representative systems in turn are used to determine the potential total amount and distribution of off-peak energy available on individual systems on an annual, seasonal, weekly and daily basis. The amount of off-peak energy is described as functions of annual hourly load shape, capacity level assumed available for producing off-peak energy, generator performance characteristics (forced and maintenance outages), and energy storage device round trip efficiency. (Author)

A77-15665 Shock tube for investigations of high-temperature MHD generators. A. D. Belykh, V. A. Gurashvili, V. S. Golubev, S. V. Pashkin, and A. A. Iakushev (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 14, Mar.-Apr. 1976, p. 353-358.) *High Temperature,* vol. 14, no. 2, Sept. 1976, p. 317-321. 6 refs. Translation.

The shock tube described was used as a plasma source for studying the physical phenomena in large-scale magnetohydrodynamic generators at thermal powers of up to 1 GW. The energy stored in the driving gas reached 10 mJ at pressures of 500 atm abs. Some results obtained at gas temperatures up to 15,000 K are examined. V.P.

A77-15666 Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator. D. K. Burenkov, V. I. Zalkind, V. V. Kirillov, B. I. Rastegaev, and A. S. Tikhotskii (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 14, Mar.-Apr. 1976, p. 359-364.) *High Temperature,* vol. 14, no. 2, Sept. 1976, p. 321-326. 9 refs. Translation.

An improved plasma probe is described which eliminates the distortion of the volt-ampere characteristics of the probe due to transient processes in the probe circuit. The probe has a device for regulating and minimizing the time of recording of the volt-ampere characteristics, thus excluding their distortion and improving the signal to noise ratio of the probe. The use of a discrete step-pulse voltage generator in the measuring circuit of the probe is used to increase measurement accuracy. B.J.

A77-15668 Acoustic properties of subsonic MHD channel. G. K. Ermolaeva, A. P. Skabin, O. L. Poliakov, and V. A. Tarasiuk (Leningradskii Politekhnicheskii Institut, Leningrad, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 14, Mar.-Apr. 1976, p. 372-377.) *High Temperature,* vol. 14, no. 2, Sept. 1976, p. 332-336. 5 refs. Translation.

The procedure proposed can be used to calculate the acoustic characteristics of a subsonic MHD-channel for any longitudinal vibration frequencies. The procedure, based on solving a linearized system of magnetohydrodynamics equations for the longitudinal vibrations, is applied to the analysis of a channel with a specified set of parameters. V.P.

A77-15778 Aerosol formation during coal combustion - Condensation of sulfates and chlorides on flyash. R. F. Pueschel (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). *Geophysical Research Letters,* vol. 3, Nov. 1976, p. 651-653. 6 refs.

Submicron flyash particles show a preferential surface concentration of sulfur and chlorine in comparison to their matrix elements, e.g., aluminum and silicon. The relationship between concentration of surface deposited matter and inverse particle diameter suggests that S and Cl are adsorbed and oxidized on flyash particles after volatilization in the high-temperature zone of the foiler. This leads to the formation of cloud nuclei even before a sulfur gas-to-particle conversion takes place. (Author)

A77-15780 Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume. R. C. Schnell, C. C. Van Valin, and R. F. Pueschel (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). *Geophysical Research Letters,* vol. 3, Nov. 1976, p. 657-660. 18 refs. Research supported by the National Research Council and National Academy of Sciences Research Associate Program; U.S. Environmental Protection Agency Grant No. EOA-TAG-E693(78-BEG).

A77-15798 # Application of simulation studies to the design and improvement of fuel control systems for aviation turbine engines (Zastosowanie badan symulacyjnych w procesie projektowania i dopracowywania ukladow paliwowo-regulacyjnych lotniczych silnikow turbinowych). M. Chrobot and A. Hager. *Technika Lotnicza i Astronautyczna,* vol. 31, Nov. 1976, p. 32-34. In Polish.

A77-15799 Cost aspects of solar energy - Selective and critical bibliography (Les aspects économiques de l'énergie solaire - Bibliographie sélective et critique). D. Cavard and P. Criqui. *Revue de l'Energie,* vol. 27, Nov. 1976, p. 533-540. 32 refs. In French.

Contributions to the literature on solar energy are selected for their coverage of economic and social aspects of the problem, in addition to relevance to ecological impact and accessibility to the nontechnical reader. The annotated bibliography is organized in groups of entries offering: (1) introductory tutorial review treatments of the overall topic; (2) proceedings of relevant conferences; (3) periodicals; (4) specific solar energy technologies or modes of utilization of solar energy (residence heating, photovoltaic conversion, distillation, direct thermal systems); (5) institutional and legal aspects; (6) research and development; (7) relevant meteorological information. Cost aspects are broached in the strict sense (cost competitivity of systems) and in the larger sense (social costs and collective advantages or penalties). R.D.V.

A77-15800 **Studies and thoughts on nuclear reactor systems (Etudes et réflexions sur les filières nucléaires).** M. Grenon. *Revue de l'Energie,* vol. 27, Nov. 1976, p. 541-548. In French.

Several types of nuclear power reactor systems are compared in terms of: costs, environmental impact, security against diversion of fissile materials, dependence on dwindling high-grade uranium reserves, fuel cycle, wastes disposal problems, and research/development problems and needs. The review is based on a Battelle team study of high temperature gas-cooled reactors (HTGR), molten salt breeders (MSBR), gas-cooled fast reactors (GCFR), light water thermal breeders (LWBR), and Canadian type heavy water reactors (CANDU), and is acknowledged only partially applicable to French conditions and reactor development interests. While all of these reactor types are technically feasible, none stand out particularly by any of the criteria, with LBWR the most costly. Further development of breeders is encouraged. R.D.V.

A77-15803 **Geothermal sources and their utilization (Die Erdwärme und ihre Nutzung).** A. Buch. *Energie,* vol. 28, Oct. 1976, p. 278-280. 9 refs. In German.

Geological aspects of temperature anomalies in West Germany favoring harnessing of geothermal heat power and the cost picture for economical exploitation of West German geothermal resources are examined. Basics of geothermal heat formations, extraction of hot water or injection of cold water, hydraulic fracturing to increase heat-transfer area, principal modes of direct utilization of geothermal power (space heating, water heating, hot bath spas), and generation of electricity are reviewed briefly. Costs of removal of pollutants and corrosion of conversion equipment are figured in. Development of cold gas turbines and heat exchangers adapted to geothermal technology requirements is recommended. R.D.V.

A77-15804 **Fuel cells (Brennstoffzellen).** R. Hüning. *Energie,* vol. 28, Oct. 1976, p. 296-298. 9 refs. In German.

A state-of-the-art survey classifies fuel cells (FC) as either low-power application-oriented devices or power-generating units, enumerates and describes various types of viable and promising FC and their applications. Early recognition of the feasibility of FC in space applications, and their indispensability in long-term space missions (particularly in manned flight), are noted. Attention is centered on FC burning natural gas as fuel. Components of a FC power-generating set are described. Promising use of FC in space heating and vehicle propulsion is indicated, with auxiliary systems (pumps, heat exchangers, water separators) not yet ready to support the FC power systems. The need for cheap electrodes, FC using air as oxidizer, and elimination of polarization at the electrodes is pointed out. R.D.V.

A77-15807 **The reprocessing of nuclear fuels.** W. P. Bebbington. *Scientific American,* vol. 235, Dec. 1976, p. 30-41.

It is pointed out that at the present time, 19 years after the first American nuclear power station went into service, the U.S. still has no commercial facility licensed to recover plutonium and unburned uranium 235 from the spent fuel of nuclear power reactors. The Federal Government is now deciding whether or not to approve the use of reactor fuel containing a mixture of the two nuclides. The fissionable material recovered from the spent fuel of three reactors is sufficient to fuel a fourth. Attention is given to the world's largest reprocessing plant at Seascale on the west coast of England, the Purex process for recovering uranium and plutonium from the spent fuel of power reactors, the design of the solvent-extraction apparatus, the 'mixer-settler', the centrifugal contactor, and the multistage contactor. G.R.

A77-15812 # **Energy research in the UK.** W. Marshall (Department of Energy, London; U.K. Atomic Energy Authority, Harwell, Berks., England). *Atom,* Dec. 1976, p. 302-313.

An overview is presented of research and development in the field of energy in the United Kingdom. Attention is given to the contribution of coal, oil and natural gas technologies and to that of nuclear energy. The overall importance of alternative energy sources (fusion, geothermal, solar, tidal, wave, wind, oil shale, and waste) is examined along with the importance of different energy conversion and distribution technologies such as coal conversion, electricity supply, and gas supply. The overall importance of energy utilization technologies (fuel utilization and energy conservation) and supporting research technologies is also considered. B.J.

A77-15813 **Some studies on sodium/sulfur cells.** R. Bauer, W. Haar, H. Kleinschmager, G. Weddigen, and W. Fischer (Brown, Boveri et Cie. AG, Heidelberg, West Germany). *Journal of Power Sources,* vol. 1, Dec. 1976, p. 109-126. 31 refs. Research supported by the Bundesministerium für Forschung und Technologie.

Findings useful in evaluation and improved design of Na/S batteries are presented. Magnesia-doped sodium/beta-alumina electrolyte used in the batteries boasts high conductivity and long life. Current collector and container materials presenting hardy resistance to corrosive attack by the Na2S4 melt have been tested. Charge-discharge cycles running into the hundreds have been obtained with laboratory prototypes, plus high rechargeability. These secondary batteries are under consideration as storage devices for load leveling in electrical power networks, and for traction in electric vehicles. R.D.V.

A77-15814 **Electric current from the direct conversion of low molecular weight C,H,O-compounds.** C. H. Hamann and P. Schmöde (Bonn, Universität, Bonn, West Germany). *Journal of Power Sources,* vol. 1, Dec. 1976, p. 141-157. 8 refs.

Results of research over the past half-decade on fuel cells (formate/air) and rechargeable cells (formate/air, glycol/air, formic acid/air) are reported. Formate/air fuel cells using alkaline electrolyte have yielded current densities of 50 mA per sq cm continuously. Comparable formate/air rechargeable cells have yielded energy densities of 71 Wh per kg at 10 mA per sq cm in one duty cycle. Still higher energy densities, plus lower costs per kWh, can be attained by exploiting the multiple rechargeability of the cells. Using ethylene glycol in place of formate fuel produces 101 Wh per kg energy density (in a single duty cycle) with cost per kWh (multiple recharges) cut down. Competitiveness of these cells with primary batteries, once production and product development have been ironed out, is claimed. R.D.V.

A77-15815 **Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte.** V. Sh. Palanker, D. V. Sokolsii, E. A. Mazulevskii, and E. N. Baibatyrov (Kazakh Academy of Sciences, Institute of Organic Catalysis and Electrochemistry, Alma-Ata, Kazakh SSR). *Journal of Power Sources,* vol. 1, Dec. 1976, p. 169-176. 12 refs.

A technique for the preparation of highly dispersed tungsten carbide, useful as a catalyst for hydrogen electrodes in acidic electrolyte fuel cells, has been developed, and the properties of this material have been investigated. Optimum conditions for obtaining highly dispersed tungstic acid (starting material for synthesis of highly dispersed tungsten carbide) are reported. Tungsten carbide of specific surface up to 30 sq m/g has been obtained. This tungsten carbide has been used as a catalyst for hydrogen electrodes. At a potential of 200 mV and 90 C, a current density of 170 mA per sq cm has been reached. It has been shown that polarization of the hydrogen electrode at a potential above 300 mV in H2SO4 over a long time increases the current on the tungsten carbide electrodes, instead of decreasing it. (Author)

A77-15816 **Fuel cell assemblies with an acidic electrolyte.** H. Böhm (Telefunken AG, Forschungsinstitut, Frankfurt am Main, West Germany). *Journal of Power Sources,* vol. 1, Dec. 1976, p. 177-192. 60 refs.

The application of fuel cells in the lower power range up to 10 kW depends on the use of commercially available liquid fuels like gasoline, diesel oil or methanol. This means a fuel conditioning to produce a hydrogen containing crude gas, which can best be consumed by a fuel cell with an acidic electrolyte. The possibilities for fuel conditioning are described. The crude gas can be oxidized at different non-noble metal catalysts, e.g., WC, which are not poisoned

by crude gas components such as CO. This report also reviews various cathode catalysts. A conceptual design of a battery able to operate in diluted acids at higher temperatures is described. (Author)

A77-15817 Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides (Das Elektroden-verbindungsmaterial, ein zentrales Bauelement in Hochtemperatur-Brennstoffzellen. II - Untersuchung ausgewählter hochleitfähiger Mischoxide). W. Baukal, W. Kuhn (Battelle-Institut, Frankfurt am Main, West Germany), H. Kleinschmager, and F. J. Rohr (Brown, Boveri et Cie. AG, Heidelberg, West Germany). *Journal of Power Sources,* vol. 1, Dec. 1976, p. 203-213. 9 refs. In German.

Results of a three-year research and development program on electrode connecting materials for high-temperature fuel cells, centered on selected highly conducting mixed oxides, specifically LaMnO3 and La(0.8)Sr(0.2)Cr(0.8)Ni(0.2)O(3), are reported. The electrical conductivity, chemical stability, and phase stability of the oxides are reported, and their compatibility with other components of the fuel cells are determined. Tests were conducted on spraying, flame pyrolysis, melt decomposition, and precipitation behavior of the oxides. The chemical stability of LaMnO3 and the workability of the latter oxide are found inadequate. R.D.V.

A77-15845 Geothermal power - The 'sleeper' in the energy race. R. Lengquist and F. Hirschfeld. *Mechanical Engineering,* vol. 98, Dec. 1976, p. 25-31.

The paper traces the history of the development of a geothermal power station at The Geysers in northern California, describes the present installation there, and discusses some of the environmental and economic aspects of the operation. A complete plant flow diagram is given, and the operating procedures are briefly summarized. P.T.H.

A77-15850 Water power in the immediate future (Die Wasserkraft in der näheren Zukunft). J. Frohnholzer. *Energiewirtschaftliche Tagesfragen,* vol. 26, Nov. 1976, p. 657-660. In German.

Data concerning the use of water power in the U.S. and Canada are presented for the years 1974, 1980, 1990, and 2000. Developments in Norway are examined. It is pointed out that of the countries considered Norway is the only country in which 100% of the produced electric power is obtained with the aid of water power. Attention is also given to water-power projects in West Germany, Switzerland, France, Italy, Austria, Belgium, Portugal, Spain, Yugoslavia, Great Britain, Sweden, and Poland. G.R.

A77-15853 Possibilities for utilizing wind energy (Nutzungsmöglichkeiten der Windenergie). S. Armbrust, A. Kussmann, and J. P. Molly (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Bauwesen- und Konstruktionsforschung, Stuttgart, West Germany). *DFVLR-Nachrichten,* Nov. 1976, p. 765-770. In German.

Advantages and disadvantages of wind energy conversion systems, rotor blade geometry and design, use of composites in blade design, and the importance of competitive power costs are discussed. The article also covers large rotor manufacturing and transport considerations, bending strength of rotor head and blade roots, advantages of articulated or unarticulated hubs, blade rigidity, design of modularized wind energy conversion systems, and pointing of the rotor system to adjust to changing wind direction. Vibration strength and fatigue requirements, de-icing and lightning protection problems, and erosion by weather are also discussed. R.D.V.

A77-15856 High-speed flywheels as possible energy storage devices in the future (Hochtourige Schwungräder als mögliche Energiespeicher der Zukunft). M. Gädke (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Struktur-mechanik, Braunschweig, West Germany). *DFVLR-Nachrichten,* Nov. 1976, p. 778-780. In German.

The usefulness of flywheels as energy-storage devices in various energy-consuming or energy-converting systems is assessed. Some composite flywheels (glass fiber reinforcement, carbon fiber reinforcement, Kevlar fiber) are found to have four times the strength of steel in flywheel applications. Coupling of flywheels with motor-generator sets, batteries, or power grids for storage and return of power is discussed (with helium or hydrogen atmospheres to minimize winding friction in motor-generator sets). Use of flywheels for energy storage in energy conversion systems with irregular energy inputs (solar energy, wind energy) is considered. Tests on existing prototypes of composite flywheels are reported, and coiling of flywheel fiber-reinforced laminates is described. R.D.V.

A77-15946 * Space solar power - An available energy source. S. Ferdman (Grumman Aerospace Corp., Bethpage, N.Y.) and R. L. Kline (NASA, Washington, D.C.). *(Horizons,* vol. 12, no. 12, 1976.) *Journal of Astronautical Sciences,* vol. 24, July-Sept. 1976, p. 243-255.

The development of satellite solar power stations is described with attention given to station design and assembly in space. Problems associated with conversion of solar energy into microwaves and with getting the station into orbit are considered. The use of a solar propulsion system for pushing the station to high orbit is discussed along with questions of station lifetime (estimated to be about thirty years). The paper is copiously illustrated with drawings projecting various aspects of station design and utilization. B.J.

A77-16201 Future energy production systems: Heat and mass transfer processes. Volume 1. Edited by J. C. Denton (American Technological University, Killeen, Tex.) and N. H. Afgan (International Centre for Heat and Mass Transfer, Belgrade, Yugoslavia). New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976. 387 p. $38.

Questions related to the utilization of solar energy are considered, taking into account specific features of radiative heat and mass transfer in solar installations, heat and mass transfer for solar energy utilization, thermal energy storage for heating and air conditioning, the charging and discharging of latent heat storage systems, the transient behavior of solid sensible heat thermal storage units for solar energy systems, and processes of heat and mass transfer in plane solar evaporators. Aspects of nuclear energy production are also discussed, giving attention to the problems of heat transfer in nuclear power engineering, hydrogen production using nuclear heat, heat transfer stability in free-convective boiling on a nonisothermal surface, the heat transfer in boiling helium to superconducting elements in power-generating equipment, and the investigation of two-phase liquid-metal magnetohydrodynamic power systems.

G.R.

A77-16202 Perspectives for world energy production. J. C. Denton (American Technological University, Killeen, Tex.). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 15-26. 18 refs.

The objective of this paper is to attempt to place the world's energy production into perspective by considering the world use of energy, the world's energy sources, and energy production systems. The world use of energy is traced from the time of prehistoric man through the present time and projected into the future to the year 2000. A limited survey of the world's energy source forms is presented and the conclusion drawn is that energy resources are plentiful and equal to the task of fulfilling mankind's needs. The desirable features of future energy production systems are to: (1) use high quality thermal energy sources, (2) use nonthermal energy driven conversion systems, and (3) preserve the quality of energy as much as possible during physical transport. (Author)

A77-16203 Environment and energy production after the year 2000. R. Gibrat. In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 27-42.

The possibility for an 'all nuclear' economy for the first decades of the 21st century is discussed. Such an economy is based on the use of the breeder reactor, which is now close to industrial realization. There are two types of high temperature reactors (HTR) which can provide heat at a high temperature. One type is being developed in the US, while studies related to the other type are pursued in Germany. The heat of the HTR can be used to obtain hydrogen as an energy carrier. Various forms of hydrogen usage are discussed and certain problems connected with an employment of the 'all nuclear' economy are examined. Attention is also given to tidal power plants, the use of solar energy, geothermal energy, nuclear fusion, and meteorological problems related to the influence of thermal wastes on the weather. G.R.

A77-16204 The problem of use of solar energy specific features of radiative, heat, and mass transfer in solar installations. V. A. Baum (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 45-54.

A description is given of results which have been obtained in a study of the characteristics of heat and mass transfer in solar installations. Questions related to the concentration of solar power are considered, taking into account a general theory of solar power concentrators. Approaches are discussed for improving the temperature conditions in dwelling houses, located in a hot dry climate, by means of suitable heat and mass exchange processes. Attention is given to room ventilation at night, solar cooling installations, a solar water evaporator of the hot-box type, and the mathematical relations for thermal calculations. G.R.

A77-16205 Heat and mass transfer for solar energy utilization. J. C. Denton (American Technological University, Killeen, Tex.). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 55-67. 10 refs.

The utilization of solar energy for terrestrial purposes employing complex systems to supply a diversity of energy demands ranging from heat to electrical power has seen a great increase in interest in the US in the last few years. The paper reviews the basic relationships which govern the heat and mass transfer processes encountered in solar collectors and energy storage units. Some unsolved problems in heat and mass transfer are identified. It is concluded that the adoption of solar energy systems is not technology limited although several technological advances would be helpful. (Author)

A77-16206 Thermal energy storage for heating and air conditioning. H. G. Lorsch (Franklin Institute, Philadelphia, Pa.), K. W. Kauffman (Pennsylvania, University, Philadelphia, Pa.), and J. C. Denton (American Technological University, Killeen, Tex.). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 69-81. 12 refs. NSF Grants No. GI-27976; No. GI-29729.

Latent heat thermal energy storage materials suitable for solar heating and air conditioning are investigated and evaluated in terms of criteria developed to judge their usefulness. Sodium sulfate decahydrate and its mixtures are shown to have undesirable melting properties. More suitable materials are paraffin waxes for solar heating, and paraffin waxes and tetrahydrofuran hydrate for air conditioning. Sensible heat storage has the economic advantage of not requiring heat transfer surfaces between storage and collection and between storage and delivery. Latent heat storage provides operational advantages of smaller temperature swings, lower required solar collector temperature, and smaller size and lower weight per unit of storage capacity. Optimization of the thermal energy storage subsystem depends on the collection and delivery characteristics of the system. Parametric designs for two latent heat materials (sodium thiosulfate pentahydrate and a paraffin wax) and for a sensible heat material (1:1 mixture of water and ethylene glycol) are compared as to cost, performance, and space requirements. (Author)

A77-16208 Transient behavior of solid sensible heat thermal storage units for solar energy systems. F. W. Schmidt and J. Szego (Pennylvania State University, University Park, Pa.). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 97-109. 7 refs.

The transient response characteristics of a solid sensible heat thermal storage unit suitable for solar energy systems have been presented. Both a single and a two-fluid storage system have been studied. The nondimensional parameters governing the storage or retrieval of heat from the unit are defined. The influence of variations in flow rates, length and storage medium thickness have been investigated. In order to obtain high heat storage per unit volume, care must be taken in the design of the storage matrix and in the selection and sequencing of the flow in the channels. (Author)

A77-16209 Irradiation field formation on the receiver of 'precise' and 'unprecise' solar concentrators. I. V. Baum (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 111-122. 14 refs.

The paper presents a theory of formation of irradiation field on a concentrator receiver taking into account the influence of both parameters of the radiation source and parameters of the reflector and receiver. A general integral solution of the problem is analyzed and a computer treatment of major generalized variants in the form of universal distribution functions is discussed. (Author)

A77-16210 A central solar energy utilization system. S. W. Yuan and L. S. Galowin (George Washington University, Washington, D.C.). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 139-148. 8 refs.

This research is concerned with the long-duration earth storage of solar heat for space and hot water heating. Preliminary analysis indicates that the properties of the ground are excellent for this purpose and will achieve a heat capacity adequate to store summer heat for winter use without excessive thermal loss due to ground conductivity. Conservative calculations were also made that sufficient heat quantity can be transferred from the earth storage of an acre of land to heating requirements of at least twelve average-size houses in most areas of the United States. (Author)

A77-16211 Hydrogen production using nuclear heat. K. F. Knoche, H. Cremer, G. Steinborn, G. Wüster, and S. Hegels (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 165-183. 8 refs.

Multistep processes for thermochemical water splitting represent attractive alternatives for future hydrogen production using nuclear heat from HTGRs. A short review of proposed cycles is given. Some general criteria limit the number of cycles: thermodynamic restrictions, feasibility of the chemical reactions in a laboratory scale, chemical engineering aspects. These criteria and the stage of development are discussed in detail. (Author)

A77-16212 Investigation of two-phase liquid-metal magnetohydrodynamic power systems. W. E. Amend, G. Fabris (Argonne National Laboratory, Argonne, Ill.), and J. Cutting (Argonne National Laboratory, Argonne, Ill.; STD Research Corp., Arcadia, Calif.). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 305-317. 14 refs.

Liquid metal magnetohydrodynamic (LMMHD) power systems are low-temperature devices with operating temperatures which are determined by the thermodynamic and physical properties of the fluids. A description is presented of an experimental program which is to provide a basic understanding of the two-phase flow in a magnetic field. Cycle studies show that the two-phase liquid-metal MHD power cycle has excellent potential for an advanced energy-conversion system in central station power generation. Experimental results indicate that the loss mechanisms associated with the LMMHD generators can be controlled. G.R.

A77-16213 **Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide.** V. K. Shikov, B. S. Petukhov, and V. D. Vilenskii (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). In: Future energy production systems: Heat and mass transfer processes. Volume 1. New York, Academic Press, Inc.; Washington, Hemisphere Publishing Corp., 1976, p. 339-347. 14 refs.

A77-16249 **Combined cycles and refined coal.** J. Papamarcos. *Power Engineering,* vol. 80, Dec. 1976, p. 34-42.

The paper describes projected advanced combined-cycle gasifiers using a clean fuel for electric power generation with higher conversion efficiency. This clean fuel can be hydrogen at some time in the future, but the prospect now is that it will first be low-Btu and/or intermediate-Btu gas made from coal. The status of gasification programs is discussed relative to moving-bed, fluidized-bed, and entrained-flow gasifiers. Particular attention is given to a clean boiler fuel demonstration plant, a fluidized bed combined cycle in which coal is burned directly in a pressurized fluidized bed combustor and with tubes in the bed carrying air rather than water, an advanced fixed bed gasifier designed to overcome most of the disadvantages inherent to the Lurgi process, a high temperature turbine program, and an integrated gasification combined cycle program of modular construction and dual fuel capability using Lurgi gasifiers and as much commercially proved equipment as possible. S.D.

A77-16250 **New England wind power...coastal or mountain.** W. K. Widger, Jr. and R. A. Derrickson, Jr. (Biospheric Consultants International, Inc.). *Power Engineering,* vol. 80, Dec. 1976, p. 43-47.

Two regions are suitable for using wind as a significant power source alternative in central and northern New England. One is the coastal and immediate offshore area of the Gulf of Maine, while the other region is the exposed ridges and summits in or peripheral to the White Mountains and other New England ranges. The paper examines some of the factors involved, especially climatological ones, if the potential of one or both of these areas were to be considered seriously for exploitation. Available direct wind data for these areas are insufficient, so that recourse is made to analog stations believed to possess reasonably similar wind and wind speed climatological characteristics. Any decision as to whether wind power is indeed a feasible alternative source for central and northern New England will require engineering, economic, and environmental systems analysis. S.D.

A77-16270 * # **Measurements of Sc I gf-values.** W. H. Parkinson, E. M. Reeves, and F. S. Tomkins (Harvard College Observatory and Smithsonian Astrophysical Observatory, Cambridge, Mass.). *Royal Society (London), Proceedings, Series A,* vol. 351, no. 1667, Dec. 8, 1976, p. 569-579. 19 refs. Grant No. NGL-22-007-006.

Absolute gf-values were obtained for 98 transitions in neutral scandium by the hook method using an inductively coupled heat-pipe oven. Of the 98 lines, 51 are classified, 33 are unclassified lines that occur in pairs with the lower energy level identified, and 14 are unclassified but are believed to originate from one of the two lower levels of the ground state. The results are compared with semiempirical and other measurement results in the literature. P.T.H.

A77-16306 # **A generalized indicator characterizing the hydrodynamics and heating efficiency of subterranean thermal circulation systems (Ob odnom obobshchennom pokazatele, kharakterizuiushchem gidrodinamiku i teploproizvoditel'nost' podzemnykh teplovykh tsirkuliatsionnykh sistem).** G. N. Kononenko. In: Mixed boundary value problems and problems of mathematical modeling. Kiev, Institut Matematiki AN USSR, 1975, p. 79-88. In Russian.

Each circulation system is characterized by its thermal hydrodynamic fields and by various zones of contact between the heat-transfer agent and the rocks. In the present paper, an attempt is made to derive a criterion by means of which the variety of fields in different circulation systems could be reduced to a single system. Such a criterion would permit comparison of the economic and technological indices of different circulation systems. The concept of a reduced pothole is introduced, and a system of equations is given, whose solution yields the parameters of the reduced pothole. V.P.

A77-16324 **Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters.** G. A. Kokliuev and E. P. Oganov. *(Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* Nov.-Dec. 1974, p. 121-124.) *Heat Transfer - Soviet Research,* vol. 8, Jan.-Feb. 1976, p. 150-154. 5 refs. Translation.

A77-16357 **The prospect for fusion.** D. J. Rose (MIT, Cambridge, Mass.) and M. Feirtag. *Technology Review,* vol. 79, Dec. 1976, p. 21-43.

The history of controlled fusion research, specific controlled fusion projects and the problems confronting them, and the present outlook for practical fusion power in coming decades are reviewed extensively. The advantages of Tokamak machines, and particularly the relatively successful M.I.T. Alcatron machine, in plasma confinement are juxtaposed to disappointments with laser fusion, theta-pinch, magnetic mirrors, and other schemes. Breeder fission reactors are compared to the breeder aspect of fusion reactors. Safety aspects of fission reactors and fusion reactors are compared. Nuclear reactions of fusion interest are examined at length. The importance of a shift in focus from physics research to engineering and technology in fusion is pointed out and the 1985-1990 period is marked as broad deadline for working out the main technological trends and resolving major difficulties for XXI-Century fusion power to be a realistic proposition. R.D.V.

A77-16368 # **Photovoltaic conversion of solar energy (Fotovoltaicka premena slunecni energie).** F. Srobar (Ceskoslovenska Akademie Ved, Ustav Radiotechniky a Elektroniky, Prague, Czechoslovakia). *Ceskoslovensky Casopis pro Fyziku, Sekce A,* vol. 26, no. 5, 1976, p. 449-463. 75 refs. In Czech.

Photovoltaic techniques and devices for direct conversion of solar energy to electricity are surveyed. The physics of photovoltaic phenomena in p-n junctions, p-n heterojunctions, and Schottky barriers are reviewed at some length, and engineering materializations of solar cells are considered. Materials for solar cells are discussed and losses of a silicon solar cell are tabulated. The high cost of pure single-crystal silicon is acknowledged as an impediment to more widespread use of Si solar cells. Emphasis is placed on factors influencing overall conversion efficiency. Trends in photovoltaic solar design for terrestrial applications are analyzed (expensive AlGaAs/GaAs/GaAs heterojunction cells and inexpensive large-area panels using thin layers of semiconductor on a metal substrate or organic thin-film substrate). R.D.V.

A77-16374 **Assessing low sulfur coal resources in Montana and Wyoming.** D. S. Renné (Battelle Pacific Northwest Laboratories, Richland, Wash.). *Air Pollution Control Association, Journal,* vol. 26, Dec. 1976, p. 1167-1170. 5 refs. Contract No. E(45-1)-1830.

A77-16471 **Hydrogen production from water by means of chemical cycles.** E. D. Glandt and A. L. Myers (Pennsylvania, University, Philadelphia, Pa.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development,* vol. 15, Jan. 1976, p.

100-108. 19 refs. Research supported by the Mobil Research and Development Corp. and ERDA.

A thermochemical process uses heat instead of work to dissociate water into hydrogen and oxygen. The principle by which a reaction with an unfavorable change in Gibbs free energy can be driven by dividing it into several steps is discussed. Dozens of cycles that operate below 800 C have been proposed but none of them has been shown to work. Previous research indicates that no two-step cycle exists. A systematic study of three-step processes was performed by classifying them into standard patterns. The result of the study is that a three-step cycle probably does not exist. (Author)

A77-16472 **Startup solvent selection for the liquefaction of lignite.** W. P. Scarrah and R. R. Dillon (North Dakota, University, Grand Forks, N. Dak.). *(American Chemical Society, National Meeting, 169th, Philadelphia, Pa., Apr. 6-11, 1975.) I & EC - Industrial and Engineering Chemistry, Process Design and Development,* vol. 15, Jan. 1976, p. 122-129. Research sponsored by the U.S. Office of Coal Research.

The liquefaction of lignite involves the reaction of lignite and hydrogen in the presence of an organic solvent which acts as a hydrogen donor. During continuous operation the solvent will be produced from the lignite; however, during the initial startup a solvent from an outside source must be provided. Batch autoclave liquefactions were run with 15 coal-derived and 10 petroleum-derived solvents to screen potential startup solvents. The criteria for comparing the solvents were divided into (1) pre-liquefaction characteristics and (2) liquefaction performance. Pre-liquefaction characteristics included (1) the percentage of liquefaction solvent contained in the raw solvents and (2) the fluidity of the raw solvents. Liquefaction performance included (1) lignite conversion and product yields, (2) flow and filtration characteristics, (3) product hydrogen:carbon atom ratios and sulfur contents, and (4) recycle solvent properties (aromaticities, sulfur contents, and recoveries). Several coal and petroleum-derived solvents were found to be suitable for startup purposes. (Author)

A77-16473 **Catalytic coal liquefaction using synthesis gas.** Y. C. Fu and E. G. Illig (ERDA, Pittsburgh Energy Research Center, Pittsburgh, Pa.). *(American Chemical Society, National Meeting, 169th, Philadelphia, Pa., Apr. 6-11, 1975.) I & EC - Industrial and Engineering Chemistry, Process Design and Development,* vol. 15, July 1976, p. 392-396. 5 refs.

High sulfur bituminous coal is liquefied and desulfurized effectively by hydrotreating with synthesis gas at temperatures of 400-450 C and operating pressures of 3000-4000 psi in the presence of cobalt molybdate and sodium carbonate catalysts, steam, and a recycle oil. Comparison with coal liquefaction using pure hydrogen and cobalt molybdate catalyst has shown that, in both systems, the optimum liquefaction temperature is in the range of 425-450 C and there is no significant difference in the coal conversion and the oil yield. The sulfur content and the viscosity of the oil product both decrease with the amount of hydrogen consumed in each system, but less total hydrogen is required for the same oil product quality in the synthesis gas than in the hydrogen system. The catalytic hydrotreating of coal using synthesis gas, unlike that using hydrogen, removes large amounts of the oxygen in coal as carbon dioxide. The off-gas, with increased H2:CO ratio, is a low-Btu gas which could be burned or utilized for methane production or methanol synthesis. The cost of hydrogen production is saved. (Author)

A77-16474 **A laboratory evaluation of precoat filtration parameters for the solvent refined coal process.** S. Katz and B. R. Rodgers (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *I & EC Industrial and Engineering Chemistry, Process Design and Development,* vol. 15, July 1976, p. 407-410. ERDA-sponsored research.

A77-16475 **Mechanisms of coal particle dissolution.** J. Guin, A. Tarrer, L. Taylor, Jr., J. Prather, and S. Green, Jr. (Auburn University, Auburn, Ala.). *I & EC - Industrial and Engineering Chemistry, Process Design and Development,* vol. 15, Oct. 1976, p. 490-494. 12 refs. Research supported by the Alabama Mining Institute and Auburn University; NSF Grant No. GI-38701.

The rate of dissolution of coal in vehicle solvent is of primary importance in coal conversion processes. In this study, dissolution of individual coal particles is followed using photomicroscopy in a sequence of batch experiments. At 350 C, coal particles are observed to disintegrate into smaller units. Effects of temperature, gas phase composition, and solvent hydrogen donor activity on the extent of particle breakup are studied. Providing sufficient hydrogen is available, the process of disintegration is observed to occur very rapidly, with the qualitative appearance of a fluid-solid surface reaction having a high activation energy. Implications of this evidence are discussed and interpreted in light of previous investigations of coal dissolution. (Author)

A77-16533 # **The storage of energy in future energy supply systems (Speicherung von Energie in zukünftigen Energieversorgungssystemen).** J. Nitsch (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Energiewandlung und elektrische Antriebe, Stuttgart, West Germany), J. Reinkenhof, and J. Sternfeld (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für chemische Antriebe und Verfahrenstechnik, Lampoldshausen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 9th, Munich, West Germany, Sept. 14-16, 1976, Paper 76-182.* 25 p. 14 refs. In German.

Possibilities for satisfying the energy requirements of human civilization and technology with the aid of fossil energy carriers, representing chemically stored solar energy, are gradually decreasing. These developments make it necessary to provide increasing amounts of primary energy for the processes required to obtain appropriate energy carriers. This trend can possibly be reversed by making use of certain processes designed to obtain an optimum utilization of primary energy. Problems in connection with the new developments are related to storage of energy requirements. The use of synthetic liquid energy carriers obtained with the aid of coal liquifaction processes appears feasible, as a temporary solution, for the energy requirements of transportation. A description is presented of a power station in which hydrogen and oxygen is obtained by electrolysis at times of low power consumption. The hydrogen and oxygen can be used later as an energy source to obtain electric power when it is needed. G.R.

A77-16534 # **Liquid hydrogen as propellant for commercial aircraft (Flüssiger Wasserstoff als Treibstoff für Verkehrsflugzeuge).** A. Quast (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 9th, Munich, West Germany, Sept. 14-16, 1976, Paper 76-188.* 29 p. 6 refs. In German.

An investigation is conducted concerning the feasibility to use liquid hydrogen as fuel for commercial aircraft. Effects related to lower fuel weight and larger tank volume compensate each other. The energy consumption in the case of an aircraft using hydrogen is, therefore, about the same as in the ccse of a corresponding conventional aircraft. However, a considerable amount of electrical energy is required to transform gaseous hydrogen into the liquid state. Liquid hydrogen is consequently significantly more expensive than synthetic hydrocarbons. As much as 40% of the operational costs of commercial aircraft can be related to fuel costs. It is concluded that a use of hydrogen in commercial aviation on the basis of the current status of technology is not economic. G.R.

A77-16551 # **Energy storage in orbital and interplanetary missions (Energiespeicherung in orbitalen und interplanetaren Missionen).** E. Igenbergs (München, Technische Universität, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 9th, Munich, West Germany, Sept. 14-16, 1976, Paper 76-189.* 28 p. In German.

A description is presented of a new method for the storage of energy during an interplanetary transfer orbit. A use of the described method can make it possible to increase the payload. The energy

which is obtained by means of solar cells or nuclear reactors, when the spacecraft is in the transfer orbit, is stored in the form of a hydrogen-oxygen mixture. An investigation is conducted concerning the optimal relation between energy supply, energy transformation, and propellant for an orbital mission. G.R.

A77-16557 # **Status of development and application of gas-stabilized heat-pipe radiators (Stand der Entwicklung und Anwendung von gasstabilisierten Heat-Pipe Radiatoren).** H. Koch (Dornier-System GmbH, Immenstaad, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 9th, Munich, West Germany, Sept. 14-16, 1976, Paper 76-192.* 28 p. In German.

The employment of a noncondensable gas in heat pipes makes it possible to obtain a certain control effect which can be used for the stabilization of the component temperature. The functional characteristics of gas-stabilized heat-pipe radiators are discussed and basic physical relationships are examined. A description of various gas-stabilized heat pipe designs is presented. Applications considered are related to gas-stabilized heat-pipe radiators for an output multiplexer and for communications satellites of the MAROTS or OTS type. G.R.

A77-16575 # **Layout and flight performance of a hypersonic transport /HST/ (Auslegung und Flugleistungen eines Hyperschall-Transport-Flugzeugs /HST/).** G. Brüning, M. Kloster, and H. Krammer (München, Technische Universität, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 9th, Munich, West Germany, Sept. 14-16, 1976, Paper 76-198.* 44 p. 31 refs. In German.

General considerations for planning and reference designs for a hypersonic transport aircraft (HST) are laid out. Selection criteria for airfoils are discussed, including a conventional wing-fuselage combination, wedge airfoils, and surfboard type airfoils. Projections for flight range, propulsion plant organization, and drag value assignments in computer models are discussed. High-Mach diagrams are plotted for performance in throttling, maneuvering, acceleration, and under loading. Literature data for thrust, fuel consumption, and drag are found to be realistic. Flight noise is considered moderate, and hydrogen fuel with water vapor as exhaust gas is environmentally safe. R.D.V.

A77-16594 Electric arc power collection for high-speed trains. D. Klapas, R. Hackam, and F. A. Benson (Sheffield, University, Sheffield, England). *IEEE, Proceedings,* vol. 64, Dec. 1976, p. 1699-1715. 68 refs. Research supported by the Union Internationale des Chemins de Fer.

Contactless methods for collecting power to drive high-speed trains (up to 500 km/h) are examined (in contrast to sliding-contact and rolling-contact methods relying on pantograph catenaries or third rails). Capacitive coupling, inductive coupling, EM wave transmission, and a high-pressure arc plasma bridge are compared as contactless techniques, with preference for the latter in this application. Arc initiation, arc length and current, electrode materials and geometry, vehicle speed, power supply voltage, weather effects, and wear on collector and distributor are investigated. EM interference effects are dealt with. The relevance of the study to MHD and fusion, high-power laser technology, and arc furnace technology is pointed out. R.D.V.

A77-16600 # **A simplified method in flight test techniques for the determination of the range performance of jet aircraft (Ein vereinfachtes flugversuchstechnisches Verfahren zur Ermittlung der Horizontalflugleistungen von Strahlflugzeugen).** R. Rosenberg (Bundesamt für Wehrtechnik und Beschaffung, Manching, West Germany). *Zeitschrift für Flugwissenschaften,* vol. 24, Nov.-Dec. 1976, p. 350-356. In German.

From the physical fundamentals of the known W/delta-method, a simplified method is derived to determine the range performance of jet aircraft. The theoretical background is provided. The flight test parameters which are to be measured result from the developed equations. The simplicity of the method, which under certain conditions is also applicable to aircraft with multishaft engines, results from a special plotting of the data. (Author)

A77-16620 Windmills change direction. P. Musgrove (Reading, University, Reading, Berks., England). *New Scientist,* vol. 72, Dec. 9, 1976, p. 596, 597.

With the aid of a brief calculation it is demonstrated that windmills with generators could provide a significant part of the electricity needed by Great Britain. The windmills could be built in shallow offshore waters. Exhausted natural gas fields could be used as reservoirs to store surplus energy in the form of hydrogen or compressed air. The economic feasibility of a use of wind energy depends on the initial capital cost of the windmill system. The development of high speed vertical axis windmills appears to offer the possibility to design windmills for which the initial capital cost is much lower than that of conventional horizontal axis windmills of similar power rating. G.R.

A77-16623 Geothermal energy as a source of electric power: Thermodynamic and economic design criteria. S. L. Milora (Oak Ridge National Laboratory, Oak Ridge, Tenn.) and J. W. Tester (California, University, Los Alamos, N. Mex.). Research supported by the Energy Research and Development Administration; Contracts No. W-7405-eng-26; No. W-7405-eng-36. Cambridge, Mass., MIT Press, 1976. 195 p. 83 refs. $14.95.

Geothermal resource characteristics are considered along with the magnitude of the resource, the environmental factors involved, a thermodynamic properties evaluation, cycle efficiencies, and aspects of working fluid selection. An investigation of power cycle thermodynamics is conducted, taking into account the available energy of low-temperature liquid and steam systems, alternate fluid cycle design criteria, single-fluid cycle optimization, an irreversibility analysis of thermodynamic performance, a working fluid evaluation, multiple cycle arrangements, and Brayton gas cycles. Questions of power cycle economics are also explored, giving attention to model development, wells, heat exchangers and condensers, turbines and pumps, an approach to an economic optimum, a cost comparison of binary-fluid and direct flashing systems, and resource temperature effects on cycle economics. Criteria for turbines and pumps are examined. G.R.

A77-16651 # **Water requirements for an integrated SNG plant and mine operation.** D. J. Goldstein (Water Purification Associates, Cambridge, Mass.) and R. F. Probstein (Water Purification Associates; MIT, Cambridge, Mass.). *U.S. Environmental Protection Agency, Symposium on Environmental Aspects of Fuel Conversion Technology, 2nd, Hollywood, Fla., Dec. 15-18, 1975, Paper.* 52 p. 41 refs. U.S. Environmental Protection Agency Contract No. 68-03-2207; NSF Grant No. SIA-74-19080A01.

Part of the environmental assessment of large plants to make synthetic natural gas from coal is the determination of the water consumed. This is particularly important in the West where coal is available but water is scarce. The paper presents details of the procedures for determining water requirements. The determination of the cost of not evaporating water for cooling but of using air cooling and condensing is also described. It is shown that water requirements are dependent on process design, mine location and climate and that generalized assessments which are not site specific and design specific are of limited value. It is also shown that the published water requirements for integrated SNG plants and mine operations in the West may be high and that the actual requirements could, depending on the location, be half the lowest estimate to date. (Author)

A77-16697 Schlieren measurements of a high density z-pinch. K. H. Finken, G. Bertschinger, and R. S. Hornady (Ruhr-Universität, Bochum, West Germany). *Zeitschrift für Naturforschung, Teil a,* vol. 31a, Nov. 1976, p. 1318-1323. 9 refs.

The dense plasma phase of a dynamic z-pinch working at a high filling pressure is studied. By using the schlieren technique it is found

that the compressed plasma column, though macroscopically stable for times less than 1 microsec develops quickly from a homogeneous state to a turbulent one with a perturbation scale length of typically several millimeters. Quantitative measurements of light deflection give electron densities of typically 10 to the 19th power per cu cm at 0.25 Torr He filling. (Author)

A77-16742 # **Electric power supply in the case of airports. I (Elektroenergieversorgung von Flughäfen. I).** H. Krause (Gesellschaft für internationalen Flugverkehr mbH, Berlin, East Germany). *Technisch-ökonomische Information der zivilen Luftfahrt,* vol. 12, no. 4, 1976, p. 222, 223. In German.

The requirements concerning the power supply systems for airports are examined. Airport installations and devices which have to be supplied, in the event of power failure, with electric power from an emergency power supply include selected installations and areas of the air traffic control system, selected navigational devices, selected obstacle lights, selected meteorological equipment and installations, and selected parts of the airport lighting system. G.R.

A77-16787 # **Potentialities and limitations of the utilization of wind machines (Possibilità e limiti d'utilizzazione degli aeromotori).** G. L. Guizzi (Roma, Università, Rome, Italy). *(Conferenza Laziale di Ingegneria Ambientale, 1st, Rome, Italy, Apr. 2, 1976.) Ingegneria,* Sept.-Oct. 1976, p. 265-274. 10 refs. In Italian.

The article reviews economic and technological exploitation of wind power in the past and the situation favoring it, and surveys the current outlook for wide-scale utilization of wind power, taking a dim view of the prospects except for pumping of water from deep wells where it is competitive with other power sources. The high cost and short life of the batteries needed to store energy derived from wind and release it on demand is seen as the major obstacle, along with the low energy concentration and irregularity in magnitude, direction, and velocity. Pumping water as part of a turbine system, and use as auxiliary power source in vehicles powered by other sources, are mentioned. Large-scale wind power farms are viewed as not only noncompetitive, but possibly conducive to climatic 'pollution' by slowing down and disturbing wind currents and patterns. R.D.V.

A77-16824 **Superalloys for advanced energy systems.** C. T. Sims. *JOM/Journal of Metals,* vol. 28, Dec. 1976, p. 7-18. 24 refs.

The use of superalloys in such energy systems as combined cycle plants, coal gasification systems, fluid bed combustion systems, high temperature gas cooled reactors and liquid metal cooled fast breeder reactors is reviewed. These alloys (including Nimonic, Hastelloy, Incoloy, and Fe-Ni-Cr austenitic alloys among others) will operate at peak temperatures of 700-1600 C in these energy systems and will require good corrosion and oxidation resistance and such special mechanical properties as rupture strength, creep strength, and thermal fatigue resistance. B.J.

DATA SUMMARY: The effect of impure He on the rupture properties of Inconel 617 and type 316 stainless steel are studied in a high temperature gas cooled reactor and iso-swelling contours are presented for a Fe-Ni-Cr austenitic system; variables are stress, time to rupture, iso-swelling conditions, mechanical property requirements, and critical temperature; one table and two figures include numeric data.

A77-16825 **The role of recycling in conservation of metals and energy.** H. H. Kellogg (Columbia University, New York, N.Y.). *JOM/Journal of Metals,* vol. 28, Dec. 1976, p. 29-32.

Problems in the recycling of metal scrap are surveyed for eight metals (Pb, Ag, Zn, Mg, Cu, Ni, Al, and stainless steel). Recycling of 'new' scrap (45 million tons annually, recycled products within basic industries) is not new, and attention is focused on recycling of 'obsolete' scrap more or less dispersed throughout the consumer economy. Hard data on amounts of the metals involved are hard to come by, methods for estimates are explained with their shortcomings, and attention is given to the energy requirements for reprocessing scrap, quality of scrap, and processability, segregability, and separability of obsolete scrap in various forms of practical interest. Factors favoring or disfavoring increased scrap recycle are explained, some reprocessing techniques are mentioned, and tabular data summarizing important aspects of the national scrap picture are presented. R.D.V.

A77-16922 **Production of atmospheric nitrous oxide by combustion.** R. F. Weiss and H. Craig (California, University, La Jolla, Calif.). *Geophysical Research Letters,* vol. 3, Dec. 1976, p. 751-753. 15 refs. NSF-supported research.

Measurements of N2O in the effluent gases from the burning of coal and fuel oil show that these are significant anthropogenic sources of atmospheric N2O. We estimate that the present global production of N2O from these sources is 1.6 Mtons N2O(N) per year and is increasing at a rate of approximately 3.5% per year. Catalytic converters for the reduction of NO emissions also represent a major potential source of atmospheric N2O. (Author)

A77-17014 **Concept of a fusion burner.** A. Hasegawa (Bell Telephone Laboratories, Inc., Murray Hill, N.J.; Nagoya University, Nagoya, Japan), T. Hatori, T. Ikuta, Y. Kodama, K. Nozaki (Nagoya University, Nagoya, Japan), and K. Itoh (Tokyo, University, Tokyo, Japan). *Nuclear Fusion,* vol. 16, Nov. 1976, p. 865, 866. NSF Grant No. IOP-74-12932.

The design of a multiple-mirror fusion burner system is presented. A magnetically confined long linear plasma machine with fuel injected from one end of the machine and burned at the other end in steady-state operation is described. CW output power of 1 GW is claimed feasible given carefully adjusted flowspeed, density, and temperature profiles. A tenfold increase in output power may be possible through use of a straight magnetic field. Use of a superconducting coil to establish the field, and of lasers and DT pellets for fuel ignition, is discussed. R.D.V.

A77-17016 **Advanced fuels for inertial confinement.** J. R. McNally, Jr. and R. D. Sharp (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Nuclear Fusion,* vol. 16, Nov. 1976, p. 868-870. 12 refs. ERDA-sponsored research.

Be-doped and B-doped fuels, beryllium hydride and isotopic variants (such as BeDT, BeH2), LiD(x)T(1-x), BD(x)T(3-x), and other pelletizable fuels are described, with some of their reactions, advantages, and disadvantages of fusion interest. Available zero-dimensional time-dependent advanced fusion fuels codes are applied to studies of some of the fuels and their behavior and reactivity. Dense pellet burning is treated as a pulsed closed charged-particle reacting system with radiation damping and constant electron density, but without neutron reactions, neutron energy deposition, or bremsstrahlung absorption. Peak temperatures, burn times to peak, and percentage tritium burnup at peak are plotted. Suggested refinements in the calculations are mentioned. R.D.V.

A77-17017 **A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices.** H. A. Bruzzone, H. J. Kelly, M. M. Milanese, and J. O. Pouzo (Buenos Aires, Universidad, Buenos Aires, Argentina). *Nuclear Fusion,* vol. 16, Nov. 1976, p. 870-873. 20 refs. Research supported by the Ministerio de Defensa, Comisión Nacional de Estudios Geo-Helioffsicos and Consejo Nacional de Investigaciones Cientlficas y Técnicas.

A77-17021 * # **LTA - Recent developments.** N. J. Mayer (NASA, Office of Aeronautics and Space Technology, Materials and Structures Div., Washington, D.C.). *Astronautics and Aeronautics,* vol. 15, Jan. 1977, p. 58-64.

NASA-sponsored studies of existing and new LTA missions showed that airships looked very promising for some two dozen civil and military applications. These include surveillance of rural and urban areas, in the form of forest and police patrols; transport of very heavy large-volume maritime, industrial, and military payloads; coastal patrol and sea control; seismographic surveys; air pollution monitoring; and moving goods to remote areas; along with a number

of less important but still attractive missions. A figure of merit of productivity (payload weight, ton moles per hour) was used to compare airships of various type and size. In each case, this criterion established an index of efficiency for evaluating not only conceptual approaches but also modes of flight. Some, in part unexpected, results of these studies are described. V.P.

A77-17058 Energy and environmental considerations in extending heat pump applications. L. J. Schmerzler and M. J. Levy (New Jersey Institute of Technology, Newark, N.J.). *Journal of Environmental Sciences,* vol. 19, Nov.-Dec. 1976, p. 16-18, 31.

The conventional heat pump is limited by economic and practical reasons to regions where the mean ambient winter temperature is no lower than 40 F. This limitation is basically due to the use of irreversible throttling expansion process which reduces the coefficient of performance, increases the power requirements, and limits the efficient use of the heat pump to relatively moderate climates. The paper describes an improved compressor-expander apparatus (CEXA) system which utilizes all the components of a conventional refrigeration system with the exception of the conventional throttling valve for expansion control, which is eliminated and replaced by a CEXA. The CEXA produces a modified thermodynamic cycle with a higher coefficient of performance and a greater useful temperature range than is presently obtainable from the conventional vapor compression system, and reduces the electrical power requirements for electrically heated and cooled buildings. The operational and thermodynamics aspects of the conventional and CEXA systems are compared. Thermodynamics methods are used to calculate the CEXA heat pump performance. S.D.

A77-17234 Fuel consumption of civil jet transport aircraft. J. P. K. Vleghert (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands). In: International Symposium on Air Breathing Engines, 3rd, Munich, West Germany, March 7-12, 1976, Proceedings. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1976, p. 139-148. 7 refs.

Fuel consumption under steady cruise conditions is analyzed using aircraft flight data logged by hand and further processed by computer. A large problem with the interpretation of the observed data is the limited reliability of the instrumentation chain, which requires extensive cross-checking, filtering and fault-eliminating, with the attendant risk that short-term deterioration passes unnoticed. Examples of possible cross-checks are given. Only part of the excess fuel consumption could be traced to the engine via test bed results. Some considerations are given with regard to the applicability of static test bed results to cruise conditions. Further flight tests with tufted nacelles showed the boundary layer aft of the fan exhaust to be unsteady in some cases, which could be related to in-service deterioration of the fan exhaust ducts. (Author)

A77-17258 Pressure ratio optimization criteria in aircraft turbojet-engines design. V. Quaggiotti (Padova, Università, Padua, Italy). In: International Symposium on Air Breathing Engines, 3rd, Munich, West Germany, March 7-12, 1976, Proceedings. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1976, p. 665-683.

Optimization criteria are obtained for the pressure ratio in an aircraft turbojet-engine of rectilinear configuration in which the propelling nozzle, the exhaust duct, the turbomachines, the intake duct, and the diffuser are aligned. The symmetric configuration and the essentially rectilinear geometry of the stream suggest a one-dimensional representation as a good approximation. The propulsive efficiency and the thermal efficiency are expressed as functions of the total pressure ratio considered as the most important design parameter. Suitable charts can be plotted as useful tools in guiding the preliminary choice between requirement of low displacement and low weight and requirement of low specific fuel consumption as an ever impelling factor due to oil crisis. S.D.

A77-17264 Variable geometry for high performance aircraft engines. J. Hourmouziadis (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). In: International Symposium on Air Breathing Engines, 3rd, Munich, West Germany, March 7-12, 1976, Proceedings. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1976, p. 781-801. 10 refs. Research supported by the Bundesministerium der Verteidigung.

An investigation was carried out to assess the feasibility of variable geometry as an active means of influencing bypass ratio, aiming at improving the adaptability of engine performance characteristics to aircraft requirements. Addition of variable geometry to existing engines and development of new optimized designs were considered. Since some variable components can also have significant effects on spillage and afterbody drag, installed performance was chosen as a basis for comparison. It is shown that active variable geometry offers a significant potential for improving turbofan performance flexibility and component handling by means of rather conventional technologies. Improvement from variable geometry in existing engines is restricted by speed limits and maximum permissible pressure levels in the core engine. S.D.

A77-17478 Spectral response of a laterally illuminated p-n junction. B. M. Seth and P. K. Bhatnagar (Delhi, University, Delhi, India). *International Journal of Electronics,* vol. 41, Dec. 1976, p. 621-624. 6 refs. Research supported by the University of Delhi and University Grants Commission of India.

A correction of the boundary condition is suggested for the Constantinescu-Goldenblum (1973) calculation of the spectral response of a laterally illuminated p-n junction. Zero surface recombination rate means that collection efficiency is independent of absorption coefficient. The possible value of laterally illuminated p-n junctions as photodetectors or as photovoltaic energy converters is reiterated. R.D.V.

A77-17525 Homeowner's guide to solar heating and cooling. W. M. Foster (Aluminum Company of America, Pittsburgh, Pa.). Blue Ridge Summit, Pa., TAB Books, 1976. 196 p. 34 refs. $7.95.

A practical handbook for consumer's guidance on solar heating/cooling, the text covers: system components, typical system arrangements, sizing of system and major components, and special discussions of solar water heaters and solar heating of swimming pools. Contour maps of annual heating degree days and mean solar radiation are presented for the continental U.S. (48 states), along with numerical data for the 50 states. Abundant diagrams and photographs illustrate the layout, assembly, and functioning of components, subsystems, and systems. Numerous particular solar heating installations are described as illustrative examples. R.D.V.

A77-17534 A combined cycle with a partial-oxidation reactor (Cycle combiné avec réacteur à oxydation partielle du combustible). J. Ribesse, A. Jaumotte (Bruxelles, Université, Brussels, Belgium), and A. De Goeyse. *Entropie,* vol. 12, no. 70, 1976, p. 15-18. In French.

A combination of power generator and lean fuel gas generator is realized by replacing the combustion chamber of a gas turbine with a reactor featuring partial oxidation of the fuel. The lean fuel gas lends itself to use in the boiler of a conventional steam cycle. The combined cycle makes it possible to raise the output of a conventional steam power plant with some boiler redesign. The cost of installation per kW generated is low. The catalytic-oxidation gas turbine system is recommended for judicious combination with other industrial facilities, furnaces in particular. Extension of the method to other fuels is also recommended. R.D.V.

A77-17541 Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer. G. A. Heyman and G. S. Turner (Beckman Instruments, Inc., Fullerton, Calif.). *(Instrument Society of America, Annual Analysis Instrumentation Symposium, 22nd, San Francisco, Calif., May 9-12, 1976.) ISA Transactions,* vol. 15, no. 3, 1976, p. 209-213.

The chemiluminescence analyzer for continuous monitoring of nitrogen oxides in stack gases measures radiation from a chemical

reaction in a system consisting of a reaction chamber for the NO-O3 reaction, a sensitive photomultiplier tube, an O3 source, and a NO2-to-NO converter. Sample conditioning and analyzer requirements of NO, NO2, and NOx by chemiluminescence system are presented. Stack gases from fossil fueled boilers and nitric acid plants are discussed separately as the requirements for successful monitoring are quite different. Potential interference from CO2, H2O, NH3, and SO2 are evaluated. S.D.

A77-17551 **Fossil energy research and development in ERDA.** P. C. White (ERDA, Washington, D.C.). *Progress in Energy and Combustion Science,* vol. 2, no. 3, 1976, p. 115-128.

The paper reviews the near-term (1975-1985), mid-term (1985-2000), and long-term (2000+) objectives of the Energy Research and Development Program. Since coal conversion technology requires considerable development to reach maturity and coal is the most abundant fossil fuel resource in the United States, coal program has received the largest share of funding. Certain program accomplishments are indicated. Included in the discussion are high and low Btu gasification, advanced power systems, direct combustion, and use of MHD in achieving successful operation of a commercial facility to generate electricity from coal or a coal-derived fuel by the late 1980s. However, petroleum and natural gas will continue to be the nation's main fossil energy source for many years. The in-situ technology program is discussed relative to oil shale and in-situ coal gasification. S.D.

A77-17555 **Problems of energy storage in solar power stations.** R. R. Aparisi and D. I. Tepliakov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *(Geliotekhnika,* no. 2, 1976, p. 3-11.) *Applied Solar Energy,* vol. 12, no. 2, 1976, p. 1-7. 10 refs. Translation.

The principal prerequisites for developing daily, seasonal, and annual energy accumulators for solar power plants are discussed, and methods for processing long-time actinometric data as a basis for evaluating accumulator dimensions are proposed. Representative accumulator designs are examined from the point of view of their applicability in solar power plants. V.P.

A77-17556 **Economic effectiveness of solar electric power stations.** A. I. Filatov and D. Iu. Ibragimov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *(Geliotekhnika,* no. 2, 1976, p. 12-18.) *Applied Solar Energy,* vol. 12, no. 2, 1976, p. 8-12. 5 refs. Translation.

The limiting values of the technological and economical indices of solar power plants at which the latter would become compatible with conventional power plants are examined. Calculations carried out for desert and semidesert regions in Turkmen SSR, characterized by high transportation costs of fuel and coal, show that under such conditions solar power plants can compete with conventional ones. V.P.

A77-17557 **Standard-size facets for the reflecting surface of a solar concentrator.** R. A. Zakhidov and Iu. A. Dudko (Akademiia Nauk Uzbekskoi SSR, Tsentral'noe Proektnoe Konstruktorsko-Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). *(Geliotekhnika,* no. 2, 1976, p. 19-21.) *Applied Solar Energy,* vol. 12, no. 2, 1976, p. 13-15. Translation.

A77-17558 **Contribution of the heat carried by solar radiation to the thermal balance of a room during the cold season and its effect on domestic fuel consumption.** A. B. Babaev and P. F. Rzaev (Azerbaidzhanskii Politekhnicheskii Institut, Baku, Azerbaidzhan SSR). *(Geliotekhnika,* no. 2, 1976, p. 41-45.) *Applied Solar Energy,* vol. 12, no. 2, 1976, p. 33-36. 5 refs. Translation.

Calculations carried out for coastal and central regions of Azerbaidzhan, characterized by an average of 2211 and 2278 radiant hours per year, respectively, show that standard consumption of heating fuel can be substantially reduced through the use of solar heat. The savings in fuel consumption and in the cost of heating facilities are calculated on the basis of meteorological and solar-radiation data. V.P.

A77-17561 **A Cassegrain system for solar radiation.** G. Ia. Umarov, A. K. Alimov, and D. N. Alavutdinov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *(Geliotekhnika,* no. 2, 1976, p. 68, 69.) *Applied Solar Energy,* vol. 12, no. 2, 1976, p. 55, 56. Translation.

A77-17588 **Nova Scotia seeks to cut oil bill for power generation.** E. Jeffs. *Energy International,* vol. 14, Jan. 1977, p. 19-21.

An environmentally unobtrusive hydroelectric power plant being built at Wreck Cove, Nova Scotia, to ease the area's dependence on increasingly costly oil imports for fuel is described. The plant is scheduled to go on line by the end of 1977. The geological environment of the plant site is described, along with hydrological features of the catchment area and surrounding terrain. Earthmoving operations and installation of major power machinery are described. The power plant will feed 200 MW (peak rating) into the Province grid when it goes into service. R.D.V.

A77-17591 **High-temperature ceramics for automobile gas turbines. II (Hochtemperaturkeramik für Automobilgasturbinen. II).** P. Walzer, M. Köhler, and P. Rottenkolber. *Motortechnische Zeitschrift,* vol. 37, Dec. 1976, p. 525-529. 31 refs. In German. Research supported by the Bundesministerium für Forschung und Technologie.

The development of ceramic components for automobile gas turbine engines is described with attention given to the steady and unsteady thermal conditions the ceramics will experience, and their anti-corrosion and strain-resistant properties. The ceramics considered for use in the automobile turbines include hot-pressed Si3N4, reaction-sintered, isostatically pressed Si3N4, hot-pressed SiC, reaction-bonded SiC, and glass ceramics. Attention is given to the stress analysis of ceramic structures and the state of the art of ceramic structural technology is reviewed emphasizing the use of ceramics for combustion chambers and ceramic shrouded turbomachinery (a fully ceramic impeller). B.J.

A77-17636 **Application of solar energy in the high-temperature range (Anwendung der Sonnenenergie im Hochtemperaturbereich).** E. Gnugesser, S. K. Mukherjee, and G. Riebold (Kraftanlagen AG, Heidelberg, West Germany). *Brennstoff-Wärme-Kraft,* vol. 28, Dec. 1976, p. 470-474. 8 refs. In German.

A description is presented of the possibilities concerning an application of solar energy for processes with operational temperatures of 100 C and higher. Attention is given to steam-jet and absorption refrigeration installations, approaches for removing the salt from seawater, the supply of heat for industrial processes, and solar thermal power stations. The design and efficiency of collectors for concentrating the solar energy on absorbers are also discussed. G.R.

A77-17762 # **Theoretical aspects of optimization of aviation gas turbine engine design variables (Teoreticheskie voprosy optimizatsii proektnykh parametrov aviatsionnykh GTD).** V. G. Maslov. *Aviatsionnaia Tekhnika,* vol. 19, no. 3, 1976, p. 72-79. 7 refs. In Russian.

Typical aircraft systems optimization criteria are presented with emphasis on their use in finding regions of optimum gas turbine engine (GTE) performance in early design stages. Attention is centered on comparative evaluations of two salient criteria: the effective specific weight of the GTE in the aircraft design system and losses incurred per ton-kilometer. Analytic formulas minimizing specific weight and specific fuel consumption are derived, along with the boundaries of those optimum performance variables in the neighborhood of minima. Optimization results for a helicopter GTE and a fixed-wing GTE with respect to the two criteria are compared numerically. R.D.V.

A77-17765 # **Analysis of parameters and characteristics of a bypass turbojet engine operating in a cycle with stepwise heat removal (Analiz parametrov i kharakteristik DTRD, rabotaiushchikh po tsiklu so stupenchatym otvodom tepla).** B. Kh. Perel'shtein.

Aviatsionnaia Tekhnika, vol. 19, no. 3, 1976, p. 94-100. 8 refs. In Russian.

A feasibility analysis is carried out for a bypass turbojet engine (BPTJ) with design complicated by addition of a self-contained vacuum module whose function is to effect heat removal in a stepwise pattern. The vacuum module comprises: a re-expansion turbine, a contact type freezer (in aerothermocompressor format), and a booster compressor. The first heat removal stage involves cooling of the working fluid in the freezer and venting to atmosphere. Positioning of the vacuum module aft of the main engine brings the pressure downstream of the power turbine down, with increased available pressure head, while specific fuel consumption is diminished by a factor of 1.21 and specific thrust is increased by a factor of 1.33. R.D.V.

A77-17801 Geothermal energy development. J. C. Rowley (California, University, Los Alamos, N. Mex.). *Physics Today*, vol. 30, Jan. 1977, p. 36-38, 41-45. 24 refs. ERDA-sponsored research.

A picture of the worldwide status of geothermal exploration and exploitation is presented, along with a survey of the main types of geothermal reservoirs, and outstanding difficulties to be overcome. Exploration, drilling, corrosion and materials selection, and costs are surveyed. Drilling costs are a paramount problem (40-80% of reservoir development and operation costs, and twice the cost of oil/gas wells); various drilling methods are described (water-jet-augmented rotary drilling, rock melting, electric spark disintegration of rock), and drilling into the magma is envisaged as a landmark. Measuring instrumentation, models of rock formations, and laboratory facilities require improvement, and high-temperature electronics for downhole use are a must; an integrated thermionic circuit design is shown. The recent growth rate of geothermal development is indicated. R.D.V.

A77-17819 Supplementary plasma heating studies in the atomic energy commission, France. T. Consoli (EURATOM and Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Grenoble, Grenoble, France). *IEEE Transactions on Plasma Science*, vol. PS-4, Dec. 1976, p. 257-271. 46 refs.

Research on supplementary heating methods suitable for toroidal plasma devices is reviewed. The methods discussed include heating by neutral beams, RF waves, and adiabatic magnetic compression. Advantages and difficulties of each method are described, the mechanisms involved are analyzed, and specific research programs carried out in France and other countries are summarized. Neutral-beam and lower-hybrid-resonance RF heating are shown to be the most promising methods investigated thus far. F.G.M.

A77-17845 Theoretical maximum for energy from direct and diffuse sunlight. W. H. Press (Harvard University, Cambridge, Mass.). *Nature*, vol. 264, Dec. 23-30, 1976, p. 734, 735. 7 refs.

An investigation is conducted concerning the numerical values of the maximum efficiencies which can be obtained in a utilization of direct and diffuse sunlight. It is found that the value for the conversion of energy in the case of diffuse sunlight is about 25% lower than the energy conversion factor in a process employing direct sunlight. The smaller energy value in the case of the diffuse sunlight is related to the greater entropy of the diffuse radiation. G.R.

A77-17895 The palirrhotrophic origin of energy metabolism. J. W. Ycas (Texas A & M University, College Station, Tex.). *Origins of Life*, vol. 7, Aug. 1976, p. 235-238. 13 refs. NSF Grant No. BMS-75-04108.

It is proposed that the earliest cellular organisms relied upon a novel type of energy transduction termed palirrhotrophy, which generates a high-energy 'currency' chemiosmotically by exploiting the rhythmic variations in salinity which occur in the estuarine environment. Calculations based on estimates of contemporary chemiosmotic transduction efficiency suggest that such a mechanism could produce usable energy in high yield. The minimum polypeptide requirement for palirrhotrophy compares favorably with that of a fermentative pathway. It is suggested that palirrhotrophic organisms exist today but are difficult to detect. (Author)

A77-17917 # Limiting capabilities with respect to electric power generation of a pulsed MHD generator operating at a resistive load (Predel'nye vozmozhnosti impul'snogo MGD-preobrazovatelia po generatsii elektricheskoi energii na omicheskuiu nagruzku). E. I. Asinovskii and V. E. Ostashev (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *Teplofizika Vysokikh Temperatur*, vol. 14, Sept.-Oct. 1976, p. 1079-1082. 6 refs. In Russian.

A77-17924 # The analysis of the temperature regimes of the operation of a gas-regulated heat pipe (K voprosu analiza temperaturnykh rezhimov raboty gazoreguliruemoi teplovoi truby). I. G. Shekriladze, Z. V. Arkaniia, G. I. Zhorzholiani, and I. I. Iopuriia (Nauchno-Issledovatel'skii Institut Stabil'nykh Izotopov, Tiflis, Georgian SSR). *Teplofizika Vysokikh Temperatur*, vol. 14, Sept.-Oct. 1976, p. 1126-1129. 6 refs. In Russian.

The operational heat regimes of a gas-regulated heat pipe are analyzed assuming the temperature and concentration of the buffer gas to vary along the heat pipe. It is further assumed that the temperature of the hot buffer gas is close to that of steam saturation, and the geometry of the heat pipe, surface heat transfer coefficients, the temperature of the ambient medium, and the mass of the inert gas injected into the pipe are all given. Pressure drops in the pipe are neglected and the thermodynamic parameters of the gas are described by an ideal-gas equation of state. The method employed can also be used to take account of longitudinal heat conduction of the wettened wick and of the outside ribbing. B.J.

A77-17939 # Increase in the efficiency of heat and power systems using large artificial accumulators of heat (Povyshenie effektivnosti teplofikatsii pri ispol'zovanii krupnykh iskusstvennykh akkumuliatorov tepla). D. S. Vlasov and B. Ia. Grislis (Akademiia Nauk Latviiskoi SSR, Fiziko-Energeticheskii Institut, Riga, Latvian SSR). *Akademiia Nauk Latviiskoi SSR, Izvestiia, Seriia Fizicheskikh i Tekhnicheskikh Nauk*, no. 5, 1976, p. 82-88. 6 refs. In Russian.

Five schemes combining heat and power production for the energy supply of urban areas are examined. The best of the schemes is one using common annular heat networks containing large artificial heat accumulators and long one-pipe heat conduits. This combined system of heat and power production is found to be of greater efficiency not only in terms of separate system turbines but on the scale of the entire system. B.J.

A77-18019 Titanium-containing Raney nickel catalyst for hydrogen electrodes in alkaline fuel cell systems. K. Mund, G. Richter, and F. von Sturm (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *(Electrochemical Society, Meeting, Washington, D.C., May 2-7, 1976.) Electrochemical Society, Journal*, vol. 124, Jan. 1977, p. 1-6. 16 refs. Research supported by the Bundesministerium für Forschung und Technologie.

In alkaline hydrogen-oxygen fuel cells Raney nickel is employed as catalyst for hydrogen electrodes. The rate of anodic hydrogen conversion has been increased significantly by using a titanium-containing Raney nickel. The properties of the catalyst powder, the influence of particle diameter, and the behavior of electrodes under load are described. Impedance measurements have been used to characterize the electrodes. In fuel cell systems the supported electrodes are normally operated at current densities up to 0.4 A per sq cm. The overload current density of 1 A per sq cm can be maintained for several hours. (Author)

A77-18072 Radiation effects on high efficiency silicon solar cells. W. Luft (TRW Defense and Space Systems Group, Redondo Beach, Calif.). *(Institute of Electrical and Electronics Engineers, Annual Conference on Nuclear and Space Radiation Effects, 13th, La Jolla, Calif., July 27-30, 1976.) IEEE Transactions on Nuclear Science*, vol. NS-23, Dec. 1976, p. 1795-1802. 17 refs.

The performance of 10 cell types from 3 manufacturers shows nonirradiated, glass-covered cell efficiencies ranging from 10.3 to

13.6% after prolonged photon illumination for cells having thicknesses from 215 to 370 microns. Efficiencies after irradiation by 1-MeV electrons to a fluence of 1 E15 e/sq cm ranged from 8.0 to 9.2%. The degradation in power output as a result of 1 E15 e/sq cm irradiation ranged from 31 to 32% for cells with a 2 ohm-cm base resistivity and from 28 to 30% for 10 ohm-cm cells. Cells having a P(+) back surface field showed the highest degradation in each resistivity group. Only a cell group using float-zone material showed significant photon degradation after electron irradiation. All other cell types showed annealing of electron irradiation damage of up to 5% after 3 E15 e/sq cm irradiation. The solar absorptance for the high efficiency cells ranges from 0.78 to 0.93. (Author)

A77-18130 # **Construction of two-dimensional steady-state solution of equations of a nonequilibrium magnetized plasma (K postroeniiu ploskikh statsionarnykh reshenii uravnenii neravnovesnoi zamagnichennoi plazmy).** V. I. Artemov and O. A. Sinkevich. *Prikladnaia Matematika i Mekhanika,* vol. 40, Sept.-Oct. 1976, p. 813-822. 19 refs. In Russian.

A method is proposed for obtaining steady two-dimensional distributions of the electric current and electron temperature in a magnetized nonequilibrium plasma with allowance for heat conductivity and convection. The solution is obtained in the form of asymptotic expansions in a small parameter. The procedure of obtaining a zeroth approximation for the external and internal expansions is examined. The problem of the current distribution in a channel with infinite electrodes is solved as an example. V.P.

A77-18196 Air electrodes for H2-air fuel cells with alkali electrolyte. K. Höhne (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *Siemens Forschungs- und Entwicklungsberichte,* vol. 5, no. 5, 1976, p. 266-271. 5 refs.

A doped silver-coated activated carbon catalyst developed for oxygen conversion was tested with regard to its catalytic ability in fuel cell processes utilizing air and hydrogen. Attention is given to the preparation of the catalysts, the operational characteristics of the cathodes in the case of an employment of air instead of oxygen, the performance of the carbon electrodes with and without silver coating, and the results obtained with nickel-doped silver-coated carbon electrodes. The investigation demonstrates the superiority of the carbon catalysts. The best electrical characteristics were obtained with the aid of an approach involving doping with nickel. G.R.

A77-18215 # **Regulatory reform of air transportation.** H. J. Wexler (Continental Airlines, Inc., Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-276.* 3 p.

A route moratorium instituted by the Civil Aeronautics Board (CAB) is considered along with a decision of the D.C. Court of Appeals which rejected the Board's argument that a temporary lag in industry profits and the fuel crisis justified its route moratorium. The pricing system administered by the CAB during the past several years is critically examined, taking into account the assumptions on which the CAB's approach is based. A proposal is made concerning a number of changes which could be realized in the public interest. G.R.

A77-18222 # **The future of air transportation - Economic association considerations.** F. J. H. Johnston (International Air Transport Association, Montreal, Canada). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-286.* 19 p.

The International Air Transport Association is responsible for providing the necessary machinery whereby international airlines can negotiate tariff agreements on international services subject to governmental approval. The essence of the future problem of international air transport is how to rationalize the desire of the peoples of the world for air transport services at the lowest possible price levels in face of the inexorable rising cost trends. The political and regulatory environment in which the industry is operating and the changes which may occur in the next ten years are outlined. The prospects for future traffic growth in the industry will be closely related to the economic health of the principal traffic generating countries. However, the economic climate is likely to be not conducive to large-scale or long-range planning by international air transport. Ways in which future prospects can be improved are pointed out. S.D.

A77-18223 # **Alkali metal space power technology applicable to national energy research and development.** W. F. Zimmerman (General Electric Co., Evendale, Ohio). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-289.* 12 p. 54 refs.

The nation's space power program developed an alkali metal technology potentially applicable to its future energy needs. The space power system was designed to utilize a nuclear reactor with a primary lithium loop and a secondary boiling/condensing potassium loop driving a potassium vapor turbine/electrical generator. Considerable design, manufacture, test and evaluation efforts were expended in the successful demonstration of the boilers, condensers, turbines, seals, valves, pumps and other components. Much of that high temperature Rankine cycle technology can be used as a basis for advanced power conversion systems; these might include fossil and nuclear fueled plants, central solar power systems or solar power satellites. (Author)

A77-18224 # **Solar power satellites - Opportunity and challenge.** G. R. Woodcock (Boeing Aerospace Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-291.* 11 p. 8 refs.

The use of solar power satellites (SPS) for supplying a significant share of the electric power needs of civilization is considered. The electric power obtained with the aid of solar cells is to be converted to microwaves which are to be transmitted to earth ground stations. The specific challenges imposed by the requirements of the microwave power transmission system are investigated. The practicality of SPS depends also on the possibility of a cost-effective construction of the required structures in space. A number of investigations are proposed to study the feasibility of the SPS concept. G.R.

A77-18225 * # **Solar photovoltaics - An aerospace technology.** J. V. Goldsmith (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-293.* 7 p. Contract No. NAS7-100.

Specific problems affecting the development of low-cost silicon solar array power sources are discussed, taking into account the potential of realizing less than $0.50/per peak watt of silicon solar array technology. A utilization of less expensive processes for the manufacture of pure silicon and more economical procedures of silicon crystal and wafer production appear desirable. Attention is given to a sheet growth process example and a concept of pulsed processing for automated cell production. G.R.

A77-18226 # **The application of aerospace technology to solar thermal electric power generation.** R. W. Hallet, Jr. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-294.* 5 p.

ERDA has established a program plan for the development of technology which will make the utilization of solar energy possible. One goal established in this connection is to provide 40,000 MW of electric power generating capacity from solar thermal electric

systems by the year 2000. According to the central receiver concept, solar rays are reflected from two axis tracking heliostats located on the ground to a receiver located at the top of a tower. Attention is given to the central receiver baseline concept, a cost breakdown by subsystem for a commercial solar central station plant, alternative receiver concepts, alternative heliostat concepts, questions of heliostat manufacturing flow, and a thermal storage subsystem. G.R.

A77-18227 # **OTEC - Aerospace and ocean engineering in partnership.** J. G. Wenzel (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-296.* 4 p.

Contributions of aerospace know-how to the development of ocean thermal energy conversion (OTEC) technology are discussed. The use of aluminum and titanium for heat transfer, development of a suitable OTEC heat exchanger, structural analysis of the 120 ft diam cold water pipe (to extend 2000 ft into the ocean and retain structural integrity under buffeting by wave, current, and pumping forces), and a spar buoy platform stabilizer are enumerated as examples of spin-offs from aerospace technology benefiting initial OTEC developments. Other likely derivatives from aerospace technology are: very large rotating machinery, electrical distribution networks, control systems, and trade-offs between energy storage and energy transmission. R.D.V.

A77-18232 # **Wind tunnel investigation of devices to reduce bus aerodynamic drag.** D. P. Raymer (Purdue University, West Lafayette, Ind.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-307.* 6 p. 6 refs. U.S. Department of Transportation Contract No. TSC-989.

Aerodynamic drag on long-haul passenger buses (specifically the common MC-7 coach) at flowspeeds scalable to typical highway cruising speeds are investigated, using 15 front-end configuration models in a wind tunnel. Reduction of fuel consumption via reduction of drag and turbulence with the aid of aerodynamic add-on devices (inflicting no penalties in costs or added total bus length) is studied. Turbulence under the bus was a persistent problem. Rear-end modifications and turning vanes failed to reduce drag. Three front-end modifications show promise and are being tested further ('top bonnet', 'full mask', and 'lip removed' configurations). Fuel savings of $834 per bus annually are anticipated if drag can be cut 21% (resulting in 10% reduction in fuel consumption at 55 mph). R.D.V.

A77-18237 * # **Technical highlights in general aviation.** J. W. Stickle (NASA, Langley Research Center, Flight Research Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-312.* 23 p. 7 refs.

Improvements in performance, safety, efficiency, and emissions control in general aviation craft are reviewed. While change is slow, the U.S. industries still account for the bulk (90%) of the world's general aviation fleet. Advances in general aviation aerodynamics, structures and materials, acoustics, avionics, and propulsion are described. Supercritical airfoils, drag reduction design, stall/spin studies, crashworthiness and passenger safety, fiberglass materials, flight noise abatement, interior noise and vibration reduction, navigation systems, quieter and cleaner (reciprocating, turboprop, turbofan) engines, and possible benefits of the Global Position Satellite System to general aviation navigation are covered in the discussion. Some of the developments are illustrated. R.D.V.

A77-18254 # **Gas turbine electric powerplants.** R. L. Hendrickson (General Electric Co., Gas Turbine Engineering and Manufacturing Dept., Schenectady, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-346.* 9 p. 9 refs.

The relatively low capital cost of gas turbines makes them the economic choice for supplying peaking power in the electric utility industry. In a few installations, the recovery of the heat in the turbine exhaust makes a very efficient operation possible. The origin of the gas engine as a by-product of steam turbine technology is considered and the development of gas turbines for aircraft propulsion during World War II is discussed. Advances in the design of heavy duty gas turbines are examined. Attention is given to a 5000 kW gas turbine, a 10,000 kW gas turbine, and the model series 5001 package power plant. G.R.

A77-18257 # **Perspectives on Satellite Solar Power.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-352.* 13 p. 31 refs.

The evolution of the concept of the Satellite Solar Power Station (SSPS) is presented and the technology options for converting solar energy in space, transmitting microwave power and converting it on earth are summarized. The development of the design concept of the SSPS based on photovoltaic and solar thermal conversion is examined and salient characteristics are provided. The details of microwave power generation, beam transmission and conversion to DC at the receiving antenna on earth are discussed. The requirements for a space transportation system, orbital construction and assembly, maintenance and operations are reviewed. The environmental effects of SSPS operations, such as stratospheric pollution by space vehicle exhaust products and of the microwave beam, including atmospheric attenuation and scattering, ionospheric propagation, and microwave biological effects, are highlighted. Economic and social issues are considered. (Author)

A77-18258 * # **The economic viability of pursuing a space power system concept.** G. A. Hazelrigg, Jr. (ECON, Inc., Princeton, N.J.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-353.* 10 p. NASA-supported research.

The development of a space power system requires no fundamental technological breakthroughs. There are, however, uncertainties regarding the degree to which necessary developments can be achieved or exceeded. An analysis is conducted concerning the implementation of a 5000 MW space-based solar power system based on photovoltaic conversion of solar energy to electrical energy. The solar array is about 13 km long and 5 km wide. Placed in geosynchronous orbit, it provides power to the earth for 30 years. Attention is given to the economic feasibility of a space power system, a risk analysis for space power systems, and the use of the presented methodology for comparing alternative technology development programs. G.R.

A77-18259 # **The construction of satellite solar power stations from non-terrestrial materials.** B. O'Leary (Princeton University, Princeton, N.J.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-354.* 6 p. 8 refs.

The principal results are discussed of a summer study conducted in 1976 at the NASA Ames Research Center. The study had been concerned with the key technical problems which would have to be resolved to make a space manufacturing of lunar materials feasible. Attention is given to the lunar mass driver as a means of transporting large quantities of lunar material to a precise point in space, three-body calculations of trajectories for lunar materials launched by mass driver from the moon to L2 and from L2 to convenient space manufacturing sites, the chemical processing of the materials, and questions concerning construction, cost, and schedule. Mass driver reaction engines are also considered along with the utilization

of earth-approaching asteroids as raw materials for space manufacturing. G.R.

A77-18260 # **Our amazing air transportation system /AIAA-SAE William Littlewood Memorial Lecture/.** R. D. Kelly (R. Dixon Speas Associates, Inc., Manhasset, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display Incorporating the Forum on the Future of Air Transportation, 13th, Washington, D.C., Jan. 10-13, 1977, Paper 77-356.* 24 p.

Early airline experience in the 1930's is discussed along with the achievements of civil air transportation during the 1940's and 1950's. Attention is given to the evolution of U.S. airline aircraft, DC-3 problems, the DC-4 aircraft, the development of an operational cost formula, the stabilized approach system for pilot training, pressurized cabin aircraft, turbine engine potentials, studies for the development of an aircraft with transcontinental nonstop capabilities and a reasonable payload, the jet competition in the U.S., aspects of engineering cooperation, professional societies and committee work, energy requirements, airline fuel specifications, questions of productivity, revenue-cost relations, the importance of timing, and future developments. G.R.

A77-18264 **World survey of major facilities in controlled fusion research.** *Nuclear Fusion, Special Supplement,* 1976. 895 p. 93 refs.

This book provides a broad and current outline of research in controlled thermonuclear fusion being conducted in 22 countries as well as by Euratom and the IAEA. The scope of the survey includes fusion reactor design groups, fusion data centers, and up-to-date information on laser and electron-beam fusion programs. A multitude of plasma devices developed and tested in the different countries are described in detail, experimental results are reported, and future plans are discussed. Essential information is summarized concerning Tokamak devices, stellarators, mirror machines, pinch experiments, theta-pinch devices, plasma-focus experiments, electron and ion ring devices, electron-beam heating studies, injectors and plasma sources, turbulent-heating research, wave and shock investigations, reactor engineering facilities, Q-machines, beam-plasma interaction experiments, RF heating and confinement studies, wave-interaction experiments, and laser-fusion research. A personnel index lists about 3500 researchers and their affiliations. F.G.M.

A77-18295 **Effects of anthropogenic emissions on climate - A review of selected topics.** L. A. Barrie, D. M. Whelpdale, and R. E. Munn (Department of the Environment, Atmospheric Environment Service, Downsview, Ontario, Canada). *Ambio,* vol. 5, no. 5-6, 1976, p. 209-212. 46 refs.

A major environmental impact of man has been to interfere with the traditional pathways of trace substances through the biosphere, which might alter climate on the local, regional, and global levels. The paper reviews pollutant-related climate effects in the light of recent research evidence, along with some new problems that have arisen. Particular attention is given to the influence of anthropogenic carbon dioxide on potential climate changes and to the effect of suspended particulates on the atmosphere's radiative balance. In addition, the urban heat island resulting from anthropogenic heat releases and from other processes related to built-up areas appears to be the best example of local climate modification. Fragility of the ozone layer due to several anthropogenic inputs to the stratosphere is discussed along with emissions from nuclear power plants that could raise the electrical conductivity of the lower atmosphere. S.D.

A77-18323 # **Relative hazard of nuclear power stations and fossil-fuel power stations to the environment (Otnositel'naia opasnost' AES i TES dlia okruzhaiushchei sredy).** Iu. V. Sivintsev and E. N. Teverovskii. *Atomnaia Energiia,* vol. 41, Oct. 1976, p. 263-267. In Russian.

The hazards presented to public health and to the environment by nuclear power stations (NPS) and fossil-fuel-burning power stations (FFPS) are compared. Volume of cooling water per kWh per year, volumes of air required to dilute harmful constituents in off-gases (SO_2, aerosols, radionuclides of inert gases) to safe tolerance limits, concentrations of trace pollutants damaging to the human organism in wastes and effluents, discharges of gaseous radioactive pollutants, and thermal pollution of water reservoirs receiving effluent streams are compared (as applicable) and tabulated for nuclear reactor power stations and several types of FFPS (burning coal, petroleum, gas). Cooling water parameters are compared for types of water cooling systems used at NPS and FFPS facilities. R.D.V.

A77-18350 **A comparison of porous silver catalysts in oxygen electrodes of alkaline fuel cells (Vergleich poröser Silber-Katalysatoren in O2-Elektroden alkalischer Brennstoffzellen).** K. Mund (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *Siemens Forschungs- und Entwicklungsberichte,* vol. 5, no. 4, 1976, p. 209-216. 14 refs. In German. Research supported by the Bundesministerium für Forschung und Technologie.

The reduction of oxygen in porous silver electrodes is considered. Measurements involving the use of a rotating electrode are conducted to determine the current-voltage characteristics without transport delay effects. A description of three types of silver catalysts is presented, taking into account materials obtained from two silver-aluminum alloys with the aid of the Raney procedure and a silver catalyst with bismuth, nickel, and titanium additions. Polarization calculations for silver electrodes are compared with experimental results, and impedance measurements are discussed. G.R.

A77-18351 **The influence of subsurface energy storage on seasonal temperature variations.** K. Taylor (Yale University, New Haven, Conn.). *Journal of Applied Meteorology,* vol. 15, Nov. 1976, p. 1129-1138. 9 refs. NSF Grant No. ATM-75-00351.

A heat balance model is used to investigate the modification of the annual temperature cycle by seasonal energy storage in the ocean and land. The neglect of horizontal heat transport in the model precludes realistic predictions but permits analytic methods to be used to clarify the interaction between the atmosphere and the surface boundary layer. It is found that at several latitudes both the magnitude of the annual variation and, to a lesser degree, the time lag between the solar heating and temperature response are significantly influenced by the subsurface heat storage. The results are compared to previous models in which either subsurface energy storage or the thermal transient time dependence was neglected. It is concluded that such simplified modeling should be avoided, if possible, since the results can differ substantially from those of the more complete model presented here. (Author)

A77-18370 **Tracking pollutants from a distance.** S. H. Melfi (U.S. Environmental Protection Agency, Las Vegas, Nev.), J. D. Koutsandreas (U.S. Environmental Protection Agency, Washington, D.C.), and J. Moran (Public Health Service, National Institute for Occupational Safety and Health, Morgantown, W. Va.). *Environmental Science and Technology,* vol. 11, Jan. 1977, p. 36-38.

EPA's program of pollution monitoring by the use of remote sensors can be divided into four basic approaches: satellite monitoring, aerial sensing, continuous monitoring at fixed sites, and grab sampling. The Remote Sensing Program in the agency's Office of Research and Development is divided into two major activities: it provides operational remote sensing technical support to the rest of the agency, and it is developing advanced remote sensing techniques to meet the critical monitoring needs of the agency. Examples of operational remote sensing are given and modes of its utilization are described. Attention is given to the development of new laser techniques including conventional lidar, differential absorption lidar, and laser fluorescence. B.J.

A77-18439 **Atmospheric carbon dioxide variations at the South Pole.** C. D. Keeling, J. A. Adams, Jr., C. A. Ekdahl, Jr., and P. R. Guenther (California, University, La Jolla, Calif.). *Tellus,* vol. 28, no. 6, 1976, p. 552-564. 17 refs. NSF Grants No. Y-910132; No. G-6542; No. G-8748; No. G-13657; No. G-17168; No. G-19168; No.

GP-4193; No. GA-873; No. GA-13645; No. GA-13839; No. GA-31324X.

Duplicate measurements of 749 discrete samples of air collected at the South Pole indicate that the seasonally adjusted concentration of atmospheric carbon dioxide in the polar Southern Hemisphere rose 3.7% between 1957 and 1971. The rise, mostly attributable to the burning of fossil fuels, has not been steady. In the mid-1960's, possibly as a result of widespread cooling of surface ocean water, it slackened for several years; recently it has accelerated. Similar changes in rate have also been observed at Mauna Loa Observatory, Hawaii, in the Northern Hemisphere and are evidently a global phenomenon. (Author)

A77-18441 # **Heat transfer problems associated with laser fusion.** T. G. Frank, I. O. Bohachevsky, L. A. Booth, and J. H. Pendergrass (California, University, Los Alamos, N. Mex.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 16th, St. Louis, Mo., Aug. 8-11, 1976, Paper.* 8 p. 14 refs. Contract No. W-7405-eng-36.

Briefly discussed are the laser-initiated fusion reaction, emissions that are produced, and methods that may be used to protect the walls of reactor cavities from these emissions. Thermal loadings encountered in laser fusion reactors will consist of energy deposition by discrete, short, intense pulses of X and gamma rays, fast alpha and other charged particles, and fusion neutrons. Presented are models of energy deposition in structural walls and blanket regions surrounding the reaction chamber and methods used to calculate resulting temperature increases and thermal stresses in these components. The results of such calculations indicate that the design conditions for the engineering of laser-initiated fusion reactors will be severe and a great amount of ingenuity and analysis will be required to meet them successfully. (Author)

A77-18443 # **Parametric studies of the thermal trap flat plate collector.** P. R. Smith, M. H. Cobble, and L. L. Lukens (New Mexico State University, Las Cruces, N. Mex.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 16th, St. Louis, Mo., Aug. 8-11, 1976, Paper.* 6 p. 5 refs.

The thermal-trap effect, or the selective surface-like behavior of some transparent materials, was investigated both theoretically and experimentally for a flat-plate solar energy collector. A comprehensive computer simulation of the thermal-trap collector was developed in order to study the effects upon performance of the various elements of the collector. A comparison of theoretically predicted performance with actual experimental performance for one version of the collector already under test proved the simulation to be very accurate. Subsequent parametric studies using the simulation indicated that the critical parameters were the thickness of the trap material and the presence or absence of a cover glazing. Therefore, four test collectors were built in which trap material and cover glazing were removable, and a series of experiments were run for trap material thicknesses of 1/8, 1/4, 1/2, 3/4, 1 and 1-1/2 in. with and without cover glazing. (Author)

A77-18444 # **Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials.** A. C. Ratzel and R. B. Bannerot (Houston, University, Houston, Tex.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 16th, St. Louis, Mo., Aug. 8-11, 1976, Paper.* 17 p. 7 refs.

This paper presents the results of a recent compilation of available commercial materials suitable for use in flat-plate solar energy collectors. Cost data current through November 1975 is included as well as estimated performance and durability data and other important mechanical and radiative properties. The gathered data has been coded for use as input to a computer simulation which predicts performance of a general flat-plate collector. In this way all combinations of cover assemblies, absorbers, and insulation can be examined. The computer simulation also assigns figures-of-merit to the various designs based on user-supplied weighting functions applied to cost, weight, durability, temperature limits, and performance at 30% and 50% heat load. In addition, minimum service can be required regarding any of the above quantities. As a demonstration of its use, the compiled material data and the simulation were used to select optimal material combinations for service in support of solar absorption cooling in the summer in Houston, Texas. (Author)

A77-18446 # **Overview of the ERDA fusion power program.** J. M. Williams (ERDA, Div. of Controlled Thermonuclear Research, Washington, D.C.). *American Society of Mechanical Engineers, National Heat Transfer Conference, 16th, St. Louis, Mo., Aug. 8-11, 1976, Paper.* 8 p.

The principal goal of the ERDA fusion power program is related to the development of the technology necessary for the safe and economical production of electricity from fusion energy. Advantages of fusion power include a virtually inexhaustible low-cost fuel supply, the absence of combustion products, the very low amount of radioactive waste products, and the inherent safety of the fusion plasma. Attention is given to key fusion plasma problems, key engineering problems, and a research and development program designed to lead to the operation of a demonstration fusion power plant. Optimism that fusion power can be developed as a safe, reliable, and economic source of electrical power before the year 2000 is supported by encouraging results from recent physics experiments. G.R.

A77-18447 # **Axial conduction in a flat-plate solar collector.** W. F. Phillips (Utah State University of Agriculture and Applied Science, Logan, Utah). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 16th, St. Louis, Mo., Aug. 8-11, 1976, Paper.* 6 p. 9 refs.

A closed form solution is presented which predicts the performance of a flat-plate solar collector and includes the effects of axial conduction in the collector plate. The results are presented in terms of a dimensionless fluid temperature rise which was found to be a function of three other dimensionless parameters associated with the collector design. Collector efficiency is also discussed and a new definition for the efficiency of a solar collector is proposed. (Author)

A77-18448 # **Use of Lexan and Kapton honeycombs to increase solar collector efficiency.** K. N. Marshall and R. K. Wedel (Lockheed Research Laboratories, Palo Alto, Calif.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 16th, St. Louis, Mo., Aug. 8-11, 1976, Paper.* 7 p. 10 refs. Contract No. E(04-3)-1081.

Experimental results are presented for Lexan and Kapton honeycomb solar collectors tested in an outdoor test facility. Performance is given in terms of both instantaneous and diurnal efficiencies. Results for various honeycomb aspect ratios are given to show the effect of aspect ratio on collector performance. A comparison is made between honeycomb and nonhoneycomb collectors with flat black absorbers. The results show that collector efficiency is increased significantly so that a cost savings may be realized through utilization of a properly designed plastic honeycomb solar collector. (Author)

A77-18449 # **Arrays of fixed flat-plate solar energy collectors - Performance comparisons for differing individual component orientations.** S. H. Janke and R. F. Boehm (Utah, University, Salt Lake City, Utah). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 16th, St. Louis, Mo., Aug. 8-11, 1976, Paper.* 10 p. 14 refs. Research supported by the University of Utah.

A determination is made regarding the energy density and flux available after passage of direct solar radiation through single and double glass covers, for panels inclined at various angles and oriented with varying azimuths; several latitudes are also considered. Results of a computer program which for any latitude, date, time of day and arbitrary panel orientation allows for atmospheric attenuation and glass transmission are displayed in several graphical formats. Orienta-

tions other than south facing are found to give greater availability of energy for a period of roughly 90 days centered about the summer solstice, and to give higher flux values early or late in the day for winter dates, but are inferior to south facing panels in other respects. (Author)

A77-18450 # **Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors.** D. O. Lee and W. P. Schimmel, Jr. (Sandia Laboratories, Albuquerque, N. Mex.). *American Society of Mechanical Engineers and American Institute of Chemical Engineers, National Heat Transfer Conference, 16th, St. Louis, Mo., Aug. 8-11, 1976, Paper.* 6 p. 7 refs.

This paper presents an analytical expression for the shadowing of a collector by adjacent units as a function of collector location, spacing and orientation. Hourly variations of solar input are accounted for as are the seasonal effects of solar zenith angle. Using the shadowing expression, an axial temperature differential analysis is used to determine the output of a linear focused solar collector being shadowed by adjacent collectors. Outputs for a typical spacing configuration are presented for a north-south oriented collector field. Calculations are based on fixed tilt east-west tracking systems. The effect of the time of day on the collector output is included in considering the equinoxes and solstices for Albuquerque, N.M. (Author)

A77-18489 **The lensed high-voltage vertical multijunction solar cell.** R. J. Soukup (Iowa, University, Iowa City, Iowa). *Journal of Applied Physics,* vol. 48, Jan. 1977, p. 440, 441.

The vertical multijunction solar cell with covering lens is a photovoltaic device which promises high-voltage high-efficiency outputs. The structure described here is a modification of a structure previously reported. It is shown that the original high-voltage vertical multijunction solar cell is capable of high voltages but not high efficiencies. The solar cell described here is capable of higher efficiencies, but a more detailed analysis than presented is necessary before a comparison between this cell and a conventional solar cell can be made. (Author)

A77-18490 **New analysis of a high-voltage vertical multijunction solar cell.** C. Hu, J. K. Carney, and R. I. Frank (MIT, Cambridge, Mass.). *Journal of Applied Physics,* vol. 48, Jan. 1977, p. 442-444. Research sponsored by the National Patent Development Corp.

An analysis and a model are presented for a vertical multijunction solar cell with covering lens, for which a 21% efficiency has been predicted previously. It is shown that the maximum conversion efficiency is in fact about 0.3%. The present analysis confirms the belief that back-to-back diodes should be designed into a solar cell only with great caution. (Author)

A77-18491 **Reply to 'New analysis of a high-voltage vertical multijunction solar cell'.** R. J. Soukup (Nebraska, University, Lincoln, Neb.). *Journal of Applied Physics,* vol. 48, Jan. 1977, p. 445.

A77-18495 **Study of emittance distribution along the walls of a cellular low-loss cell in the case of a base surface with arbitrary emission indicatrix (Etude de la distribution de l'émittance le long des parois d'une cellule antipertes, dans le cas d'une surface de base à indicatrice d'émission quelconque).** P. Gallet and A. Ropke (Aix-Marseille I, Université, Marseille, France). *Nouvelle Revue d'Optique,* vol. 7, Nov.-Dec. 1976, p. 369-374. 15 refs. In French.

A method is developed for determining the emittance distribution along the walls of a cell in a low-loss cellular structure with black or diffuse gray base surfaces, for the case where the base surface exhibits an arbitrary shape of emission indicatrix in the far infrared (IR), and reflection from that surface is purely specular. The method is then applied to two particular cases exhibiting ellipsoidal indicatrices of emission. Determination of the emittance distribution along the cell walls facilitates establishing thermal budgets of the base surfaces, and thereby ascertaining the anti-radiative properties of the structures. R.D.V.

A77-18496 **Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range (Etude et réalisation d'une surface sélective destinée à la conversion thermique de l'énergie solaire - Application à la moyenne température).** R. Pasquetti and F. Papini (Aix-Marseille I, Université, Marseille, France). *Nouvelle Revue d'Optique,* vol. 7, Nov.-Dec. 1976, p. 375-380. 12 refs. In French.

A hot selective surface intended for direct thermal conversion of solar energy at medium temperatures (from 80 to 200 C) is discussed. The optical properties of the surface so described are found from the effect of absorption and emission, cutoff frequency, and other properties on the radiation budget of the surface. A selective structure comprising two thin layers and a metallic support (PbS or ZnS films on highly conducting Al substrate) is considered. A Zn or Ni support is examined and found promising. R.D.V.

A77-18500 **The influence of the Reynolds number on the profiles of velocity and concentration in free jets of different density (Der Einfluss der Reynoldszahl auf den Verlauf der Geschwindigkeiten und Konzentrationen von Freistrahlen unterschiedlicher Dichte).** B. Lenze (Karlsruhe, Universität, Karlsruhe, West Germany). *Forschung im Ingenieurwesen,* vol. 42, no. 6, 1976, p. 184-186. 5 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

A method employed by Ebrahimi (1976) has been used in the study of jets involving various gaseous media, including hydrogen, natural gas, air, and carbon dioxide. Nozzles with diameters of 4, 6, 8, and 10 mm were employed. Measurements were conducted of the static pressure, the total pressure, and the gas concentration. The experimental data for all four media show that the velocity and the concentration decrease, in the initial portion of the jet, depend on the value of the Reynolds number. No effect of the Reynolds number can be observed if the distance of the measurement position from the nozzle opening exceeds a value of 50 times the nozzle diameter. The obtained relationships are discussed. G.R.

A77-18517 **Preparation and characteristics of CuGaSe2/CdS solar cells.** N. Romeo, G. Sberveglieri, L. Tarricone (CNR, Istituto di Fisica, Parma, Italy), and C. Paorici (CNR, Laboratorio MASPEC, Parma, Italy). *Applied Physics Letters,* vol. 30, Jan. 15, 1977, p. 108-110. 5 refs.

p-CuGaSe2/n-CdS heterojunctions have been prepared by depositing CdS films on p-type CuGaSe2 single crystals whose initial resistivity was .01 ohm cm and changed to 1 ohm cm after the CdS film deposition. The CdS films, which were grown by a multisources method, exhibit a room-temperature resistivity of 0.1 ohm cm. The absolute quantum efficiency of these devices as photovoltaic detectors reaches the value of 80% at a wavelength of 5800 A. As solar cells, these heterojunctions at 25 C display a solar power conversion efficiency of 5% when they are exposed to the solar light whose intensity is 71 mW/sq cm. When the heterojunctions are directly polarized, they emit light in a broad band which is centered at about 7700 A. An external electroluminescent emission efficiency of about 0.05% has been measured at liquid-nitrogen temperature. (Author)

A77-18582 **Fractionation and structural characterizatior of coal liquids.** M. Farcasiu (Mobil Research and Development Corp., Princeton, N.J.). *Fuel,* vol. 56, Jan. 1977, p. 9-14. 8 refs. Research supported by the Mobil Research and Development Corp. and Electric Power Research Institute.

A method of characterizing coal liquids in terms of fractions of different chemical functionality is described. This method is based on chromatographic fractionation of both benzene-soluble and pyridine-soluble components by sequential elution with specific solvents on silica gel columns. The paper presents the theoretical criteria for choosing the conditions and the sequence of elution solvents, the methods used to establish the chemical structure, and model compound comparisons. (Author)

A77-18583 **Differential scanning calorimetry studies on coal. II - Hydrogenation of coals.** O. P. Mahajan, A. Tomita, J. R. Nelson, and P. L. Walker, Jr. (Pennsylvania State University, University Park, Pa.). *Fuel,* vol. 56, Jan. 1977, p. 33-39. 21 refs. NSF Grant No. GI-38974.

Results of exothermic heats involved during hydrogenation of twenty U.S. raw coals of varying rank at 5.6 MPa (gauge) and temperatures up to 570 C are reported. The heat evolved during hydrogenation up to 570 C decreases with increase in coal rank. A part of the total heat released during hydrogenation of coals appears to be due to the exothermic reaction between H2 and surface carbon-oxygen complexes removed during the reaction. The transition temperature (corresponding to the onset of exotherms) is markedly dependent on coal rank. A sharp increase in the transition temperature occurs for coals having a carbon content, on a dry-ash-free basis, in the 75-80% range. Demineralization of coals lower in rank than high-volatile-A bituminous decreases the heat of hydrogenation: for higher-rank coals, exothermic heats increase upon demineralization. The presence of pyrite has a beneficial catalytic effect on coal hydrogenation. (Author)

A77-18584 **Coal liquefaction with soluble transition-metal complexes.** N. Holy, T. Nalesnik, and S. McClanahan (Western Kentucky University, Bowling Green, Ky.). *Fuel,* vol. 56, Jan. 1977, p. 47, 48. 8 refs. Research supported by the Institute for Mining and Minerals Research.

Several transition-metal complexes were tested for their effectiveness in liquefying coal under very mild conditions. Liquefaction was not observed, probably because interaction with the coal deactivates the catalyst. (Author)

A77-18585 **Perturbation analysis of second-order effects in kinetics of oil-shale pyrolysis.** D. Finucane, J. H. George, and H. G. Harris (Wyoming, University, Laramie, Wyo.). *Fuel,* vol. 56, Jan. 1977, p. 65-69. 8 refs. Contract No. E(49-18)-2234.

Perturbation techniques are used to develop a procedure for obtaining rate constants in a nonlinear model of the kinetics of oil-shale pyrolysis. Assuming that certain substances - kerogen, bitumen, oil and gas - can be measured by an experiment, and that a certain structure governing the chemical reactions is known, the rate constants are determined by a least-squares procedure. (Author)

A77-18597 **The future importance of solar energy for the supply of the German Federal Republic with energy (Zukünftige Bedeutung der Sonnenenergie für die Energieversorgung der Bundesrepublik Deutschland).** D. Oesterwind and M. Meliss. *Energiewirtschaftliche Tagesfragen,* vol. 26, Dec. 1976, p. 712, 714, 716, 718-720. 30 refs. In German.

An evaluation is conducted concerning the possible significance of solar energy for West Germany. The total amount of solar energy received on the territory of West Germany per year is found to be 90 times greater than the amount of primary energy consumed in this country during the year 1975. The entire energy requirements of West Germany could, therefore, in principle, be satisfied with the aid of solar energy. However, on the basis of an energy conversion efficiency of about 6%, it would, in this case, be necessary to cover about 6% of the entire national area with solar-electrical collectors. Attention is given to the installation of solar heating systems on new one- and two-family houses, energy storage problems in connection with seasonal differences of solar radiation, economic factors, and advantages of solar energy related to an absence of air pollution effects and its domestic availability. G.R.

A77-18598 **A solar house with heat pipe collectors (Ein Solarhaus mit Wärmerohr-Kollektoren).** G. Gehrke. *Energiewirtschaftliche Tagesfragen,* vol. 26, Dec. 1976, p. 726-728. In German.

A description is given of a solar house project involving the installation of collectors on the roof of a residential house located at the outskirts of Essen in West Germany. The solar installation provides heating for a residential area of 190 sq m. Energy for a hot-water supply system is also supplied. A heat storage system provides a heat reserve for days on which the amount of solar radiation is insufficient. G.R.

A77-18721 * **Aerodynamics as a subway design parameter.** D. W. Kurtz (California Institute of Technology, Jet Propulsion Laboratory, Thermophysics and Fluid Dynamics Section, Pasadena, Calif.). *High Speed Ground Transportation Journal,* vol. 10, Fall 1976, p. 247-254. 13 refs. Contract No. NAS7-100.

A parametric sensitivity study has been performed on the system operational energy requirement in order to guide subway design strategy. Aerodynamics can play a dominant or trivial role, depending upon the system characteristics. Optimization of the aerodynamic parameters may not minimize the total operational energy. Isolation of the station box from the tunnel and reduction of the inertial power requirements pay the largest dividends in terms of the operational energy requirement. (Author)

A77-18723 **Evaluating revenue sources for public transit - A new frontier for environmental planners.** R. Shinn and W. D. Conn (California, University, Los Angeles, Calif.). *High Speed Ground Transportation Journal,* vol. 10, Fall 1976, p. 267-295. 22 refs. Research sponsored by the U.S. Department of Transportation.

The paper identifies alternative sources of revenue for the support of public transportation and suggests a comprehensive framework within which these alternative revenue sources may be evaluated. Particular attention is devoted to those sources of revenue (gasoline taxes, parking surcharges, congestion tolls, etc.) which positively impact on regional environmental and transportation planning objectives at the same time that they provide new revenue for transit support. The paper draws on a limited number of existing studies to identify (1) the potential range of future revenue deficits facing U.S. transit operations; (2) the sources, amounts, and distribution of existing revenues going to support transit in the largest U.S. metropolitan areas; (3) alternative financing mechanisms available; (4) evaluation criteria which have previously been employed to select revenue sources for transit support; and (5) new criteria which could be employed to provide a more complete evaluation. (Author)

A77-18738 **Energy and environmental impacts of materials alternatives - An assessment of quantitative understanding.** A. H. Purcell (George Washington University, Washington, D.C.) and F. L. Smith (U.S. Environmental Protection Agency, Washington, D.C.). *Resource Recovery and Conservation,* vol. 2, Dec. 1976, p. 93-102. 39 refs.

The literature was reviewed to determine which materials may require the least energy for manufacture and use, which may have the least detrimental effect on the environment, and what effect recycling may have on both factors. There is substantial agreement as to the benefits of recycling on environmental quality and conservation, although, there are some important variations in the attempts to quantify the benefits. There is less agreement as to the relative energy consumption and effect on the environment of using materials. This is due chiefly to the substantial number of variables that enter into the evaluations as well as the difficulty in weighting their relative effects. The development of environmental profile analysis - in which subimpacts are weighted before being combined into aggregate impact measurements - appears to be a promising approach to making the analysis of energy and environmental factors more meaningful. (Author)

A77-18739 **Fuel gas recovery from controlled landfilling of municipal wastes.** D. C. Augenstein, D. L. Wise, R. L. Wentworth (Dynatech R/D Co., Cambridge, Mass.), and C. L. Cooney (MIT, Cambridge, Mass.). *Resource Recovery and Conservation,* vol. 2, Dec. 1976, p. 103-117. 10 refs. Research supported by the Consolidated Natural Gas Service Co.

Experiments were carried out in unstirred reactors for the digestion to fuel gas of shredded municipal solid waste and sewage sludge at high total solids concentration. Waste and sludge solids together comprised up to 48 percent by weight of the reactor contents. Finely divided calcium carbonate dispersed in the aqueous

phase was employed as a pH buffer. Results of experiments showed that conversion to fuel gas of up to 0.128 cu m per kg solid waste was obtained. In a separate experiment, alkaline pretreatment of the solid waste component preceding digestion further improved conversion to fuel gas. An engineering analysis was conducted for application of these results to a controlled landfill system. The incremental capital cost to modify a landfill for fuel gas production was estimated to be $4.6 million, and incremental operating cost under $300,000 per year. The fuel gas cost was estimated to be near $0.70/GJ. It appears that the system evaluated has potential for making possible the economic recovery of fuel gas from solid waste through substantial reduction in the capital and operating costs of a conventional anaerobic digestion system. (Author)

A77-18754 Organization of long range transport of air pollution monitoring in Europe. B. Ottar (Norwegian Institute for Air Research, Lillestrom, Norway). *(U.S. Department of Agriculture, Ohio State University, U.S. Department of the Interior, and NSF, International Symposium on Acid Precipitation and the Forest Ecosystem, 1st, Columbus, Ohio, May 12-15, 1975.) Water, Air, and Soil Pollution,* vol. 6, Sept.-Nov. 1976, p. 219-229. 10 refs.

On the initiative of OECD and especially of the Scandinavian countries, a joint research program was established to study the long range transport of air pollutants. In the program, atmospheric dispersion models are used to describe the emission, dispersion, and deposition of SO2 and sulfate with particular emphasis on acidification of precipitation. An emission field has been constructed for Europe and data from the European weather forecasting system are used for the dispersion calculations. Results show that the main cause for acidification of precipitation is the increasing use of fossil fuels. Large amounts of H2SO4 can be transported over distances up to a few thousand kilometers. Work in progress to establish a more permanent system for the monitoring of air pollutants in Europe is discussed. B.J.

A77-18790 Power resource estimate of ocean surface waves. N. N. Panicker (Woods Hole Oceanographic Institution, Woods Hole, Mass.). *Ocean Engineering,* vol. 3, Dec. 1976, p. 429-439. 9 refs. ERDA Contract No. WA-76-3104.

The distribution of wave energy and power as functions of longitude and latitude are presented for the Northern Hemisphere at 12Z, October 2, 1975. Both the large peak of the distribution in the Atlantic Ocean and the smaller peak in the Pacific Ocean are found to be at longitudes towards the eastern end of the ocean basins. This 'eastern accumulation' of wave energy and power offers interesting contrast to the western intensification of currents. Distribution of wave power with latitude shows peaks of wave power in the midlatitudes. The total surface wave energy in the seas of the world for the same time is estimated to be 1600 times 10 to the 15th J. The corresponding total wave power estimate is 90 times 10 to the 15th W. The rate of renewal of wave power is estimated to be 1 to 10 TW, about the present level of world power consumption. (Author)

A77-18882 General Motors Sulfate Dispersion Experiment - Assessment of the EPA HIWAY model. D. P. Chock (GM Research Laboratories, Warren, Mich.). *Air Pollution Control Association, Journal,* vol. 27, Jan. 1977, p. 39-45. 16 refs.

A major objective of the General Motors Sulfate Dispersion Experiment was to investigate the validity of the Environmental Protection Agency's HIWAY dispersion model. This model was the basis for the high roadside predictions made by EPA in 1975. Comparisons of measurements with predictions show that at the pedestrian level downwind from the road, the model works fairly well under unstable conditions, but overpredicts for stable conditions. The overpredictions get worse as the wind speed decreases, as the wind direction becomes parallel to the road, and as the distance from the road increases. For the upwind dispersion, however, the model is inapplicable. Under extremely stable or worst meteorological conditions, variable winds at different heights and plume-rise due to the heated exhaust completely invalidate the model. The overpredictions at the bottom level downwind can be very substantial. When the wind is parallel to the road, overpredictions occur at all sampling positions. (Author)

A77-18898 Chemical evolution of photosynthesis. A. A. Krasnovskii (Akademiia Nauk SSSR, Institut Biokhimii, Moscow, USSR). *Origins of Life,* vol. 7, Apr. 1976, p. 133-143. 29 refs.

The utilization of solar energy during the evolution of carbonaceous matter on earth, solar-energy conversion in the membranes of primary probionts, and solar-energy conversion modes during biological evolution are considered on the basis of data from laboratory experiments. The employment of inorganic photoreceptors by probionts is discussed along with the synthesis of porphin from pyrrole and formaldehyde, the photochemistry of porphyrins, and photochemical reactions in probiont membranes. The role of pigments in photosynthetic cells is examined, emphasizing the evolution of blue-green algae and photosynthetic bacteria. F.G.M.

A77-18932 # Hydrogen as a fuel in compression ignition engines. G. A. Karim (Calgary, University, Calgary, Alberta, Canada). *Archiwum Termodynamiki i Spalania,* vol. 7, no. 1, 1976, p. 89-100. 15 refs.

Review is made of some of the main operational features associated with the use of hydrogen as a fuel in engines. The paper presents some findings of an investigation into the performance of a compression ignition engine fueled with hydrogen. Most of the experimental work reported relates to a laboratory dual fuel engine where hydrogen was introduced just outside the engine cylinder, mixed with the necessary air, compressed and then ignited by the injection of a small quantity of liquid fuel near the end of compression. Moreover, the role of various operating parameters on the onset of autoignition in a motor engine in the absence of a deliberate source of ignition was established analytically. The paper then concludes with the examination of the prospects of using hydrogen-oxygen mixtures in engines. (Author)

A77-18984 Utilization of remote sensing techniques to detect land use effects on wildland water quality. G. B. Coltharp, D. H. Graves, and M. C. Hammetter (Kentucky, University, Lexington, Ky.). In: American Society of Photogrammetry, Annual Meeting, 42nd, Washington, D.C., February 22-28, 1976, Proceedings. Falls Church, Va., American Society of Photogrammetry, 1976, p. 368-372. 5 refs.

Multistage sampling techniques are being utilized to determine and monitor land use changes and the effects of such changes on water quality in the Cumberland Plateau region in eastern Kentucky. Land use practices being monitored include forest fertilization, logging, and surface mining. Vegetation inventory and physical, chemical and bacteriological water quality data provide the ground truth for correlation efforts. Manually-operated spot densitometers are being used to identify vegetation signatures on Landsat multispectral and seasonal 1:24,000 color infrared and multispectral transparencies. Densitometry data will be correlated with ground truth information in the attempt to develop a water quality prediction model. Color additive viewing of satellite and aircraft multispectral imagery is being evaluated for land use monitoring and change detection potential. (Author)

A77-19012 The pay-off for advanced technology in commercial aircraft design and operation. D. G. Brown (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England) and K. S. Lawson (British Aircraft Corp., Ltd., Weybridge, Surrey, England). *(Royal Aeronautical Society, Spring Convention on Seeds for Success in Civil Aircraft Design in the Next Two Decades, London, England, May 19, 20, 1976.) Aeronautical Journal,* vol. 80, Nov. 1976, p. 461-467.

Prospects for introduction of advanced technology and increased sales of aircraft in the future are discussed, with emphasis on subsonic conventional aircraft. World service fleet requirements predictions are put forth, historical trends in the civil aircraft development picture and market are reviewed, along with fares and earnings, payload/weight ratios, fuel prices, and direct operating costs, and their interactions. Advances in materials, active control,

wing design and reduced wing weight, ATC improvements, fuel efficiency, and their effects on costs and efficiency in airline and airport operation are assessed, along with aircraft and airport noise abatement. A substantial market for new aircraft, even if only to replace aircraft retired from service on a time basis, is predicted for the decade ahead. R.D.V.

A77-19043 Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volumes 1 & 2. Conference sponsored by the Coopération Méditerranéenne pour l'Energie Solaire and University of Petroleum and Minerals. Edited by M. A. Kettani (University of Petroleum and Minerals, Dhahran, Saudi Arabia) and J. E. Soussou (Development Analysis Associates, Inc., Cambridge, Mass.). Cambridge, Mass., Development Analysis Associates, Inc., 1976. Vol. 1, 799 p.; vol. 2, 741 p. In English and French. Price of two volumes, $150.

The broad topics discussed include the measurement, collection, and concentration of solar energy, the storage of solar energy (via hydrogen and photochemical processes), photovoltaic conversion (the use of solar cells), and other conversion schemes such as photoelectrochemical converters and solar thermal power generation. Attention is also given to solar heating and cooling, and to the use of solar energy for agriculture, desalination, and greenhouses. National solar energy programs are discussed.

B.J.

A77-19044 * Survey of quantitative data on the solar energy and its spectra distribution. M. P. Thekaekara (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 47-72. 18 refs.

This paper presents a survey of available quantitative data on the total and spectral solar irradiance at ground level and outside the atmosphere. Measurements from research aircraft have resulted in the currently accepted NASA/ASTM standards of the solar constant and zero air mass solar spectral irradiance. The intrinsic variability of solar energy output and programs currently under way for more precise measurements from spacecraft are discussed. Instrumentation for solar measurements and their reference radiation scales are examined. Insolation data available from the records of weather stations are reviewed for their applicability to solar energy conversion. Two alternate methods of solarimetry are briefly discussed.

(Author)

A77-19046 Autonomous station for the acquisition and concentration of heliometric data (Station autonome de saisie et de concentration de données heliomètriques). J. Colomes and M. Lorgeou (Commissariat à l'Energia Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 77-84. In French.

The SHA-K7 heliometric station has been constructed to investigate the conditions necessary for the site of a solar energy conversion system. The station operates in the periodic acquisition mode and records data from the following sensors on a magnetic tape: (1) a pyrheliometer for direct solar radiation, (2) a pyranometer for global radiation, (3) a hemispheric pyrradiometer for global and infrared sky radiation, and (4) an ambient-temperature sensor. The station is so designed that it can be left alone for a period of a month, and need be revisited only to retrieve the tape. B.J.

A77-19047 Development of a mobile solar testing and recording /STAR/ system. B. Nimmo and R. Larsen (Florida Technological University, Orlando, Fla.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 85-97. 11 refs.

A mobile solar testing and data handling system has been designed and constructed for the purpose of providing field test data on older solar water heating systems. The system described in this paper was designed for the determination of performance parameters. This STAR (Solar Testing And Recording) system has environmental and system instrumentation and data handling capability housed within a small mobile trailer. The system records and processes the data automatically allowing for convenient long term data collection under a variety of user and environmental conditions.

(Author)

A77-19049 Computation of solar radiation design curves. R. H. Mirza (Pakistan University of Engineering and Technology, Lahore, Pakistan). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 115-123. 9 refs. Research supported by the Pakistan University of Engineering and Technology.

Solar radiation curves are given to help engineers and architects in calculating intensities of solar radiation incident on various surfaces. These values include direct solar radiation on a surface normal to the solar beam and diffuse sky radiation on a horizontal surface. A curve based on American measurements is given for calculating intensity of diffuse sky radiation incident on vertical surfaces. This curve gives due consideration to the nonisotropic distribution of sky radiance. The concept of direct radiation factors in building climatology is briefly discussed. (Author)

A77-19051 Contribution to the study of solar energy collectors - Selective plates and cells. G. Péri, P. Gallet, F. Papini, and R. Pasquetti (Aix-Marseille I, Université, Marseille, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 155-165. 10 refs.

A scope is presented on the properties of selective surfaces, mainly their optical characteristics. The antiradiative and anticonvective properties of non-loss cells are given and the association of both selective surfaces and non-loss cells is detailed. Then, the influence of the optical properties on the energy balance of a hot flat plate collector is presented, taking into account the received and emitted radiative spectra. Finally, a practical application is described: the thermal efficiency of a solar steam generator is computed versus the incident energy and the running temperature of the apparatus.

(Author)

A77-19052 Progress in development and application of selective surfaces. A. B. Meinel (Arizona, University, Tucson, Ariz.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 166-179. 9 refs. NSF-supported research.

The attainment of highly selective absorbing and transmitting surfaces opens the question of where they can be effectively used in solar collectors. Decisions on use depend on the cost-benefit ratio of each type: chemical, electrochemical, CVD and vacuum deposited. A review of the characteristics of each type is given. Applications depend on situations where high selectivity provides sufficient benefit. The most favorable ones are in cases of zero or low optical concentrations and of working temperatures in the 150-350 C range. Some applications are also described. (Author)

A77-19053 Thin film solar acceptors. G. Burrafato, A. Pennisi (Catania, Università; CNR, Catania, Italy), G. Giaquinta, N. A. Mancini, and S. O. Troia (Catania, Università, Catania, Italy). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 180-187. 7 refs.

Tandem systems are realized using as absorber a film of InSb, a degenerate semiconductor, and a layer of Ag or Al acting as reflector. Heating measurements are performed and compared with analogous measurements performed with conventional systems. Different thicknesses both of the InSb film and metallic layer are tested. To improve the collection efficiency, tandum systems, where the absorber is made up by several layers of InSb of various thickness separated by plastic layers, are also tested. The results are presented and some perspectives in the application of these methods are indicated. (Author)

A77-19054 Waveguide high pass filter for thermal conversion of solar energy. J. H. A. Van Wakeren and J. Verhoeven (Stichting voor Fundamenteel Onderzoek der Materie, Institut voor Atoom- en Molecuulphysica, Amsterdam, Netherlands). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 188-193. Research supported by the Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek and EURATOM.

A selective surface with large transmission for solar radiation and high reflectance for thermal infrared is discussed. The surface consists of an evaporated metallic layer of 10 microns. In the metallic layer are drilled as many holes as possible. Each square centimeter contains 100 million holes with a diameter of 1 micron. A black-body placed behind this filter receives solar radiation while its own radiation losses are reduced, because of reflection of the infrared on the filter. (Author)

A77-19055 Temperature optimization for power production of infinite heat transfer solar absorbers. L. S. Cheema and P. Singh (Punjab Agricultural University, Ludhiana, India). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 194-204. 6 refs.

The paper includes the theoretical aspects of thermal performance of a solar heat absorber. It is found that the ratio of the absorber to the stagnation temperatures completely predicts the thermal performance of collection systems. The result of the analysis is used to obtain the optimum outlet temperature of heat transfer fluid for maximum Carnot efficiency. Simple numerical calculations optimizing the outlet temperature of the transfer fluid are included. The results of the analysis are presented as functions of dimensionless parameters. These are applicable to both concentrating and non-concentrating collection systems. (Author)

A77-19056 Procedure for characterizing flat plate solar collectors (Processus de caractérisation de capteurs solaires plans). C. Blanchard, J. Colomes, R. Lebourg, and R. Ployart (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, Essonne, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 205-212. In French.

The procedure employed by the Commissariat à l'Energie Atomique for the characterization of solar collectors consists of two steps: (1) determination of the thermal characteristics of the collector under a luminous flux whose intensity and spectral distribution are known, and (2) adjustment of the results by means of the code CAPSOL which describes the thermal equilibrium of a collector with consideration of ambient temperature, useful flux, and infrared flux. The extrapolation to solar flux from different values of incident flux allows the determination of such characteristics as conversion efficiency as a function of flux. B.J.

A77-19057 Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity (Thermostatique et thermocinétique d'un insolateur plan de capacité calorifique constante). J. Fléchon, G. Martin (Nancy I, Université, Nancy, France), R. Wertwijn, and I. Touré (Ecole Normale Supérieure, Bamako, Mali). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 215-226. 11 refs. In French.

It is demonstrated that a flat solar collector (for a solar-refrigerator cooling system) is characterized by a thermostatic constant linking the intensity of solar radiation at normal incidence to the equilibrium temperature of the collector. The constant depends on the number of windows, the shape of the device, and the ambience which is assumed invariable. An optimization procedure for the collector is proposed defining an upper limit for its heat capacity and the number of windows needed for sufficient energy conversion. B.J.

A77-19058 Termosole flat plate collectors. E. Coffari (Termosole, Rome, Italy). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 227-232.

The Termosole flat plate solar collector utilizes two 4 mm panes of high quality glass with a 12 mm dry air interstice. The collector uses two electrically-welded blackened steel plates. The heat exchanging fluid (CH3CHOHCH2OH 40 pct aqueous solution) flows in the interstitial channels produced by separately pressing the two steel plates before welding. A panel 1328 mm x 840 mm with 28 vertical channels connected to two horizontal collecting ducts has been produced. Experiments measuring the net absorption by the panel vs the angle of incidence and also the thermal dispersion of the collector are presented. B.J.

A77-19059 Performance of an annular cylindrical solar collector. P. C. Lobo, R. P. Kluppel, and S. R. de Araújo (Paraíba, Universidade Federal, João Pessoa, Brazil). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 233-244. 6 refs.

A digital computer simulation is used to predict the performance of an annular spaced cylindrical solar collector. The device consists of a transparent glass tube, mirrored over part of its circumference, surrounding the absorber tube. Two cases are considered: first, the annular space is evacuated; and second, it is filled with air. The calculation is carried out for various maximum insolation rates and external convective coefficients. (Author)

A77-19060 Solar water heater using hardened black polythene pipe absorbers. Y. H. Hamid (Institute of Solar Energy and Related Environmental Research, Khartoum, Sudan). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 245-250. Research supported by the National Council for Research.

A solar water heating system has been suggested for use in Northern Sudan, involving the use of forced circulation employing an elevated constant-head tank. This paper describes the absorber for use in the solar collector of the system. The proposed absorber is to be constructed out of 1 inch internal diameter hardened polythene black pipes, with equal lengths of these pipes interconnected by U-shaped elbows to form a series coil of parallel sections of pipes. The absorber which was tested has overall dimensions of 0.60 m x 2.8 m and an effective surface area of 1.55 sq m. Test results show that the hourly value of the overall efficiency of the collector are comparable with values attained by collectors having metallic absorbers. B.J.

A77-19061 Solergy collector concept. R. H. Smith (Solergy, Inc., San Francisco, Calif.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1.

Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 251-264.

The Solergy solar collector concept is the use of an immobile reflective surface optimized for the purpose of directing sunlight onto an absorber pipe using the properties of an Archimides spiral. The reflector is composed of two shapes which flow together, forming a single continuous curve. A spiral portion of the curve directs light onto the absorber pipe. A parabolic section of the reflector gives the collector a significant degree of flux concentration. The flux concentration is increased to the maximum degree consistent with acceptance of sunlight during at least six daylight hours every day of the year. B.J.

A77-19062 Design and fabrication of solar concentrators. T. Sakurai (Tohuku University, Sendai, Japan). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 267-291. 14 refs.

This paper is a survey of the work done on the design and fabrication of solar concentrators. The fabrication of paraboloidal mirror segments for a 70 kW solar furnace is described together with an improved method of generating a toroidal surface. Economical but less accurate methods of fabrication are also given. Finally, a preliminary study of a large concentrator composed of mirror segments and a sun-following device is introduced. (Author)

A77-19063 Captation and concentration of solar energy. H. Kleinwächter. In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 292-300.

Various methods of solar energy concentration are presented depending on the level of concentration desired. Special concentrators studied by the author include pyramidal geometries. Special consideration is given to a satellite collecting system made up of several units orbiting in an asynchronous path around the earth. Each satellite is constituted by an icosahedron frame supporting microwave-controlled mirrors. (Author)

A77-19064 An inflatable solar concentrator for a high temperature storage system. C. S. Taylor (Organisation Européenne pour la Recherche Nucléaire, Geneva, Switzerland). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 301-313.

The optical problems of high concentration solar collectors are discussed. The design of an inflatable parabolic membrane mirror is presented. The material cost for such a mirror would be less than $1 per square meter for a lifetime of several years. This mirror is part of a system designed to produce heat at 750 C to be stored by fluoride eutectics. (Author)

A77-19065 Performance of two fixed-mirror solar concentrators for process heat. J. F. Kreider (Environmental Consulting Services, Inc., Boulder, Colo.) and R. Winston (Chicago, University, Chicago, Ill.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 314-324. 20 refs. Research supported by the University of Chicago, Environmental Consulting Services, ERDA, and NSF.

Within the past two years two new concentrators capable of process steam production and not requiring diurnal tracking of the sun were developed. The first consists of a fixed segment of a spherical mirror and a small cylindrical absorber which moves in a planar motion to track the sun; it is referred to as the Stationary Reflector/Tracking Absorber (SRTA) concentrator. The second, the Compound Parabolic Concentrator (CPC), is capable of collecting some diffuse radiation. Both collectors are analyzed theoretically and their test data are presented. (Author)

A77-19067 Double-reflection solar energy concentrators (Concentrateurs d'énergie solaire par double reflexion du rayonnement). H. Cortes (Rennes, Institut National des Sciences Appliquées, Rennes, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 329-337. In French.

A solar concentrator concept is described consisting of the convergence at a point focus of rigorously parallel rays which are to undergo two successive reflections. The analysis is carried out for two types of solar mirrors: a spherical one and a circular toroidal one. B.J.

A77-19068 Periodically adjustable concentrators adapted to solar cell panels. H. Durand, J. Michel, J. J. Hunzinger, and C. Hily (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 338-358.

The specifications of stationary trapezoidal-groove east-west concentrators for solar cells are examined. The geometrical gain of simple trapezoidal grooves is investigated, and the practical yearly average gain is calculated for various configurations, taking account of the effects of tilting, reflection coefficient, and diffused light. A monthly adjustable system is found to give yearly gains between two and three depending on conditions, bringing a savings of up to 50 per cent in solar electricity costs. B.J.

A77-19069 Stationary solar concentrators for industrial heating and cooling. W. Szulmayer (New South Wales, University, Kensington, Australia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 359-364.

A fixed-position linear concentrator suitable for industrial use is described. A refractor strip acts as a cylindrical lens, focussing radiation onto a straight pipe. Suitable design can ensure focussing at oblique angles of radiation incidence. Altitude focussing is more critical, as angular deviations shift the focal line away from the target. To correct these deviations, a reflector channel is joined to the flat refractor strip. This linear concentrator can operate continuously without Sun-tracking. Arrangements of the concentrators for industrial purposes, are discussed, together with heat extraction rates at temperatures in the 90 C to 130 C range. (Author)

A77-19070 A new method for collector field optimization. M. S. Abdel-Monem, A. F. Hildebrandt, F. W. Lipps, and L. L. Vant-Hull (Houston, University, Houston, Tex.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 372-387. 5 refs. NSF-ERDA-supported research.

A comprehensive computer simulation program has been used to optimize heliostat locations in a collector field and to compute the fraction of the solar energy which actually strikes the receiver. The new optimization method makes a 10 percent improvement over previous approximations. (Author)

A77-19071 Cylindrical mirror collector field. R. H. Smith (Solergy, Inc., San Francisco, Calif.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 388-395.

This paper describes an improved design for a solar collector. This design uses a cylindrical mirror field and a Solergy receiver to obtain concentration ratios over 40. This system is compared with the solar tower and it is found that it could achieve similar performances with lower cost and higher reliability. (Author)

A77-19072 **Solar production of hydrogen as a means of storing solar energy.** T. N. Veziroglu and S. Kakac (Miami, University, Coral Gables, Fla.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 399-417. 37 refs.

The hydrogen energy concept fits well with solar energy for storing, transmitting, and utilizing it. This paper discusses four basic methods for producing hydrogen from solar energy: direct thermal, thermochemical, electrolytic, and photolytic methods. The direct thermal method is found to have the potential of highest thermal efficiency. B.J.

A77-19073 **On the storage of solhydrogen.** H. K. Abdel-Aal and M. Y. Nazmy (University of Petroleum and Minerals, Dhahran, Saudi Arabia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 418-428. 21 refs.

The two main methods of storing hydrogen produced by solar energy are examined: ammonia storage and metal hydride storage. In the latter process, metal hydrides such as magnesium or iron-titanium hydride are decomposed releasing absorbed hydrogen, while the metal can be reused in a closed cycle. Attention is also given to the use of liquid hydrogen for overseas transportation and to the use of hydrogen in fuel cells. B.J.

A77-19074 **Thermo-chemical production of hydrogen.** A. M. Sayigh, J. A. Sabbagh, E. Abdul-Salam, and E. M. Abdul-Azeem (Riyadh, University, Riyadh, Saudi Arabia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1.
Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 429-434. 8 refs.

A closed cycle thermochemical hydrogen production procedure is proposed which uses FeBr2 and ZnBr2 as intermediate materials in the water decomposition process. An analysis of the enthalpy of formation of reactants and products has shown that the maximum operating temperature will be less than 500 C. The use of solar heating, either through tubular vacuum collectors and parabolic reflectors or through a solar furnace, could be used to provide the 500 C. B.J.

A77-19075 **The theory of hydrogen production in a photoelectrochemical cell.** J. O. Bockris and K. Uosaki (South Australia, Flinders University, Bedford Park, Australia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 435-470. 48 refs.

A qualitative model is set up for the calculation of the relations between rate of photon impact on an electrode and the number of successful transitions of resultant electrons to form hydrogen. The theory is applied to semiconductors. The dependence of the photo-current upon a number of parameters is derived. The theoretical results are used to estimate the actual performance of cells which would evolve hydrogen and oxygen under the influence of light. The calculated efficiencies vary from about 0.1 to 30 percent. The ideal semiconductor in this type of direct photo-producer of hydrogen is discussed. (Author)

A77-19076 **Solar energy utilization - The photochemical approach.** E. Broda (Wien, Universität, Vienna, Austria). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 471-480. 13 refs.

The essential feature of bacterial and plant photosynthesis is the light-powered transfer of an electron to a compound with a standard redox potential about equal to that of hydrogen in neutral solution. A hypothesis is put forward on how photolysis evolved in the history of organisms. Theoretically, it is possible to photolyse water into hydrogen and oxygen without participation of organisms, or even biogenic substances. This necessitates the application of the membrane principle where hydrogen and oxygen are set free in different loci. Hydrogen could be used as a basis for a technical hydrogen economy. (Author)

A77-19077 **The photosynthetic production of hydrogen.** G. Neil, D. J. D. Nicholas, J. O. Bockris, and J. F. McCann (South Australia, Flinders University, Bedford Park; Adelaide, University, Adelaide, Australia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 481-487. 8 refs.

This paper examines the hydrogen producing capabilities of Anabaena Cylindrica, a blue-green algae. The experimental set up is described and results showing hydrogen and ethylene evolution with *time are presented for several solutions. It is estimated that to* produce hydrogen from solar energy to power a city of one million people at a rate of 10 kW per person, an area of about 400 sq km would be needed. However, many problems still need to be solved before producing hydrogen on a large scale via biological systems becomes feasible. (Author)

A77-19078 **Storage of solar energy in the form of potential hydraulic energy.** M. A. Kettani (University of Petroleum and Minerals, Dhahran, Saudi Arabia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1.
Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 492-498. 5 refs.

In areas where topography and solar energy income are compatible, solar energy could be used to pump water up to a higher level to be stored behind a dam. The stored water can then be used to produce hydroelectric energy in the conventional manner. The used water will then flow down to a reservoir at a lower level to be pumped up again in a closed cycle. For the system to be effective, losses of water by evaporation should be minimized, since water is acting here as a working fluid only. The feasibility of such a scheme is studied. (Author)

A77-19079 **Design and performance of thermal storage water tank.** Y. Nakajima (Kogakuin University, Kogakuin, Japan). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 499-511. 8 refs.

The dynamic property and the design of the thermal storage tank are presented, and the relationship between the dynamic property of the tank and the performance of solar collectors is explained. The dynamic property of the thermal storage system is expressed as a transfer function, and its analysis is based on experimental results. Practical design methods for suitable dynamic performance in the storage tank are developed, and the relationship between the temperature response coefficient and the efficiency of the solar collector is described. (Author)

A77-19080 **Photovoltaic effect applications.** F. P. Califano (Napoli, Università, Naples, Italy). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1.
Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 515-533. 10 refs.

The photovoltaic effect is examined theoretically with attention given to efficiency as a function of the energy band gap. The properties of a number of solar-cell materials (silicon and gallium arsenide) are discussed, considering energy losses, the effects of doping on mobility, lifetime, and diffusion length, efficiency as a

function of junction depth, and the characteristics of surface coatings. Different types of photocells are examined including high efficiency cells, high concentration cells, thin film cells, cadmium sulfide cells, and photovolt cells. The best current-day photocells are compared and cost analyses are presented. B.J.

A77-19081 An analysis of silicon solar cell parameters for terrestrial applications. E. Y. Wang (Wayne State University, Detroit, Mich.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 534-549. 8 refs.

The effects of excess junction current and series resistance on the parameters - short-circuit current, open-circuit voltage, and fill factor - of silicon solar cells for terrestrial applications are investigated. Cells considered in the study are of 0.01, 0.1, 1, and 10 ohm-cm base material and are examined at various sunlight intensities. It was found that the short-circuit current is independent of any excess junction mechanism, that the open-circuit voltage is relatively insensitive to the various junction mechanisms, and that the fill factor strongly depends on junction mechanisms. B.J.

A77-19082 Deposition of polycrystalline silicon solar cells. J. J. Brissot and C. Belouet (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 550-562. 14 refs.

In the 1960s attempts were made to prepare low cost solar cells for terrestrial applications. It was anticipated that p-n cells obtained from polycrystalline layers deposited on a conductive graphite substrate and classically diffused might exhibit a significant photovoltaic effect in so far as the grains of the layers were large enough. A new procedure for developing silicon solar cells has been devised. A ribbon-like carbon substrate licks the molten silicon floating zone, and through wetting action drives a silicon film which freezes at a certain height above the melt giving rise to the polycrystalline layer. The polycrystalline layers prepared this way were studied experimentally, with layer thickness, grain size, and SiC formation among the parameters investigated. B.J.

A77-19083 The silicon ribbon solar cell. K. V. Ravi and A. I. Mlavsky (Mobil Tyco Solar Energy Corp., Waltham, Mass.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 563-587. 10 refs.

The technique of growing ribbon shaped crystals of silicon by the edge-defined, film-fed growth (EFG) process is discussed. A discussion of the growth process is followed by an analysis of the ribbon quality. A detailed economic analysis indicates that low cost photovoltaic systems can be realized through the use of this technology. (Author)

A77-19087 A sulfurization process for the preparation of photovoltaic Cu/x/S and CuInS2 thin films. J. Shewchun (McMaster University, Hamilton, Ontario, Canada) and J. J. Loferski (Brown University, Providence, R.I.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 624-642. 9 refs. NSF Grant No. GI-38102X.

The preparation of Cu2S films with present techniques is extremely difficult. For this reason a technique has been developed involving the control of the partial pressure of sulfur by passing a flowing mixture of hydrogen sulfide, argon and hydrogen over copper films evaporated on various substrates. CuInS2 films can also be formed in the same way by sputtering CuIn films onto substrates. By adjusting the hydrogen/hydrogen-sulfide ratio and the reaction time, various phases of the Cu(x)S system can be produced. Characterization of these films was made and photovoltaic junctions were formed with Cu(x)S films on silicon and cadmium sulfide. (Author)

A77-19088 Cuprous oxide Schottky photovoltaic cells as potential solar energy converters. E. Y. Wang, D. Trivich, H. Sawalha, and G. Thomas (Wayne State University, Detroit, Mich.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 643-650. 9 refs.

Cuprous oxide, a relatively low cost material, could lead to useful photovoltaic cells. This paper presents calculations of the potential conversion efficiency of cuprous oxide Schottky diodes. A semi-empirical analysis leads to an estimated efficiency of about 3 percent with a fill factor of 0.48. Directions for further improvement are identified, and the ultimate efficiency could reach 12 percent. An economic analysis of a large scale utilization of cuprous oxide cells is compared to silicon cells for terrestrial application, and shows that such cells could be a viable alternative. (Author)

A77-19089 Photovoltaic systems using sunlight concentration. C. E. Backus, D. L. Evans (Arizona State University, Tempe, Ariz.), and E. L. Ralph (Spectrolab, Inc., Sylmar, Calif.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 653-667. 6 refs. NSF Grant No. GI-41898.

The main factors conditioning the cost and efficiency of photovoltaic systems using sunlight concentration are reviewed, giving attention to solar cell performance at high light intensity, cell encapsulation and bonding materials, concentrator performance, and heat rejection characteristics. Component characteristics were incorporated into a computer program to simulate system performance and to begin preliminary cost analysis. It was found that concentration systems can be cheaper than flat arrays even at projected costs for cells (50 cents/peak W), and that conventionally processed silicon cells can operate at light intensities exceeding 100 suns at efficiencies comparable to current production space cells. B.J.

A77-19090 Double-faced silicon solar cell system. M. M. Anwar (Pakistan Institute of Nuclear Research and Technology, Rawalpindi, Pakistan). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 668-674.

A solar cell active on both sides was designed. It requires special connections to the p- and n-layers. Such cells are mounted in a panel at a distance of a flat mirror. The panel is kept fixed and provides 70 to 80 percent additional power. This paper describes the fabrication of these special cells and discusses their costs. (Author)

A77-19091 Meeting electric power needs with photovoltaic power systems. E. L. Ralph and I. M. Shahryar (Spectrolab, Inc., Sylmar, Calif.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 675-681.

This paper reports the development of new processes for the manufacture of solar cells, performed without use of vacuum chambers and expensive masking techniques, thus providing the possibility of reduced costs by automation using conventional semiconductor processing machinery. The contacts are printed on the cells by conventional silk screen machinery. The p+ back field is formed by diffusing aluminum from a printed back contact. The anti-reflection coating is formed by spinning and baking a TiO2-SiO2 glass film. Air mass zero efficiencies of over 10 per cent and high reliability were achieved. (Author)

A77-19092 Encapsulation of solar cell modules. B. Dalibot (La Radiotechnique-Compelec, Paris, France). In: Heliotechnique and development; Proceedings of the International Conference,

Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 682-686.

The two principal encapsulation technologies for solar cells - epoxy printed circuits and resin-glass - are discussed briefly along with the mechanical and climatic conditions which determine their design. Several photographs of working modules used for various applications (a power station, a solar-powered light beacon, and a solar-powered radio beacon) are presented. B.J.

A77-19093 Alternating photoelectrochemical converters (Convertisseurs photoélectrochimiques alternatifs). J. P. David and L. Aiache (Aix-Marseille III, Université, Marseille, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 689-707. 34 refs. In French.

After a brief discussion of photoelectrochemical conversion, a number of converters are reviewed including cells with chemical reactions in the solution, and cells with semiconductor electrodes. Particular attention is given to alternating photoelectrochemical converters which use alternating illumination of the two electrodes to overcome the traditional limitations of photoelectrochemical conversion, namely polarizations associated with activation and with concentration-diffusion. In these alternating converters, the active medium contains spontaneous oscillations of concentration which possibly may be coupled to alternating illumination to permit a resonant amplification and stabilization of chemical oscillations. B.J.

A77-19094 Investigation of a TiO2/electrolyte solar cell and the photocatalytic water decomposition. W. Gissler (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerche, Ispra, Italy). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 708-719. 24 refs.

To demonstrate the feasibility of semiconductor/electrolyte solar cells a TiO2/0.1 m Na2SO4/Pt cell has been constructed and tested. The quantum efficiency of the cell was 85 per cent. This rather high value could be achieved by a systematic analysis of different sample preparation techniques. However, due to the large band gap of 3.06 eV, the solar energy conversion efficiency is small. The possibility of a photocatalytic water decomposition has been investigated at very high light intensities corresponding to about 100 sun intensities. The result was negative. (Author)

A77-19095 Solar thermal power generation. W. P. Teagan, S. Atallah, and P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 720-738.

This paper discusses the preliminary design and feasibility analysis of a 100-kW electric generation station utilizing solar energy. The primary components of the system are an advanced flat-plate solar collector array and a Rankine-cycle engine which utilizes an organic fluid. Preliminary estimates for the cost of power generated by the proposed facility lies between 3.9 and 6.8 cents/kWhr. A marked improvement in collection efficiency can be realized by the addition of a simple reflector system which in turn would reduce the cost of power generation by 15-30 percent. (Author)

A77-19096 Organic Rankine Cycle Engine development and solar energy utilization. S. Ichikawa and M. Watanabe (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 739-752.

The Solar-Heat Actuated Organic Rankine-Cycle Engine is one of the most advantageous means of utiizing solar heat, because it is compact and reliable. This paper discusses the development in Japan of such engines since 1961. In particular, it describes a 490 kW packaged unit, recently commercialized, and a standardized series of 25 kW and 50 kW packaged units. These units could be applied to a large variety of power requirements, such as electrical generation, water pumping, air-conditioning and refrigeration. (Author)

A77-19097 Electric energy from atmospheric water vapor. V. P. Starr and N. E. Gaut (Environmental Research and Technology, Inc., Concord, Mass.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 759-772. 14 refs.

The utilization of the latent heat of condensation of atmospheric water vapor for the purpose of commercial electric power generation is proposed. This notion of latent energy is analyzed theoretically on the basis of studies of rotating fluid flows, with particular examination of the tornado mechanism. A latent energy power plant scheme is tentatively proposed consisting of a spool-shaped one-piece rotor around which tornado-like winds are generated. A combined cycle plant using the latent energy concept is also discussed. B.J.

A77-19098 Aerothermic power plant with artificial cyclone. E. Nazare. In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 773-776.

A tower of the venturi type is conceived so that air convected by solar heat be guided into accelerator ducts. The whirl having been thus started, the Coriolis forces due to the rotation of the earth sustain the cyclone rotation. With a difference of temperature of 50 C, a 300 m high tower could produce 650 MW of electricity. For equal power a tower will cost 4 times less than a nuclear power plant. It can also complement the conventional plants by recuperating part of the 60 per cent thermic energy lost to the atmosphere. The cycle being natural, it will not create any ecology disorder and can in certain cases constitute a climatic regulator. (Author)

A77-19099 Energy considerations in HHE power systems. R. E. Scott (University of Petroleum and Minerals, Dhahran, Saudi Arabia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 1. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 777-784. 6 refs.

A Helioelectrolytic scheme is examined which is similar to a Heliohydroelectric system. A hole is dug into the earth and water is allowed to fall into it. At the bottom the water is collected and electrolyzed to hydrogen and oxygen. These gases escape to the surface of the earth via a second hole. Energy is abstracted from the water as it falls by means of conventional turbines. The gases are also available at the surface for recombination and energy release. The energy relationships of this system are examined and compared with the conventional Heliohydroelectric system. (Author)

A77-19103 Efficiency tests on a linear parabolic concentrator for medium and high temperatures. O. Barra, M. Conti, L. Di Stefano, E. Santamato, R. Scarmozzino, and R. Visentin (Calabria, Universita, Cosenza, Italy). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 53-61.

The performance of a 20 sq m parabolic cylindrical mirror is described with reference to the optical properties (concentration ratio, reflection efficiency), to the thermodynamic properties (efficiency obtained in the conversion of solar energy into heat at temperatures in the range 100-350 C) and with reference to applications to a desalting cycle or to the production of mechanical energy. (Author)

A77-19104 **Selection of optimal pan color for solar water heater.** Y. Abdallah and I. Gourgi (University of Petroleum and Minerals, Dhahran, Saudi Arabia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 62-67.

This paper reports the effect of color on heat absorption. Four pans made out of galvanized steel were used in these experiments. One was painted black, the second white, the third gray, and the fourth was left unpainted. In the first group of experiments the four pans were tested for their performance. In the second, brass shavings were placed in the white pan and iron shavings in the unpainted pan. In all experiments water temperature was measured at various times of the day. The gray pan was found to yield the best results. (Author)

A77-19105 **Survey of absorption refrigeration systems.** R. K. Swartman (Western Ontario, University, London, Canada). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 71-82. 17 refs.

The use of solar-powered absorption refrigeration processes for refrigeration and ice-making applications is discussed, taking into account intermittent and continuous systems. The principles of absorption refrigeration are examined and a description is given of a number of experimental absorption refrigeration systems. Commercially available continuous absorption units are being installed at present in various buildings to demonstrate the feasibility of solar cooling. An innovative possibility is related to the combination of the cooling mode with the heating mode in a single system. An intermittent absorption system making use of this possibility could provide both heating and cooling for a solar house. G.R.

A77-19106 **Solar-powered refrigeration by intermittent solid absorption systems.** A. Eggers-Lura (International Solar Power Co., Ltd., Soborg, Denmark), P. Bechtoft Nielsen, B. Stubkier, and P. Worsoe-Schmidt (Danmarks Tekniske Hojskole, Lyngby, Denmark). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 83-104. 33 refs.

A survey of the literature on the intermittent solid-absorption refrigeration system is presented with particular reference to the potential use of such systems in solar-powered refrigeration plants. The results of an independent study of various systems are reported, and the preliminary design of a small ice-making plant with a flat-plate solar collector is described. A cost estimate for the plant indicates that solar-powered refrigeration may be economically feasible, especially in areas where other forms of energy are too expensive. (Author)

A77-19108 **Factors affecting the use of solar energy for cooling.** K. H. Khalil (Cairo University, Cairo, Egypt), I. A. Sakr, and A. I. Hegazi (National Research Centre, Solar Energy Laboratory, Cairo, Egypt). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 125-132.

Refrigeration appears to be a logical use of solar energy in tropical zones. This paper describes some of the factors considered in the design of a solar energy refrigeration system in Egypt. Insolation data for Cairo are presented. The storage alternatives are discussed. The experimental set-up of a solar refrigerator is shown. (Author)

A77-19109 **The two enemies of industrial development of solar energy - Simplicity and economy (Les deux ennemis du développement industriel de l'énergie solaire - Simplicité et économie).** M. Touchais (Coopération Méditerranéenne pour l'Energie Solaire, Marseille, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 135-143. In French.

The real problem of industrial development and use of solar energy is not to be sought in terms of simplicity of design and economy of implementation. The best solutions and best adapted ones are not generally simple. This is illustrated on the example of home solar heating. It is concluded that the technological problems of solar energy should be solved before considering commercialization. P.T.H.

A77-19110 **Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia.** R. W. Jones, A. Kremheller, and I. R. Titze (University of Petroleum and Minerals, Dhahran, Saudi Arabia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 144-159. 12 refs.

A report is given on the initiation of a project to investigate the feasibility of a solar-powered residence in the Eastern Province of Saudi Arabia. As a first step, the operation of such a house will be simulated by digital computer, concentrating primarily on a system which includes space heating and cooling and a hot water supply for domestic use. The model to be used and the available meteorological data are outlined. Preliminary results are given for a simulation of the cooling system only. (Author)

A77-19111 **Combined solar and petroleum energy HVAC system for a commercial building in Dhahran.** R. C. Hamilton (Tracor, Inc., Rockville, Md.), M. Lokmanhekim, and M. Nazli (George Washington University, Washington, D.C.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 160-179. 15 refs.

This paper reports the results of a preliminary study to compare the principal systems combining solar and petroleum energy HVAC system for a well insulated and sun shaded three story 100,000 square foot building in Dhahran, Saudi Arabia. The prime candidate system is a nocturnal sky radiation cooled covered pond followed by further water chilling by a heat pump driven by a petroleum fuel engine or turbine. The chilled water is stored underground in insulated tanks ready to cool the building the following day. (Author)

A77-19112 **Preliminary design data for a solar house in Riyadh, Saudi Arabia.** A. M. Sayigh and E. M. Abdul-Salam (Riyadh, University, Riyadh, Saudi Arabia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 180-190. 12 refs.

This paper examines some of the factors affecting the design of a solar house in Riyadh, Saudi Arabia. First, it considers some of the local building materials. Then, air-conditioning systems are evaluated for possible inclusion in the planned house. Also, solar cells are planned for generating electricity. (Author)

A77-19113 **Heating a building by means of solar and electrical energy (Chauffage d'un local au moyen de l'énergie solaire et électrique).** A. Spyridonos (*Democritos Nuclear Research Centre*, Athens, Greece). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 191-198. 12 refs. In French.

A method of local space heating utilizing solar energy combined with nighttime reliance on electrical energy is proposed. Cost estimates assume lower rates for use of electrical power during the night. The electrical energy is stored at nights in a water tank capable

of providing the daytime calories for local space heating. This combination system has been test-run during the winter months in Greece with daylight lasting ten hours. R.D.V.

A77-19114 Application of solar heat to buildings in Austria. F. Viehböck, P. Braun, R. Dobrozemsky, F. Rüdenauer, E. Panzhauser (Wien, Technische Universität, Vienna, Austria), and P. Gilli (Graz, Technische Hochschule, Graz, Austria). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 199-209. Research supported by the Austrian Ministry of Science and Research.

A solar-heating research project undertaken in Austria is described. In this project, the building housing a scientific institute in Salzburg is being used as a demonstration solar-energy plant which employs decentralized heat pumps and a system consisting of roof-mounted collectors, heaters, isolation valves, a pair of circulation pumps, several heat exchangers, heat storage tanks, and associated piping. Maximum utilization of the solar energy collected by the given roof area is emphasized in the project. Instrumentation of the plant to measure the incoming solar heat, the collector efficiency, and the distribution of thermal power in the various circuits is discussed. F.G.M.

A77-19115 Environmentally designed housing incorporating solar energy. T. A. Lawand (McGill University, Montreal, Canada). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 210-235. 13 refs. Research supported by the Donner Foundation and the Department of Supplies and Services.

Four environmentally designed partially solar heated houses are being built for use by Quebec Indian populations. The paper summarizes the design philosophy of the solar systems which were adapted, and discusses an experimental solar rock wall developed for use under these conditions. The different climatic conditions at the test sites are also listed. The four solar systems are briefly described, three systems are passive and one uses forced air circulation and a separate heat storage system. (Author)

A77-19116 Lumiducts for Ecopolis. G. Rottier (Damascus University, Damascus, Syria). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 236-246.

This paper discusses a new concept of urbanism that would optimize the presence of sunlight where and when it is needed. The settlement on which this concept is applied, Ecopolis, would use lumiducts for its lighting needs. This city is described and the principles of lumiducts are presented. (Author)

A77-19117 Water pumping - A practical application of solar energy. F. Fiatte (Compagnie Française des Pétroles, Paris, France) and M. Clémot (Commissariat à l'Energie Atomique, Montargis, Loiret, France). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 331-339.

This paper reviews the characteristics and advantages of solar pumping installations. Existing 1 kW and 25 kW stations are described. These stations are integrated with buildings which can be used to house a school, a market or a dispensary. (Author)

A77-19118 New frontiers in solar and other energy options. M. F. Abdel-Hameed (Northern Illinois University, De Kalb, Ill.) and A. A. El-Difrawi (Kentucky, University, Lexington, Ky.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 525-540. 31 refs.

Opposition to nuclear power is gaining momentum in recent years because of reliability, security, safety, and radiactive and thermal pollution. The paper presents a review of several alternative approaches of otherwise unconventional energy systems, especially those nonpolluting sources available naturally as geothermal, waves and tidal, wind, and solar power. Solar energy is definitely considered a major option for large-scale supply of energy. Particular attention is given to the energy production capabilities of photosynthesis and synthetic leaf, hydrogen energy, space colonization, and colonization of marginal earth habitats. Energy production applications in various countires are also discussed. S.D.

A77-19119 Solar heating projects at the Institute for Environmental Research. G. Braunlich, K. Frey, and E. Podesser (Institut für Umweltforschung, Graz, Austria). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 541-557.

This paper summarizes projects carried out at the Institute for Environmental Research in Austria. The principal activities deal with solar heating. Design methods for solar collectors are discussed. Four applications are described: tobacco drying, water heating, swimming-pool heating, and solar greenhouses. (Author)

A77-19120 Economic and social impact of solar powered transportation systems. J. L. Duda (Computer Sciences Corp., Falls Church, Va.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 558-569. 9 refs.

This paper outlines a methodical approach to the study of the economic and social aspects of the use of solar-generated electric power for transportation purposes. The potential socioeconomic impacts of solar-powered transportation systems can be far-reaching. The approach is basically that of impact analysis. Impacted industries are identified and quantified as to their net positive or negative effect on the economy. The main danger in such an approach is simply leaving out or misjudging the real effect of the introduction of proposed transportation systems. A sample case is presented for an electric powered public/private conveyance. (Author)

A77-19121 Hydel and solar power for Pakistan. M. I. Khan (Pakistan University of Engineering and Technology, Lahore, Pakistan). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 576-582.

This paper reviews the energy resources of Pakistan, and makes projection for future needs. If Pakistan is to implement its development plans and increase energy self-sufficiency, it should develop its two principal energy resources: hydel and solar. (Author)

A77-19122 Geothermal energy in Saudi Arabia and its use in connection with solar energy. G. Otkun (Ministry of Agriculture and Water, Riyadh, Saudi Arabia) and A. M. Sayigh (Riyadh, University, Riyadh, Saudi Arabia). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 583-595. 9 refs.

Geothermal energy could be extracted from hot springs and deep aquifers. This paper presents a survey of the geothermal energy potential of Saudi Arabia. It also discusses the possibility of combining solar and geothermal energy to produce fresh water and electricity. (Author)

A77-19123 Improved use of energy. R. Hatami (Arya Mehr University of Technology, Teheran, Iran). In: Heliotechnique

and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 596-602.

The sudden sharp increase in the price of fossil fuels has destabilized the world's energy economy. This otherwise unfortunate event has had the beneficial effect of revising the methods of energy consumption and initiating a search for new energy sources. The various possibilities of energy conservation in buildings and recovery of waste from nuclear plants are briefly reviewed. V.P.

A77-19124 Formulation of energy policies - The case of West Africa. J. E. Soussou (Development Analysis Associates, Inc., Cambridge, Mass.) and W. W. Seifert (MIT, Cambridge, Mass.). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 609-635. 16 refs. Research sponsored by the U.S. Agency for International Development.

Developing countries should rely upon a complete survey of available technologies including their technical feasibility, development time and costs, along with the means of evaluating various technologies within the overall socio-economic system of a given region. The paper describes the initial phase of such a study directed to the Sahel-Sudan region of West Africa. The principal technological alternatives to the use of wood and oil are nuclear, wind, and solar energy. Two simple models which may be refined and used to evaluate energy options are described. The first projects energy demands for various assumptions of development policies. The second projects the costs of various options which may be chosen to supply the energy requirements. At this stage, it appears that solar energy and more specifically the production of methane from grass holds the greater promise for the region. S.D.

A77-19125 The role of solar energy in developing nations - The perspectives in Mali (Rôle de l'énergie solaire dans les pays en voie de développement - Perspectives Maliennes). C. Traoré (Ministère du Développement Industriel et du Tourisme, Laboratoire de l'Energie Solaire, Bamako, Mali). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 641-658. In French.

Work completed or in progress at the National Solar Energy Laboratory of Mali is discussed. The different projects include the use of solar energy for heating of water, distillation, drying, cooking, and the development of solar pumps. The use of solar energy in climate-control is also considered along with means for the popularization of solar energy studies. The possible role of solar energy in the economy of Mali and that of other developing nations is examined. B.J.

A77-19126 Research at the EURATOM-CCR Center. J. Gretz (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerche, Ispra, Italy). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 665-669.

This paper summarizes briefly the work done at CCR-Ispra on solar energy research. This work concentrates mainly on collector development including use of selective surfaces and concentration, semiconductor/electrolyte cells, and biochemical conversion of sunlight. (Author)

A77-19127 Solar energy in Switzerland (Energie solaire en Suisse). R. E. Müller (Office Fédéral de l'Economie Energétique, Bern, Switzerland). In: Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volume 2. Cambridge, Mass., Development Analysis Associates, Inc., 1976, p. 681-695. 18 refs. In French.

The development of solar energy in Switzerland is reviewed from the points of view of technical, economic and climatological factors. Attention is given to historical developments in the field and to solar energy in the private business sector, here emphasizing the development of four types of solar heating systems for hot-water production and domestic or local heating. The industrial fabrication of solar collectors and installations is examined along with the role of the government in the field. The use of solar energy for purposes of refrigeration and cheese-making is also considered. B.J.

A77-19172 # Linear model of a dissipative PWM shunt regulator (Modèle linéaire d'un régulateur shunt PWM dissipatif). M. Clique and A. J. Fossard (Ecole Nationale Supérieure de l'Aéronautique et de l'Espace, Toulouse, France). *ESA Scientific and Technical Review*, vol. 2, no. 3, 1976, p. 221-229. 11 refs. In French.

Small-signal dynamic behavior of a dissipative pulse-width modulation (PWM) shunt regulator is analyzed. Two methods are used for establishing the transfer functions relating the regulated voltage to the PWM duty cycle and to the current delivered to the solar generator: the first is based on averaging techniques, and the second is based on a linearized model obtained from the equations of state expressing the structure of the system within each phase. P.T.H.

A77-19175 The seat belt light is on. H. E. Tolle (United Air Lines, Inc., Chicago, Ill.). *Exxon Air World*, vol. 29, no. 1, 1976, p. 5-9.

Future trends affecting growth and revenues of the airline industry are projected with consideration of factors governing passenger travel demand, the profit picture, competition, political constraints, and fuel costs. Success in fuel conservation, the fuel fraction of operating costs, effects of U.S. (FEA, EPA, FAA, CAB, DOT) government regulations, trends in passenger fares and freight rates, impact of inflation, expected slow and modest technological advances, forecasts of the potential passenger market, demographic trends affecting future passenger travel demand, and the capital investment picture are surveyed, along with European competition. Population growth, smaller families, higher incomes, increased leisure time, and increased foreign travel are foreseen as pluses, while higher fares and costs, increased consumer savings, and electronic substitutes for business travel are seen as minuses. R.D.V.

A77-19181 # A system model for the investigation of alternative energy strategies (Ein Systemmodell zur Untersuchung alternativer Energiestrategien). H.-H. Maier. Hannover, Technische Universität, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1975. 185 p. 46 refs. In German.

The reported investigation provides an integrated mathematical dynamic model for the study of alternative developments of future energy systems with respect to the possibilities of their realization and the totality of their effects. Attention is given to questions related to the available reserves regarding the required materials, the possibility of material substitution, economic effects, effects on the environment, and technological developments. Conceivable conflicts between short-term and long-term solutions are pointed out. The considerations of the investigation are based on the division of the earth in ten regions proposed by Pestel and Mesarovic (1974), giving particular attention to Western Europe. G.R.

A77-19184 # Desulfurization of flue gases with iron/III/ oxide on porous carrier material - Theoretical and experimental investigation concerning the modelling of semicontinuous solid bed reactors with gas-solid reactions (Entschwefelung von Rauchgasen mit Eisen/III/-Oxid auf porösem Trägermaterial - Theoretische und experimentelle Untersuchung zur Modellierung halbkontinuierlicher Festbettreaktoren mit Gas-Feststoff-Reaktionen). E. Richter. Erlangen-Nürnberg, Universität, Fachbereich Ingenieurwissenschaften, Dr.-Ing. Dissertation, 1975. 278 p. 150 refs. In German.

Processes involving the emission of sulfur oxides are considered along with the methods which can be used to reduce the quantity of the emitted pollutants. The characteristics of regenerative processes for flue gas desulfurization are examined and a description is provided of flue gas desulfurization procedures which utilize iron(III) oxide on carrier substances. The modelling of a test reactor and questions of experimental planning are discussed. Attention is given to aspects of experimental design, details concerning the conduction of the experiment and its evaluation, and a summarizing interpretation of the test results. G.R.

A77-19247 # **The dynamics of STOL /The Daniel and Florence Guggenheim Lecture/.** R. D. Hiscocks (National Research Council, Ottawa, Canada). *International Council of the Aeronautical Sciences, Congress, 10th, Ottawa, Canada, Oct. 3-8, 1976, Paper 76-01.* 13 p. 23 refs.

Aspects of the aeronautical history in Canada are examined, taking into account investigations conducted by Turnbull, contributions made by Bell, the significance of air transportation for Canada, developments related to high lift and controllability at low airspeeds, and the employment of small STOL aircraft. With STOL aircraft it is feasible to operate between a small community airport and special assigned runways at a major center without conflict with heavy traffic. Handicaps for short range STOL related to aerial navigation problems are pointed out and approaches for overcoming these handicaps are considered. Attention is given to the development of new materials for aircraft construction, the economic justification for STOL, and the characteristics of the next generation of STOL. G.R.

A77-19293 **Pulsed energy conversion with a dc superconducting magnet.** M. Cowan, E. C. Cnare, W. B. Leisher, W. K. Tucker, and D. L. Wesenberg (Sandia Laboratories, Albuquerque, N. Mex.). *Cryogenics,* vol. 16, Dec. 1976, p. 699-704. 8 refs. ERDA-supported research.

A generator system for pulsed power is described which employs a dc superconducting magnet in a magnetic flux compression scheme. Experience with a small-scale generator together with projections of numerical models indicate potential applications to fusion research and commercial power generation. When the system is large enough, pulse energy can exceed that stored in the magnet, and pulse rise time can range from several microseconds to tens of milliseconds. (Author)

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STAR ENTRIES

N77-10032*# Lockheed-California Co., Burbank.
LH2 AIRPORT REQUIREMENTS STUDY Final Report, Sep. 1975 - Feb. 1976
G. D. Brewer, ed. Oct. 1976 202 p refs
(Contract NAS1-14137)
(NASA-CR-2700; LR-27581) Avail: NTIS HC A10/MF A01 CSCL 21D

A preliminary assessment of the facilities and equipment which will be required at a representative airport is provided so liquid hydrogen LH2 can be used as fuel in long range transport aircraft in 1995-2000. A complete facility was conceptually designed, sized to meet the projected air traffic requirement. The facility includes the liquefaction plant, LH2, storage capability, and LH2 fuel handling system. The requirements for ground support and maintenance for the LH2 fueled aircraft were analyzed. An estimate was made of capital and operating costs which might be expected for the facility. Recommendations were made for design modifications to the reference aircraft, reflecting results of the analysis of airport fuel handling requirements, and for a program of additional technology development for air terminal related items. Author

N77-10033*# Boeing Commercial Airplane Co., Seattle, Wash. Dept. of Preliminary Design.
AN EXPLORATORY STUDY TO DETERMINE THE INTEGRATED TECHNOLOGICAL AIR TRANSPORTATION SYSTEM GROUND REQUIREMENTS OF LIQUID-HYDROGEN-FUELED SUBSONIC, LONG-HAUL CIVIL AIR TRANSPORTS Final Report
Washington NASA Sep. 1976 176 p refs Prepared in cooperation with United Airlines and Air Products and Chemicals, Inc.
(Contract NAS1-14159)
(NASA-CR-2699; D6-75775) Avail: NTIS HC A09/MF A01 CSCL 01C

A baseline air terminal concept was developed which permitted airlines and the airport to operate JP- or LH2-fueled aircraft at common terminal gates. The concept included installation of a hydrogen liquefaction and storage facility on airport property, as well as the fuel distribution system. The capital investment and hydrogen-related operating costs to the airlines were estimated. Author

N77-10104*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
HIGH-EFFICIENCY SOLAR CONCENTRATOR
F. L. Lansing and J. Dorman *In its* The Deep Space Network 15 Oct. 1976 p 99-109 ref

Avail: NTIS HC A10/MF A01 CSCL 10A

A new type of solar concentrator is presented using liquid lenses and simple translational tracking mechanism. The concentrator achieves a 100:1 nominal concentration ratio and is compared in performance with a flat-plate collector having two sheets of glazing and non-selective coating. The results of the thermal analysis show that higher temperatures can be obtained with the concentrator than is possible with the non-concentrator flat-plate type. Furthermore, the thermal efficiency far exceeds that of the comparative flat-plate type for all operating conditions. Author

N77-10105*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A TWO-DIMENSIONAL FINITE DIFFERENCE SOLUTION FOR THE TRANSIENT THERMAL BEHAVIOR OF TUBULAR SOLAR COLLECTOR
F. L. Lansing *In its* The Deep Space Network 15 Oct. 1976 p 110-127 refs
Avail: NTIS HC A10/MF A01 CSCL 10A

A numerical procedure was established using the finite-difference technique in the determination of the time-varying temperature distribution of a tubular solar collector under changing solar radiancy and ambient temperature. Three types of spatial discretization processes were considered and compared for their accuracy of computations and for selection of the shortest computer time and cost. The stability criteria of this technique was analyzed in detail to give the critical time increment to ensure stable computations. The results of the numerical analysis were in good agreement with the analytical solution previously reported. The numerical method proved to be a powerful tool in the investigation of the collector sensitivity to two different flow patterns and several flow control mechanisms. Author

N77-10116*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY REPORT ON THE CTS TRANSIENT EVENT COUNTER PERFORMANCE THROUGH THE 1976 SPRING ECLIPSE SEASON
N. John Stevens, Robert R. Levell, and Vernon W. Klinect 1976 28 p refs Presented at Spacecraft Charging Conf., Colorado Springs, 27-29 Oct. 1976; sponsored by AF
(NASA-TM-X-73487; E-8879) Avail: NTIS HC A03/MF A01 CSCL 22B

The transient event counter (TEC), senses and counts transients having a voltage rise of greater than five volts in three separate wire harnesses: the attitude control harness, the solar array instrumentation harness and the solar array power harness. The operational characteristics of TEC are defined and the preliminary results obtained through the first 90 days of operation including the spring 1976 eclipse season are presented. The results show that the Communications Technology Satellite was charged to the point where discharges occurred. The discharge induced transients did not cause any anomalous events in spacecraft operation. The data indicate that discharges can occur at any time during the day without preference to any local time quadrant. The number of discharges occurring in the one second sample interval are greater than anticipated. The compilation and review of the data is continuing. Author

N77-10149*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STATUS OF SERT 2 THRUSTERS AND SPACECRAFT 1976
William R. Kerslake 1976 12 p refs Proposed for presentation at Intern. Elec. Propulsion Conf., Key Biscayne, Fla., 15-17 Nov. 1976; sponsored by AIAA
(NASA-TM-X-73501) Avail: NTIS HC A02/MF A01 CSCL 21C

The historical record of the SERT II ion thrusters and spacecraft performance for 6 1/2 years since the February 1970 launch is reviewed. The most recent ion thruster operation test shows no changes since 1974. Thruster 2 is fully operational with no performance degradation. Thruster 1 has a high voltage grid short, but continues to demonstrate cathode and discharge relight capability. Spacecraft orbit and dynamic analysis indicates a stable, sun-synchronous spacecraft orientation by 1979. An attitude adjustment maneuver was performed in August 1976 to achieve this orientation and provide sufficient continuous solar power for thruster operation in 1979. Author

N77-10220# Environmental Protection Agency, Research Triangle Park, N.C. Monitoring and Data Analysis Div.
NATIONAL EMISSIONS DATA SYSTEMS (NEDS) FUEL USE REPORT, 1973 Final Report
Apr. 1976 130 p
(PB-253908/8; EPA-450/2-76-004) Avail: NTIS HC A07/MF A01 CSCL 21D

Annual estimates of total consumption of major fuels such as coal, fuel oil, natural gas, gasoline, and diesel fuel are summarized. Estimates of the consumption of a number of other comparatively minor fuels are also included. The data are distributed according to major categories of air pollutant emissions sources and are reported for the nation as a whole and for individual states, territories, and the District of Columbia. GRA

N77-10221# Southwest Research Inst., San Antonio, Tex.
PROTOCOL TO CHARACTERIZE GASEOUS EMISSIONS AS A FUNCTION OF FUEL AND ADDITIVE COMPOSITION Final Report, Feb. 1974 - Jun. 1975
Harry E. Dietzmann Sep. 1975 132 p refs
(Contract EPA-68-02-1275)
(PB-253363/6; EPA-600/2-75-048) Avail: NTIS HC A07/MF A01 CSCL 21D

An engine dynamometer test schedule for additive effects is validated. Previous problems with vehicle to engine dynamometer comparability were solved by the use of a Clayton power absorption unit and a fixed flywheel as an inertia simulator. Thus, adequate road simulation was achieved. Numerous analytical techniques were developed including analysis for SO2, H2S, COS, methyl and ethyl mercaptan, ammonia, N,N-dimethylnitrosamine, hydrocarbon distribution, and sulfate. No additive derived products were found in the study of two commercial additive packages with either catalyst or non-catalyst engine configurations. The mileage accumulation schedule used resulted in overly high rates of accumulation of intake manifold deposits for both additive and base fuels. GRA

N77-10222# National Academy of Sciences - National Research Council, Washington, D.C. Committee on Toxicology.
FUELS AND FUEL ADDITIVES FOR HIGHWAY VEHICLES AND THEIR COMBUSTION PRODUCTS. GUIDE TO EVALUATION OF THEIR POTENTIAL EFFECTS ON HEALTH Final Report
1976 52 p refs
(Contract EPA-68-01-0432)
(PB-254088/8; NAS/ACT/P-755) Avail: NTIS HC A04/MF A01 CSCL 06T

Problems associated with testing fuels, fuel additives and their combustion products for potential public health problems are discussed. Conclusions follow: (1) Initial evaluation of safety of a new fuel-additive combination should include comparison between a standard fuel and the new combination. (2) Biologic methods suggested for initial evaluation should be sensitive to the possibility that known human health effects from such sources may increase or diminish. (3) Separate considerations and more extensive research on most metal-containing additives should be required because of their persistence in the environment and their tendency to accumulate in the body. (4) All methods will need careful validation and inter-laboratory studies. (5) Interpreting results of studies on combustion products is difficult at best; decisions should be made by informed scientists. (6) Appropriate epidemiologic and analytic studies should be conducted whenever new fuel-additive combinations are introduced. GRA

N77-10224# Federal Energy Administration, Washington, D.C.
NATIONAL PETROLEUM PRODUCT SUPPLY AND DEMAND, 1976 - 1978
Christopher B. Alt May 1976 249 p refs
(PB-254969/9; FEA/B-76/281) Avail: NTIS HC A11/MF A01 CSCL 21D

A documentation of the short term petroleum product supply and demand forecasting methodology is presented. Four petroleum product supply and demand forecasts are presented for the period 1976 through 1978. The four forecasts consist of a base case and three alternative cases: (1) composite low demand, (2) composite high demand, and (3) low domestic supply. The four cases differ with respect to the following: (1) projections of economic growth, (2) impact of natural gas curtailments on petroleum demand, (3) nomal or abnormal weather, (4) implementation of the Energy Policy and Conservation Act of 1975, (5) estimates of conservation savings, and (6) projections of domestic crude oil production. GRA

N77-10228# Rheinische Braunkohlenwerke A.G., Cologne (West Germany).
GASIFICATION OF COAL AND ITS FUTURE ASPECTS REGARDING THE USE OF HEAT FROM HIGH-TEMPERATURE NUCLEAR REACTORS
H. Teggers 25 Aug. 1975 19 p refs Presented at the Intern. Seminar for Heat and Mass Transfer, Dubrovnik, Yugoslavia, 25 Aug. 1975
(INIS-MF-1965) MF available from INIS Section, International Atomic Energy Agency, P. O. box 590 A-1011, Vienna, Austria

Recent demands to convert coal to synthetic natural gas or synthetic gas are considered in terms of increased prices for oil and natural gas. The economic feasibility of gasification of coal by using heat from gas cooled high temperature nuclear reactors is also discussed. The possibilities and problems of this process are shown and compared with conventional processes. ERA

N77-10271*# Massachusetts Inst. of Tech., Cambridge.
SOME DYNAMIC PROBLEMS OF ROTATING WINDMILL SYSTEMS
John Dugundji *In* NASA. Langley Res. Center Advan. in Eng. Sci., Vol. 2 1976 p 439-447 refs

(Grant NSF AER-75-00826)
Avail: NTIS HC A20/MF A01

The basic whirl stability of a rotating windmill on a flexible tower is reviewed. Effects of unbalance, gravity force, gyroscopic moments, and aerodynamics are discussed. Some experimental results on a small model windmill are given. Author

N77-10305*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ADVANCES IN ENGINEERING SCIENCE, VOLUME 3
1976 464 p refs Presented at the 13th Ann. Meeting of the Soc. of Eng. Sci., Hampton, Va., 1-3 Nov. 1976; sponsored by JIAFS and George Washington Univ. 4 Vol.
(NASA-CP-2001-Vol-3) Avail: NTIS HC A20/MF A01 CSCL 13M

Papers concerning acoustics, environmental modeling, and energy technology are presented.

N77-10342*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SOLAR HOT WATER SYSTEMS APPLICATION TO THE SOLAR BUILDING TEST FACILITY AND THE TECH HOUSE
Ross L. Goble, Ronald N. Jensen, and Robert C. Basford *In its* Advan. in Eng. Sci., Vol. 3 1976 p 1237-1246

Avail: NTIS HC A20/MF A01 CSCL 10A

Projects which relate to the current national thrust toward demonstrating applied solar energy are discussed. The first project has as its primary objective the application of a system comprised of a flat plate collector field, an absorption air conditioning system, and a hot water heating system to satisfy most of the annual cooling and heating requirements of a large commercial office building. The other project addresses the application of solar collector technology to the heating and hot water requirements of a domestic residence. In this case, however, the solar system represents only one of several important technology items, the primary objective for the project being the application of space technology to the American home: Author

N77-10344*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HYDROGEN-FUELED SUBSONIC AIRCRAFT: A PERSPECTIVE
Robert D. Witcofski *In its* Advan. in Eng. Sci., Vol. 3 1976 p 1265-1278 refs
Avail: NTIS HC A20/MF A01 CSCL 21D

The performance characteristics of hydrogen-fueled subsonic transport aircraft are compared to those using conventional aviation kerosene. Additional aspects discussed include potential improvements in the exhaust emissions characteristics of aircraft

jet engines, problems associated with onboard fuel containment, results of recent studies of the impact of hydrogen-fueled aircraft on the airport and associated ground support equipment, and estimates of the cost and thermal efficiency of producing synthetic aviation fuels from coal. Author

N77-10379*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
BEST-RANGE FLIGHT CONDITIONS FOR CRUISE-CLIMB FLIGHT OF A JET AIRCRAFT
Francis J. Hale *In* NASA. Langley Res. Center Advan. in Eng. Sci., Vol. 4 1976 p 1713-1719 refs

Avail: NTIS HC A22/MF A01
The Breguet range equation was developed for cruise climb flight of a jet aircraft to include the climb angle and is then maximized with respect to the no wind true airspeed. The expression for the best range airspeed is a function of the specific fuel consumption and minimum drag airspeed and indicates that an operational airspeed equal to the fourth root of three times the minimum-drag airspeed introduces range penalties of the order of one percent. Author

N77-10391# Bureau of Mines, College Park, Md. Metallurgy Research Center.
RECYCLING TRENDS IN THE UNITED STATES: A REVIEW
Max J. Spendlove May 1976 29 p refs
(PB-254222/3; BM-IC-8711) Avail: NTIS HC A03/MF A01 CSCL 13B
Support for recycling in the United States is discussed in terms of the growing demand for goods and services of mineral origin and the declining mineral supply. The low probability of meeting future deficits by discovering large new domestic resources or by significantly improving mineral supply and/or energy conversion technologies in the near future is emphasized. Author

N77-10465*# Washington State Univ., Pullman. Computer Science Dept.
AN INVESTIGATION OF CONDENSATION HEAT TRANSFER IN A LOSED TUBE CONTAINING A SOLUBLE NONCONDENSABLE GAS Final Report
Elric W. Saaski and Richard J. Hanson [1976] 82 p refs
(Grant NsG-2015)
(NASA-CR-149095) Avail: NTIS HC A05/MF A01 CSCL 20D
A more exact one-dimensional condensation heat transfer model for insoluble gases was developed and compared with experimental data. Modifications to this model to accommodate soluble gas behavior were also accomplished, and the effects on gas front behavior demonstrated. Analytical models for condensation heat transfer are documented, and an optical method used for measuring gas concentration profiles is outlined. Experimental data is then presented and interpreted. Author

N77-10542# Brookhaven National Lab., Upton, N.Y.
CLOSED BRAYTON CYCLE USING HYDROGEN AS A WORK FLUID
J. R. Powell, F. J. Salzano, W. S. Yu, and J. Milau 1976 12 p refs Presented at the 1st World Hydrogen Energy Conf., Miami Beach, Fla., 1 Mar. 1976 Sponsored by ERDA
(BNL-20899; Conf-760304-9) Avail: NTIS HC A02/MF A01
A high efficiency power cycle is proposed which uses H2 gas as a working fluid in a regenerative closed Brayton cycle. The H2 gas is compressed by an absorption/desorption cycle on metal hydride (Fe TiH/sub x/) beds. Low temperature solar or geothermal heat (T approximately 100 C) is used for the compression process, and high temperature fossil or nuclear heat (T approximately 700 C) supplies the expansion work in the turbine. Typically, approximately 90 percent of the high temperature heat input is converted to electricity, while approximately 3 kW of low temperature heat is required per kW of electrical output. Author (ERA)

N77-10590*# Earth Satellite Corp., Washington, D.C.
APPLICATION OF LANDSAT-2 DATA TO THE IMPLEMENTATION AND ENFORCEMENT OF THE PENNSYLVANIA SURFACE MINING CONSERVATION AND RECLAMATION ACT Progress Report, 19 Jun. - 19 Sep. 1976
Orville R. Russell, Principal Investigator 19 Sep. 1976 5 p ERTS
(Contract NAS5-21998)
(E77-10007; NASA-CR-148978; C-1037-2-6) Avail: NTIS HC A02/MF A01 CSCL 08I

N77-10610*# Perceptronics, Inc., Woodland Hills, Calif.
DEVELOPMENT OF SIGNAL PROCESSING ALGORITHMS FOR ULTRASONIC DETECTION OF COAL SEAM INTERFACES Final Report
Dennis D. Purcell and Moshe Ben-Bassat Aug. 1976 43 p refs
(Contract NAS8-31782)
(NASA-CR-150024; PFTR-1030-76-8) Avail: NTIS HC A03/MF A01 CSCL 08I
A pattern recognition system is presented for determining the thickness of coal remaining on the roof and floor of a coal seam. The system was developed to recognize reflected pulse echo signals that are generated by an acoustical transducer and reflected from the coal seam interface. The flexibility of the system, however, should enable it to identify pulse-echo signals generated by radar or other techniques. The main difference being the specific features extracted from the recorded data as a basis for pattern recognition. Author

N77-10623# Bureau of Mines, Amarillo, Tex. Helium Operations.
HELIUM RESOURCES OF THE UNITED STATES, 1973 Information Circular, 1976
B. J. Moore Mar. 1976 23 p refs
(PB-252473/4; BM-IC-8708) Avail: NTIS HC A02/MF A01 CSCL 10A
The helium resources of the nation are reported in four categories:(1) helium in storage; (2) helium in measured helium-rich natural gas reserves; (3) helium in measured helium-lean natural gas reserves, and (4) helium in indicated and undiscovered natural gas resources. GRA

N77-10624# Bureau of Mines, Washington, D.C.
MINERALS IN THE US ECONOMY: TEN-YEAR SUPPLY-DEMAND PROFILES FOR MINERAL AND FUEL COMMODITIES
Jul. 1975 102 p refs
(PB-252994/9; BM-SP-2-75) Avail: NTIS HC A06/MF A01 CSCL 08I
The Bureau of Mines has prepared supply-demand diagrams and tables to highlight the flow of minerals through the U.S. economy. The selected mineral supply-demand tables and flow diagrams comprise one output from the information and data collected and compiled by the Bureau of Mines on a continuing basis covering mineral production, consumption, prices, shipments, imports, exports, and stocks, as well as industry activities in all States and abroad. The 10-year data base terminates with 1973 figures because adequate world information was not available beyond that date. Moreover, 1974 was an anomalous year with respect to prices, supply, and demand for many commodities. GRA

N77-10625# RAND Corp., Santa Monica, Calif.
THE LONG-RUN MARGINAL COSTS OF ENERGY
Kent P. Anderson and James C. DeHaven Feb. 1975 277 p refs
(Grants NSF GI-44; NSF SIA-74-18660)
(PB-252504/6; R-1590-NSF; NSF/RA/N-75-225) Avail: NTIS HC A13/MF A01 CSCL 10A
The following areas (not necessarily in order of significance) were judged to be most important in the near-term national energy situation; crude oil production (lower-48, Alaskan, foreign),

conveyance by pipeline and tanker, refining, and distribution; natural gas production (lower-48, Alaskan), transmission, and distribution; syncrude production from domestic shale, transmission, and refining; coal production (surface and underground eastern and western--high and low sulfur) and transportation; central station electric power generation (nuclear- and fossil-fueled), transmission, and distribution; and nuclear fuel. Component costs of each system are provided. GRA

N77-10626# Massachusetts Inst. of Tech., Cambridge. Energy Lab.
THE SUPPLY OF COAL IN THE LONG RUN: THE CASE OF EASTERN DEEP COAL
Martin B. Zimmerman Sep. 1975 87 p refs
(Grant NSF SIA-73-07871-A02)
(PB-252642/4; MIT-EL-75-021) Avail: NTIS HC A05/MF A01 CSCL 08I

A methodology is developed for estimating long-run supply curves for coal. The method relies on engineering information and geological data and is applied to deep mining in the Eastern United States. Cost functions are estimated combining engineering and econometric procedures. Information on the geology of coal deposits is used in conjunction with the cost functions to estimate how costs will behave over time as output cumulates. The procedure is applied separately to low sulfur and high sulfur coal. GRA

N77-10633# Lewin and Associates, Inc., Washington, D.C.
THE POTENTIAL AND ECONOMICS OF ENHANCED OIL RECOVERY Final Report
Apr. 1976 274 p refs
(Contract FEA-CO-03-50222-000)
(PB-254991/3; FEA/B-76/221) Avail: NTIS HC A12/MF A01 CSCL 21D

The amount of oil that can be made available through enhanced recovery methods and the time and cost involved in its production are discussed. Potential oil reserves in California, Louisiana, and Texas are emphasized. GRA

N77-10636* National Aeronautics and Space Administration. Pasadena Office, Calif.
HYDROGEN-RICH GAS GENERATOR Patent
John Houseman (JPL) and Donald J. Cerini, inventors (to NASA) (JPL) Issued 28 Sep. 1976 15 p Filed 10 Jul. 1974 Supersedes N76-18460 (14 - 09, p 1127) Sponsored by NASA
(NASA-Case-NPO-13560-1; NASA-Case-NPO-13561-1; US-Patent-3,982,910; US-Patent-Appl-SN-487156; US-Patent-Class-48-61; US-Patent-Class-23-281; US-Patent-Class-48-116; US-Patent-Class-48-117; US-Patent-Class-48-197R; US-Patent-Class-48-212; US-Patent-Class-123-3; US-Patent-Class-252-373; US-Patent-Class-423-650; US-Patent-Class-431-11; US-Patent-Class-431-41; US-Patent-Class-431-116; US-Patent-Class-431-162; US-Patent-Class-431-170) Avail: US Patent Office CSCL 10B

A process and apparatus are described for producing hydrogen-rich product gases. A spray of liquid hydrocarbon is mixed with a stream of air in a startup procedure and the mixture is ignited for partial oxidation. The stream of air is then heated by the resulting combustion to reach a temperature such that a signal is produced. The signal triggers a two way valve which directs liquid hydrocarbon from a spraying mechanism to a vaporizing mechanism with which a vaporized hydrocarbon is formed. The vaporized hydrocarbon is subsequently mixed with the heated air in the combustion chamber where partial oxidation takes place and hydrogen-rich product gases are produced.
Official Gazette of the U.S. Patent Office

N77-10637*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LSSA (LOW-COST SILICON SOLAR ARRAY) PROJECT Quarterly Project Report, Apr. - Jun. 1976
8 Oct. 1976 172 p Sponsored in part by ERDA
(Contract NAS7-100)
(NASA-CR-149091; JPL-5101-7; ERDA/JPL-1012-76/6; QPR-1) Avail: NTIS HC A08/MF A01 CSCL 10A

Methods are explored for economically generating electrical power to meet future requirements. The Low-Cost Silicon Solar Array Project (LSSA) was established to reduce the price of solar arrays by improving manufacturing technology, adapting mass production techniques, and promoting user acceptance. The new manufacturing technology includes the consideration of new silicon refinement processes, silicon sheet growth techniques, encapsulants, and automated assembly production being developed under contract by industries and universities. Author

N77-10638*# Honeywell, Inc., Minneapolis, Minn. Energy Resources Center.
DESIGN, FABRICATION, TESTING, AND DELIVERY OF A SOLAR ENERGY COLLECTOR SYSTEM FOR RESIDENTIAL HEATING AND COOLING
T. H. Holland and J. T. Borzoni Oct. 1976 148 p refs
(Contract NAS8-31327)
(NASA-CR-150032) Avail: NTIS HC A07/MF A01 CSCL 10A

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. Author

N77-10640*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EARLY OPERATION EXPERIENCE ON THE ERDA/NASA 100 kW WIND TURBINE
John C. Glasgow and Bradford S. Linscott Sep. 1976 25 p refs
(NASA-TM-X-71601; E-8076) Avail: NTIS HC A02/MF A01 CSCL 10A

As part of the Energy Research and Development Administration (ERDA) wind energy program, NASA Lewis Research Center is testing an experimental 100-kW wind turbine. Rotor blade and drive shaft loads and tower deflection were measured during operation of the wind turbine at rated rpm. The blade loads measured are higher than anticipated. Preliminary results indicate that air flow blockage by the tower structure probably caused the high rotor blade bending moments. Author

N77-10642*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A SUMMARY OF THE ECAS MHD POWER PLANT RESULTS
George R. Seikel and L. P. Harris (GE Co., Schenectady, N. Y.) 1976 24 p refs Presented at the 3d US-USSR Colloq. on Magnetohydrodyn., Moscow, 21-22 Oct. 1976
(NASA-TM-X-73491; E-8884) Avail: NTIS HC A02/MF A01 CSCL 10B

The performance and the cost of electricity (COE) for MHD systems utilizing coal or coal derived fuels are summarized along with a conceptual open cycle MHD plant design. The results show that open cycle coal fired recuperatively preheated MHD systems have potentially one of the highest coal-pile-to-bus bar efficiencies (48.3%) and also one of the lowest COE of the systems studied. Closed cycle, inert gas systems do not appear to have the potential of exceeding the efficiency of or competing with the COE of advanced steam plants. Author

N77-10643# Oak Ridge National Lab., Tenn. Energy Div.
TRANSPORTATION ENERGY CONSERVATION DATA BOOK
A. S. Loebl, D. J. Bjornstad, D. F. Burch, E. B. Howard, J. F. Hull, D. G. Madewell, N. S. Malthouse, and M. C. Ogle Oct. 1976 279 p refs
(Contract W-7405-eng-26)
(ORNL-5198) Avail: NTIS HC A13/MF A01

Statistical data on energy use in the transportation sector are presented in the form of tables, graphs, and charts. The following topics are covered in six chapters: characteristics of transportation modes; energy characteristics, including energy consumption by source and by sector, and energy intensiveness; conservation alternatives; government impacts, including expenditures, regulations and research, development, and demonstration spending; energy supply, including domestic petroleum production, prices, and projections; and transportation demand, including population characteristics and economic determinants. A bibliography of data sources is provided at the end of each chapter, and a more general bibliography is included at the end of the book.
Author

N77-10644# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
UTILIZATION OF GEOTHERMAL ENERGY
I. I. Glass Aug. 1976 74 p refs Sponsored in part by the Sci. Council of Can.
(UTIAS-Review-40; CN-ISSN-0082-5247) Avail: NTIS HC A04/MF A02

Like the sun, the earth is a vast energy source. The utilization of this geothermal furnace is still in its infancy. The heat flow from the mantle to the surface is the energy equivalent to 2 x 10 to the 11th power barrels of oil per year. Although today only local hot spots yielding dry and wet steam, and shallow hot water sites are used economically, future technology may well lead to a much greater utilization through additional imaginative and sophisticated exploitation of available regions of dry hot rock, and deep areas of significant heat flow. Author

N77-10646# Energy Research and Development Administration, Washington, D.C.
CREATING ENERGY CHOICES FOR THE FUTURE. PUBLIC MEETING ON A NATIONAL PLAN FOR ENERGY RESEARCH, DEVELOPMENT, AND DEMONSTRATION
1975 227 p Conf. held in Seattle, 2 Dec. 1975
(CONF-751228-P2) Avail: NTIS HC A11/MF A01

Papers are presented dealing with a national plan for energy research and development. State, University, and private sectors are represented. J.M.S.

N77-10647# ACE-Federal Reporters, Inc., Washington, D.C.
CREATING ENERGY CHOICES FOR THE FUTURE
1975 382 p Proceedings of Public Meeting on a Natl. Plan for Energy Res., Develop., and Demonstration, Seattle, 2 Dec. 1975
(CONF-751228-P1) Avail: NTIS

A public meeting was held and its purpose was to permit an exchange of information between the people of the Pacific Northwest and the Federal government, specifically the Energy Research and Development Administration, to provide information to the public and to receive input from the public about that agency's national energy research, development, and demonstration plan in creating energy sources for the future. In addition to presentations by seven preliminary speakers, presentations of 26 other speakers representing Federal and state governments, universities and the private sector, as well as the panel discussions, are included. ERA

N77-10648# Brookhaven National Lab., Upton, N.Y.
PROSPECTS FOR HYDROGEN PRODUCTION BY WATER ELECTROLYSIS TO BE COMPETITIVE WITH CONVENTIONAL METHODS
S. Srinivasan and F. J. Salzano 1976 16 p refs Presented at the 1st World Hydrogen Energy Conf., Miami Beach, Fla., 1 Mar. 1976 Sponsored by ERDA
(BNL-20877; Conf-760304-10) Avail: NTIS HC A02/MF A01

With the impending unavailability of oil and natural gas, hydrogen will be produced on a large scale in the United States (1) from coal, or (2) by water electrolysis using electricity derived from nuclear or solar energy. In many parts of the world which lack fossil fuels, the latter will be the only possible method. The cost of purification of hydrogen produced from fossil fuels will increase its cost to about the same level as that of electrolytic hydrogen. When hydrogen is required in relatively small quantities too, the electrolytic method is advantageous. To minimize the cost of hydrogen produced by water electrolysis, it is necessary to reduce capital costs and approach 100 percent energy efficiencies. The General Electric Solid Polymer Water Electrolyzer and Teledyne Alkaline Water Electrolysis Cells, both operating at about 120-150 C, look most promising in achieving the goals of low capital cost and high energy efficiency. Author (ERA)

N77-10650# Los Alamos Scientific Lab., N.Mex.
GEOTHERMAL ENERGY FOR POWER GENERATION
Jefferson W. Tester 1976 8 p refs Presented at the IEEE Region Six Conf., Tucson, Ariz., 7-9 Apr. 1976
(Contract W-7405-eng-36)
(LA-UR-76-369; Conf-760416-1) Avail: NTIS HC A02/MF A01

The magnitude of the geothermal resource base for natural hydrothermal systems and for artificially stimulated dry hot rock systems is evaluated for the United States with respect to necessary technology required for development. The utilization of geothermal fluids ranging in temperature from 100 to 300 deg C is discussed from a thermodynamic and economic viewpoint. Direct steam flashing and a number of binary-fluid Rankine cycle arrangements employing nonaqueous working fluids are compared as to the performance of their power conversion cycle. In addition, the status of component development for advanced geothermal conversion systems is discussed. A generalized cost model is developed for predicting electric generating costs as a function of characteristics of the resource, including geothermal temperature gradient, reservoir capacity, and fluid temperature. ERA

N77-10651# Minnesota Univ., Minneapolis. Dept. of Electrical Engineering.
SOLAR POWER ARRAYS FOR THE CONCENTRATION OF ENERGY
V. D. Albertson Nov. 1975 19 p refs
(Contract E(11-1)-2699)
(COO-2699-2) Avail: NTIS HC A02/MF A01

A model is developed which yields the solar flux density distribution on the surface of a vertical cylindrical receiver mounted on a tower centrally located in a horizontal circular ring-shaped mirror field. The flux density at a given location on the receiver surface is shown to be given by the numerical integration of a simple analytical expression. Strategies are examined for redistributing the solar flux input to obtain a desired distribution or maintain a specified distribution throughout the day. The solar flux density distribution is expressed as a dimensionless concentration ratio which can be derived from universal curves and then used in the design of receivers to meet specified flux levels.
Author (ERA)

N77-10652# California Univ., Livermore. Lawrence Livermore Lab.
WILL THE LARGE-SCALE PRODUCTION OF HYDROGEN BE PART OF THE ENERGY PROBLEM OR PART OF ITS SOLUTION
G. D. Sauter 31 Dec. 1975 18 p refs Presented at the First World Hydrogen Energy Conf., Miami Beach Fla., 1-3 Mar. 1976
(Contract W-7405-eng-48)
(UCRL-76844; Conf-760304-11) Avail: NTIS HC A02/MF A01

The energy dynamics of nuclear reactors as a means of generating hydrogen were analyzed. Attention was focused on the following questions, over a range of values for the rate of expansion of the reactor network and the ratio of the energy required to build a reactor to the energy it produces: (1) the energy cost of developing a given system whether it would produce more energy than it costs or be a net drain on our already troubled energy economy, and (2) given that the system will produce net energy, whether the energy would be produced in adequate amounts and in a timely fashion. Based on the results of this analysis, a specific scenario was examined - the development by the year 2000 of the capacity to generate annually the amount of hydrogen which has the heat content of the natural consumed in the U.S. in 1970. For this scenario, it

appears that the reactors, rather than the hydrogen, will be the energy storage mechanism. ERA

N77-10653# Westinghouse Electric Corp., Lester, Pa. Heat Transfer Div.

ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION Quarterly Progress Report, 1976

R. M. Chamberlain, D. L. Keairns, B. W. Lancaster, L. A. Salvador, E. F. Sverdrup, E. J. Vidt, and P. W. Pillsbury 15 Oct. 1975 172 p refs

(Contract E(49-18)-1514)

(FE-1514-176) Avail: NTIS HC A08/MF A01

Analytical tasks and experiments necessary to evolve a coal gasification system for electric power generation are reported. Development unit's devolatilizer/desulfurizer underwent cold flow dynamics tests and is now ready to begin hot operation on coal. Test facilities for developing low Btu gas burning combustors to be fitted to large utility-type gas turbines are now in operation. Feasibility of constructing combustors to fit the space envelope of utility gas turbines was established; refinement of the designs to better deal with startup, turndown, dual fuel operation and emissions control is under way. Maximum economic potential of this process will be realized by cleaning the product gas of particulates and trace contaminants at 1600 F before burning in a gas turbine. Efforts both to define the required cleanliness and to assure removal of particulates down to present fuel gas standards are as yet inconclusive. A conceptual design for a gasification plant embodying fluid bed principles and sized to process coal for the largest commercially available utility gas turbine was developed. Author (ERA)

N77-10655# Sandia Labs., Albuquerque, N.Mex.

SURVEY OF HIGH TEMPERATURE THERMAL ENERGY STORAGE

T. T. Bramlette, R. M. Green, J. J. Bartel, D. K. Ottesen, C. T. Schafer, and T. D. Brumleve Mar. 1976 181 p refs

(Contract AT(29-1)-789)

(SAND-75-8063) Avail: NTIS HC A09/MF A01

The generic classes of storage concepts considered are sensible heat, latent heat, and heat of reversible chemical reaction. The study includes (1) a review of the basic thermodynamic aspects of thermal energy storage; (2) a summary of storage concepts which were conceptualized and/or built and tested, including comparisons of system characteristics within the generic classes; and (3) specific technology surveys within the areas of materials problems, heat transfer and fluid mechanics problems and systems application. It is shown that the design and engineering of thermal storage systems have not progressed beyond the most simple concepts. Current technology appears adequate to support the development of most sensible heat concepts and simple latent heat concepts. ERA

N77-10656# Oak Ridge National Lab., Tenn.

WASTE HEAT VS CONVENTIONAL SYSTEMS FOR GREENHOUSE ENVIRONMENTAL CONTROL: AN ECONOMIC ASSESSMENT

M. Olszewski, S. J. Hilenbrand, and S. A. Reed Mar. 1976 39 p refs

(Contract W-7405-eng-26)

(ORNL/TM-5069) Avail: NTIS HC A03/MF A01

Because of rising fuel costs greenhouse operators are seeking alternate methods and fuels to heat their greenhouses. A hypothetical greenhouse operation using power plant reject heat for winter heating was investigated on a cost basis. The greenhouse temperature control system, which is used for both heating and cooling, operates by flowing water down an evaporative pad while air is drawn across the pad. This direct contact energy exchange provided cooling in the summer, by water evaporation, while heating in the winter is provided by sensible heat transfer. The warm water for winter heating is supplied by the reject heat from a power plant. A comparison of the total cost for the bimodal system and a traditional greenhouse system indicates that the bimodal system is economically competitive if the pad water inlet temperature is maintained above 80 F. An analysis of typical greenhouse fixed and operating costs and revenue shows that the use of fossil fuels (coal or natural gas) results in an operating loss for all but mild climates. Author (ERA)

N77-10657# Maryland Univ., College Park. Dept. of Mechanical Engineering.

CCMS SOLAR ENERGY PILOT STUDY SOLAR HEATING AND COOLING SYSTEMS IN BUILDINGS

F. H. Morse, ed. and I. B. Rose, ed. Dec. 1975 153 p refs Presented at Ann. Meeting of the CCMS Solar Energy Pilot Study, Palo Alto, Calif., 4-6 Aug. 1975

(Contract AT(40-1)-4908)

(UMD-4908-5; Conf-750879) Avail: NTIS HC A08/M A01

The objectives of the 1975 CCMS Solar Energy Pilot Study Meeting were: (1) to review the activities of the CCMS Pilot Study since the Odeillo meeting and to discuss the activities planned for the coming year, (2) to provide the participants with an up-to-date description of the status of the solar heating and cooling systems programs of the participating countries; (3) to discuss and approve the recommendations of the format committee; (4) to provide the participants with status reports on those projects for which special format reports will be prepared during the coming year; and (5) to hear the report of The Zero Energy House Project Group and to discuss the formation of additional project groups. Countries represented at the meeting included Australia, the Bahamas, Belgium, Brazil, Canada, Denmark, El Salvador, FR of Germany, France, Greece, Israel, Italy, Jamaica, Netherlands, New Zealand, Philippines, Portugal, Saudi Arabia, Spain, Sweden, UK, UNESCO, and USA. ERA

N77-10658# Dravo Corp., Pittsburgh, Pa. Chemical Plants Div.

HANDBOOK OF GASIFIERS AND GAS TREATMENT SYSTEMS Final Report

Feb. 1976 171 p refs

(Contract E(49-18)-1772)

(FE-1772-11) Avail: NTIS HC A08/MF A01

The intent of this handbook is to provide a ready reference on gasifiers and gas treatment systems that are or may be applicable to coal conversion technology. The handbook contains sections on 22 gasifiers and 20 gas-treatment systems, including those presently available in the commercial market as well as those currently under development. The handbook is comprised of objective information collected from various sources and includes data, such as: the state of development, a description of the process, capacity, products, by-products, utilities and environmental considerations. The handbook is not intended as a comparative evaluation, but rather as an impartial reference on the current technology. ERA

N77-10659# Addis Translations International, Portola Valley, Calif.

UNDERGROUND FUEL GASIFICATION

A. Kroms Dec. 1975 9 p refs Transl. into ENGLISH from Technikas Apskats (Lincoln, Neb.), v. 35, 1962 p 16-17 Prepared for Lawrence Livermore Lab., Livermore, Calif. Sponsored by ERDA

(UCRL-Trans-10998) Avail: NTIS HC A02/MF A01

Gasification of coal facilitates supply and distribution logistics, improves the quality of the energy vehicle (especially with low quality coal) and permits more efficient conversion to heat at the consumption end. Underground gasification would minimize much difficult and dangerous work, and may be the only way to use narrow or lower grade strata. If the coal is gasified with air, the gas obtained has a low heating value and is not suitable for long distance transport; if oxygen or steam is used, the product is a high grade water gas. Underground gasification methods and experience in several countries are outlined briefly. The results were not too favorable. ERA

N77-10662# California Univ., Berkeley. Lawrence Berkeley Lab.

A LINEAR ECONOMIC MODEL OF FUEL AND ENERGY USE IN THE UNITED STATES. VOLUME 1: MODEL DESCRIPTION AND RESULTS Final Report

C. Roger Glassey and Peter Benenson Dec. 1975 180 p refs

(PB-252485/8; EPRI-ES-115-Vol-1) Avail: NTIS HC A09/MF A01 CSCL 10A

A linear programming model of the U.S. economy in 1972 with emphasis on energy and fuel use was constructed, based on the 1967 national input-output table updated to 1972. The results describe the direct and indirect economic impacts of each shortage simulated. Changes in gross national product, total employment, employment by industry and occupation, fuel substitution in the electric utilities and iron and steel sectors, imports, and output by sector are among the results calculated by the model. Published final demand and industrial capacity projections for 1975, 1980, and 1985 were combined with the 1972 model to permit investigation of the impacts of energy shortages in these years. GRA

N77-10663# California Univ., Berkeley. Lawrence Berkeley Lab.

A LINEAR ECONOMIC MODEL OF FUEL AND ENERGY IN THE UNITED STATES. VOLUME 2: SUBMODELS AND DATA Final Report

C. Roger Glassey and Peter Benenson Dec. 1975 138 p refs
(PB-252486/6; EPRI-ES-115-Vol-2) Avail: NTIS HC A07/MF A01 CSCL 10A

A model is developed for investigating the pattern of energy use in the United States and to examine the economic impacts of fuel and energy shortages. The submodel description and data are presented. GRA

N77-10664# Tetra Tech, Inc., Arlington, Va.

ENERGY FACT BOOK 1975. PARTS 1-5: APPENDIXES A-H

Glen Tomlinson 30 Jun. 1975 198 p refs
(Contract N00014-74-C-0348)
(AD-A023010; TETRAT-A-642-75-169-Pt-1-5) Avail: NTIS HC A09/MF A01 CSCL 10/1

Contents: Present energy situation; Energy R and D in other countries; Energy R and D legislation during the 93rd and 94th congresses; Federal government energy research and development. GRA

N77-10665# Battelle Columbus Labs., Ohio.

ENERGY: THE POLICY PLANNING FRAMEWORK IN STATE GOVERNMENTS. VOLUME 1: SUMMARY REPORT

Jules J. Duga, David W. Malone, and Richard M. Davis 1976 48 p refs
(Grant NSF SIA-75-18811)
(PB-254466/6; NSF/RA-760120-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 04A

A summary of the evaluation methodology developed and a brief description of the status of energy policy planning across the country, particularly in the five states funded through the NSF/RANN programs are presented. The methodology was developed for the purpose of providing a framework within which programs could be evaluated. GRA

N77-10666# Battelle Columbus Labs., Ohio.

ENERGY: THE POLICY PLANNING FRAMEWORK IN STATE GOVERNMENTS. VOLUME 2: APPENDICES

Jules J. Duga, David W. Malone, and Richard M. Davis 1976 90 p refs
(Grant NSF SIA-75-18811)
(PB-254467/4; NSF/RA-760121-Vol-2) Avail: NTIS HC A05/MF A01 CSCL 05A

For abstract, see N77-10665.

N77-10667# Acres American, Inc., Buffalo, N. Y.

UNDERGROUND PUMPED STORAGE RESEARCH PRIORITIES

David C. Willett Apr. 1976 132 p refs
(PB-254413/8; EPRI-AF-182) Avail: NTIS HC A07/MF A01 CSCL 10A

The current status of underground pumped storage is examined to identify specific elements requiring developmental work to encourage the adoption of the concept by electric power utilities. Aspects reviewed include siting and site investigation, provision of access to the underground facilities, the excavation of the lower reservoir cavern, and the availability of the requisite rotating equipment. Primary areas recommended for developmental work include the adaption of mining technology to the lower cavern excavation, the development of hoist equipment capable of handling loads to 120 tons, and the extension of single-stage reversible pump turbine capability to the 2,460 foot (750-meter) to 3,280 foot (1,000-meter) head range. GRA

N77-10669# ICF, Inc., Washington, D.C.

SUMMARY OF EPA ENERGY POLICY ANALYSIS

William C. Stitt and Donald G. Ogilvie 1975 128 p refs
(Contract EPA-68-01-0590)
(PB-253361/0) Avail: NTIS HC A07/MF A01 CSCL 10A

Topic areas discussed include: The nature of the energy--environmental problem; U.S. energy consumption and supply outlook; key energy proposals; and Macro-environmental implications of energy growth. GRA

N77-10670# ICF, Inc., Washington, D.C.

GASOLINE AND DISTILLATE SHORTAGE SITUATION: 1972-1976

1976 151 p
(Contract EPA-68-01-0590)
(PB-253322/2) Avail: NTIS HC A07/MF A01 CSCL 21D

A partial listing of contents includes: dynamics of the tight gasoline and distillate supply situation; effects of government policy on fuel shortages; outlook for gasoline and distillate demand and supply; estimating problems and policymaking implications; short and moderate term demand-supply estimates; government policy options; elements of an approach to solving oil supply problems; specific oil policy options. GRA

N77-10672# Delaware Univ., Newark. Inst. of Energy Conversion.

THEORETICAL PROSPECTS OF THE CdS-Cu2S SOLAR CELL

A. Rothwarf Mar. 1976 16 p refs Presented at the Intern. Conf. on Solar Elec., Toulouse, 1-5 Mar. 1976
(Grants NSF AER-72-03478-A04; NSF GI-34782)
(PB-252409/8; NSF/RANN/AER-72-03478-A04/TR76; NSF/RA-760059) Avail: NTIS HC A02/MF A01 CSCL 10B

The role of interface states in determining the properties of the cells is demonstrated. The effects of crystallite size are included. Ways of increasing the efficiency of the cells are indicated. GRA

N77-10673# Little (Arthur D.), Inc., Cambridge, Mass.

A LOCATION MATRIX PLAN FOR THE RESIDENTIAL SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM. VOLUME 1: FINDINGS AND RECOMMENDATIONS

May 1976 41 p
(Contract H-2350)
(PB-253784/3; ADL-C-78534-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 13A

A detailed plan for the experimental portion of the residential solar heating and cooling demonstration program to be conducted by HUD is given. The plan is designed to permit HUD, in a structured series of demonstration projects, to investigate the effect of building codes, zoning regulations, tax procedures, and other administrative activities on the practical use of solar energy for heating and cooling buildings and heating domestic water in various climate and geographic areas. The report recommends site locations for the site-systems projects, states the type of systems that are most compatible with the site locations that have been recommended, and presents a general schedule of events describing how the program is expected to evolve. GRA

N77-10674# Delaware Univ., Newark. Inst. of Energy Conversion.

DIRECT SOLAR ENERGY CONVERSION FOR LARGE SCALE TERRESTRIAL USE Final Report, 1 Jun. 1972 - 30 Jun. 1975

K. W. Boer 30 Jun. 1975 279 p refs
(Grant NSF AER-72-03478)

(PB-252539/2; NSF/RANN/AER-72-03478-A03/FR/7 NSF/RA/N-75-233) Avail: NTIS HC A13/MF A01 CSCL 10B

Significant progress was made on all major aspects of the CdS/Cu2S solar cell. Cell fabrication facilities and techniques were established. Substrate and CdS characteristics were studied; electron microscopy and diffraction were used to determine its topography and crystal structure. Energy dispersive X-ray diffraction, Rutherford backscattering, and Auger studies were made in the Cu(x)S and heterojunction regions. Copper diffusion in CdS, and the synthesis and high temperature phase behavior of Cu(x)S are discussed. Solar simulation facilities are established and described. Junction capacitance, uniformity of cell response, electron diffusion length and Cu(x)S sheet resistance measurements are described. GRA

N77-10675# General Electric Co., Philadelphia, Pa. Space Div.

TWO COMPONENT THERMAL ENERGY STORAGE MATERIAL Final Report

E. M. Mehalick and A. T. Tweedie Nov. 1975 45 p refs Sponsored in part by ERDA

(Grant NSF AER-74-09186)

(PB-252592/1; NSF/RANN/SE/AER-74-09186; NSF/RA/N-75-231) Avail: NTIS HC A03/MF A01 CSCL 10C

A thermal energy storage medium consisting of a slurry of spherically shaped capsules of encapsulated paraffin in a water carrier combines the advantages of the heat capacity of a phase change material and the high heat transfer rate of a slurry. The feasibility of this concept was evaluated by subjecting samples of such slurries to simulated solar system environmental conditions which included thermal cycling, system temperature levels, and slurry flow agitation due to stirring and pumping. The results of the evaluation program showed that paraffin can be encapsulated with a wall durable enough to withstand the temperature, thermal cycling, and moderate agitation without damage. The slurry storage capacity was also shown to be a factor of two higher than a water system on a per unit volume basis, assuming a 20F temperature change and a 40% solids slurry. The potential exists for even higher storage capacities at higher solids concentration levels. GRA

N77-10676# Schlesinger (Robert J.), Tarzana, Calif.

HYBRID SIMULATION OF SOLAR HVAC SYSTEM FOR HOUSE RETRO-FIT DESIGN Final Report

Robert J. Schlesinger Sep. 1975 61 p refs Sponsored in part by ERDA

(Grant NSF GI-43896)

(PB-252608/5; ERDA/SE/GI-43896/PR/75/10; NSF/RA/N-75-224) Avail: NTIS HC A04/MF A01 CSCL 13A

A small analog solar HVAC simulator that can be used as a research tool as well as provide a possible approach to sizing solar systems for retro-fit installations in dwellings is discussed. The circuitry used in the simulator, as well as plots of the data obtained with the system are given. The simulator responds to the weather, the life style of the occupants, and the energy needs of the building. The data and plots provide performance results for several collector/storage combinations simulated. GRA

N77-10678# American Cyanamid Co., Stamford, Conn. Chemical Research Div.

CADMIUM STANNATE SELECTIVE OPTICAL FILMS FOR SOLAR ENERGY APPLICATIONS Quarterly Progress Report, 1 Jan. - 31 Mar. 1976

G. Haacke and L. C. Burton (Delaware Univ., Newark) Apr. 1976 32 p refs

(Grant NSF AER-73-07957)

(PB-254879/0; NSF/RANN/SE/AER73-07957/PR-76; NSF/RA-760101; QPR-1) Avail: NTIS HC A03/MF A01 CSCL 10B

Spray-coating development was concentrated on improving the optical transmission of low sheet resistance cadmium stannate films. Conditions for the sputter deposition of (Cd2SnO4) onto glass were established to solve the adhesion problem encountered with Zn(x)Cd(1-x)S films. Cadmium stannate coated silicon wafers were found to be efficient selective solar heat absorbers. The CdS backwall solar cell development was extended to the Zn(x)Cd(1-x)S system. Open circuit voltages of 0.63 volts were achieved. GRA

N77-10680# RAND Corp., Santa Monica, Calif.

A SIMULATION ANALYSIS OF US ENERGY DEMAND, SUPPLY, AND PRICES

Kent P. Anderson Oct. 1975 106 p refs

(Grants NSF GI-44; NSF SIA-74-18660)

(PB-254314/8; R-1591-NSF/EPA; NSF/RA/N-75-301) Avail: NTIS HC A06/MF A01 CSCL 10A

This report describes the development of a simulation model of U.S. energy demand, supply and price, and comments on the results obtained in initial test runs. Details of the model are included for use by researchers familiar with common current specifications of supply and demand functions. The model includes the following user demand sectors and energy types: (1) residential (electricity, gas, oil); (2) commercial (electricity, gas, oil), (3) industrial (electricity, gas, distillate and residual oils), (4) transportation (petroleum products); and (5) residual (coal, electricity, gas, oil). The model contains the following supply activities: (1) coal; (2) petroleum; (3) gas; and (4) electricity. In addition several energy supply and demand projections are provided for analysts interested in the application of models to energy problems. GRA

N77-10681# American Univ., Washington, D.C.

RESEARCH ON ELECTROCHEMICAL ENERGY CONVERSION SYSTEMS Final Technical Report, Oct. 1971 - Jun. 1975

Alayne A. Adams and Robert T. Foley Dec. 1975 124 p refs

(Contract DAAK02-72-C-0084; DA Proj. 1T1-61102-A-34A) (AD-A023689; FTR-7) Avail: NTIS HC A06/MF A01 CSCL 10/2

The research on electrochemical energy conversion system has involved work on two tasks: a search for electrolytes alternative to phosphoric acid for direct and indirect hydrocarbon-air fuel cells, and a study of the corrosion characteristics of electrolytes for intermediate-temperature hydrocarbon-air fuel cells. A tabulation of the characteristics of an ideal fuel cell electrolyte established that there were five classes of chemical compounds that could be the sources of new, improved electrolytes. One class, the fluorinated sulfonic acids, through one member of the class, trifluoromethanesulfonic acid monohydrate, was investigated in some depth. This compound, when used as an electrolyte in hydrocarbon-air half cells, exhibits exceptional properties in comparison to conventional electrolytes such as phosphoric acid. The electrooxidation of propane and hydrogen is increased by an order of magnitude. The limiting current for the electroreduction of oxygen is increased somewhat but the open circuit potential for the air electrode is increased from 0.98 v (in phosphoric acid) to 1.13 v. GRA

N77-10684# Energy Research Corp., Danbury, Conn.

FUEL CELL STACKS Semiannual Report, Dec. 1974 - Aug. 1975

S. G. Abens and B. S. Baker Mar. 1976 33 p

(Contract DAAK02-74-C-0367)

(AD-A024216; ERC-7396-S) Avail: NTIS HC A03/MF A01 CSCL 10/2

Processes for the manufacture of phosphoric acid fuel cell components are described. Electrodes, matrices, and bipolar gas distribution plates for use in fuel cells with an active area of about 0.4 sq. ft. have been fabricated. Initial performance of 10-cell stacks has been studied with pure and co-containing hydrogen as fuel. Author (GRA)

N77-10685# Boston Univ., Mass. Dept. of Chemistry.

PHOTOCHEMICAL CONVERSION OF SOLAR ENERGY Quarterly Progress Report, 1 Jan. - 31 Mar. 1976

Norman N. Lichtin 28 May 1976 26 p refs Prepared in cooperation with Exxon Res. and Eng. Co., Linden, N. J.

(Grants NSF AER-72-03579-A05; NSF GI-38103)

(PB-255703/1; NSF/RANN/SE/AER-72-03579/A05; NSF/RA-760163) Avail: NTIS HC A03/MF A01 CSCL 07E

Ohmic resistance of the SnO2 electrode of the iron-thionine (TH+) TI-TL SnO2/Pt cell was shown to contribute to current losses. Thin TiO2 layers reduced with H2 at 500C provide a promising selective anode for the iron-TH(+) cell. Tuluidine blue O shows photogalvanic activity comparable to that of TH(+). Substantial sensitization to the blue of the photogalvanic activity of TH(+), methylene blue and azure A were demonstrated for a number of dyes, of which Rhodamine 6G is the most effective sensitizer. The dependence of the composition and kinetics of decay of the photostationary state of acidic iron-TH(+) solutions on solvent anions and initial concentrations of solutes was measured and correlated with rates of elementary reactions. GRA

N77-10686# Institute of Gas Technology, Chicago, Ill. Applied Combustion Research.

BURNER DESIGN CRITERIA FOR CONTROL OF NOx FROM NATURAL GAS COMBUSTION. VOLUME 1: DATA ANALYSIS AND SUMMARY OF CONCLUSIONS Final Report, Jun. 1973 - Sep. 1975

D. R. Shoffstall Apr. 1976 204 p
(Contract EPA-68-02-1360)
(PB-254167/0; EPA-600/2-76-098-a-Vol-1) Avail: NTIS HC A10/MF A01 CSCL 13A

An analysis and details are given of trials conducted with natural gas to determine the relationship between combustion aerodynamics and pollution emission characteristics of industrial burners. Three burner types were studied (kiln, ported baffle, and movable vane boiler), based on relative gas load and estimated total industrial emissions. Experimental measurements on a pilot-scale furnace included baseline characterization of each burner and variation of primary operating parameters (air preheat, air/fuel ratio, firing rate, heat release rate, position of gas nozzle in burner block, and air swirl intensity). Additional emissions data were gathered for suspected control conditions (fuel injector design, flue gas recirculation, fuel/air momentum ration, and burner block angle). It also describes in detail the experimental facility and sampling probes used to collect the data. GRA

N77-10687# National Bureau of Standards, Washington, D.C. Center for Building Technology.

ANALYSIS OF SOLAR ENERGY SYSTEM FOR THE GSA DEMONSTRATION OFFICE BUILDING AT MANCHESTER, NEW HAMPSHIRE Final Report

Tamami Kusuda, Stanley T. Liu, John W. Bean, and James P. Barnett 1 Mar. 1976 34 p refs
(PB-254179/5; NBSIR-76-1056) Avail: NTIS HC A03/MF A01 CSCL 13A

The effect of solar collector sizes and the amount of storage on the overall energy consumption of a building was determined. GRA

N77-10688# National Conference of State Legislatures, Washington, D.C.

ANALYSIS OF STATE SOLAR ENERGY OPTIONS

R. G. Jones, Helen M. Sramek, and Joette M. Pelster Jun. 1976 66 p refs
(Contract FEA-CO-12-60496-00)
(PB-254730/5; FEA/E-76/302) Avail: NTIS HC A04/MF A01 CSCL 13A

Criteria are evaluated for use by state governments in considering actions to stimulate the solar market. Areas discussed are solar market economics, tax incentives, and solar energy and electric utilities. GRA

N77-10689# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.

RESEARCH ON SOLAR ENERGY STORAGE SUBSYSTEMS UTILIZING THE LATENT HEAT OF PHASE CHANGE OF PARAFFIN HYDROCARBONS FOR THE HEATING AND COOLING OF BUILDINGS Annual Report

John A. Bailey, James C. Mulligan, Chang-Kwang Liao, Selcuk I. Guceri, and M. Krishna 1976 138 p refs
(Grant NSF GI-44381)
(PB-254665/3; NSF/RA-760100) Avail: NTIS HC A07/MF A01 CSCL 10A

An analytical and experimental research program designed to assess the potential of a solar energy storage subsystem (thermal capacitor) using the latent heat of fusion of paraffin hydrocarbons for the heating and cooling of buildings is described. An idealized model of a flat plate thermal capacitor based on uniaxial heat conduction with a change of phase and an absence of natural convection in the phase change material is assumed. Analyses are presented for the premelting, melting, and postmelting regimes. An experimental system consisting of a prototype thermal capacitor, fluid flow control unit, and hydraulic pumping system is described. GRA

N77-10690# Urban Systems Research and Engineering, Inc., Cambridge, Mass.

BASELINE ENERGY FORECASTS AND ANALYSIS OF ALTERNATIVE STRATEGIES FOR AIRLINE FUEL CONSERVATION

Jul. 1976 199 p
(Contract FEA-C-04-50088-00)
(PB-255351/9; FEA/D-76/026; FEA/D-CP-48) Avail: NTIS HC A09/MF A01 CSCL 10A

Baseline forecasts of airline activity and energy consumption to 1990 were developed to evaluate the impact of fuel conservation strategies. Alternative policy options to reduce fuel consumption were identified and analyzed for three baseline levels of aviation activity within the framework of an aviation activity/energy consumption model. By combining the identified policy options, a strategy was developed to provide incentives for airline fuel conservation. Strategies and policy options were evaluated in terms of their impact on airline fuel conservation and the functioning of the airline industry as well as the associated social environmental, and economic costs. GRA

N77-10697# California Univ., Livermore. Lawrence Livermore Lab.

METHODS IN ENVIRONMENTAL SAMPLING FOR RADIONUCLIDES

R. C. Ragaini 1 Feb. 1976 16 p refs Presented at Proc. on Radionuclides in the Environment, Palto Alto, Calif., 22 Nov. 1975
(Contract W-7405-eng-48)
(UCRL-77722; Conf-751174-2) Avail: NTIS HC A02/MF A01

Methods of environmental sampling for radionuclides around operational and preoperational nuclear power plants are reviewed. The implications of the established radiation standards and their effect on sampling procedures are examined in detail. Transport mechanisms of radionuclides in liquid effluent, and the deposition of airborne radionuclides onto soil and vegetation are discussed. Water and soil sampling procedures are evaluated. The Lawrence Livermore Laboratory program of terrestial gamma ray surveys at preoperational nuclear power plants is described. ERA

N77-10700# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Physik der Atmosphaere.

MATHEMATICAL SIMULATION AND EMPIRICAL DETERMINATION OF THE AEROCHEMICAL AND THERMAL ATMOSPHERIC POLLUTION RESULTING FROM ENERGY CONVERSION PROCESSES [MATHEMATISCHE SIMULATION UND MESSTECHNISCHE ERFASSUNG DER BEI ENERGIEWANDLUNGSPROZESSEN AUFTRETENDEN LUFTCHEMISCHEN UND THERMISCHEN BELASTUNG DER ATMOSPHAERE]

H. Fortak and D. Paffrath 1975 20 p refs In GERMAN
(DLR-IB-553-75/1) Avail: NTIS HC A02/MF A01

The prediction of atmospheric pollution effects resulting from power plants using a mathematical-meteorological simulation model with empirically determined input parameters is discussed. The model is aimed at climatological forecasting and takes into account heat, water vapor, and contaminant emission by energy conversion plants. ESA

N77-10707# Electric Power Research Inst., Palo Alto, Calif.
THE PROCEEDINGS OF THE NOx CONTROL TECHNOLOGY SEMINAR
Feb. 1976 436 p refs Seminar held at San Francisco, 5-6 Feb. 1976
(PB-253661/3; EPRI-SR-39) Avail: NTIS HC A19/MF A01 CSCL 07A

On February 5 and 6, 1976, EPRI sponsored a conference in San Francisco on the status of technology for control of oxides of nitrogen from power generation facilities. Coal-fired steam generators, gas turbines and synthetic fuel NOx emissions were covered during the two-day seminar. Representatives of electric utilities, regulatory agencies, academic institutions, research organizations and other industries were present. The purpose of this seminar was three fold: first, to acquaint the utility industry with stringent NOx emission standards for fossil fueled power plants currently under consideration by regulatory bodies; second, to evaluate the current state of the art for NOx control; and finally, to assess future technical options for NOx control and, where possible, to present their economic consequences. GRA

N77-10709# Abcor, Inc., Cambridge, Mass. Walden Research Div.
GROWTH EFFECTS OF MAJOR LAND USE PROJECTS. VOLUME 2: COMPILATION OF LAND USE BASED EMISSION FACTORS Final Report
Frank Benesh Jun. 1976 114 p refs
(Contract EPA-68-02-2076)
(PB-255302/2; C-781-b-Vol-2; EPA-450/3-76-012-b-Vol-2) Avail: NTIS HC A06/MF A01 CSCL 13B

Growth effects of major land use projects is a research program whose goal is to formulate a methodology to predict air pollutant emissions resulting from the construction and operation of two types of major land use projects, large residential projects and large concentrations of employment (i.e., office parks and industrial parks). Emissions are quantified from the major project, from land use induced by the major project, from secondary activity occurring offsite (i.e., generation of electricity by utilities), and from motor vehicle traffic associated with both the major project and its induced land uses. The development of a set of land use based emission factors (i.e., emissions per unit of building floor area or per dwelling unit) are presented that are used to estimate emissions from the induced land uses and secondary activities. To accomplish this, energy consumption in several categories of buildings is quantified. The emission sources may be principally categorized as follows: Stationary source emissions occurring on the site of the major project (e.g., the on-site combustion of fuel oil for space heating needs); stationary source emissions occurring at the land use induced by the major project (e.g., the on-site combustion of fuel oil for space heating needs); and secondary (i.e., occurring off-site) stationary source emissions (e.g., the combustion of fuel oil at the local electric utility to serve the electricity demand of the major project and induced land uses). GRA

N77-10715# Battelle Columbus Labs., Ohio.
CHEMICAL AND PHYSICAL CHARACTERIZATION OF AUTOMOTIVE EXHAUST PARTICULATE MATTER IN THE ATMOSPHERE Annual Summary Report, Nov. 1973 - Aug. 1974
J. F. Foster, D. A. Trayser, E. R. Blosser, and F. A. Creswick 22 Mar. 1976 106 p refs
(PB-253375/0; CRC-APRAC-CAPE-19-70-4; ASR-5) Avail: NTIS HC A06/MF A01 CSCL 13B

Cars were operated on a chassis dynamometer, discharging exhaust into a dilution tunnel, from which samples of diluted exhaust were taken for chemical and physical characterization of suspended particles. Particulate matter was studied in two separate research programs. Results are given from a series of tests on one 1973 catalyst-equipped car, modified for 1975 emission controls, which was operated at steady speeds and on the 1975 Federal Test Procedure (FTP) cycle. Sulfuric acid and sulfur oxide emissions were measured. The characteristics of particles emitted by two 1970 cars, with 1971 engines, using leaded or unleaded fuel and operating without catalysts on the 1972 FTP cycle are described. GRA

N77-10717# California Univ., Berkeley. College of Engineering.
THE FORMATION OF NITROGEN OXIDES FROM FUEL NITROGEN Final Report
R. F. Sawyer, N. J. Brown, R. D. Matthews, M. C. Branch, and S. M. Banna Mar. 1976 85 p refs Sponsored by EPRI
(PB-252462/7; EPRI-223-1-FR) Avail: NTIS HC A05/MF A01 CSCL 21B

The chemistry of fuel nitrogen and oxides of nitrogen reactions in combustion was studied. The ability to account quantitatively for all of the nitrogen constituted a major part of this effort. Other studies of fuel-nitrogen chemistry, nitrogen compound measurement, and premixed flame experiments are discussed. GRA

N77-10719# Harbridge House, Inc., Boston, Mass.
COST ANALYSIS OF TWO AIR QUALITY ATTAINMENT STRATEGIES Final Report
Nancy W. Sheldon, Susan McKittrick, Daniel Garson, and Catherine Bragg 15 Jun. 1976 71 p refs
(Contract EPA-68-01-1561)
(PB-254182/9; EPA-901/9-76-006) Avail: NTIS HC A04/MF A01 CSCL 13B

The economic costs associated with implementation of two strategies for attainment and short-term maintenance of particulate standards are evaluated. Strategies proposed for application to the City of Worcester are the replacement of marginal burners with more energy efficient modern equipment and the conversion of sources using residual oil to the use of lighter fuels and/or fuels of lower sulfur content. Only the economic costs to owners of affected facilities are involved. GRA

N77-10720# Meteorology Research, Inc., Altadena, Calif.
THE CHEMISTRY, DISPERSION, AND TRANSPORT OF AIR POLLUTANTS EMITTED FROM FOSSIL FUEL POWER PLANTS IN CALIFORNIA Final Report, Sep. - Nov. 1974
T. B. Smith, W. H. White, J. A. Anderson, and S. L. Marsh Nov. 1975 105 p refs
(Contract ARB-3-929)
(PB-254449/2; MR175-FR-1382; ARB-R-3-929-75-48) Avail: NTIS HC A06/MF A01 CSCL 13B

The effects of large, fossil fuel plants on the air quality environment in California were investigated. The program consisted of SF6 tracer releases from three different power plants and downwind sampling of SO2, SF6, and sulfates on the ground and in an instrumented aircraft. NOx and other pollutants were also sampled in the aircraft. With only one major exception the plumes from the plants were confined to the low level mixing layer and impacted at ground levels from 13 to 24km downwind of the plant. An unusual feature of the Haynes-Alamitos studies was the consistency of the plume direction from the plants. The reaction of NO, NO2 and O3 in the plumes occurred rapidly and resulted in ozone deficits in the plumes. The conversion of SO2 to sulfate occurred too slowly to be detected within the downwind distance of the identifiable plumes. GRA

N77-10722# Battelle Columbus Labs., Ohio.
REDUCTANT GASES FOR FLUE GAS DESULFURIZATION SYSTEMS Final Task Report, May 1974 - Mar. 1976
D. W. Hissong, K. S. Murthy, and A. W. Lemmon May 1976 248 p refs
(Contract EPA-68-02-1323)
(PB-254168/8; EPA-600/2-76-130) Avail: NTIS HC A11/MF A01 CSCL 07A

Study results are presented for use of coal or residual-oil gasification to produce a hydrogen/carbon monoxide-rich gas for use as a reductant for regenerable flue gas desulfurization (FGD) processes. Two different reduction systems are considered: one for the type of FGD process that produces a concentrated SO2 stream; the other, for the type that uses a liquid-phase Claus reactor. Data on the composition of the raw gas from several gasifiers are analyzed. To supplement the data on trace

constituents in the gas, thermodynamic calculations were made to determine the equilibrium gas-phase concentrations for a typical coal and typical gasification conditions. GRA

N77-10731# Environmental Protection Agency, Research Triangle Park, N.C. Office of Air Quality Planning and Standards.
COMPILATION OF AIR POLLUTANT EMISSION FACTORS. SUPPLEMENT
Apr. 1976 59 p refs
(PB-254274/4; AP-42-Suppl-6) Avail: NTIS HC A04/MF A01 CSCL 21B

Emissions data are presented for fuel oil combustion, open burning, heavy-duty, natural-gas-fired pipeline compressor engines, alfalfa dehydrating, sugar cane processing, natural gas processing, and woodworking operations. ERA

N77-10812# Systems Science and Software, La Jolla, Calif.
COMPUTER MODELING OF COAL GASIFICATION REACTORS Quarterly Technical Progress Report, 30 Jun. - 30 Sep. 1975
15 Oct. 1975 31 p refs
(Contract E(49-18)-1770)
(FE-1770-4) Avail: NTIS HC A03/MF A01

The FLUB code is a finite difference, numerical formulation of the unsteady one-dimensional equations describing chemically inert, gas fluidized bed dynamics. These equations, developed within the framework of the theory of interacting continua, express mass and momentum conservation for both the solid particles and the gas phase of a fluidized bed. The FLUB code was extended to include the balance equations for chemical species transport and the principle of conservation of energy in both solid and gaseous phases. The differential equations for solid particle-gaseous phase flow are briefly presented. To this system of equations, the balance equations for chemical species in the fluidized bed are adjoined. The corresponding difference equations for species transport are then derived. This difference scheme, presently used in FLUB, is based upon well-established numerical methods. Advanced developments are outlined. Author (ERA)

N77-10891# General Atomic Co., San Diego, Calif.
CHARACTERISTICS OF A FIRST GENERATION COMMERCIAL FUSION POWER PLANT
C. C. Baker, C. R. Harder, and P. H. Sager, Jr. 11 Dec. 1975 30 p refs
(Contract E(04-3)-167)
(GA-A-13661) Avail: NTIS HC A03/MF A01

A brief survey was made to identify the major design parameters and features of a first generation commercial fusion plant using a noncircular Tokamak reactor. This study was made to provide a frame of reference for developing a conceptual design of a demonstration plant which is intended to demonstrate the principal features of a commercial plant on a scalable basis. Based on a review of size trends in the utility industry, the plant was sized to produce about 2,200 MW(e) gross output. Allowing for expected parasitic power requirements, the net station output is approximately 1,800 MW(e). The plant is described in some detail. ERA

N77-10941# Federal Energy Administration, Washington, D.C. Office of Policy and Analysis.
DIRECTORY OF FEDERAL ENERGY DATA SOURCES: COMPUTER PRODUCTS AND RECURRING PUBLICATIONS
May 1976 84 p
(PB-254163/9; FEA/B-76/219) Avail: NTIS HC A05/MF A01 CSCL 09B

Federally sponsored energy-related information is announced. The information on magnetic tape is primarily in the form of data files. However, there are also computer programs, data base reference services, and mathematical models. The items are listed under broad subject categories. The citations include title, responsible agency, dates of coverage, accession number, availability information, and abstract. Each entry is indexed by subject, originating agency, and accession number. GRA

N77-10964# Columbia Univ., New York. School of Engineering and Applied Science.
RESOURCE RECOVERY TECHNOLOGY FOR URBAN DECISION-MAKERS
Helmut W. Schulz, Bernard J. Bortz, Mounir Neamatalla, Ronald M. Szostak, and Godfred Tong Jan. 1976 127 p refs Sponsored in part by NSF
(PB-252458/5; NSF/RA-760026) Avail: NTIS HC A07/MF A01 CSCL 13B

Contents: Characteristics of municipal solid waste; Economic comparison of energy recovery processes; Economic factors in materials recovery; Biochemical conversion processes; Guide for decision making; Appendices (Financial and organizational arrangements, Pyrolysis of dewatered sewage sludge, Calculation of economic figures of merit, Sample request for proposal, advisory committee and research staff). GRA

N77-10970# Transportation Research Board, Washington, D.C.
UTILITY FACILITIES IN TRANSPORTATION CORRIDORS
G. W. Bradley 1976 50 p refs
(PB-255635/5; TRB/TRR-571; ISBN-0-309-02484-6) Avail: NTIS HC A03/MF A01 CSCL 13B

This record deals with: (1) the concept of an energy corridor to establish a precedent for the orderly, controlled transmission of sources of all types of energy from supplier to user; (2) the state of the art of common trenching of utilities; (3) an examination of the increasing complexities involved in providing essential utility and transportation services; (4) a discussion of wastewater recycling along transportation corridors; and (5) a highlighting of the severity and complexity of the utility pole accident problem and a recommendation for further specific actions. GRA

N77-10974# Hittman Associates, Inc., Columbia, Md.
UNDERGROUND COAL MINING: AN ASSESSMENT OF TECHNOLOGY Final Report
Jul. 1976 475 p refs Prepared in cooperation with Pa. State Univ., Univ. Park and George Washington Univ., Washington, D. C. Sponsored by EPRI
(PB-255726/2; EPRI-AF-219) Avail: NTIS HC A20/MF A01 CSCL 08I

The methodology, techniques, and processes of technology assessment are applied to domestic underground mining of coal. Advanced technologies and systems for increased production of deep mined coal are identified and alternative R and D and institutional strategies that may make such technologies viable are developed. Major areas of uncertainty facing the future of the underground coal mining industry are stipulated. The sensitivity of increased production to these uncertainties are determined, and strategies and timetables for the resolution of the uncertainties are formulated. Major alternatives for filling institutional gaps, if any, between the various industries involved in the extraction and utilization of underground mined coal are defined. GRA

N77-11054*# AiResearch Mfg. Co., Phoenix, Ariz.
STUDY OF SMALL TURBOFAN ENGINES APPLICABLE TO SINGLE-ENGINE LIGHT AIRPLANES Final Report
G. L. Merrill Sep. 1976 118 p refs
(Contract NAS2-8582)
(NASA-CR-137944; AiResearch-76-211893) Avail: NTIS HC A06/MF A01 CSCL 21E

The design, efficiency and cost factors are investigated for application of turbofan propulsion engines to single engine, general aviation light airplanes. A companion study of a hypothetical engine family of a thrust range suitable to such aircraft and having a high degree of commonality of design features and parts is presented. Future turbofan powered light airplanes can have a lower fuel consumption, lower weight, reduced airframe maintenance requirements and improved engine overhaul periods as compared to current piston engined powered airplanes. Achievement of compliance with noise and chemical emission regulations is expected without impairing performance, operating cost or safety. Author

N77-11055*# National Aeronautics and Space Administration, Washington, D.C.

AIRCRAFT FUEL CONSERVATION TECHNOLOGY. TASK FORCE REPORT, SEPTEMBER 10,1975
10 Sep. 1975 141 p
(NASA-TM-X-74295) Avail: NTIS HC A07/MF A01 CSCL 21E

An advanced technology program is described for reduced fuel consumption in air transport. Cost benefits and estimates are given for improved engine design and components, turboprop propulsion systems, active control systems, laminar flow control, and composite primary structures. A.H.

N77-11084*# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
SPACE STATION SYSTEMS ANALYSIS STUDY. PART 1, VOLUME 1: EXECUTIVE STUDY
1 Sep. 1976 41 p
(Contract NAS9-14958)
(NASA-CR-151102; MDC-G6508-Pt-1-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 22B

Potential space station system options were examined for a permanent, manned, orbital space facility and to provide data to NASA program planners and decision makers for their use in future program planning. There were ten space station system objectives identified. These were categorized into five major objectives and five supporting objectives. The major objectives were to support the development of: (1) satellite power systems, (2) nuclear energy plants in space, (3) space processing, (4) earth services, and (5) space cosmological research and development. The five supporting objectives, to define space facilities which would be basic building blocks for future systems, were: (1) a multidiscipline science laboratory, (2) an orbital depot to maintain, fuel, and service orbital transfer vehicles, (3) cluster support systems to provide power and data processing for multiple orbital elements, (4) a sensor development facility, and (5) the facilities necessary to enhance man's living and working in space. S.M.

N77-11085*# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
SPACE STATION SYSTEMS ANALYSIS STUDY. PART 1, VOLUME 2: TECHNICAL REPORT Final Report
1 Sep. 1976 252 p refs
(Contract NAS9-14958)
(NASA-CR-151103; MDC-G6508-Pt-1-Vol-2) Avail: NTIS HC A12/MF A01 CSCL 22B
For abstract, see N77-11084.

N77-11108# Fairchild Space and Electronics Co., Germantown, Md.
NUCLEAR-POWERED HYSAT SPACECRAFT: COMPARATIVE DESIGN STUDY
B. Raab Aug. 1975 63 p
(Contract AT(49-15)-3063)
(ERDA-SNS-3063-8; FSEC-NSG-217-75/60) Avail: NTIS HC A04/MF A01

The study shows that the all nuclear spacecraft can have a substantial weight advantage over a hybrid (nuclear/solar) or all solar spacecraft, owing to a further reduction in power requirement, and to the elimination of such equipment as the sensor gimbal and rotating joint assemblies. Because the need for a sun-oriented section is eliminated, the all nuclear spacecraft can be designed as a monolithic structure, with the sensor and other payload firmly secured in a fixed position on the structure. This enhances attitude stability while minimizing structural weight and eliminating the need for flexible fluid lines. Sensor motion can be produced, varied, and controlled within the limits specified by the study contractors by moving the entire spacecraft in the prescribed pattern. A simple attitude control system using available hardware suffices to meet all requirements. ERA

N77-11158# Oxford Univ. (England). Engineering Lab.
METALHYDRIDES
A. J. W. Horrox 1976 11 p refs
(OUEL-1146/76) Avail: NTIS HC A02/MF A01

The first phase of research work carried out at Battelle, Geneva, on metal hydrides is presented. The project is sponsored by 20 companies in Europe and Japan. As a result of the studies Battelle believes to have found the alloy in which the necessary conditions, reversibility of hydride formation under favorable conditions, hydrogen storage capacity, maximum number of recycling operations possible, and cost, are optimized. Systems studied include magnesium, iron/titanium, lithium aluminum hydride, and lanthanum/nickel. ESA

N77-11175*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EVALUATION OF POTASSIUM TITANATE AS A COMPONENT OF ALKALINE FUEL CELL MATRICES
Robert E. Post Washington Nov. 1976 27 p refs
(NASA-TN-D-8341; E-8174) Avail: NTIS HC A03/MF A01 CSCL 10A

Various forms of potassium titanate were found to have almost complete resistance to chemical attack in 45 wt % KOH at 150 C (423 K) for up to 9600 hours. Electron microscopy and X-ray diffraction disclosed important differences with respect to fibricity and stability. The octatitanate appeared to possess the best combination of properties. It was concluded that potassium titanate could be produced in a more asbestos-like form. Fiber dispersion is important in matrix manufacture.Author

N77-11198*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
REDUCTION OF GASEOUS POLLUTANT EMISSIONS FROM GAS TURBINE COMBUSTORS USING HYDROGEN-ENRICHED JET FUEL Progress Report
Richard M. Clayton 15 Oct. 1976 58 p refs
(Contract NAS7-100)
(NASA-CR-149146; JPL-TM-33-790) Avail: NTIS HC A04/MF A01 CSCL 21D

Recent progress in an evaluation of the applicability of the hydrogen enrichment concept to achieve ultralow gaseous pollutant emission from gas turbine combustion systems is described. The target emission indexes for the program are 1.0 for oxides of nitrogen and carbon monoxide, and 0.5 for unburned hydrocarbons. The basic concept utilizes premixed molecular hydrogen, conventional jet fuel, and air to depress the lean flammability limit of the mixed fuel. This is shown to permit very lean combustion with its low NOx production while simulataneously providing an increased flame stability margin with which to maintain low CO and HC emission. Experimental emission characteristics and selected analytical results are presented for a cylindrical research combustor designed for operation with inlet-air state conditions typical for a 30:1 compression ratio, high bypass ratio, turbofan commercial engine. Author

N77-11200# Institute for Energy Analysis, Oak Ridge, Tenn.
METHANOL FROM COAL FUEL AND OTHER APPLICATIONS
Carl O. Thomas (Tenn. Univ.), Jeffrey W. Hodgson (Tenn. Univ.), Sydney L. Carroll (Tenn. Univ.), Thurman C. Hardin (Clemson Univ.), and Rafael Munoz-Candelario (Puerto Rico Univ.) Feb. 1976 61 p refs Sponsored by ERDA
(ORAU-126; LEA-75-2) Avail: NTIS HC A04/MF A01

The automobile accounts for about one-third of the petroleum consumption in the U.S. Other transportation sectors, utilities, manufacturing, industrial chemicals, residences, etc., also are heavy consumers. Project Independence goals require a significant reduction in petroleum imports which probably cannot be fully offset by increased domestic production. Three parallel actions therefore are necessary: conservation; improved fuel economy; and development of substitute liquid or gaseous fuels derived from coal, shale, or other carbonaceous raw materials. The technologies for conversion of coal to low-BTU gas and the subsequent synthesis of methanol already exist. The methanol fuel issues then are the technical suitability of methanol for large-scale fuel applications, energy yields versus other synthetic fuel strategies, economics, environmental effects, and competitive supply/demand considerations in terms of both raw materials and end uses. ERA

N77-11201# Brookhaven National Lab., Upton, N.Y.
HYDROGEN FOR ENERGY STORAGE: A PROGRESS

REPORT OF TECHNICAL DEVELOPMENTS AND POSSIBLE APPLICATIONS

F. J. Salzano, C. Braun, A. Beaufrere, S. Srinivasan, G. Strickland, and J. J. Reilly Jan. 1976 37 p refs Presented at Eng. Found. Conf., Pacific Grove, Calif., 8 Feb. 1976 Sponsored by ERDA

(BNL-20931) Avail: NTIS HC A03/MF A01

The technologies of electrochemical hydrogen production and storage for application as an energy supply and storage media are developed. Work specifically aimed at the possible utilization of hydrogen in an electric utility is described. A system involving hydrogen production, storage and reconversion where the hydrogen is utilized strictly for eletric-to-electric storage applications is considered. The process and physical configuration, performance and costs of such a system are presented and discussed, as well as the prognosis for eventual application in a utility system. A more promising application involving the use of hydrogen in a dual mode system in which hydrogen is produced for direct injection into existing natural gas lines or utilized as a fuel cell fuel is also discussed. The key requirement necessary to make hydrogen production attractive for utility application is the flexible and maximum utilization of the capital facilities required for production, storage, and where applicable electric conversion. Author (ERA)

N77-11207# Applied Systems Corp., Vienna, Va.

THE PRODUCTION AND REFINING OF CRUDE OIL INTO MILITARY FUELS Final Report

Herbert Bartick, Kumar Kunchal, Duane Switzer, Robert Bowen, and Rita Edwards Aug. 1975 215 p refs

(Contract N00014-75-C-0055)

(AD-A024652) Avail: NTIS HC A10/MF A01 CSCL 21/4

The technical objectives of the program were to demonstrate that a wide spectrum of military operational fuels derived from shale oil crude could be obtained in a commercial industrial facility with minimum or minor modification, and to incentivize industry in oil shale development and technology. Shale oil crude was processed into gasoline, heavy fuel oil, and JP-4 in small laboratory quantities in the United States by the Bureau of Mines (ERDA) and private industry, however, no large scale commercial refining of the shale oil crude into a wide variety of products had been attempted up until this program. The various fuels produced met a majority of the military, federal, and commercial specifications requirements. However, these fuels tended to exhibit storage and thermal instabilities. In addition, the fuels contained a high wax content, high particulate matter, and high gum content. It is concluded that it is feasible to obtain military and civilian operational fuels from shale oil crude using a commercial refinery. However, additional effort has to be extended to overcome some refinery and operational problems to obtain maximum yields and improved properties. GRA

N77-11208# Deputy Chief of Staff for Research Development and Acquisition (Army), Washington, D.C.

REPORT OF THE ARMY SCIENTIFIC ADVISORY PANEL AD HOC GROUP ON FIRE-SAFE FUELS Final Report

Mar. 1976 17 p refs

(AD-A023763) Avail: NTIS HC A02/MF A01 CSCL 21/4

The vulnerability of combat vehicles to catastrophic fuel fires is of continuing major concern to the U.S. Army. An Army Scientific Advisory Panel Ad Hoc Group was organized to review the present Army Fire-Safe Fuel program and provide guidance for future research and development efforts in this area. The group advises long-term basic research, environmental impact and chronic toxicity programs be undertaken. Additionally, physical fuels management efforts, corrosion/material influence, and involvement of DARPA should be pursued. Extensive bibliography is included. Author (GRA)

N77-11268*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TEST PROGRAM FOR TRANSMITTER EXPERIMENT PACKAGE AND HEAT PIPE SYSTEM FOR THE COMMUNICATIONS TECHNOLOGY SATELLITE

James F. DePauw, Karl E. Reader, and John V. Staskus Washington Nov. 1976 38 p refs

(NASA-TM-X-3455; E-8832) Avail: NTIS HC A03/MF A01 CSCL 17B

The test program is described for the 200 watt transmitter experiment package and the variable conductance heat pipe system which are components of the high-power transponder aboard the Communications Technology Satellite. The program includes qualification tests to demonstrate design adequacy, acceptance tests to expose latent defects in flight hardware, and development tests to integrate the components into the transponder system and to demonstrate compatibility. Author

N77-11340*# New Mexico Univ., Albuquerque. Dept. of Mechanical Engineering.

INVESTIGATION OF PERFORMANCE LIMITS IN AXIAL GROOVE HEAT PIPES Final Report

K. Thomas Feldman Jul. 1976 42 p refs

(Grant NsG-2064)

(NASA-CR-137912; UNM-TR-ME-70(76)NASA-365-1) Avail: NTIS HC A03/MF A01 CSCL 20D

The entrainment-shear performance limit which occurs in axial groove heat pipes was investigated and explained. In the existing heat pipe literature the entrainment heat flux limit is defined as the condition where the Weber number is greater than or equal to one. In this analysis, the critical value for the entrainment Weber number is found to be 2 pi less than or equal to 3 pi. Perhaps more important to the heat pipe designer than the entrainment performance limit is the prediction of the

N77-11380# General Electric Co., Wilmington, Mass.

DEVELOPMENT OF FUEL CELL CO DETECTION INSTRUMENTS FOR USE IN A MINE ATMOSPHERE

R. M. Dempsey, A. B. LaConti, M. E. Nolan, R. A. Torkildsen, and G. Schnakenberg 19 Dec. 1975 95 p refs

(Contract DI-BM-HO-357078)

(PB-254823/8; BM-OFR-77-76) Avail: NTIS HC A05/MF A01 CSCL 14B

A fuel cell sensor instrument for monitoring of carbon monoxide in a mine atmosphere was developed. Parametric testing was conducted on two-electrode and three-electrode sensor cells to define performance and life characteristics as a function of temperature, feed flow, and applied sensor voltage. Extended life testing was conducted on best sensor cells under continuous and intermittent operation with feed gases to define possible life limitations for the mine application. Reliable, efficient gas sampling and electronic control circuitry were fabricated for use with the fuel cell sensor and integrated into a device to meet performance and design specifications for a portable, battery-powered handheld direct indicating gas detector for use underground. GRA

N77-11399*# Kanner (Leo) Associates, Redwood City, Calif.

BOSCH TECHNICAL INSTRUCTION. GASOLINE INJECTION D AND L-JETRONIC

U. Adler Washington NASA Jul. 1976 54 p refs Transl. into ENGLISH from the German report

(Contract NASw-2970)

(NASA-TT-F-17111) Avail: NTIS HC A04/MF A01 CSCL 21A

Two variations of a gasoline injection system are described. In one case, fuel injection is regulated by the pressure in the intake manifold. In the other, the fuel injection rate is determined by the volume of air passing through the intake manifold.Author

N77-11417# Army Materials and Mechanics Research Center, Watertown, Mass.

CERAMIC MATERIALS AND COMPONENTS FOR SMALL AUTOMOTIVE GAS TURBINE ENGINE

30 Apr. 1975 46 p

(AD-A025472) Avail: NTIS HC A03/MF A01 CSCL 21/5

The vehicular ceramic gas turbine offers the potential of at least a 30% improvement in fuel economy compared to today's piston engine and could be made available on a production basis by the mid-1980's. The beneficial impact in future energy demands, multiple fuel potential and lessened dependence on foreign materials is sufficient motivation to initiate the recommended programs. Author (GRA)

N77-11475# Transportation Research Board, Washington, D.C.
OPTIMIZING THE USE OF MATERIALS AND ENERGY IN TRANSPORTATION CONSTRUCTION
1976 81 p refs Proceedings held at Washington, D. C., 12-14 Nov. 1975 Sponsored by FEA, FHWA, and ERDA
(PB-253713/2; TRB/SR-166; ISBN-0-309-02477-3) Avail: NTIS HC A05/MF A01 CSCL 13C

These proceedings include the papers by the 4 keynote speakers who emphasized the following: the energy crisis is real and serious; how energy implications can affect roadway decision making; the construction materials situation and where materials may be in short supply; and one contractor's view of how energy and materials can be optimized. These papers are followed by the reports of the 7 topics chairmen, a general discussion, and suggestions from state transportation agencies on ways to minimize the impact of energy and material shortages. GRA

N77-11491*# Servicio Geologico de Bolivia, La Paz.
THE 29950 EARTH RESOURCE TECHNOLOGY SATELLITE (ERTS-A) SENSOR DATA FOR MINERAL RESOURCE SECTOR DEVELOPMENT AND REGIONAL LAND USE SURVEY, MARCH - AUGUST 1976
Carlos E. Brockmann, Principal Investigator Aug. 1976 31 p Sponsored by NASA Original contains color imagery. Original photography may be purchased from the EROS Data Center, 10th and Dakota Avenue, Sioux Falls, S. D. 57198 ERTS
(E77-10028; NASA-CR-149131) Avail: NTIS HC A03/MF A01 CSCL 08F

N77-11509# Federal Energy Administration, Washington, D.C. Office of Regulation Development.
MANDATORY CANADIAN CRUDE OIL ALLOCATION REGULATIONS Final Environmental Impact Statement
May 1976 375 p refs
(PB-255319/6; FEA/H-76/220; FES-76/1) Avail: NTIS HC A16/MF A01 CSCL 10A

On January 30, 1976 the Federal Energy Administration (FEA) promulgated regulations to allocate diminishing amounts of Canadian crude oil deliveries during the period of 1976 through 1981, the last year in which some amount of Canadian crude would be made available. The regulations reflect FEA's action to minimize the impact of the Canadian action. GRA

N77-11511# Massachusetts Inst. of Tech., Cambridge. Energy Lab.
BASIC STUDIES OF COAL PYROLYSIS AND HYDROGASIFICATION Quarterly Progress Report, 21 Feb. - 20 May 1976
T. W. Bush, J. B. Howard, W. A. Peters, and E. M. Suuberg 1976 25 p refs
(Grant NSF AER-75-13673)
(PB-254878/2; NSF/RA-760156; QPR-4) Avail: NTIS HC A02/MF A01 CSCL 07A

The low pressure batch sample reactor apparatus underwent the final modifications necessary to accomplish total product analyses. Concurrently with the development of the low pressure system, the successful modifications were incorporated into a design of the high pressure hydrogenation reactor. The analysis scheme for either reactor involves capturing products in four classes: (1) char; (2) gas; (3) condensible liquid; and (4) tar. The designs for many components of the laminar flow reactor were finalized. These components include the gas preheater, the coal particle feeder, the gas pressure and flow rate control system, and the process temperature control system. GRA

N77-11513# Little (Arthur D.), Inc., Cambridge, Mass.
STUDY OF THE FEASIBILITY OF FEDERAL PROCUREMENT OF FUELS PRODUCED FROM SOLID WASTES Final Report
Jul. 1975 256 p refs
(Contract EPA-68-01-2951)
(PB-255695/9; EPA-SW-123c) Avail: NTIS HC A12/MF A01 CSCL 13B

The feasibility for boilers to use solid waste as a supplementary fuel is studied. Data necessary to write guideline to aid operators of boilers in modifying their systems to use solid waste as a supplementary fuel are provided. The study examines industrial sized boilers, the modifications necessary, the solid waste preparation required, and system economics. GRA

N77-11515# Lewin and Associates, Inc., Washington, D.C.
ECONOMIC LIMITS OF OCS PRODUCTION WELLS
Apr. 1976 13 p
(Contract FEA-CO-03-50222-00)
(PB-255320/4; FEA/B-76/317) Avail: NTIS HC A02/MF A01 CSCL 08I

The costs are examined of OCS (outer continental shelf) oil production. Operating and maintenance costs and the economic life of offshore platforms are discussed. GRA

N77-11516# Resource Planning Associates, Inc., Cambridge, Mass.
IDENTIFICATION AND ANALYSIS OF MID-ATLANTIC ONSHORE OCS IMPACT
Feb. 1976 284 p refs Prepared for the Middle Atlantic Governors' Coastal Resources Council
(Contract FEA-CA-05-50078-00)
(PB-254925/1; RA-75-46C) Avail: NTIS HC A13/MF A01 CSCL 08I

Literature on onshore socioeconomic and environmental impacts related to Outer Continental Shelf oil and gas recovery is reviewed. Management decisions and policy choices for the next decade, and additional study needs are discussed. GRA

N77-11518# Bureau of Mines, Pittsburgh, Pa. Mining and Safety Research Center.
APPLYING COMPUTER-DRAWN MAPS OF GEOLOGIC DATA TO ANALYSIS OF MINING PROBLEMS
Charles M. McCulloch Jun. 1976 32 p refs
(PB-255497/0; BM-RI-8151) Avail: NTIS HC A03/MF A01 CSCL 08I

The principles of using computers to draw maps and plot geologic data of mining areas are discussed. The types of maps that can be drawn by a computer are discussed using as examples two separate areas where poor roof and gas emissions caused mining problems. Such maps can be used not only to help identify problem areas, but also to predict areas where problems could occur, thus giving mine operators time to work out solutions prior to mining. The average cost of a computer-drawn map for a mine property is less than $100, including computer time and man-hours for data preparation. GRA

N77-11525 Pittsburgh Univ., Pa.
MULTI-YEAR TIME FRAME OPTIMIZATION OF POWER SYSTEMS WITH FOSSIL, NUCLEAR, HYDRO, PUMPED STORAGE AND PEAKING UNITS Ph.D. Thesis
Federico Angel Viramontes 1976 175 p
Avail: Univ. Microfilms Order No. 76-21798

An existing multi-year nuclear management program for fossil and units is expanded in order to include hydroelectric and pumped storage generating facilities. The partial forced outrages of the generating units are included. The hydroelectric plan considered has one reservoir that is fed by a river with stochastic described flow. Because of the nature of the problem, the optimization technique selected is dynamic programming. The volume of the water stored in the reservoir is the state variable and the amount of water released through the hydroelectric generator is the decision variable. The model takes into consideration the partial forced outages of the hydroelectric unit. The model is implemented with a computer code and an example is presented. For the pumped storage plant a dynamic programming model is presented that selects the optimal weekly pumping and generating hours. Dissert. Abstr.

N77-11526 Arizona Univ., Tucson.
A BASIS FOR ANALYZING PROSPECTIVE POWER GENERATION IN TERMS OF ENVIRONMENTAL MANAGEMENT AND ENERGY USE Ph.D. Thesis

John Bradley Chickering 1976 262 p
Avail: Univ. Microfilms Order No. 76-22481

The technical and forensic interrelationships of regional power capacity and requirements, energy resource use and availability, and environmental correlatives are investigated with respect to large stationary electric power generation facilities. United States policies regarding energy and environmental impact need improved coordination in order to conserve both. A standard is proposed for use as an adjunct with existing legal and technical procedures, and addressing the interrelationships of energy resource use and environmental impact to be anticipated from the addition of power plants within a control region, irrespective of power generation mode and fuel used. Consideration of interregional exchanges is included. Model parametry is developed, with reference to the distinction between Federal agency expertise in administering such matters, and the legislative and judicial functions as conditions precedent and subsequent. Dissert. Abstr.

N77-11528*# Transemantics, Inc., Washington, D.C.
INDUSTRIAL DEVELOPMENT OF SILICON SOLAR CELLS
Y. Salles NASA Aug. 1976 15 p refs Transl. into ENGLISH from Acta Electronica (France), v. 18, Oct. 1975 p 339-343
(Contract NASw-2792)
(NASA-TT-F-17139) Avail: NTIS HC A02/MF A01 CSCL 10A

Silicon solar cells were first developed and manufactured for space applications. Following a cost reduction due to technological progress, the use of the solar cells has greatly increased. The evolution of different technological steps in manufacturing solar cells and panels for terrestrial applications is described. The conversion efficiency of the cells in the BPX 47 A Panel is now 12.5 % (it was 9 % during the last few years). A cost analysis is carried out. Author

N77-11529*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OPTIMIZED SELECTIVE COATINGS FOR SOLAR COLLECTORS
G. McDonald and Henry B. Curtis Jun. 1967 12 p refs Presented at the Am. Electroplaters Soc., Denver, 29 Jun. 1976
(NASA-TM-X-73498; E-8896) Avail: NTIS HC A02/MF A01 CSCL 10A

The spectral reflectance properties of black nickel electroplated over stainless steel and of black copper produced by oxidation of copper sheet were measured for various plating times of black nickel and for various lengths of time of oxidation of the copper sheet, and compared to black chrome over nickel and to converted zinc. It was determined that there was an optimum time for both plating of black nickel and for the oxidation of copper black. At this time the solar selective properties show high absorptance in the solar spectrum and low emittance in the infrared. The conditions are compared for production of optimum optical properties for black nickel, black copper, black chrome, and two black zinc conversions which at the same conditions had absorptances of 0.84, 0.90, 0.95, 0.84, and 0.92, respectively, and emittances of 0.18, 0.08, 0.09, 0.10, and 0.08, respectively. Author

N77-11530*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EVALUATION OF FLAT-PLATE COLLECTOR EFFICIENCY UNDER CONTROLLED CONDITIONS IN A SOLAR SIMULATOR
Susan M. Johnson and Frederick Simon 1976 19 p refs Presented at the Intern. Solar Energy Soc. Conf., Winnipeg, Canada, 15-20 Aug. 1976
(NASA-TM-X-73520; E-8932) Avail: NTIS HC A02/MF A01 CSCL 10A

The measured thermal efficiencies of 35 collectors tested with a solar simulator, along with the correlation equations used to generalize the data, are presented. The single correlation used is shown to apply to all the different types of collectors tested, including one with black paint and one cover, one with a selective surface coating and two covers, and an evacuated-tube collector. The test and correlation technique is also modified by using a shield so that collectors larger than the simulator test area can also be tested. This technique was verified experimentally for a shielded collector for which the collector shielded area was 31% of the solar simulator radiation area. A table lists all the collectors tested, the collector areas, and the experimental constants used to correlate the data for each collector. Author

N77-11532*# General Electric Co., Wilmington, Mass.
SOLID POLYMER ELECTROLYTE (SPE) FUEL CELL TECHNOLOGY, PROGRAM REVIEW, PHASE 2
29 Apr. 1976 40 p
(Contract NAS9-14345)
(NASA-CR-150957) Avail: NTIS HC A03/MF A01 CSCL 10A

The purpose of the solid polymer electrolyte (SPE) fuel cell program is to advance the SPE fuel cell technology in four target areas. These areas are: (1) reduced fuel cell costs; (2) reduced fuel cell weight; (3) improved fuel cell efficiency; and (4) increased systems compatibility. Author

N77-11533# Atomic Energy of Canada Ltd., Ottawa (Ontario).
RESEARCH AND DEVELOPMENT FOR CANADIAN NUCLEAR POWER
J. A. L. Robertson Jan. 1976 22 p refs
(AECL-5314) Avail: ERDA Depository Libraries HC $3.50; AECL $3.00

Rapid expansion of the successful CANDU (Canada deuterium uranium) reactor system offers immediate substitution for scarce oil and gas, combined with long-term security of energy supplies. A continuing large and vigorous R and D program on nuclear power is essential to achieve these objectives. The program, described here, consists of tactical R and D in support of the current CANDU reactor system, strategic R and D to develop and demonstrate advanced CANDU systems, and exploratory R and D to put Canada in a position to exploit any fusion opportunities. Two support activities, management of radioactive wastes and techniques to safeguard nuclear materials against diversion, although integral components of the nuclear power programs, are identified separately because they are currently of special public interest. ERA

N77-11535# Pennsylvania State Univ., University Park. Coal Research Section.
PROBLEMS AND SOLUTIONS IN THE USE OF COAL ANALYSES
P. H. Given and R. F. Yarzab Nov. 1975 46 p refs
(Contract E(49-18)-390)
(FE-0390-1) Avail: NTIS HC A03/MF A01

The various complex energy problems have stimulated a great resurgence of interest in processes for the conversion of coals into clean gaseous and liquid fuels. Chemical analyses are important to the development of these new processes to a much greater extent than in the well established methods of using coal. Standard procedures for performing the various necessary analyses have been available for many years. The problems arise because all coals are composed of an organic component (orginally derived from green plants) and an inorganic component (consisting of minerals such as clays and pyrite). If one wishes to know how much of each of these major components is present, the obvious thing to do is to burn away the organic matter and weigh the remaining ash. But in the process the inorganic components also change. Alternatively, it is desired to determine how much of the element carbon is present in the organic fuel. The standard method unfortunately cannot distinguish between the organic carbon and a form of inorganic carbon present in significant amounts in some coals. Various problems of interpreting and using coal analyses are reviewed. Finally, some consideration is given to the contribution modern instrumental methods may make to coal analysis. Author (ERA)

N77-11537# Sandia Labs., Albuquerque, N.Mex.
SOLAR RADIATION AVAILABILITY TO VARIOUS COLLECTOR GEOMETRIES: A PRELIMINARY STUDY
E. C. Boes Feb. 1976 30 p refs

(Contract AT(29-1)-789)
(SAND-76-0009) Avail: NTIS HC A03/MF A01

Solar energy collectors of various designs and installation orientations are being built or used. Because most existing solar energy data consists of measurements of total radiation incident upon a horizontal surface, and because geometric conversion to radiation incident upon another surface is difficult, the amounts of solar energy available to various locations are not well known. Solar energy availabilities to various collectors for both clear and average days in each of the four seasons at Albuquerque, Blue Hill, and Omaha are reported. Unlike several similar previous studies, the amounts of solar energy given here are based directly on representative data samples consisting of simultaneous measurements of direct-normal and total-horizontal radiation of these three sites. ERA

N77-11538# Sheldahl Co., Northfield, Minn. Advanced Products Div.
SOLAR POWER ARRAY FOR THE CONCENTRATION OF ENERGY. TASK 2: MODIFICATIONS TO A SPECULAR PHOTOMETER
D. A. Robinson Feb. 1976 6 p
(Contract E(11-1)-2699)
(COO-2699-3) Avail: NTIS HC A02/MF A01

The design, fabrication, and calibration are described which were completed for the modified specular photometer. The basic instrument is designed to examine the reflection or transmission of solar materials by measuring the amount of radiation which is reflected or transmitted by the material into a given acceptance aperture. ERA

N77-11539# Brookhaven National Lab., Upton, N.Y.
ATTIC CONCENTRATOR TYPE SOLAR ENERGY COLLECTOR
J. G. Cottingham 4 Feb. 1976 12 p
(Contract E(30-1)-16)
(BNL-50493) Avail: NTIS HC A02/MF A01

Inexpensive tested features of several solar energy collectors have been combined to produce an efficient low cost system. Reflector surfaces supported on metal reinforced corrugated paper redirect and concentrate solar radiation upon an inexpensive shallow pond type receiver formed by a simple wooden frame and a plastic liner. The attic with a greenhouse type south facing side forms a wind screen for the concentrator assembly permitting the use of these light weight structures. Component cost and performance estimates are given. ERA

N77-11540# Energy Research and Development Administration, Washington, D.C. Div. of Solar Energy.
NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING (RESIDENTIAL AND COMMERCIAL APPLICATIONS)
Oct. 1975 85 p refs
(ERDA-23A) Avail: NTIS HC A05/MF A01

This report is concerned primarily with the Federal portion of the National Program for Solar Heating and Cooling. It incorporates and modifies, where appropriate, previous Federal Government plans on solar heating and cooling. Topics considered in detail include: goals and objectives; major constraints to achieving rapid and widespread utilization; strategy; residential demonstrations; commercial demonstrations; research and development; collection and dissemination of information; additional policy measures required to achieve rapid and widespread utilization; and management. Appendices consist of solar heating and cooling (functional description), rationale for goals and objectives, summary of finding estimates, instructions for participation, list of comments received on ERDA-23, and participating personnel. ERA

N77-11543# Siam Inst. for Mathematics and Society, Philadelphia, Pa.
MATHEMATICS FOR ENERGY
Donald R. Snow (Brigham Young Univ.) 11 Jul. 1975 17 p refs
(Grant NSF MPS-75-05769)
(PB-252463/5; NSF/ERG-76-4) Avail: NTIS HC A02/MF A01 CSCL 10A

Large scale and economic considerations related to energy rather than specific technologies are emphasized, but additional mathematical problems arising in current and future technologies are suggested. Several of the papers dealt with linear programming models of large scale systems related to energy. These included economic models, policy models, energy sector models for supply and demand and environmental concerns. One of the economic models utilized variational techniques including such things as the Hamiltonian, the Euler-Lagrange differential equation, transversality and natural boundary conditions. GRA

N77-11544# Cornell Univ., Ithaca, N.Y. Dept. of Agricultural Economics.
USER'S GUIDE TO PETROLEUM INDUSTRY SURVEY DATA TYPE
Jan Locken, Kathy Cole, and Duane Chapman 9 Jun. 1976 297 p refs
(Grant NSF AER-76-09748; NSF GI-41470)
(PB-256635/4; NSF/RA-760185; NSF/DF-76-001A) Avail: NTIS HC A13/MF A01 CSCL 10A

Data cover the following areas: general ownership, management, and financial structure of the companies; oil and natural gas well ownership and production, assignments, and exploratory and developmental wells; natural gas sales, purchases, processing, and gathering; petroleum refining in 1964-73; marketing; transportation and storage; foreign operations and their revenue, net worth, and ownership; uranium and coal; and, financial questions including security issues, auditing and law firms retained by the companies, and investment, revenues, cost and profits. GRA

N77-11545# West Virginia Univ., Morgantown. Dept. of Industrial Engineering.
THE USE OF AN INTERACTIVE ENERGY MODEL FOR TECHNOLOGY ASSESSMENT WITH SPECIAL REFERENCE TO UNDERGROUND COAL GASIFICATION
Jack Byrd, Jr. 1976 45 p refs
(Grant NSF GI-32724)
(PB-255543/1; NSF/RA-760130) Avail: NTIS HC A03/MF A01 CSCL 10A

Decision criteria are incorporated into a technology assessment model for new energy technologies using an interactive simulation model. Six steps for technology assessments are enumerated: (1) Define the assessment task; (2) describe relevant technologies; (3) describe the existing state; (4) formulate alternative objectives; (5) identify action options; and (6) conduct impact analyses. Merit and utilization of this procedure are demonstrated in conjunction with underground coal gasification research. GRA

N77-11546# Federal Energy Administration, Washington, D.C. Office of Energy Resource Development.
STRATEGIC PETROLEUM RESERVE Draft Environmental Impact Statement
Jun. 1976 323 p
(PB-255476/4; FEA/G-76/331) Avail: NTIS HC A14/MF A01 CSCL 10A

The strategic petroleum reserve program was mandated by the energy policy and conservation act of 1975. FEA has identified three alternative storage systems for satisfying the objectives of the program. These alternatives, which consist of solution mined cavities in salt, conventional mines and above ground tankage, are discussed. Prototype worst case facilities were developed to characterize these systems and to provide a basis for determining potential program impacts and resource requirements. Author

N77-11547# Stanford Univ., Calif. Dept. of Materials Science and Engineering.
APPLIED RESEARCH ON II-VI COMPOUND Quarterly Progress Report, 1 Jan. - 31 Mar. 1976
Richard H. Bube, Alan Fahrenbruch, E. H. Z. Taheri, Julio Aranovich, and Fredrik Buch Apr. 1976 45 p refs
(Grant NSF AER-75-1679)

(PB-254637/2; NSF/RA-760102) Avail: NTIS HC A03/MF A01 CSCL 10B

From electron beam induced current measurements a minority carrier diffusion length of 0.4 micrometers was obtained in the CdTe of the p-Cd/n-CdS film-on crystal solar cell. Primary results on a p-CdTe/n-1TO (indium-tin oxide) cell show excellent diode characteristics, a high V sub open current oc but low filter factor ff.A preliminary cell using a solution sprayed layer of CdS on crystal p-CdTe gives a solar efficiency of 5.6%. Measurements of non-ohmic Au and Ni contacts to p-CdTe indicate that the junctions are Schottky barriers 0.3 to 0.5 eV high. (GRA)

N77-11548# Ohio State Univ. Research Foundation, Columbus.
SEMICONDUCTOR-ELECTROLYTE PHOTOVOLTAIC ENERGY CONVERTER Quarterly Report, 1 Feb. - 30 Apr. 1975
W. W. Anderson and Larry B. Anderson 25 Jun. 1975 38 p refs
(Grant NSF AER-74-13292)
(PB-252837/0; OSURF-4122-1; NSF/RA/N-75-285) Avail: NTIS HC A03/MF A01 CSCL 10B

The physical processes involved in the conversion of radiant energy to electrical and/or chemical energy in a semiconductor-electrolyte cell are described. These processes are then related to the problem of solar energy conversion and the desirable characteristics of such a cell are defined and potential efficiency of the device is shown to be comparable to that of a pn junction solar cell. Photo current and differential capacitance were measured as a function of terminal potential with CdS- and GaAs-electrolyte photovoltaic cells to determine open circuit voltage, and power conversion efficiency. For both cells, the quantum efficiency was larger than unity at short wavelengths indicating that current doubling is occurring at the interface.
GRA

N77-11549# Stanford Research Inst., Arlington, Va.
MEETING REPORT: ADVANCED FOSSIL FUELS SECTOR GROUP
Jun. 1976 75 p refs Held at Cincinnati, 31 Mar. 1976
(Contract EPA-68-01-1981)
(PB-255117/4; EPA-600/7-76-001) Avail: NTIS HC A04/MF A01 CSCL 21D

The general areas of concern were: (1) a review of the second sector group meeting with indications of action taken; and (2) the development of oil shale processing, in which the following areas were addressed: health effects and environmental assessment programs at EPA, ERDA, and DOD; environmental measurements and technology programs at EPA, ERDA, and DOD; and industrial point of view. GRA

N77-11551# Syracuse Univ., N.Y. Coll. of Engineering.
COMMERCIAL BUILDING UNITARY HEAT PUMP SYSTEM WITH SOLAR HEATING Final Report, 31 Dec. 1974 - 31 Oct. 1975
Eugene E. Drucker, J. E. LaGraff, W. H. Card, Manus Ucar, and William S. Fleming 31 Oct. 1975 207 p refs
(Grants NSF GI-43895; ERDA-75-S-134)
(PB-255488/9; NSF/RANN/SE/GI-43895/PR-74-4; NSF/RA/N-75-310) Avail: NTIS HC A10/MF A01 CSCL 13A

An algorithmic computational program has been written for determining the overall performance of a heating and cooling system for a typical school and an office building. The system employs a series of water-to-air heat pumps connected in a closed loop, with a flat plate, water cooled solar collector for heating and a large water storage tank. The computer program includes an economic analysis of the solar assisted system on a 30 year life cycle basis, with interest rate, energy cost and escalation, and solar system cost as basic economic variables.
GRA

N77-11552# Ernst and Ernst, Washington, D.C.
ENERGY-ECONOMY RELATIONSHIPS Final Report
Jun. 1976 313 p refs
(Contract DI-14-03-6101N)
(PB-255171/1) Avail: NTIS HC A14/MF A01 CSCL 05C

In order to address the relationships between energy (and electricity) use and economic development, both aggregated national data and detailed industry data were examined. The objectives were to provide a theoretical and quantitative description of the relationships between energy electricity, employment, and output for specified industry groups, focusing on electricity use in the aluminum industry because of its importance as a Pacific Northwest electricity consumer. GRA

N77-11553# Federal Energy Administration, Washington, D.C. Office of Data and Analysis.
ENERGY INFORMATION ACTIVITIES AT THE FEA
Gil Rodgers May 1976 49 p refs
(PB-253962/5; FEA/B-76/218) Avail: NTIS HC A03/MF A01 CSCL 05B

Information is given to support three primary missions of the FEA. First, extensive, accurate data are needed to implement FEA programs, particularly regulatory operations. Second, reliable energy information is needed to develop and evaluate Federal energy policy. Third, FEA has a legislative mandate to publish statistical reports and analyses, data summaries, fact sheets, and other information to ensure that decision makers and the general public are kept fully informed. This publication explains those information activities. GRA

N77-11556# Washington State Univ., Pullman. Dept. of Sociology and Social Research Center.
SOCIETAL IMPLICATIONS OF ENERGY SCARCITY. SOCIAL AND TECHNOLOGICAL PRIORITIES IN STEADY STATE AND CONSTRICTING SYSTEMS Final Report
Lewis F. Carter, Louis N. Gray, and Theodore Greenstein 8 Jun. 1975 192 p refs Held at Portland, Ore., 7-8 Jun. 1975 Sponsored by NSF
(PB-253097/0; NSF/ERGSS-76-6) Avail: NTIS HC A09/MF A01 CSCL 10A

A partial listing of contents includes: projections of energy demand, supply, and pricing; technological alternatives - the case of nuclear reactors; socialization and acquisitiveness; office decentralization through telecommunications; growth politics and community environmental change; scarcity and crime; multinational corporations and national economies; the social scientist's role in energy policy; and monitoring and assessing social impacts. GRA

N77-11557# Tetra Tech, Inc., Arlington, Va.
ENERGY USE IN THE CONTRACT CONSTRUCTION INDUSTRY Final Report
18 Feb. 1975 185 p refs
(Contract DI-14-01-0001-1664)
(PB-245422/1; TETRAT-A-412-75-011-F; FEA/E1-1661) Avail: NTIS HC A09/MF A01 CSCL 10B

An analysis of energy use in the contract construction industry compiled to determine the amount of energy used and the potential impact that national energy shortages would have on the industry is reported. Analysis includes building construction, heavy construction, and special trades. The industry structure, energy use, intraindustry variations, energy supply, and substitutability and conservation of fuels are stipulated. Contractors in the following industries are analyzed: single family housing; residential building; industrial building; nonresidential construction; highway and street; bridge, tunnel, and elevated highway; waterworks, sewer, pipeline, communication line, and power line; heavy construction, swimming pool and fence; and special trades. GRA

N77-11558# Tetra Tech, Inc., Arlington, Va.
ENERGY USE IN THE CONTRACT CONSTRUCTION INDUSTRY. APPENDIX A: STUDY METHODOLOGY
18 Feb. 1975 179 p
(Contract DI-14-01-0001-1664)
(PB-245423/9; TETRAT-A-412-75-011-App-A; FEA/EI-1664-A) Avail: NTIS HC A09/MF A01 CSCL 10B

Data are presented describing the activity of the contract construction industry expressed in terms of the dollar value of construction. A prime requirement of the methodology employed

was the development of a traceable relationship between the dollar value of construction activity and the type of construction, geographical area of construction, and the energy consumed during construction. The basic methodology used to estimate fuel and energy use for representative construction projects involved the following: (1) postulating representative construction projects of at least three sizes for each division of the industry; and (2) identifying energy-consuming equipment required for each project and determining fuel and energy consumption rates for each equipment type. GRA

N77-11559# Parsons (Ralph M.) Co., Washington, D.C.
ENERGY USE IN THE CONTRACT CONSTRUCTION INDUSTRY. APPENDIX B: ASSESSMENT OF CONSTRUCTION EQUIPMENT AVAILABILITY, ENERGY REQUIREMENTS, AND CONSTRUCTION INDUSTRY CAPACITY TO SUPPORT PROJECT INDEPENDENCE
18 Feb. 1975 201 p
(Contract DI-14-01-0001-1664)
(PB-245424/7; TETRAT-A-412-75-011-App-B; FEA/EI-1664-B) Avail: NTIS HC A10/MF A01 CSCL 10B

Various sources are discussed for: (1) energy and energy-producing processes, necessary construction equipment used in these processes, hours required for operating the equipment, and estimated energy consumed by the construction equipment; (2) availability of necessary construction equipment; (3) impact of equipment availability on the nation's capability to expand the output of energy-producing facilities; and (4) capability of the construction industry to support Project Independence. GRA

N77-11561# Stanford Univ., Calif.
PROCEEDINGS OF THE WORKSHOP ON MODELING THE INTERRELATIONSHIPS BETWEEN THE ENERGY SECTOR AND THE GENERAL ECONOMY
J. Daniel Khazzoom Jul. 1976 206 p refs Conf. held at Washington, D. C., 29-30 Jan. 1976 Sponsored by Elec. Power Res. Inst.
(PB-255696/7; EPRI-SR-45) Avail: NTIS HC A10/MF A01 CSCL 10A

Modeling the interrelationships between the energy sector and the rest of the economy is reported in a state of the art discussion. Reflections on the use and abuse of energy models in policy-making and policy as a constraint on model development and use are considered. The significance of transition problems in the use of energy models for policy purposes and the implications of regulation and industry structure for policy-oriented energy models are summarized. GRA

N77-11562# National Highway Inst., Washington, D. C.
CONFERENCE REPORT: ENERGY CONSERVATION IN TRANSPORTATION AND CONSTRUCTION
H. W. Busching, D. O. Covault, R. L. Dean, and R. Lochow 10 May 1976 291 p refs Conf. held in Atlanta, 2-5 Dec. 1975 Sponsored in part by Am. Road Builder's Assoc., Washington, D.C., Clemson Univ., S. C., and Ga. Inst. of Tech., Atlanta
(PB-255857/5; FHWA-NHI-76-N001) Avail: NTIS HC A13/MF A01 CSCL 10A

The following topics are discussed: highway transportation's response to energy conservation; alternate transport modes and energy consumption; alternate freight modes; public transportation and energy conservation; rail transportation - its place in the Nation's energy conservation program; vehicle performance; optimizing the use of materials and energy in construction; options for conserving energy in transportation; transportation system design; and energy conservation related to traffic operations. GRA

N77-11563# Equitable Environmental Health, Inc., Woodbury, N.Y.
SELECTED ASPECTS OF WASTE HEAT MANAGEMENT: A STATE-OF-THE-ART STUDY Final Report
Allen Serper Jun. 1976 510 p refs
(PB-255697/5; EPRI-FP-164) Avail: NTIS HC A22/MF A01 CSCL 13B

The state-of-the-art is considered for: (1) treatment of evaporative cooling systems and offstream cooling system effluents; (2) determination of additional treatment required to utilize wastewater from sewage treatment plants as makeup for cooling systems and boilers; (3) mathematical modeling for power plant cooling systems and discharges; (4) examination of field monitoring programs; (5) present research to reduce the capital cost and penalties associated with dry cooling towers; and (6) identification of areas where future research is needed. GRA

N77-11565# Israel Atomic Energy Commission, Yavneh. Soreq Nuclear Research Center.
THE CONTRIBUTION OF NUCLEAR TECHNOLOGY TOWARD THE SOLUTION OF ENERGY PROBLEMS
S. Yiftah Sep. 1974 18 p ref In HEBREW Presented at Natl. Symp. on Energy, Netanya (Israel), 19 Mar. 1974 Submitted for publication
(INIS-mf-1867) MF available from INIS Section, International Atomic Energy Agency, P. O. Box 590 A-1011, Vienna, Austria

The evolution of nuclear technology in the area of power production is evaluated for the next thirty years. For the years 1974-1985, many installations of PWR, BWR, PHWR and HTGR type reactors are assumed. In the years 1985-1995, there will be installation of commercial fast breeder reactors, and in the years 1995-2005, there will be coexistence of types of terminal reactors, fast breeders and fusion reactors. ERA

N77-11572# California Univ., Livermore. Lawrence Livermore Lab.
DRAFT ENVIRONMENTAL ASSESSMENT OF APPLICATION BY ERDA FOR A SPECIAL LAND USE PERMIT FOR USE OF PUBLIC LANDS IN WYOMING FOR IN SITU COAL GASIFICATION EXPERIMENTS
W. Mead 22 Jan. 1976 42 p
(Contract W-7405-eng-48)
(UCID-17011) Avail: NTIS HC A03/MF A01

The proposed experiment represents a major element in an LLL program to explore and develop a unique method of in situ coal gasification. The new method promises to provide economic access to the enormous western coal resource, while avoiding some of the principal environmental drawbacks of conventional coal-recovery methods. The LLL approach involves the creation of a zone of permeable coal--an underground packed-bed reactor--through the use of chemical high explosives emplaced in an array of drilled holes. Oxygen and steam are supplied to the in situ reactor through an injection well, and the combustible mixture of product gases is withdrawn through suitable exhaust wells. The injected oxygen allows some of the coal to burn so as to provide process heat for the desired reactions. The withdrawn product gases would be cleaned and upgraded in a surface facility to provide high-Btu pipeline-quality gas. The proposed Hoe Creek experiment will consist of explosively fracturing and dewatering

N77-11573# Energy Research and Development Administration, Laramie, Wyo. Energy Research Center.
ENVIRONMENTAL IMPACT STUDIES RELATED TO UNDERGROUND COAL GASIFICATION
Dennis D. Fischer, R. Michael Boyd, and Leo A. Schrider Apr. 1975 15 p refs
(TID-27003) Avail: NTIS HC A02/MF A01

The proposed environmental studies are an attempt to determine those areas which may influence development of UCG technology to the commercial stage. They will be conducted in an experimental project which is small in scale and which may not be totally representative of some future commercial operation. Information will be gathered concerning areas of major concern which can be used to determine if further studies are necessary. Additionally these studies will be site specific. How applicable the results might be to a site exhibiting totally different climatological and geological characteristics is unknown. More questions will be raised than will be answered, but these studies should give indications of the magnitude of possible environmental impacts resulting from UCG which will be needed to decide the worth of UCG as a new energy recovery technology. In any event, these studies will be conducted while this possible new

energy recovery technique is still in the experimental phase rather than after commercial development has started. Author (ERA)

N77-11575# Rensselaer Polytechnic Inst., Troy, N.Y. Center for Technology Assessment.
ELECTRIC ENERGY SUPPLY ALTERNATIVES FOR NEW YORK. PHASE 2: AN APPRAISAL OF ELECTRICAL ENERGY ALTERNATIVES AVAILABLE TO THE STATE OF NEW YORK Interim Report, 1 Sep. 1974 - 31 Aug. 1975
Martin Becker Aug. 1975 172 p refs Sponsored by New York State Energy and Development Authority
(PB-249881/4; NYSERDA-75/02) Avail: NTIS HC A08/MF A01 CSCL 06J

A mathematical model was developed to facilitate comparison of alternate strategies. On the basis of data assembled and model calculations performed, observations are presented regarding commercial nuclear and coal power generation options for the near term as they relate to health, safety, and environmental impact as well as to the traditional capital and fuel cost criteria. Longer-term benefits as may be derived from the combustion of refuse and from renewable solar/wind resources are examined. Power need projections as reduced by conservation are compared to potential growth in electric demand due to substitutions of heating fuels and accelerated application of heat pump technology. GRA

N77-11577# Stanford Univ., Calif. Dept. of Civil Engineering.
HEAT TREATMENT OF REFUSE FOR INCREASING ANAEROBIC BIODEGRADABILITY Semiannual Progress Report, 1 Jul. - 31 Dec. 1975
James M. Gossett, Joseph B. Healy, Jr., David C. Stuckey, Lily Y. Young, and Perry L. McCarty 31 Jan. 1976 96 p refs
(Grant NSF AER-74-17940-A01)
(PB-252924/6; CE-TR-205;
NSF/RANN/SE/AER-74-17940-A01; NSF/RA/N-75-283)
Avail: NTIS HC A05/MF A01 CSCL 21D

Various heat treatment procedures are considered in converting refractory organic materials to biodegradable substances so they will be convertible to methane gas. Organic refuse materials are being subjected to temperatures from 25 to 250 C, pH from 1 to 13, and for times up to 3 hours. Biodegradability is being assessed with a Warburg respirometer. Some of the chemical added for pH control was found to be consumed during heat treatment, reducing the concentration in solution which is effective in transforming organics. Semi-continuous digestion of refuse at 35 C and at a 15 day detention time resulted in 35% reduction in volatile solids and conversion of waste to methane. GRA

N77-11581# TRW Systems Group, Redondo Beach, Calif.
FIELD TEST SAMPLING/ANALYTICAL STRATEGIES AND IMPLEMENTATION COST ESTIMATES: COAL GASIFICATION AND FLUE GAS DESULFURIZATION Final Report, Jun. - Dec. 1975
J. W. Hamersma and S. L. Reynolds Apr. 1976 120 p refs
(Contract EPA-68-02-1412)
(PB-254166/2; TRW-24916-6041-RU-00;
EPA-600/2-76-093-b) Avail: NTIS HC A06/MF A01 CSCL 07A

Sampling and analysis implementation costs for two energy related process technologies are given. Wet limestone scrubbing of flue gas and a Lurgi coal gasification system. Two different sampling and analytical approaches were costed which would yield the same information output. The first approach, requiring two levels of sampling and analytical effort, is called the phased sampling program. The second approach was a direct single effort to achieve the same level of information for decision making as the phased approach. In the test cases, costed from sample acquisition through analysis, the phased sampling and analytical approach was the most cost effective. (GRA)

N77-11588# Environmental Technology Assessment, Inc., Oak Brook, Ill.
THE AIR QUALITY AND ECONOMIC IMPLICATIONS OF SUPPLEMENTARY CONTROL SYSTEMS IN ILLINOIS Final Report
Jay E. Norco and Roger K. Raufer Nov. 1975 122 p refs Sponsored by the Ill. Inst. for Environ. Quality
(PB-255699/1; IIEQ-75-22) Avail: NTIS HC A06/MF A01 CSCL 13B

The Illinois Pollution Control Board completed a series of inquiry hearings into the sulfur dioxide regulations and, subsequently, asked the Illinois Institute for Environmental Quality to investigate supplementary control systems (SCS) as an air pollution control strategy. The purpose of this investigation was to assess the possible impact on Illinois of supplementary control systems as a strategy for attaining air quality standards with minimum economic impact while, at the same time, conserving low sulfur fuels and maintaining the viability of the Illinois coal mining industry. The study is directed toward using this system with electric power plants. GRA

N77-11589# Automotive Testing Labs., Inc., Aurora, Colo.
AN EVALUATION OF HIGH ALTITUDE ENGINE MODIFICATION DEVICES (ECONO-KIT)
Mar. 1976 340 p
(Contract EPA-68-02-2315)
(PB-255556/3) Avail: NTIS HC A15/MF A01 CSCL 13B

In Colorado and other high altitude areas, the motor vehicle plays a disproportionate and adverse role in atmospheric pollution due to fuel enrichment and other inherent factors associated with engine operation in these areas. As a consequence, a sizeable program is required, not only for emission reduction in elevated areas, but for fuel economy improvement as well. The report deals with the devices, which include certain parametric adjustments to help compensate for the high altitude effect on carburetion and combustion in the conventional automobile engine. GRA

N77-11599# Systems Applications, Inc., San Rafael, Calif.
THEORETICAL, NUMERICAL, AND PHYSICAL TECHNIQUES FOR CHARACTERIZING POWER PLANT PLUMES
Thomas W. Tesche, Gary Z. Whitten, Mark A. Yocke, and Mei-Kao Liu Feb. 1976 204 p refs Sponsored by Electric Power Res. Inst.
(EPRI Proj. 572-2)
(PB-253099/6; EPRI-EC-144) Avail: NTIS HC A10/MF A01 CSCL 13B

The chemistry and physics of plumes from fossil fuel power plants are assessed. Recent airborne measurement programs suggest that ozone may be found in power plant plumes in concentrations exceeding background levels. The question is raised whether the observed ozone build-up is due to interferences from urban plumes, measurement difficulties, or random fluctuations in atmospheric ozone concentrations. The Electric Power Research Institute (EPRI) is presently sponsoring field measurement programs designed to determine whether ozone is formed in plumes, and mathematical modeling studies that will point out conditions favorable to ozone production. GRA

N77-11602# Stanford Research Inst., Menlo Park, Calif.
RESEARCH TO ANTICIPATE ENVIRONMENTAL IMPACTS OF CHANGING RESOURCE USAGE Final Report, Apr. 1975 - Apr. 1976
Kendall D. Moll, ed. Apr. 1976 254 p refs Proceedings held at Menlo Park, Calif., 27-28 Aug. 1975
(Contract EPA-68-01-2940)
(PB-256293/2; SU-SRI-3570-17; EPA-600/9-76-022) Avail: NTIS HC A12/MF A01 CSCL 13B

This compilation of papers by 14 eminent authorities from government, academia, industry, and other institutions deals with research and policy problems facing EPA from recent and prospective changes in the availability of such natural resources as energy, minerals, agricultural land, and clean air and water. Among the major themes are the complex nature of interactions among resources, environments, and social values; and the need for research into the patterns of these interactions. Other themes call for increased research emphasis on patterns of resource flow and usage, on economic and social incentives for controlling the environment, on emergent potentially critical ecological problems, on several specific applied research and technology development programs, and on environmental

monitoring and assessment techniques. The papers were delivered at a 1975 symposium held at Stanford Research Institute. GRA

N77-11603# Exxon Research and Engineering Co., Linden, N.J.
INVESTIGATION AND ASSESSMENT OF LIGHT-DUTY-VEHICLE EVAPORATIVE EMISSION SOURCES AND CONTROL Final Report
P. J. Clarke Jun. 1976 105 p ref
(Contract EPA-68-03-2172)
(PB-255813/8; EPA-460/3-76-014) Avail: NTIS HC A06/MF A01 CSCL 13F

The effectiveness of current evaporative control systems (ECS) is assessed along with the feasibility of various hardware approaches which control evaporative emissions to a very low level. The performance of ECS's in current use was evaluated by using the Sealed Housing for Evaporative Determinations (SHED) procedure on twenty 1973-75 cars with representative control systems. The measured emissions ranged from 0.5 to 30.6 grams per test, and the twenty car average was 8.7 grams per test. Hardware was then developed to improve ECS performance. Six production vehicles were modified to demonstrate the feasibility of improving current systems. These modifications were successful in lowering the evaporative emissions to less than 2.0 grams per test for each of the six modified vehicles. This six car group consisted of vehicles manufactured by General Motors, Ford, Chrysler, American Motors, Volvo and Mazda; and the costs of required hardware have been estimated at $2, $2, $6, $2, $2, and $25, respectively. GRA

N77-11695# Energy Research and Development Administration, Oak Ridge, Tenn. Technical Information Center.
ERDA ENERGY INFORMATION DATA BASE: MAGNETIC TAPE DESCRIPTION
Feb. 1976 19 p refs
(TID-4581-R3) Avail: NTIS HC A02/MF A01

The feasibility of establishing an energy center at Glasgow Air Force Base, near Glasgow, Montana was studied. A preliminary analysis of the energy situation of the Montana region is presented along with the pressing regional needs for high BTU gas and petroleum crude oil, or equivalents. With the relative proximity of major coal resources in the Fort Union Coal Region, particular effort was applied to coal conversion as the basis for a potential energy park at Glasgow AFB. Detailed process analysis and preliminary economics for a coal conversion, energy production complex are also presented with brief consideration of alternate energy center concepts, including a nuclear energy center and multipurpose, energy-agro-industrial park. ERA

N77-11911 Pennsylvania Univ., Philadelphia.
TRADE-OFF ANALYSES FOR MULTI-OBJECTIVE TRANSPORTATION PLANS Ph.D. Thesis
Mehmet Oezdemir Akyilmaz 1976 314 p
Avail: Univ. Microfilms Order No. 76-22646

Trade-off analyses provide explicit presentation of the levels of achievement of various objectives by alternative transportation plans. This explicit presentation of the objective achievements is the core of information required for comparisons to be made among the alternatives. An evaluation method is developed to compare and evaluate the various types of trade-off analyses. This method which is cyclic in nature provides the characteristics (advantages and disadvantages) of trade-off analyses on which the comparison is based. Approaches are evaluated on the basis of a list of evaluation criteria. During this evaluation process, a new format is developed to present the generated trade-off information by the corridor planning model. Five types of trade-off approaches are investigated in this research. Various weighting schemes and constraint schemes are presented. To avoid difficulties in generating the information for one of the approaches, a strategy is recommended which will presumably lead to the selection of the best (best in terms of decision-maker's utility) alternative to be implemented. Dissert. Abstr.

N77-11923# Washington Univ., Seattle. Urban Transportation Program.
ASSESSING THE RELATIONSHIP BETWEEN URBAN FORM AND TRAVEL REQUIREMENTS: A LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK
James W. Clark Aug. 1975 47 p refs
(Contract FWPCA-WA-11-0003)
(PB-254988/9; UMTA-URT-3-75-6) Avail: NTIS HC A03/MF A01 CSCL 05K

The relationship between urban form and transportation energy consumption is studied. A thesis is that study of the relationship has been hampered by a lack of an operational definition for the concept of urban form. Addressing itself to this need, it is proposed that urban spatial structure be measured in terms of size, shape, and activity distribution of the urbanized area. The review of literature classifies previous studies according to the aspect of urban form which was investigated. Travel requirements appear to increase as urban area population increases, but beyond this finding, no clear relationship between urban form and total urban travel requirements has yet been established. GRA

N77-11927# Army War Coll., Carlisle Barracks, Pa.
AN ANALYSIS OF THE TECHNOLOGY ROLE IN US POWER DURING THE MID-RANGE PERIOD Student Essay
Edward Miltner 21 Nov. 1975 31 p refs
(AD-A024042) Avail: NTIS HC A03/MF A01 CSCL 05/1

The role of technology predominates all elements of U.S. power. It is the key ingredient of defense planning; it looms as the bright spot in our balance of trade; it represents the heart of detente; it is responsible for the enormous improvement in our quality of life; and it is in the direction of technology that mankind seeks solutions in this new age of global interdependency and increased shortages of natural resources. The accelerating importance of technology to our nation's security and world leadership posture stands in astonishing contrast to the long and continuing decline of U.S. funding for research and development. A decline that poses a threat to our national defense - to our economic power - to the quality of life. Data was provided primarily from business and technology periodicals, federal budget review and texts pertaining to technology and its impact on the future. Federal support of R and D has dropped severely over the last decade to 1.2% of GNP. In view of the facts respecting the vital nature of technology to the nation and this reduced support of the R and D effort in the United States, it is recommended that all of the elements of U.S. power be reflected in the President's cabinet. The President's cabinet should be reorganized so that all five elements of U.S. power are represented, and in particular there be created a Secretary of Science and Technology and as a principal arm he creates a National Institute of Science and Technology. It is further suggested that national policy be established to provide five percent of gross national product for research and development. Author (GRA)

N77-11930# Urban Mass Transportation Administration, Washington, D.C. Office of Research, Development and Demonstration.
FUTURE SCENARIOS FOR URBAN TRANSPORTATION Final Report
Michael Patrick Leahy Aug. 1975 120 p refs
(PB-255349/3; UMTA-RDD-9-75-1) Avail: NTIS HC A06/MF A01 CSCL 13B

Using total energy consumption comparisons, the internal combustion auto that meets DOT suggested fuel economy standards for 1980 (19.6 mpg) is twice as energy intensive as the diesel bus, three times as energy intensive as rapid rail and the electric bus, and five times as energy intensive as the electric car and the advanced GRT. It is concluded that to decrease energy consumption, improve urban air quality, and improve urban transportation, strategies should be aimed at achieving a transit and electric intensive modal split. Opportunities for action include (1) strongly supporting HR 8800, which, if passed, will appropriate $160 million for 5 years to the Energy Research and Development Administration (ERDA) for Electric Vehicle R and D; (2) working in cooperation with ERDA to develop an urban private passenger electric vehicle and improved battery powered electric bus. GRA

N77-12052# Boeing Vertol Co., Philadelphia, Pa.
ADVANCED HELICOPTER STRUCTURAL DESIGN INVESTI-

GATION. VOLUME 1: INVESTIGATION OF ADVANCED STRUCTURAL COMPONENT DESIGN CONCEPTS Final Report, Jun. 1974 - May 1975

Donald J. Hoffstedt and Sidney Swatton Mar. 1976 368 p refs

(Contract DAAJ02-74-C-0066; DA Proj. 1F2-62208-AH-90)

(AD-A024662; D210-10965-1; USAAMRDL-TR-75-56A) Avail: NTIS HC A16/MF A01 CSCL 01/3

A preliminary design study for a complete helicopter, incorporating advanced structural design concepts and advanced material, was conducted by the Boeing Vertol Company. The purpose was to evaluate the impact of advanced concepts and materials on the payload and configuration of a medium utility transport helicopter when compared to a baseline helicopter of conventional design. Major structural systems were identified with assessment of structural efficiency, cost/producibility, fail-safety, safety, reliability, maintainability, survivability, and crashworthiness. In addition, risk and feasibility assessment of the advanced structural systems was conducted. Author (GRA)

N77-12166# National Bureau of Standards, Washington, D.C. Inst. for Materials Research.

THE ELECTRON FACTOR IN CATALYSIS ON METALS ELECTROCATALYSIS ON NON-METALLIC SURFACES Final Report

L. H. Bennett and A. D. Franklin May 1976 71 p refs Sponsored in part by NSF and ERDA

(PB-256264/3; NBSIR-75-1049) Avail: NTIS HC A04/MF A01 CSCL 07D

Two related workshops were held in topics of importance for energy conversion. These topics, concerned with some of the science underlying the development of fuel cells for electric utility use, are: (1) the electron factor in catalysis on metals; and (2) electrocatalysis on non-metallic surfaces. Discussions of the needs and expected benefits, lists of attendees, descriptions of the programs and summaries of the major problems, advances, and opportunities revealed by the workshops are included.

Author

N77-12182*# TRW Systems Group, Redondo Beach, Calif.

HEAT PIPE MATERIALS COMPATIBILITY Final Report

J. E. Eninger, G. L. Fleischman, and E. E. Luedke Jan. 1976 46 p refs

(Contract NAS3-19128)

(NASA-CR-135069; TRW-26148-6004-RU-00) Avail: NTIS HC A04/MF A01 CSCL 11F

An experimental program to evaluate noncondensable gas generation in ammonia heat pipes was completed. A total of 37 heat pipes made of aluminum, stainless steel and combinations of these materials were processed by various techniques, operated at different temperatures and tested at low temperature to quantitatively determine gas generation rates. In order of increasing stability are aluminum/stainless combination, all aluminum and all stainless heat pipes. One interesting result is the identification of intentionally introduced water in the ammonia during a reflux step as a means of surface passivation to reduce gas generation in stainless-steel/aluminum heat pipes. Author

N77-12203# National Bureau of Standards, Washington, D.C.

SHIP STEEL WELDMENTS FOR LOW TEMPERATURE SERVICE Final Report

H. I. McHenry May 1976 9 p refs Submitted for publication Sponsored by Maritime Administration, Washington D. C.

(PB-256997/8) Avail: NTIS HC A02/MF A01 CSCL 11F

The ship steels, welding practices and weldment toughness requirements applicable to low temperature regions of liquefied-natural-gas (LNG) tankers are reviewed. In the construction of LNG ships, the principal welding productivity problem is the low deposition rate associated with the low heat input welding practices required to provide sufficient toughness in the weld heat-affected-zone (HAZ). A potential solution to this problem is to use improved steels which can be welded using efficient procedures and still provide satisfactory HAZ toughness. The steelmaking practices that contribute to low temperature toughness are reviewed with respect to economic limitations associated with ship steels and to their potential for improving HAZ toughness. GRA

N77-12230*# Atlantic Richfield Co., Harvey, Ill. Technical Center.

SYNTHESIS AND ANALYSIS OF JET FUEL FROM SHALE OIL AND COAL SYNCRUDES

J. P. Gallagher, T. A. Collins, T. J. Nelson, M. J. Pedersen, M. G. Robison, and L. J. Wisinski 17 Nov. 1976 64 p refs

(Contract NAS3-19747)

(NASA-CR-135112; M1.76-1) Avail: NTIS HC A04/MF A01 CSCL 21D

Thirty-two jet fuel samples of varying properties were produced from shale oil and coal syncrudes, and analyzed to assess their suitability for use. TOSCO II shale oil and H-COAL and COED syncrudes were used as starting materials. The processes used were among those commonly in use in petroleum processing-distillation, hydrogenation and catalytic hydrocracking. The processing conditions required to meet two levels of specifications regarding aromatic, hydrogen, sulfur and nitrogen contents at two yield levels were determined and found to be more demanding than normally required in petroleum processing. Analysis of the samples produced indicated that if the more stringent specifications of 13.5% hydrogen (min.) and 0.02% nitrogen (max.) were met, products similar in properties to conventional jet fuels were obtained. In general, shale oil was easier to process (catalyst deactivation was seen when processing coal syncrudes), consumed less hydrogen and yielded superior products. Based on these considerations, shale oil appears to be preferred to coal as a petroleum substitute for jet fuel production. Author

N77-12231# Battelle Columbus Labs., Ohio.

FUEL CONTAMINANTS. VOLUME 1: CHEMISTRY Final Report, Jun. 1975 - Feb. 1976

E. J. Mezey, Surjit Singh, and D. W. Hissong Jul. 1976 179 p refs 2 Vol.

(Contract EPA-68-02-2112)

(PB-256020/9; EPA-600/2-76-177-a-Vol-1) Avail: NTIS HC A09/MF A01 CSCL 21D

Information on the characteristics of solid and liquid fuels is reviewed. The chemical and physical characteristics of components of the fuel are dealt with which are sources of sulfur, nitrogen, and trace element pollutants when that fuel is utilized. Part of the sulfur and most of the nitrogen originate from compounds common to the fuels reviewed (coal, petroleum, tar sand oil, and shale oil). These are primarily organic sulfur and organic nitrogen compounds. For liquid fuels, intrinsic centers of sulfur and nitrogen contamination are found in the colloidal suspensions commonly known as asphaltenes and the more soluble resins.

GRA

N77-12232# Naval Research Lab., Washington, D.C.

ELECTROSTATIC PROPERTIES OF JP-5 JET FUEL FROM ALTERNATE SOURCES

J. T. Leonard May 1976 9 p refs

(WF57571301)

(AD-A025684; NRL-MR-3294) Avail: NTIS HC A02/MF A01 CSCL 21/4

The electrostatic properties of JP-5 fuel from alternate sources were determined. Two properties electrical conductivity and electrostatic charging tendency - were measured on seven samples. Five coal-derived fuels and one sample derived from tar sands exhibited properties similar to jet fuels derived from petroleum and hence should not develop unusual ignition hazards in field handling. A JP-5 produced from shale had higher values of conductivity and charging tendency than petroleum-derived fuels, but the combination of the two properties indicates that no abnormal electrostatic hazards should be encountered.

Author (GRA)

N77-12332*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AUXILIARY POWER SYSTEM FOR ACTIVITY COOLED AIRCRAFT Patent Application

Robert A. Jones, inventor (to NASA) Filed 24 Nov. 1976 9 p (NASA-Case-LAR-11626-1; US-Patent-Appl-SN-744542) Avail: NTIS HC A02/MF A01 CSCL 20D

A method is described for extracting heat energy from an active cooling system in an aircraft as a source of auxiliary power. A secondary coolant such as a water-glycol mixture removes heat from near the outer surfaces of the vehicle and circulates through a heat exchanger. Cryogenic fuel such as liquid hydrogen is first pressurized and passed through the heat exchanger and a turbine on its way to the engine. The temperature of the fuel is raised in the heat exchanger to a value above that which is required for the engine, because the fuel temperature and pressure will drop across the turbine. The turbine converts this excess heat to provide energy to pressurize the fuel, circulate the secondary coolant and drive other aircraft equipment. Author

N77-12402* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

MECHANICAL THERMAL MOTOR Patent

Leopold A. Hein and William N. Myers, inventors (to NASA) Issued 26 Oct. 1976 8 p Filed 30 Jun. 1975 Supersedes N75-27561 (13 - 18, p 2276)
(NASA-Case-MFS-23062-1; US-Patent-3,987,630; US-Patent-Appl-SN-591569; US-Patent-Class-60-527) Avail: US Patent Office CSCL 13I

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 cylinder 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. Official Gazette of the U.S. Patent Office

N77-12406*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EMISSIONS AND PERFORMANCE OF CATALYSTS FOR GAS TURBINE CATALYTIC COMBUSTORS

David N. Anderson 1977 42 p refs Proposed for presentation at 22d Ann. Intern. Gas Turbine Conf., Philadelphia, 27-31 Mar. 1977; sponsored by ASME
(NASA-TM-X-73543; E-8975) Avail: NTIS HC A03/MF A01 CSCL 21A

Three noble-metal monolithic catalysts were tested in a 12-centimeter diameter combustion test rig to obtain emissions and performance data at conditions simulating the operation of a catalytic combustor for an automotive gas turbine engine. Tests with one of the catalysts at 800 K inlet mixture temperature 300,000 pa (3 atm) pressure, and a reference velocity (catalyst bed inlet velocity) of 10 m/sec demonstrated greater than 99 percent combustion efficiency for reaction temperatures higher than 1300 K. With a reference velocity of 25 m/sec the reaction temperature required to achieve the same combustion efficiency increased to 1380 K. The exit temperature pattern factors for all three catalysts were below 0.1 when adiabatic reaction temperatures were higher than 1400 K. The highest pressure drop was 4.5 percent at 25 m/sec reference velocity. Nitrogen oxides emissions were less than 0.1 g NO2/kg fuel for all test conditions. Author

N77-12475*# Ohio Dept. of Economic and Community Development, Columbus.

DEVELOPMENT OF A MULTI-DISCIPLINARY ERTS USER PROGRAM IN THE STATE OF OHIO Quarterly Progress Report

Paul E. Baldridge, Principal Investigator 10 Sep. 1976 5 p ref ERTS
(Contract NAS5-22399)
(E77-10045; NASA-CR-149181; QPR-5) Avail: NTIS HC A02/MF A01 CSCL 05B

The author has identified the following significant results. A preliminary comparison of the land use maps derived from high altitude photography and imagery generated from land use CCT's shows considerable correlation of data. Most land use features are best identified on LANDSAT data taken over a full year, showing the effects of the four seasons. It appears that the most cost effective and timely way of providing land use data is to use LANDSAT data for identifying 75 to 90 percent of land use categories, using temporal data. For surface mining, close examination of LANDSAT, Skylab, and aircraft data covering the same area where linears were found seems to indicate that the type of resolution characteristic of LANDSAT data results in a better definition of linears of one or more miles. Long line linears were found in the vicinity of known gas production areas in Ohio.

N77-12476*# ECON, Inc., Princeton, N.J.

SEASAT: A CANDIDATE OCEAN INDUSTRY ECONOMIC VERIFICATION EXPERIMENTS

B. P. Miller 16 Sep. 1976 88 p refs
(Contract NASw-2558)
(NASA-CR-149228; Rept-76-112-1) Avail: NTIS HC A05/MF A01 CSCL 05C

The economic benefits of an operational SEASAT system are discussed in the areas of marine transportation, offshore oil and natural gas exploration and development, ocean fishing, and Arctic operations. A description of the candidate economic verification experiments which could be performed with SEASAT-A is given. With the exception of the area of Arctic operations, experiments have been identified in each of the areas of ocean based activity that are expected to show an economic impact from the use of operational SEASAT data. Experiments have been identified in the areas of the offshore oil and natural gas industry, as well as ice monitoring and coastal zone applications. Emphasis has been placed on the identification and the development of those experiments which meet criteria for: (1) end user participation; (2) SEASAT-A data utility; (3) measurability of operational parameters to demonstrate economic effect; and (4) non-proprietary nature of results. Author

N77-12485# Bochum Observatory (West Germany). Inst. fuer Weltraumforschung.

REMOTE SENSING OF GEOTHERMIC ACTIVITIES OF THE VOLCANOES AETNA, STROMBOLI AND VESUV BY MEANS OF INFRA-RED NOAA-VHRR-SATELLITE DATA

Heinz Kaminski 1976 17 p refs In GERMAN; ENGLISH summary Presented at the 16th Intern. Tech. Sci. Meeting on Space, Rome, 18-20 Mar. 1976
Avail: NTIS HC A02/MF A01

Geothermal investigations of volcanoes in southern Italy were made using high resolution (900 m ground resolution) NOAA 2, 3, and 4 remote sensing data. The thermal activity of the volcanoes is represented as delta F sub D, i.e., film density difference compared to the sea water film density in the period May to September 1974. The intensity variations of the three volcanoes are similar, which might mean that the volcanoes have the same magma source. ESA

N77-12486*# National Field Investigations Center, Denver, Colo.

AN APPLICATION OF ERTS TECHNOLOGY TO THE EVALUATION OF COAL STRIP MINING AND RECLAMATION IN THE NORTHERN GREAT PLAINS Final Report

Feb. 1975 120 p Sponsored by NASA and EPA
(NASA-CR-149208; PB-255590/2; EPA-330/3-75-001) Avail: NTIS HC A06/MF A01 CSCL 08G

The coal mines in Wyoming, Montana, North and South Dakota were studied using remote sensing data from Earth Resources Technology Satellite (ERTS). The study documented the size, shape and location of the actively mined area, untouched spoils piles, reclaimed or recontoured areas, newly vegetated areas and abandoned spoils piles within each of the 30 active,

inactive or proposed coal mine sites. Land use, or classification, at each mine evaluated was defined by computer processing of ERTS data from digital magnetic tapes. (GRA)

N77-12500# Federal Energy Administration, Washington, D.C.
A SURVEY OF SALT DEPOSITS AND SALT CAVERNS: THEIR RELEVANCE TO THE STRATEGIC PETROLEUM RESERVE
Charles J. Jirik and Louis K. Weaver Jul. 1976 72 p refs
(PB-255948/2; FEA/S-76/310) Avail: NTIS HC A04/MF A01 CSCL 08I

Rock salt has been mined in the United States by underground mining since 1867 and by large scale water-leaching methods since shortly after World War II. Since the 1940's, underground caverns have become very useful for storing liquefied petroleum gases and natural gas. Of all underground storage capacity in reservoirs of all types in the United States, about 93 percent is in salt. To evaluate the potential of any salt deposit as a storage site, information regarding all major activities, past and present, on each deposit was determined. Those activities are summarized as they pertain to LPG storage, salt production, and sulfur production operations on each appropriate site. GRA

N77-12502# American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc., Washington, D. C.
PROCEEDINGS OF THE MINERAL ECONOMICS SYMPOSIUM: WINNING THE HIGH STAKES AT THE CRITICAL COMMODITY GAME
K. L. Wang, ed. and B. W. Klein, ed. 11 Nov. 1975 104 p Symp. held at Arlington, Va., 11 Nov. 1975
(PB-255607/4; NSF/RA-760162) Avail: NTIS HC A06/MF A01 CSCL 08I

The proceedings of the First Mineral Economics Symposium are reported. Of the 170 (approximately) people in attendance, five departments of Government and 13 Government agencies are represented as well as attendees from industry, trade associations, academia, nonprofit research organizations and foundations, and independent consultants. A forum for exchanging views on commodity agreements and cartels and the related economic stockpile issue was provided. GRA

N77-12504 Pennsylvania Univ., Philadelphia.
PLANNING MODELS FOR THE ASSESSMENT OF ADVANCED ENERGY STORAGE SYSTEMS Ph.D. Thesis
Fred Shuen Tak Ma 1976 181 p
Avail: Univ. Microfilms Order No. 76-22731

Two alternative approaches are identified: a system storage which can be charged electrically by any conventional power plant of the system; and a solar storage which can only store non-electrical energy extracted from a renewable source (e.g., by solar thermal conversion). In both approaches, the storage is included as a limited source of energy generation in a power system. They are structured as optimal control formulations which include important basic technological parameters. The optimization problem is then solved using dynamic programming. The feasibility of a candidate configuration of each advanced technology is compared with those of advanced designs of gas turbines and combined cycles. Results of this study indicate that, based on moderately projected cost and life span estimates, the specific storage systems are more expensive than gas turbines and combined cycles. Dissert. Abstr.

N77-12506# California Univ., Livermore. Lawrence Livermore Lab.
FLAT-PLATE SOLAR COLLECTOR HANDBOOK. A SURVEY OF PRINCIPLES, TECHNICAL DATA AND EVALUATION RESULTS
Herbert W. Newkirk, comp. 29 Mar. 1976 95 p refs
(Contract W-7405-eng-48)
(UCID-17086) Avail: NTIS HC A05/MF A01

Principles of flat plate solar absorption are discussed. Medium temperature collectors produced and sold by thirteen foreign and domestic manufacturers are evaluated. Criteria for selection are: intention by the manufacturer that the equipment be used only for heating and cooling buildings and for domestic hot water heating, and evaluation of the collector by NASA using a solar simulator as a basis for collector selection and performance prediction. Data presented in this handbook were abstracted from information received from the participating companies and from NASA reports. Author

N77-12509*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Telecommunications Div.
WIND POWER PREDICTION MODELS
R. Levy and H. McGinness 15 Nov. 1976 61 p refs
(Contract NAS7-100)
(NASA-CR-149235; JPL-TM-33-802) Avail: NTIS HC A04/MF A01 CSCL 10A

Investigations were performed to predict the power available from the wind at the Goldstone, California, antenna site complex. The background for power prediction was derived from a statistical evaluation of available wind speed data records at this location and at nearby locations similarly situated within the Mojave desert. In addition to a model for power prediction over relatively long periods of time, an interim simulation model that produces sample wind speeds is described. The interim model furnishes uncorrelated sample speeds at hourly intervals that reproduce the statistical wind distribution at Goldstone. A stochastic simulation model to provide speed samples representative of both the statistical speed distributions and correlations is also discussed. Author

N77-12513*# Honeywell Corporate Research Center, Bloomington, Minn.
DIP COATING PROCESS: SILICON SHEET GROWTH DEVELOPMENT FOR THE LARGE-AREA SILICON SHEET TASK OF THE LOW-COST SILICON SOLAR ARRAY PROJECT Annual Report
J. D. Heaps, R. B. Maciolek, J. D. Zook, W. B. Harrison, M. W. Scott, G. Hendrickson, H. A. Wolner, L. D. Nelson, T. L. Schuller, and A. A. Peterson 28 Sep. 1976 97 p refs Prepared for JPL
(Contract NAS7-100)
(NASA-CR-149242; ERDA/JPL-954356-76/2; AR-1) Avail: NTIS HC A05/MF A01 CSCL 10A

The technical and economic feasibility of producing solar cell quality sheet silicon by dip-coating one surface of carbonized ceramic substrates with a thin layer of large grain polycrystalline silicon was investigated. The dip-coating methods studied were directed toward a minimum cost process with the ultimate objective of producing solar cells with a conversion efficiency of 10% or greater. The technique shows excellent promise for low cost, labor-saving, scale-up potentialities and would provide an end product of sheet silicon with a rigid and strong supportive backing. An experimental dip-coating facility was designed and constructed, several substrates were successfully dip-coated with areas as large as 25 sq cm and thicknesses of 12 micron to 250 micron. There appears to be no serious limitation on the area of a substrate that could be coated. Of the various substrate materials dip-coated, mullite appears to best satisfy the requirement of the program. An inexpensive process was developed for producing mullite in the desired geometry. Author

N77-12517*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SPACE-TO-EARTH POWER TRANSMISSION SYSTEM
Grady H. Stevens and Richard Schuh Nov. 1976 143 p refs
(NASA-TM-X-73489; E-8885) Avail: NTIS HC A07/MF A01 CSCL 10A

A preliminary analysis was conducted to establish the requirements of a space-to-earth microwave power transmission system. The need for accurate phase control on the transmitter was established and methods for assessing the impact of power density and thermal constraints on system performance were demonstrated. Potential radio frequency interference was considered. The sensitivity of transmission system scale to variations in power source, transportation and orbital fabrication and assembly costs was also determined. Author

N77-12518*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MEASURED PERFORMANCE OF A 3 TON LiBr ABSORP-

TION WATER CHILLER AND ITS EFFECT ON COOLING SYSTEM OPERATION

David Namkoong 1976 10 p Presented at the Intern. Solar Energy Meeting, Winnipeg, Can., 15-20 Aug. 1976

(NASA-TM-X-73496; E-8894) Avail: NTIS HC A02/MF A01 CSCL 10A

A three ton lithium bromide absorption water chiller was tested for a number of conditions involving hot water input, chilled water, and the cooling water. The primary influences on chiller capacity were the hot water inlet temperature and the cooling water inlet temperature. One combination of these two parameters extended the output to as much as 125% of design capacity, but no combination could lower the capacity to below 60% of design. A cooling system was conceptually designed so that it could provide several modes of operation. Such flexibility is needed for any solar cooling system to be able to accommodate the varying solar energy collection and the varying building demand. It was concluded that a three-ton absorption water chiller with the kind of performance that was measured can be incorporated into a cooling system such as that proposed, to provide efficient cooling over the specified ranges of operating conditions. Author

N77-12519*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STATUS OF SILICON SOLAR CELL TECHNOLOGY

Henry W. Brandhorst, Jr. 1976 17 p refs Presented at the 2d Intern. Conf. on Solid State Devices, Tokyo, 1-3 Sep. 1976; Sponsored by Japan. Soc. of Appl. Phys.

(NASA-TM-X-73531; E-8956) Avail: NTIS HC A02/MF A01 CSCL 10A

Major progress in solar cell technology leading to increased efficiency has occurred since 1970. Technical approaches leading to this increased output include surface texturing, improved antireflection coatings, reduced grid pattern area coverage, shallow junctions and back surface fields. The status of these developments and their incorporation into cell production is discussed. Future research and technology trends leading to further efficiency increases and substantial cost reductions are described. Author

N77-12520*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

OUTDOOR PERFORMANCE RESULTS FOR NBS ROUND ROBIN COLLECTOR NO. 1

Dean R. Miller Nov. 1976 10 p refs

(NASA-TM-X-73547; E-8983) Avail: NTIS HC A02/MF A01 CSCL 10A

The efficiency of a PPG flat-plate solar collector was evaluated utilizing an outdoor solar collector test facility at the NASA-Lewis Research Center, as part of the National Bureau of Standards 'round robin' collector test program. The correlation equation for collector thermal efficiency Eta curve fit of the data was: Eta = 0.666 - 1.003(Btu/hr-sq ft-F) Theta, where the parameter Theta is the difference between the average fluid temperature and the ambient temperature, all divided by the total flux impinging on the collector. Author

N77-12521*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TEMPERATURE DISTRIBUTION OF A HOT WATER STORAGE TANK IN A SIMULATED SOLAR HEATING AND COOLING SYSTEM

David Namkoong Nov. 1976 17 p refs

(NASA-TM-X-73549; E-8985) Avail: NTIS HC A02/MF A01 CSCL 10A

A 2,300-liter hot water storage tank was studied under conditions simulating a solar heating and cooling system. The initial condition of the tank, ranging from 37 C at the bottom to 94 C at the top, represented a condition midway through the start-up period of the system. During the five-day test period, the water in the tank gradually rose in temperature but in a manner that diminished its temperature stratification. Stratification was found not to be an important factor in the operation of the particular solar system studied. Author

N77-12522*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE REDOX FLOW SYSTEM FOR SOLAR PHOTOVOLTAIC ENERGY STORAGE

Patricia ODonnell and Randall F. Gahn 1976 9 p refs Presented at the Twelfth Photovoltaic Specialists Conf. sponsored by the Inst. of Elec. and Electron. Eng., Baton Rouge, La., 15-18 Nov. 1976

(NASA-TM-X-73562; E-9006) Avail: NTIS HC A02/MF A01 CSCL 10A

A new method of storage was applied to a solar photovoltaic system. The storage method is a redox flow system which utilizes the oxidation-reduction capability of two soluble electrochemical redox couples for its storage capacity. The particular variant described separates the charging and discharging function of the system such that the electrochemical couples are simultaneously charged and discharged in separate parts of the system. The solar array had 12 solar cells; wired in order to give a range of voltages and currents. The system stored the solar energy so that a load could be run continually day and night. The main advantages of the redox system are that it can accept a charge in the low voltage range and produce a relatively constant output regardless of solar activity. Author

N77-12523*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYSIS OF EPITAXIAL DRIFT FIELD N ON P SILICON SOLAR CELLS

Cosmo R. Baraona and Henry W. Brandhorst, Jr. 1976 10 p Presented at the Twelfth Photovoltaic Specialists Conf. sponsored by the Inst. of Elec. and Electron. Eng., Baton Rouge, La., 15-18 Nov. 1976

(NASA-TM-X-73563; E-9007) Avail: NTIS HC A02/MF A01 CSCL 10A

The performance of epitaxial drift field silicon solar cell structures having a variety of impurity profiles was calculated. These structures consist of a uniformly doped P-type substrate layer, and a P-type epitaxial drift field layer with a variety of field strengths. Several N-layer structures were modeled. A four layer solar cell model was used to calculate efficiency, open circuit voltage and short circuit current. The effect on performance of layer thickness, doping level, and diffusion length was determined. The results show that peak initial efficiency of 18.1% occurs for a drift field thickness of about 30 micron with the doping rising from 10 to the 17th power atoms/cu cm at the edge of the depletion region to 10 to the 18th power atoms/cu cm in the substrate. Stronger drift fields (narrow field regions) allowed very high performance (17% efficiency) even after irradiation to 3x10 to the 14th power 1 MeV electrons/sq cm. Author

N77-12524*# Battelle Columbus Labs., Ohio.

REVIEW OF WORLD EXPERIENCE AND PROPERTIES OF MATERIALS FOR ENCAPSULATION OF TERRESTRIAL PHOTOVOLTAIC ARRAYS Final Report

D. C. Carmichael, G. B. Gaines, F. A. Sliemers, C. W. Kistler, and R. D. Igou 21 Jul. 1976 194 p refs Prepared for JPL Sponsored in part by ERDA

(Contracts NAS7-100; JPL-954328)

(NASA-CR-149215; ERDA/JPL-954328-76/4) Avail: NTIS HC A09/MF A01 CSCL 10A

Published and unpublished information relating to encapsulation systems and materials properties was collected by searching the literature and appropriate data bases (over 1,300 documents were selected and reviewed) and by personal contacts including site and company visits. A data tabulation summarizing world experience with terrestrial photovoltaic arrays (50 installations) is presented in the report. Based on criteria of properties, processability, availability, and cost, candidate materials were identified which have potential for use in encapsulation systems for arrays with a lifetime of over 20 years high reliability, an efficiency greater than 10 percent, a total price less than $500/kW, and a production capacity of 500,000 kW/yr. The recommended materials (all commercially available) include, depending upon the device design, various borosilicate and soda-lime glasses and numerous polymerics suitable for specific encapsulation system functions. Author

N77-12525# California Univ., Livermore. Lawrence Livermore Lab.

CALIFORNIA ENERGY OUTLOOK
E. Behrin and R. L. Cooper 6 Feb. 1976 49 p refs
(Contract W-7405-eng-48)
(UCRL-5196-Rev-1) Avail: NTIS HC $4.00

Projections are made for primary energy sources and energy demands in secondary and end-use markets in California. Fuel conservation, particularly in transportation, and increased supplies of oil and gas through the expected deregulation of oil and gas prices, as well as state imports of Alaskan oil, will sustain the California economy through 1985 without major increases in foreign imports. The resumption of offshore drilling in the Santa Barbara channel, exploitation of Elk Hills reserves, and the completion of the Alaska oil and gas pipelines are major factors in enhancing energy supplies in California through 1985. For the period 1985 to 2000 new energy technologies must be developed to prevent a substantial deterioration in the standard of living due to rapidly escalating energy costs and/or increased reliance on uncertain foreign sources. Author (ERA)

N77-12526# Ernst and Ernst, Washington, D.C.
REVIEW OF ENERGY FORECASTING METHODOLOGIES AND ASSUMPTIONS Final Report
Jun. 1976 351 p refs
(Contract DI-14-03-6101N)
(PB-255170/3) Avail: NTIS HC A16/MF A01 CSCL 10A

A systematic identification and description of energy forecasting methodologies used both within and outside of the Pacific Northwest are reported. Identification and comparative discussion of basic socioeconomic and other assumptions used in such forecasts, including discussions of how each varies, why variances occur, the potential effects of the variations on forecasting results, and reasons for including or excluding specific assumptions in the different forecast methodologies were described. A comparative discussion of interrelationships between electric energy forecasts, other energy forecasts, and non-energy forecasts presently in use in the Pacific Northwest are discussed. GRA

N77-12527# Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis.
NET ENERGY FROM NUCLEAR POWER
Ralph M. Rotty, A. M. Perry, and David B. Reister May 1976 118 p refs Sponsored by FEA
(PB-254059/9; IEA-75-3; FEA/B-76/702) Avail: NTIS HC A06/MF A01 CSCL 18E

An analysis of net energy from nuclear power plants is dependent on a large number of variables and assumptions. The energy requirements are reported as they relate to reactor type, concentration of uranium in the ore, enrichment tails assay (the operating mode of enrichment plants), and possible recycle of uranium and plutonium. GRA

N77-12528# Stanford Research Inst., Menlo Park, Calif.
COSTS OF ALTERNATIVE SOURCES OF ELECTRICITY Final Report
Jeffrey G. Witwer Jul. 1976 64 p refs
(Contract DI-14-03-6108N; SRI Proj. 4963-100)
(PB-255765/0) Avail: NTIS HC A04/MF A01 CSCL 10B

Interest in alternative sources of electricity has been increasing in the hope of reducing future cost increases and reducing environmental impacts of energy production. This is a study of the costs of the following alternative sources of electrical energy: solar thermal, solar photovoltaic, wind, magnetohydrodynamics (MHD), fusion, agricultural residues, geothermal energy and municipal solid waste. GRA

N77-12529# UOP, Inc., Des Plaines, Ill.
OPTIMIZATION OF PT-DOPED KOCITE (TRADEMARK) ELECTRODES IN H3 PO4 FUEL CELLS Interim Progress Report, Sep. 1975 - Feb. 1976
L. B. Welsh, R. W. Leyerle, and G. L. Hervert Mar. 1976 53 p refs
(Contract DAAG53-76-C-0014; DA Proj. 1G7-62708-AH-67)
(AD-A025326; IPR-1) Avail: NTIS HC A04/MF A01 CSCL 10/1

The use of UOP Pt-doped Kocite (Trademark) materials as low cost air and/or fuel electrocatalysts in phosphoric acid electrolyte fuel cells is being optimized. Kocite materials are composite structures consisting of pyropolymers chemically bonded to refractory substrates. Fuel cell electrodes are fabricated from these materials and tested as anodes or cathodes in model fuel cells with Teflon bonded Pt black electrodes as counter electrodes. Kocite materials are currently being produced in 200-400 gram quantities using two types of high surface area aluminas. Lifetime testing of Kocite electrodes as cathodes indicates no catalyst deterioration occurs for periods in excess of 500 hours for temperatures from 140 to 180 C. Both the thickness and density of the catalyst layer have been varied as part of the program to optimize the electrode structure. Preliminary results indicate little change in performance with catalyst layer density, but suggest that an improved performance may be obtainable with a thinner catalyst layer. GRA

N77-12530# Federal Energy Administration, Washington, D.C. Office of Oil and Gas.
CRUDE OIL SUPPLY ALTERNATIVES FOR THE NORTHERN TIER STATES
Aug. 1976 79 p
(PB-255991/2; FEA/G-76/350) Avail: NTIS HC A05/MF A01 CSCL 21D

The feasibility, cost, and potential environmental, social, and economic impacts are assessed for various alternate crude oil supply sources and transportation systems for Canada, Washington, Montana, Wisconsin, North Dakota, Minnesota, and Michigan. The historical current, and projected Canadian actions with regard to crude oil exports are described. The petroleum supply structure for crude oil and finished products affecting the Northern Tier are analyzed. Demand forecasts for the U.S. and for each of the six states are projected. Short-term supply solutions for the Northern Tier states are discussed. GRA

N77-12531# Bonner and Moore Associates, Inc., Houston, Tex.
CRUDE SUPPLY ALTERNATIVES FOR THE NORTHERN TIER STATES. VOLUME 1: EXECUTIVE SUMMARY
24 Jul. 1976 42 p
(Contract FEA-CR-05-60593-00)
(PB-255992/0; RAH-070A-Vol-1; FEA/G-76/358) Avail: NTIS HC A03/MF A01 CSCL 21D

Major conclusions drawn from an analysis of various alternatives for supply of crude oil and petroleum products to the Northern Tier States are presented. GRA

N77-12532# Bonner and Moore Associates, Inc., Houston, Tex.
CRUDE SUPPLY ALTERNATIVES FOR THE NORTHERN TIER STATES. VOLUME 2: TECHNICAL REPORT
25 Jul. 1976 447 p refs
(Contract FEA-CR-05-60593-00)
(PB-255993/8; RAH-070-Vol-2; FEA/G-76/359) Avail: NTIS HC A19/MF A01 CSCL 21D

For abstract, see N77-12531

N77-12533# Stanford Research Inst., Menlo Park, Calif.
IMPACTS OF SYNTHETIC LIQUID FUEL DEVELOPMENT. AUTOMOTIVE MARKET. VOLUME 1: SUMMARY Final Report
Edward M. Dickson, Robert V. Steele, Evan E. Hughes, Barry L. Walton, and R. Allen Zink Jun. 1976 117 p
(Contract EPA-68-03-2016)
(PB-255994/6; SRI-EGU-3505-UR-1-Vol-1; EPA-600/7-76-004-a) Avail: NTIS HC A06/MF A01 CSCL 21D

The impacts of the development of synthetic liquid fuels from coal and oil shale are assessed. The fuels considered are synthetic crude oils from coal and oil shale and methanol from coal. Key issues examined in detail are the technology and all of its resource requirements, net energy analyses of the technological options, a maximum credible implementation schedule, legal mechanisms for access to coal and oil shale resources, financing of a synthetic liquid fuels industry, decision making in the petroleum industry, government, incentive policies, local and national economic impacts, environmental effects of strip mining, urbanization of rural areas, air pollution control, water resources and their availability, and population growth and boom town effects in previously rural areas. GRA

N77-12534# Stanford Research Inst., Menlo Park, Calif.
IMPACTS OF SYNTHETIC LIQUID FUEL DEVELOPMENT. AUTOMOTIVE MARKET. VOLUME 2 Final Report
Edward M. Dickson, Robert V. Steele, Evan E. Hughes, Barry L. Walton, and R. Allen Zink Jul. 1976 867 p refs
(Contract EPA-68-03-2016)
(PB-255995/3; SRI-EGU-3505-Vol-2; EPA-600/7-76-004-B)
Avail: NTIS HC A99/MF A01 CSCL 21D
For abstract, see N77-12533.

N77-12535# DARCOM Intern Training Center, Texarkana, Tex.
THE FEASIBILITY OF SOLAR ENERGY USAGE ON RED RIVER ARMY DEPOT Final Report
Gerald W. Crowder Apr. 1976 59 p refs
(AD-A025119; DARCOM-ITC-02-08-76-203) Avail: NTIS HC A04/MF A01 CSCL 13/1
This feasibility study considers the usage of solar energy to heat and cool the main office buildings on the Red River Army Depot, Texarkana Texas. Solar Energy costs are compared with the present heating and cooling system costs with an economic analysis using the annual worth and present worth methods. GRA

N77-12536# Wisconsin Univ., Madison. Engineering Experiment Station.
INCREASED FUEL ECONOMY IN TRANSPORTATION SYSTEMS BY USE OF ENERGY MANAGEMENT: SECOND YEAR'S PROGRAM. EXECUTIVE SUMMARY Final Report
N. H. Beachley and A. A. Frank Dec. 1975 22 p
(Contract DOT-OS-30112)
(PB-256117/3; DOT-TST-76-57) Avail: NTIS HC A02/MF A01 CSCL 21D
Design and analytic evaluation of experimental vehicles equipped with a flywheel energy management powerplant (FEMP) are covered. Development of modeling techniques that permit the accurate prediction of transient emissions from an automobile over any driving cycle are discussed. A limited investigation of the fuel-saving potential of relatively straightforward changes to transmissions and drivetrain systems is included. GRA

N77-12538# Arizona Univ., Tucson.
SYMPOSIUM ON THE FUNDAMENTAL OPTICAL PROPERTIES OF SOLIDS RELEVANT TO SOLAR ENERGY CONVERSION
H. Ehrenreich (Harvard Univ., Cambridge) and B. O. Seraphin Nov. 1975 53 p refs Symp. held at Tucson, Ariz., 20-23 Nov. 1975
(Contract NSF DMR-75-18134)
(PB-256615/6) Avail: NTIS HC A04/MF A01 CSCL 10B
Photothermal solar energy conversion and the optical properties of solids are considered. The optical properties of solids at high temperatures are discussed as well as the optical properties and band structures of materials. The photo and thermal stability of solids are stipulated. GRA

N77-12539# Spectrolab, Inc., Sylmar, Calif.
LOW REFLECTIVITY SOLAR CELLS Final Report, 31 May 1974 - 4 Jan. 1976
Paul Stella and James Avery Jan. 1976 83 p refs
(Contract F33615-74-C-2044; AF Proj. 3145)
(AD-A025922; Rept-380-4686F; AFAPL-TR-75-98) Avail: NTIS HC A05/MF A01 CSCL 10/3
Techniques for both reducing and changing specular reflectance from silicon solar cell assemblies (cell and cover) were developed. Mechanical and chemical treatments of quartz cell covers yielded surfaces that acted like nearly perfect diffusers of incoming visible radiation. A four order of magnitude reduction in specular reflectivity was achieved in this manner. Selective etches and multiple antireflection (AR) coatings were used to reduce the total reflection from the cell. Etches such as sodium and potassium hydroxide reduced the total reflection over the entire silicon cell spectrum (350-1100 nm) to below one percent, with a corresponding increase in output current of nearly eight percent over conventionally prepared surfaces. Some degradation in fill factor was observed with the etched surface so that the current increase at the load voltage was somewhat less than at short circuit. GRA

N77-12540# Federal Energy Administration, Washington, D.C. Office of Data and Analysis.
PETROLEUM MARKET SHARES. REPORT ON SALES OF PROPANE TO ULTIMATE CONSUMERS, 1975
30 Apr. 1976 82 p refs
(PB-255624/9; FEA/B-76/307) Avail: NTIS HC A05/MF A01 CSCL 21D
Data are summarized for the period January 1975 through December 1975, provided by refiners and by a sample of independent marketers of propane and propane-butane mixes. Nationally, the total 1975 sales of propane to utlimate consumers as reported in the survey decreased approximately 944 million gallons (10 percentage points) relative to 1974 levels. In 1975, the market share of refiner sales to ultimate consumers decreased approximately 4.7 percentage points over 1974 levels. Non-branded and branded independent marketers appeared to have increased their market share by 2.6 and 2.1 percentage points, respectively. GRA

N77-12545# Gordian Associates, Inc., New York.
EVALUATION OF THE AIR-TO-AIR HEAT PUMP FOR RESIDENTIAL SPACE CONDITIONING Final Report
23 Apr. 1976 293 p refs
(Contract FEA-CO-50171-00)
(PB-255652/0; FEA/D-76/340) Avail: NTIS HC A13/MF A01 CSCL 13A
The reliability, market acceptance and energy effectiveness (in comparison to electric resistance and fossil fuel space heating systems) of the electric heat pump for residential space heating were evaluated. The impact of increased heat pump saturation on the nation's primary fuel reserves was also evaluated and justified policy options for the government toward this form of space heating were developed. The approach adopted in the study was (1) to critically evaluate available sources of technical information on heat pump performance and market applicability, (2) to make inquiries of selected electric utilities, heat pump manufacturers and heating and air-conditioning contractors, and (3) to compare by computer simulation the energy effectiveness of the heat pump versus electric resistance and fossil fuel space heating systems for representative climatological regions of the continential United States. GRA

N77-12547# North Carolina State Univ., Raleigh. Center for Marine Coastal Studies.
CONFERENCE PROCEEDINGS, ENERGY FROM THE OCEANS, FACT OR FANTASY
Jerome Kohl, ed. Jan. 1976 118 p refs Conf. held at Raleigh, N. C., 27-28 Jan. 1976 Sponsored by NOAA
(PB-256093/6; UNC-SG-76-04; NOAA-76052603) Avail: NTIS HC A06/MF A01 CSCL 10B
Partial Contents: An overview of the oceans as energy sources; Wave power - nodding duck wave energy extractors; Oceanic windpower; Salinity gradients, tides and waves as energy sources; Legal, political, and environmental aspects of ocean thermal energy conversion; Potential mariculture yield of floating sea thermal power plants; Maritime aspects of producing products at OTEC plants, at sea and delivering them to the United States; A Gulf Stream based ocean thermal differences power plant. GRA

N77-12548# Solarex Corp., Rockville, Md.
DEVELOPMENT OF 20 PERCENT EFFICIENT SOLAR CELL Final Project Report, 1 Jun. 1974 - 31 Aug. 1975
J. Lindmayer Oct. 1975 92 p ref
(Grant NSF GI-43090)

(PB-255903/7; NSF/RANN/SE/GI-43090/FR-75-2; NSF/RA/N-75-309) Avail: NTIS HC A05/MF A01 CSCL 10B

The terrestrial efficiency of silicon solar cells was increased to 20%. The gain in efficiency was obtained by improving the optical coupling, the current, the photovoltage, and the fill factor. Extensive theoretical and experimental work was required to relate these quantities to the basic properties of silicon, the other materials used, and to their interactions. The better understanding of the junction properties has resulted in over 600 mV of photovoltage and nearly 80% fill factor, all significant improvements in the state of the art. GRA

N77-12549# Federal Energy Administration, Washington, D.C. Office of Energy Resource Development.

IMPLEMENTING COAL UTILIZATION PROVISIONS OF ENERGY SUPPLY AND ENVIRONMENTAL COORDINATION ACT

Apr. 1976 42 p ref

(PB-255855/9; FEA/G-76/193) Avail: NTIS HC A03/MF A01 CSCL 10B

The status and current strategy of FEA's program for implementing the coal utilization provisions of the Energy Supply and Environmental Coordination Act of 1974 (ESECA)(P.L.93-319) as amended by the Energy Policy and Conservation Act (EPCA)(P.L.94163) are reviewed. GRA

N77-12551# Brown Univ., Providence, R. I. Div. of Engineering.

ASSESSMENT OF CADMIUM SULFIDE PHOTOVOLTAIC ARRAYS FOR LARGE SCALE ELECTRIC UTILITY APPLICATIONS Final Report

Edgar A. DeMeo Feb. 1976 52 p refs Sponsored by Elec. Power Res. Inst.

(PB-255646/2; EPRI/ER-188) Avail: NTIS HC A04/MF A01 CSCL 10B

A procedure is described which yields nominal cost and performance objectives for any solar cell material employed in noncentrating photovoltaic central stations with horizontal arrays, as functions of powerplant capital cost and structure and wiring costs. Results obtained based on subsystems cost and performance parameters judged to be realistic imply that economically competitive utility central station applications will probably require cell conversion efficiencies of 12% or greater and cell costs near one dollar per square foot. Recent results with Cu2S/CdS cells suggest that these objectives may be achievable. GRA

N77-12552# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

MARITIME AND CONSTRUCTION ASPECTS OF OCEAN THERMAL ENERGY CONVERSION (OTEC) PLANT SHIPS

W. H. Avery, R. W. Blevins, G. L. Dugger, and E. J. Francis Apr. 1976 41 p refs Sponsored by Maritime Admin.

(PB-255639/7; APL/JHU-SR-76-1A; MA/RD-940-T76065) Avail: NTIS HC A03/MF A01 CSCL 10B

An analysis of the maritime, construction, and cost aspects of Ocean Thermal Energy Conversion (OTEC) plant ships for deployment in tropical oceans to produce ammonia and other energy intensive products is given. A concept was developed for OTEC plant ships for use at selected sites in tropical oceans to produce energy intensive products on board. These platforms are very stable under normal operating conditions and serve many other needs. GRA

N77-12553# Westinghouse Research Labs., Pittsburgh, Pa.

THIN FILM SOLAR CELLS FOR TERRESTRIAL APPLICATIONS Quarterly Progress Report, 1 Jan. - 31 Mar. 1976

F. A. Shirland, W. J. Biter, E. W. Greeneich, A. J. Simon, and T. P. Brody 14 May 1976 57 p refs

(Grants NSF AER-75-19712; NSF AER-74-14718-A01) (PB-255606/6; Rept-76-9G9-TFSOL-R2; NSF/RANN/SE/AER74-14918-A01/PR; NSF/RA-760129; QPR-3) Avail: NTIS HC A04/MF A01 CSCL 10B

The quality and reproducibility of the vacuum deposited CdS film are studied. Variations in the CdS film structure are related to topological features of the substrate. Difficulties with low output cells were traced to copper contamination of the CdS films. An abbreviated re-calibration of the pre-barrier etch and the barrier dip conditions was carried out using the dual component grid system. Preliminary experiments indicate that cooling the cell to LN2 temperature during deposition of the grid contact on the Cu2S layer makes it possible to deposit gold and aluminum without depressing the cell voltage. GRA

N77-12554# Bechtel Corp., San Francisco, Calif.

PRELIMINARY ECONOMICS AND COMMENT: IN-SITU GASIFICATION OF COAL FOR POWER AND SNG

Nov. 1975 32 p refs Sponsored by NSF

(PB-256034/0) Avail: NTIS HC A03/MF A01 CSCL 08I

A preliminary assessment of the commercial role of in-situ gasification of coal is presented. In-situ gasification of coal has been suggested as an alternative to above-ground gasification of coal to produce power or synthetic natural gas from coal. Preliminary cost comparison between the two systems of gasification leading to those products is considered. The comparison was made for both western coal and eastern coal. GRA

N77-12555# Little (Arthur D.), Inc., Cambridge, Mass.

OUTLOOK FOR RESEARCH AND DEVELOPMENT IN THE UNDERGROUND GASIFICATION OF COAL

Nov. 1975 44 p refs Sponsored by NSF

(PB-256155/3; ADL-760012) Avail: NTIS HC A03/MF A01 CSCL 08I

The potential of in-situ coal gasification technology is compared with conventional coal extraction and utilization to produce pipeline gas or electricity. Also discussed are the nature of the research and development program that appears warranted to bring the technology to the state of commercial acceptance, and significant technical problem areas. GRA

N77-12560# Istituto Superiore di Sanita, Rome (Italy). Lab. di Fisica.

PHYSICAL AND BIOLOGICAL ASPECTS OF THERMAL POLLUTION IN SEA WATER

L. Maiani 7 Nov. 1975 41 p refs In ITALIAN; ENGLISH summary Presented at the Seminar on Principi della Lotta contro gli Inquinamenti delle Acque Marine, Rome, 14-23 Apr. 1975 (ISS-L-75/14) Avail: NTIS HC A03/MF A01

The main physical and biological phenomena related to the discharge of refrigeration waters in marine environment are illustrated. In particular, the size of the coastal areas potentially involved in thermal pollution phenomena in connection with the present forecasts of electric energy production in Italy is discussed, based on the energy budget of an electric power plant making use of either nuclear or natural fuels. Author (ESA)

N77-12568# Equitable Environmental Health, Inc., Woodbury, N.Y.

SELECTED ASPECTS OF WASTE HEAT MANAGEMENT

Allen Serper Jun. 1976 56 p Sponsored by Electric Power Research Inst.

(PB-254401/3; EPRI/FP-165) Avail: NTIS HC A04/MF A01 CSCL 13B

The study reviews the state-of-the-art in: (1) treatment of evaporative cooling systems and offstream cooling system effluents; (2) additional treatment required to utilize wastewater from sewage treatment plants as makeup for cooling systems and boilers; (3) mathematical modeling for power plants cooling systems and discharges; (4) current and recent field monitoring programs; (5) present research to reduce the capital cost and penalties associated with dry cooling towers; and (6) areas where future research is needed. GRA

N77-12571# Environmental Health Lab., McClellan AFB, Calif.
A BIOENVIRONMENTAL STUDY OF EMISSIONS FROM REFUSE DERIVED FUEL Final Report
Jerry W. Jackson Jan. 1976 114 p refs
(AD-A024661; EHL-M-76M-2) Avail: NTIS HC A06/MF A01 CSCL 13/2

Refuse derived fuel (processed municipal solid waste) was used as a supplement to coal in a utility boiler (80,000 lbs. steam per hour). Furnace emissions were determined from coal, and from 1:1 and 2:1 mixes (by volume) of refuse derived fuel (RDF) and coal respectively. In comparison with coal, the 1:1 mix had significantly lower sulfur dioxide, hydrocarbon and nitrogen oxide emission levels. Particulate emissions were unchanged. Lead, chloride and fluoride emissions were significantly increased. The 2:1 mix had lower SO2 and HC emission levels but higher nitrogen oxide emissions and erratic particulate emissions. Lead, chloride and fluoride emissions were significantly increased. Operators had difficulty controlling furnace temperature, fuel distribution and fuel: air ratios during use of the 2:1 mix. Except for increased lead emissions, the use of RDF in a 1:1 mix with coal was favorably indicated. The increased emission of lead creates a complex environmental question. No Federal emission or air quality standard for lead has been promulgated and scientific controversy exists as to an 'accepte' level for airborne lead. The EPA has not proposed any standards, but has issued an opinion calling for the reduction of lead whenever possible. Any planned use of RDF in units not equipped with efficient particulate control devices (efficient for submicrometer particles) must address the problem of increased lead emission. Lead was found predominantly in the submicrometer particle size fraction. Particles in the stack effluent contained 245 times more lead than particles collected by a multiclone. GRA

N77-12572# Arctec, Inc., Columbia, Md.
TESTS OF OIL RECOVERY DEVICES IN BROKEN ICE FIELDS, PHASE 2 Final Report, Jul. - Dec. 1975
L. A. Schultz Jan. 1976 178 p refs
(Contract DOT-CG-51487-A)
(AD-A025748; Rept-273-C; USCG-D-55-76) Avail: NTIS HC A09/MF A01 CSCL 13/2

This final report summarizes the results of tests conducted in broken ice cover with crude oil and No. 2 fuel oil of five oil spill recovery devices manufactured by Lockheed, Marco, Ocean Systems, JBF Scientific, and Oil Mop. Additional tests were conducted to determine the natural spill thickness of crude oil and No. 2 fuel oil in open water at low temperature and in broken ice over. The spreading tests indicated that thin oils will spread to a very thin layer whether in open water or in broken ice cover. Heavy oils in broken ice cover will achieve a natural equilibrium thickness many times greater than the open water thickness due to the partial containment of the oil by the broken ice pieces. The oil recovery tests demonstrated that modifications made to the Lockheed and Marco devices did improve their performance when operating in broken ice cover. Tests conducted with the OSI, JBF, and Oil Mop units were more elementary in nature and did not incorporate modification of the devices for use in ice. GRA

N77-12576# Massachusetts Inst. of Tech., Cambridge. Center for Transportation Studies.
AIR QUALITY CONSIDERATIONS IN TRANSPORTATION PLANNING: FINDINGS AND RECOMMENDATIONS ON TRANSPORTATION CONTROL PLANNING, PHASE 2 Final Report
Elizabeth Bennett, Creig Harvey, Ann Rappaport, and Mabelle Bessey 30 Dec. 1975 223 p refs
(Contract EPA-68-01-2476)
(PB-256424/3; CTS-75-21) Avail: NTIS HC A10/MF A01 CSCL 13B

Transportation control plan (TCP) development was merged with ongoing transportation activities. Recommended procedures for assessing the consistency between transportation proposals and air quality needs are presented. Opportunities for improving coordination among DOT and EPA programs are identified. Issues involved in parking management are explored, and recommendations are made on the development of amendments to the Clean Air Act. GRA

N77-12581# University of Southern Calif., Los Angeles. Allan Hancock Foundation.
TEMPERATURE EFFECTS OF CRUDE OIL IN THE UPPER INTERTIDAL ZONE Final Report
Dale Straughan Jul. 1976 67 p refs Sponsored by ERA
(PB-255956/5; EPA-600/2-76-127) Avail: NTIS HC A04/MF A01 CSCL 13B

Experiments were conducted in the field and laboratory in Southern California to determine the effects of heavy black asphaltic Santa Barbara crude oil on the intertidal barnacle Chthamalus fissus. Observations were also made on surfaces in the Santa Barbara Channel oiled following the 1969 Santa Barbara oil spill. The data presented support the original hypothesis that this type of oil acts as a black body. It is this black body effect which has a long term influence on Chthamalus fissus distribution after the oil has developed a hard surface crust. GRA

N77-12587# Teknekron, Inc., Berkeley, Calif.
ASSESSMENT OF THE IMPACT OF PROPOSED THERMAL EFFLUENT GUIDELINES FOR THE STEAM ELECTRIC POWER INDUSTRY
11 Nov. 1976 120 p
(Contract FEA-C-04-50041-00)
(PB-255937/5; TK-75-0016; FEA/D-76/338) Avail: NTIS HC A06/MF A01 CSCL 13B

The possible impacts on the electrical utility industry of proposed water pollution control regulations are assessed. The Federal Water Pollution Control Amendments of 1972 are analyzed as well as the proposed regulations affecting the steam electric power industry which EPA issued as part of the implementation of that Act. The potential near term fuel penalty associated with mandated dates for compliance and coverage of existing steam generating units is explored in depth. GRA

N77-12592# Energy and Environmental Analysis, Inc., Arlington, Va.
LAWS AND REGULATIONS AFFECTING COAL WITH SUMMARIES OF FEDERAL, STATE, AND LOCAL LAWS AND REGULATIONS PERTAINING TO AIR AND WATER POLLUTION CONTROL, RECLAMATION, DILIGENCE AND HEALTH AND SAFETY, PART 1
Jun. 1976 571 p refs
(Contract DI-14-01-0001-2115)
(PB-255927/6; DOI/OMPRA/CL-76/01-Pt-1) Avail: NTIS HC A24/MF A01 CSCL 13B

All of the federal, state, and local laws and regulations which affect the production and consumption of coal are summarized. GRA

N77-12597# Industrial Environmental Research Lab., Research Triangle Park, N. C.
PROCEDDINGS: SYMPOSIUM OF FLUE GAS DESULFURIZATION, VOLUME 1
Richard D. Stern, Wade N. Ponder, and Roger C. Christman (TRW, Inc., Cleveland, Ohio) May 1976 562 p refs Symp. held in New Orelans, Mar. 1976
(PB-255317/0; EPA-600/2-76-136-a-Vol-1) Avail: NTIS HC A24/MF A01 CSCL 13B

The proceedings document the presentations made during the symposium, which dealt with the status of flue gas desulfurization technology in the United States and abroad. Subjects considered included: regenerable, non-regenerable, and advanced esses; process costs; and by-product disposal, utilization, and marketing. The purpose of the symposium was to provide developers, vendors, users, and those concerned with regulatory guidelines with a current review of progress made in applying processes for the reduction of sulfur dioxide emissions at the full- and semi-commercial scale. GRA

N77-12598# C-E Power Systems, Windsor, Conn.
LABORATORY ANALYSIS OF SOLVENT REFINED COAL
R. W. Borio Jun. 1976 56 p Sponsored by Elec. Power Res. Inst.
(PB-255550/6; EPRI-1235-2A; TR-1) Avail: NTIS HC A04/MF A01 CSCL 13B

With respect to air pollution control in electric power generation, two basic routes were pursued: (1) to clean up the

flue gas before admitting it to the atmosphere, and (2) to clean up the fuel before it is burned in the utility boiler. A solvent refined coal (SRC) process was pursued and construction of a pilot plant was completed. The process solubilizes about 95% of the moisture-ash-free coal in a dissolver operated at 1800 psig and 825 F with a residence time on the order of 30 minutes. The technical feasibility of using SRC as a utility power plant fuel is determined. GRA

N77-12879# Stanford Univ., Calif. High Temperature Gasdynamics Lab.
LIMITING MECHANISMS IN MHD GENERATOR PERFORMANCE Final Report, 15 Nov. 1971 - 15 May 1975
Dec. 1975 127 p refs
(Contract F33615-72-C-1088; AF Proj. 3145)
(AD-A025949; SU-HTGL-104; AFAPL-TR-76-21) Avail: NTIS HC A07/MF A01 CSCL 10/2

Experimental and analytical studies were undertaken to investigate loss mechanisms in MHD generators associated with the boundary layers and the electrodes. Measurements were made of the electrode boundary layer profiles of velocity, static temperature, and electron number density in an operating MHD generator for both subsonic and supersonic flows. Good agreement with a theory which included MHD effects was obtained for subsonic flow and somewhat less satisfactory agreement for supersonic flow where three-dimensional effects were thought to be significant. A theory was developed for predicting boundary layer parameters on the insulating wall of an MHD generator. It was shown that for high power density application of interest to the Air Force, separation may occur as a result of the non-uniform current distribution in the magnetic field direction. The Hall field breakdown between adjacent electrodes was investigated and the importance of the interelectrode gap width was demonstrated. Voltages considerably in excess of the standard 40 volts per electrode pair (or per centimeter) were obtained for the larger gaps, and the importance of the insulator in the breakdown mechanism was postulated. Transient start-up performance of MHD generators was modelled analytically, and it was shown that by suitably controlling the design and thermal capacitance of the electrodes, the generator power response can be tailored to meet the requirements for the pulsed operation studied. GRA

N77-12893# Lockheed Missiles and Space Co., Palo Alto, Calif.
EFFECTIVENESS OF HEAT-EMITTING COATINGS WITH VARIABLE DEGREE OF BLACKNESS
I. P. Gavrilova, G. N. Groshkova, and M. M. Koltun 1976 4 p refs Transl. into ENGLISH from Kosmich. Issled. Akad. Nauk SSSR (Moscow), v. 14, no. 1, 1976 p 156-158
Avail: NTIS HC A02/MF A01; National Translation Center, John Crerar Library, Chicago, Ill. 60616

The production and application of heat emitting coatings whose emissivity would increase with the rise of temperature were investigated. Optical coatings, consisting of polished germanium plates with reflecting aluminum layer, and plates of single-crystalline indium antimonide doped by zinc were found suitable for this purpose. It was found that a temperature rise results in the appearance of a large number of excess free current carriers in the plates. The high coefficient of reflection, assured by the backing layers, starts to diminish and the emissivity grows abruptly. The developed coatings, or solar energy converters, are applicable to solar apparatus as they will diminish the absorption of earth's thermal radiation and protect solar panels and thermoelectrical generators from cooling. The efficiency of these coatings permits the maintainint of an equilibrium temperature on the surface of apparatus. I.M.

N77-12930# Federal Energy Administration, Washington, D.C. Office of Policy and Analysis.
ECONOMICS OF DEPLETABLE RESOURCES: MARKET FORCES AND INTERTEMPORAL BIAS
James L. Sweeney 30 Jun. 1976 52 p refs
(PB-255623/1; FEA/B-76/028) Avail: NTIS HC A04/MF A01 CSCL 05C

Optimal and market determined extraction patterns for a depletable resource available (at a cost) from many reserves of various grades are examined. Under a general set of conditions optimal allocations of a depletable resource can be supported by a purely competitive market. The concept of a time-varying market imperfection function is introduced to determine whether specific market form will overextract or underextract the resource (in comparison to a competitive allocation). The intertemporal biases associated with depletion allowances, monopolies, externalities, vulnerability costs, and price regulations are analyzed. GRA

N77-12946# Aerospace Corp., El Segundo, Calif.
PERSONAL RAPID TRANSIT RESEARCH CONDUCTED AT THE AEROSPACE CORPORATION
C. L. Olson and H. Bernstein Jun. 1976 295 p refs
(Contract DOT-UT-60006)
(PB-256846/7; UMTA-CA-06-0071-76-1) Avail: NTIS HC A13/MF A01 CSCL 13F

Research conducted on the conceptual and experimental development of Personal Rapid Transit (PRT) during the period from 1968 to 1975 is summarized. The work considered not only the technical and operational aspects of the PRT concept, but also included estimates of PRT capital and operating costs, analyses of system safety and reliability, analyses of urban applications and associated economics, evaluation of PRT energy utilization, development of PRT planning methodologies, and assessments of PRT deployment impacts. Technology shortfalls associated with the possible future implementation of the specific PRT concept are identified, and research and development activities to overcome these shortfalls are recommended. GRA

N77-13012# Technische Hogeschool, Delft (Netherlands). Dept. of Aeronautical Engineering.
COMPARATIVE WIND TUNNEL INVESTIGATION OF SAIL PROFILES FOR WINDMILLS [VERGELIJKEND WINDTUNNELONDERZOEK VAN PROFIELEN VAN FOKWIEKEN VOOR WINDMOLENS]
P. L. Fauel Feb. 1975 20 p In DUTCH
(VTH-191) Avail: NTIS HC A02/MF A01

Low speed wind tunnel tests were carried out to determine sail profiles for improving the performance of classical Dutch windmills. Results are presented in graphs, in which the coefficient of force-in-plane related to the wind velocity is depicted as function of the ratio between circumferential speed and effective wind velocity. It appears that improvements in performance may be obtained by changing the shape of the sails. ESA

N77-13064*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COST/BENEFIT ASSESSMENT OF THE APPLICATION OF COMPOSITE MATERIALS TO SUBSONIC COMMERCIAL TRANSPORT ENGINES
J. R. Faddoul and R. A. Signorelli Nov. 1976 33 p refs
(NASA-TM-X-73557; E-8996) Avail: NTIS HC A03/MF A01 CSCL 21E

Results from a number of studies concerned with the cost and benefits of applying advanced composite materials to commercial turbofan engines are summarized. For each application area the optimistic and pessimistic benefit projections were averaged to arrive at a projected yearly percentage fuel savings for a commercial fleet of advanced technology transport aircraft. Engine components included in the summary are the fan section which includes fan blades, fan frame/case, and the blade containment ring; the nacelle; and the high pressure turbine blades and vanes. The projected fuel savings resulting from the application of composites are 1.85 percent for the fan section, 1.75 percent for the nacelle, and 2.35 percent for the high pressure turbine. Author

N77-13110# Centre National d'Etudes Spatiales, Toulouse (France).
TESTING AND FABRICATION OF SOLAR ABSORBERS FOR THE D5A' SATELLITE [MISE AU POINT ET FABRICATION D'ABSORBEURS SOLAIRES POUR LE SATELLITE D5A']
Jacques Simon and Michel Riboulet (ONERA, Toulouse) May 1976 15 p refs In FRENCH; ENGLISH summary
(CNES-NT-37) Avail: NTIS HC A02/MF A05

A vacuum evaporated absorber coating consisting of layers of SiOx - NiCr - Al was developed for use on the French D5A' satellite. This coating has a solar absorptance coefficient of 0.70 and an infrared emittance coefficient of 0.045. Qualification tests (storage, humidity, thermal cycling, ultraviolet irradiation, particle irradiation, etc.) are reported. Author (ESA)

N77-13229# Bureau of Mines, Washington, D.C.
HISTORICAL FUELS AND ENERGY CONSUMPTION DATA, 1960 - 1972, UNITED STATES BY STATES AND CENSUS DISTRICTS EAST OF THE MISSISSIPPI
Lulie H. Crump May 1976 462 p
(PB-255176/0; BM-IC-8704) Avail: NTIS HC A20/MF A01 CSCL 21D

Salient historical data on consumption of fuels and energy are summarized by state and census district for the years 1960 through 1972. Data are given for the residential, commercial, industrial, and transportation sectors. GRA

N77-13230# Bureau of Mines, Washington, D.C.
HISTORICAL FUELS AND ENERGY CONSUMPTION DATA, 1960 - 1972, UNITED STATES BY STATES AND CENSUS DISTRICTS WEST OF THE MISSISSIPPI
Lulie H. Crump May 1976 431 p
(PB-255177/8; BM-IC-8705) Avail: NTIS HC A19/MF A01 CSCL 21D

For abstract, see N77-13229.

N77-13231# Naval Air Propulsion Test Center, Trenton, N.J. Dept. of Propulsion Technology and Projection Engineering.
EVALUATION OF A JP-5 TYPE FUEL DERIVED FROM OIL SHALE Interim Report
J. Solash, C. J. Nowack, and R. J. Delfosse May 1976 47 p refs
(AD-A025417; NAPTC-PT-82) Avail: NTIS HC A03/MF A01 CSCL 21/4

A kerosene fuel derived from oil shale was evaluated for suitability as a substitute for petroleum derived JP-5. Engine performance and gaseous emissions were evaluated using a T63-A-5A engine. Specification analyses were performed to determine conformance with the MIL-T-5624J specification for JP-5 grade fuel. Engine performance of the oil shale derived fuel was equivalent to that of a typical petroleum derived JP-5. While carbon monoxide (CO) and unburned hydrocarbon (THC) emissions of the oil shale fuel were equivalent to those of petroleum fuels, the nitrogen oxides were higher for the oil shale fuel. A high concentration of fuel bound nitrogen was implicated as the cause for the high nitrogen oxide emissions. The oil shale derived fuel was found not to conform to specifications for contamination, existent gums, thermal stability, freeze point and viscosity at -34.5 C (-30 F). A program of post-refinery upgrading studies was initiated in order to improve these deviant properties. This program included filtration, distillation, clay and acid treatment and urea extraction. It was found that no one single post-refinery treatment could improve all deviant properties. Author (GRA)

N77-13232# Mitre Corp., McLean, Va.
SURVEY OF ALCOHOL FUEL TECHNOLOGY, VOLUME 1
Bernard Baratz, Robert Ouellette, Wayne Park, and Betsy Stokes Nov. 1975 143 p refs 2 Vol.
(Contract NSF C-925)
(PB-256007/6; M74-61-Vol-1) Avail: NTIS HC A07/MF A01

Information on alcohols as fuels is presented. Current and ongoing research is tabulated. GRA

N77-13233# Mitre Corp., McLean, Va.
SURVEY OF ALCOHOL FUEL TECHNOLOGY, VOLUME 2
Betsy Stokes and Wayne Park Nov. 1975 68 p refs 2 Vol.
(Contract NSF C-925)
(PB-256008/4; M74-61-Vol-2) Avail: NTIS HC A04/MF A01

A bibliography covering all aspects of alcohol fuel technology is presented. GRA

N77-13234# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
THE IMPACT OF JP-4/JP-8 CONVERSION ON AIRCRAFT ENGINE EXHAUST EMISSIONS Interim Technical Report, Jul. 1975 - Feb. 1976
William S. Blazowski May 1976 52 p refs
(AF Proj. 3048)
(AD-A026546; AFAPL-TR-76-20) Avail: NTIS HC A04/MF A01 CSCL 21/4

The proposed conversion of predominant Air Force fuel usage from JP-4 to JP-8 has created the need to examine the dependence of engine pollutant emission on fuel type. Available data concerning the effect of fuel type on emissions has been reviewed. T56 single combustor testing has been undertaken to determine JP-4/JP-8 emission variations over a wide range of simulated engine cycle operating conditions at idle. In addition, a J85-5 engine was tested using JP-4 and JP-8. Results of the previous and new data collectively led to the following conclusions regarding conversion to JP-8: (a) HC and CO emission changes will depend upon individual combustor design features, (b) no change to NOx emission will occur, and (c) an increase in smoke/particulate emissions will result. It is recommended that these findings be incorporated into air quality analytical models to define the overall impact of the proposal conversion. Further, it is recommended that combustor analytical models be employed to attempt prediction of the results described herein. Should these models be successful, analytical prediction of JP-8 emissions from other Air Force engine models may be substituted for more combustor rig or engine testing. Author (GRA)

N77-13235 British Library Lending Div., Boston Spa (England).
INVESTIGATION OF THE MECHANISM OF CLEANING HEATING SURFACES BY THE PULSATION METHOD
Ya. M. Shchelokov, E. M. Telegin, V. N. Podymov, F. N. Imamutdinov, M. I. Kuklinskii, A. I. Berezhinskii, N. L. Semikolenykh, Yu. V. Akhmin, A. P. Bokovets, and V. I. Dmitrin 1976 14 p refs Transl. into ENGLISH from Stal (USSR), no. 4, 1976 p 377-380
(BLL-M-25448-(5828.4F)) Avail: British Library Lending Div., Boston Spa, Engl.

The mechanism of the removal of dust deposits from tube surface under the action of flame pulsations was analysed on an experimental rig. The main cleaning effect is secured by the shock wave; impetus of the jet and the stream of gases flowing over the surface play no substantial part. A pulsation cleaning system is described for an operating experimental converter-gas waste-heat boiler. Author

N77-13324 Drexel Univ., Philadelphia, Pa.
ASSESSMENT OF POWER SYSTEM SECURITY UNDER LOAD UNCERTAINTY Ph.D. Thesis
Gabriel Chike Ejebe 1976 218 p
Avail: Univ. Microfilms Order No. 76-24225

A method was developed for the assessment of power system steady state security in the presence of load uncertainty. A set-theoretic formulation of the security assessment problem was developed and is based on the complete characterization of the set of operating states - generation levels - for which the system is permanently secure in the presence of uncertainties in the bus load levels. This explicit characterization constitutes a permanently secure region. Dissert. Abstr.

N77-13355 New Mexico Univ., Albuquerque.
ANALYSIS OF A HEAT PIPE EXCHANGER Ph.D. Thesis
Joseph Olorunfemi Amode 1976 131 p
Avail: Univ. Microfilms Order No. 76-25650

A computer program was developed to predict heat pipe performance, finned-tube heat exchanger performance, and the overall performance of a finned-tube heat exchanger. The computer analysis uses conventional heat exchanger design techniques and a new heat pipe design technique which includes probabilistic design of artery wick heat pipes. The heat pipe exchanger analysis program is normally used by specifying the mass flow rates, inlet temperatures, and inlet pressures of the hot and cold air streams. The heat transfer capability of the heat pipes was matched with that of the finned-tube heat exchanger in order to select appropriate heat pipes, and thus obtain minimum volume, weight, and cost for the heat exchanger. The results predicted by the

heat pipe heat exchanger analysis program were compared to the data available in the literature, and relatively good agreement was obtained. Dissert. Abstr.

N77-13426*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AUTOMOTIVE GAS TURBINE FUEL CONTROL Patent Application
H. S. Gold, inventor (to NASA) Filed 8 Nov. 1976 28 p
(NASA-Case-LEW-12785-1; US-Patent-Appl-SN-739909) Avail: NTIS HC A03/MF A01 CSCL 21E

A fuel control useful for automotive-type gas turbines and particularly advanced gas turbines utilizing variable geometry components to improve mileage and reduce pollution emission is disclosed. The fuel control described compensates for fuel density variations, inlet temperature variations, turbine vane actuation, acceleration, and turbine breaking. These parameters are utilized to control various orifices, spool valves and pistons in a desired manner. NASA

N77-13484 Illinois Univ., Urbana-Champaign.
ISOTOPIC CHARACTERIZATION OF ILLINOIS NATURAL GAS Ph.D. Thesis
Dennis Dale Coleman 1976 185 p
Avail: Univ. Microfilms Order No. 76-24060

To characterize natural gas from various sources in Illinois, over 100 samples were collected and analyzed. Of these, 19 samples from gas wells in Paleozoic bedrock were studied. This gas appears to have been formed by thermal decomposition of organic material. In addition, 22 samples from gas wells in glacial drift were analyzed. The origin of this gas from bacterial decomposition of organic material within the glacial drift was confirmed by radiocarbon dating of methane. Evidence suggests that the primary mode of methane migration in glacial drift is in solution with ground water. Analyses of 52 samples of gas from freshwater wells indicate that all but two of these samples are of bacterial origin. Several samples of methane from artificial sources including water wells and sanitary landfills, were also analyzed. Finally, a model of kinetic isotope effects during bacterial production of methane was developed and compared to both experimental and natural systems. Dissert. Abstr.

N77-13516# Resource Planning Associates, Inc., Cambridge, Mass.
THE EXPLORATION, DEVELOPMENT AND PRODUCTION OF NAVAL PETROLEUM RESERVE NUMBER 4 Final Report
19 Jul. 1976 386 p refs
(Contract FEA-CR-05-60579-00)
(PB-256714/7; FEA/S-76/368) Avail: NTIS HC A17/MF A01 CSCL 10A

The history of exploration in and the resource potential of NPR-4 are discussed. Likely levels of investment, manpower, and resources necessary to explore and develop NPR-4 are outlined. Alternative management programs for NPR-4 exploration and development are analyzed and the likely social and environmental impacts of NPR-4 exploration and development are addressed. GRA

N77-13525 Committee on Science and Technology (U. S. House).
INVENTORY OF ENERGY RESEARCH AND DEVELOPMENT (1973 - 1975), VOLUME 1
Washington GPO 1976 921 p refs Rept. for Subcomm. on Energy Res., Development and Demonstration of Comm. on Sci. and Technol., 94th Congr., 2d Sess., Jan. 1976 Sponsored by ERDA and NSF Prepared by ORNL
(Contract W-7405-eng-26)
(GPO-64-734-Vol-1) Avail: SOD HC $8.60

An updated assessment of the national energy resources and technology is presented. The inventory listings encompass all energy-related research and development concerned with: (1) energy sources, (2) electric power generation, transmission, distribution, and storage, (3) energy uses and conservation, (4) economic and legal aspects; and (5) health and environmental studies. Bibliographies with short description of the studies are organized in four volumes as prepared for the U. S. House of Representatives. I.M.

N77-13526 Committee on Science and Technology (U. S. House).
INVENTORY OF ENERGY RESEARCH AND DEVELOPMENT (1973 - 1975), VOLUME 2
Washington GPO 1976 1341 p refs Rept. for Subcomm. on Energy Res., Development and Demonstration of Comm. on Sci. and Technol., 94th Congr., 2d Sess., Jan. 1976 Sponsored by ERDA and NSF Prepared by ORNL
(Contract W-7405-eng-26)
(GPO-64-734-Vol-2) Avail: SOD HC $12.00
For abstract, see N77-13525.

N77-13527 Committee on Science and Technology (U. S. House).
INVENTORY OF ENERGY RESEARCH AND DEVELOPMENT (1973 - 1975), VOLUME 3
Washington GPO 1976 1317 p refs Rept. for Subcomm. on Energy Res., Development and Demonstration of Comm. on Sci. and Technol., 94th Congr., 2d Sess., Jan 1976 Sponsored by ERDA and NSF Prepared by ORNL
(Contract W-7405-eng-26)
(GPO-64-734-Vol-3) Avail: SOD HC $12.00
For abstract, see N77-13525.

N77-13528 Committee on Science and Technology (U. S. House).
INVENTORY OF ENERGY RESEARCH AND DEVELOPMENT (1973 - 1975), VOLUME 4
Washington GPO 1976 1408 p refs Rept. for Subcomm. on Energy Res., Development and Demonstration of Comm. on Sci. and Technol., 94th Congr., 2d Sess., Jan. 1976 Sponsored by ERDA and NSF Prepared by ORNL
(Contract W-7405-eng-26)
(GPO-64-734-Vol-4) Avail: SOD HC $13.00
For abstract, see N77-13525.

N77-13532*# General Electric Co., Philadelphia, Pa. Space Div.
DEFINITION STUDY FOR PHOTOVOLTAIC RESIDENTIAL PROTOTYPE SYSTEM
Neal F. Shepard, Ralph Landes, and William P. Kornrumpf Sep. 1976 271 p refs
(Contract NAS3-19769)
(NASA-CR-135039; Doc-76SDS4225) Avail: NTIS HC A12/MF A01 CSCL 10B

A site evaluation was performed to assess the relative merits of different regions of the country in terms of the suitability for experimental photovoltaic powered residences. Eight sites were selected based on evaluation criteria which included population, photovoltaic systems performance and the cost of electrical energy. A parametric sensitivity analysis was performed for four selected site locations. Analytical models were developed for four different power system implementation approaches. Using the model which represents a direct (or float) charge system implementation the performance sensitivity to the following parameter variations is reported: (1) solar roof slope angle; (2) ratio of the number of series cells in the solar array to the number of series cells in the lead-acid battery; and (3) battery size. For a Cleveland site location, a system with no on site energy storage and with a maximum power tracking inverter which feeds back excess power to the utility was shown to have 19 percent greater net system output than the second place system. The experiment test plan is described. The load control and data acquisition system and the data display panel for the residence are discussed. Author

N77-13533*# Martin Marietta Corp., Denver, Colo.
DEFINITION STUDY FOR PHOTOVOLTAIC RESIDENTIAL PROTOTYPE SYSTEM Final Report
M. S. Imamura, R. Hulstrom, C. Cookson, B. H. Waldman (Brooks Waldman Assoc.), and R. Lane (Brooks Waldman Assoc.) Sep. 1976 303 p refs
(Contract NAS3-19768)
(NASA-CR-135056; MCR-76-394; ERDA/NASA-19768) Avail: NTIS HC A14/MF A01 CSCL 10A

A parametric sensitivity study and definition of the conceptual design is presented. A computer program containing the solar irradiance, solar array, and energy balance models was developed to determine the sensitivities of solar insolation and the corresponding solar array output at five sites selected for this study as well as the performance of several solar array/battery systems. A baseline electrical configuration was chosen, and three design options were recommended. The study indicates that the most sensitive parameters are the solar insolation and the inverter efficiency. The baseline PST selected is comprised of a 133 sq m solar array, 250 ampere hour battery, one to three inverters, and a full shunt regulator to limit the upper solar array voltage. A minicomputer controlled system is recommended to provide the overall control, display, and data acquisition requirements. Architectural renderings of two photovoltaic residential concepts, one above ground and the other underground, are presented. The institutional problems were defined in the areas of legal liabilities during and after installation of the PST, labor practices, building restrictions and architectural guides, and land use. Author

N77-13534*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

WIND TUNNEL MEASUREMENTS OF THE TOWER SHADOW ON MODELS OF THE ERDA/NASA 100 KW WIND TURBINE TOWER

Joseph M. Savino and Lee H. Wagner Nov. 1976 37 p
(NASA-TM-X-73548; E-8984) Avail: NTIS HC A03/MF A01 CSCL 10B

Detailed wind speed profile measurements were made in the wake of 1/25 scale and 1/48 scale tower models to determine the magnitude of the speed reduction (the tower shadow). The 1/25 scale tower modeled closely the actual wind turbine including the service stairway and the equipment elevator rails on one face. The 1/48 scale model was made of all tubular members. Measurements were made on the 1/25 scale model with and without the stairway and elevator rails, and on the 1/48 all tube model without stairs and rails. The test results show that the stairs and rails were a major source of wind flow blockage. The all tubular 1/48 scale tower was found to offer less resistance to the wind than the 1/25 scale model that contained a large number of square sections. Shadow photos are included to show the extent of the blockage offered to the wind from various directions. Author

N77-13535*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STANDARDIZED PERFORMANCE TESTS OF COLLECTORS OF SOLAR THERMAL ENERGY - A FLAT-PLATE COPPER COLLECTOR WITH PARALLEL MYLAR STRIPING

Susan M. Johnson Nov. 1976 8 p ref
(NASA-TM-X-73553; E-8991) Avail: NTIS HC A02/MF A01 CSCL 10A

Basic test results are reported for a flat plate solar collector whose performance was determined in a solar simulator. The collector was tested over ranges of inlet temperatures, fluxes and one coolant flow rate. Collector efficiency is correlated in terms of inlet temperature and flux level. Author

N77-13536*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STANDARDIZED PERFORMANCE TESTS OF COLLECTORS OF SOLAR THERMAL ENERGY: AN EVACUATED FLAT-PLATE COPPER COLLECTOR WITH A SERPENTINE FLOW DISTRIBUTION

Susan M. Johnson Nov. 1976 8 p ref
(NASA-TM-X-73415; E-9001) Avail: NTIS HC A02/MF A01 CSCL 10A

Basic test results are given for a flat plate solar collector whose performance was determined in the NASA-Lewis solar simulator. The collector was tested over ranges of inlet temperatures, fluxes and one coolant flow rate. Collector efficiency is correlated in terms of inlet temperature and flux level. Author

N77-13537*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

STATUS OF THE ERDA/NASA PHOTOVOLTAIC TESTS AND APPLICATIONS PROJECT

J. N. Deyo, H. W. Brandhorst, Jr., and A. F. Forestieri 18 Nov. 1976 10 p Presented to the 12th Photovoltaic Specialists Conf., 15-18 Nov. 1976; sponsored by the Inst. of Electrical and Electronic Engineers
(NASA-TM-X-73567) Avail: NTIS HC A02/MF A01 CSCL 10A

The Tests and Applications Project of the ERDA Photovoltaic Program is concerned with the testing of photovoltaic systems and the growth of their use in real terrestrial applications. This activity is an important complement to the development of low cost solar arrays by providing requirements based on application needs and stimulating markets to create demand to absorb increasing production capacity. A photovoltaic system test facility is now operational, market stimulation has been initiated through applications, and standards for terrestrial cell measurements established. Author

N77-13539# Stockholm Univ. (Sweden). Dept. of Meteorology.

AN ESTIMATE OF THE INTERACTION OF A LIMITED ARRAY OF WINDMILLS

Carl Crafoord Nov. 1975 43 p refs Sponsored in part by Swed. Board for Energy Source Develop.
(Contract STU-75-3130)
(DM-16) Avail: NTIS HC A03/MF A01

Using logarithmic wind profiles, the increment of roughness parameter, as an infinite array of windmills is added to an already rough surface, is calculated by a method of superposition of surface stress and windmill drag. The obtained logarithmic profiles are used to calculate the relative power of a single windmill in an unlimited array. These values are then used as limiting values for the relative power of a windmill unit in a limited array, using a simple continuity model of energy flow. Various examples are given to illustrate the efficiency of different windmill units and array sizes. Examples are also given for a tentative 100 MW group station, using different rated power units. The results are to be seen as mainly qualitative due to the crudeness of the assumptions involved. Fairly independent of chosen rated power of the individual units, group stations with small arrays (5 to 10 rows) seem to be mainly fed by horizontal flow, but for larger array sizes exceeding 50 x 50 units, the vertical flux from above becomes more important. Author (ESA)

N77-13540# Bosch (Robert) G.m.b.H., Stuttgart (West Germany). Zentralabteilung Forschung.

MANUFACTURING AND EVALUATION OF PHTHALOCYANINES AS CATALYSTS FOR FUEL CELLS Final Report

Hermann Ziener, Hermann Fischer, and Uwe Krong Bonn Bundesmin. fuer Forsch. u. Technol. Jul. 1976 139 p refs In GERMAN; ENGLISH summary Sponsored by Bundesmin. fuer Forsch. u. Technol.
(BMFT-FB-T-76-25; BMFT-NT-145) Avail: NTIS HC A07/MF A01; ZLDI, Munich, DM 28,80

Various phthalocyanines were synthesized and their abilities to catalize the electrochemical reduction of oxygen were compared. A reaction scheme of the catalyzed oxygen reduction was worked out. Reaction-kinetic measurements show that the phthalocyanines are attacked by the hydrogen peroxide produced in the catalyzed reaction. As the phthalocyanines also decompose in acid electrolytes, they cannot be expected to be usable catalysts in acid fuel cells. Investigation of the interactions of the phthalocyanines with carbon black substrates indicate that their catalytic properties are lost when free valencies of the central atom are saturated by phenolic surface groups of the carbon black.
Author (ESA)

N77-13541# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Lampoldshausen (West Germany). Inst. fuer Chemische Raketenantriebe.

PRODUCTION OF CHEMICAL ENERGY CARRIERS BY NON-EXPANDABLE ENERGY SOURCES

Joachim Nitsch 8 Jun. 1976 45 p refs In GERMAN; ENGLISH summary Report will also be announced as translation

(ESA-TT-338)
(DLR-FB-76-32) Avail: NTIS HC A03/MF A01; DFVLR, Cologne, DM 22.40

The different forms of energy (radiation, high-temperature heat, and electricity) arising from non-expandable energy sources like solar energy can be used for the production of chemical energy-carriers. Possible methods are the splitting of water by means of photolysis, thermochemical cycles, and electrolysis, as well as the storage of energy in closed loop chemical systems. These methods are described, and efficiencies and costs of the production of these energy carriers are specified. Special problems of the long-distance transportation of hydrogen produced by solar energy are described and the resulting costs estimated.

Author (ESA)

N77-13542# Thermo Electron Corp., Waltham, Mass.
A STUDY OF INPLANT ELECTRIC POWER GENERATION IN THE CHEMICAL, PETROLEUM REFINING, AND PAPER AND PULP INDUSTRIES Summary Report
S. E. Nydick, J. P. Davis, J. Dunlay, S. Fain, and R. Sukhuja Jun. 1976 18 p
(Contract FEA-CO-04-50224-00)
(PB-255658/7; TE5429-97-76; FEA/D-76/320) Avail: NTIS HC A02/MF A01 CSCL 10B

The maximum thermodynamic and economic potentials for increased inplant electric power generation by steam turbine, gas turbine, and diesel topping and steam and organic bottoming cycles were determined for the chemical, petroleum refining, and paper and pulp industries with and without government sponsored economic incentives. Institutional, legal and regulatory constraints were also assessed. GRA

N77-13543# Thermo Electron Corp., Waltham, Mass.
A STUDY OF IMPLANT ELECTRIC POWER GENERATION IN THE CHEMICAL, PETROLEUM REFINING, AND PAPER AND PULP INDUSTRIES Final Report
S. E. Nydick, J. P. Davis, J. Dunlay, S. Fain, and R. Sukhuja Jun. 1976 314 p refs
(Contract FEA-CO-04-50224-00)
(PB-255659/5; RE5429-97-76; FEA/D-76/321) Avail: NTIS HC A14/MF A01 CSCL 10B

For abstract, see N77-13542.

N77-13548# Naval Postgraduate School, Monterey, Calif.
HYDRAULIC RAM EFFECT ON COMPOSITE FUEL CELL ENTRY WALLS M.S. Thesis
Alfred Nicholas Duva, Jr. Mar. 1976 76 p refs
(AD-A024832) Avail: NTIS HC A05/MF A01 CSCL 10/2

Catastrophic failure of a partially filled aircraft fuel cell due to impact and penetration by a high speed projectile often occurs due to a phenomenon known as hydraulic ram. The structural response of the fuel tank walls to hydraulic ram should be of vital concern to the designers of aircraft fuel cells. Considerable research has been conducted to determine the effects of hydraulic ram on metallic fuel cells, but very little attention has been given to fuel cells made with the new advanced composite materials. The purpose of this research is to examine the various effects of hydraulic ram on a graphite/epoxy wall when subjected to penetration by a .222 caliber projectile. Eight hydraulic ram tests are made on a clamped 11-inch square plate 0.067 inches thick at projectile velocities between 2,600 and 2,800 fps. The engineering properties of the laminate are determined both analytically and experimentally. The low velocity shots caused only slight damage to the plate. At the higher velocities, the hydraulic ram caused considerable damage, including total severance of the plate from its clamped support over much of the outer perimeter. The results of this research illustrate the importance of the method of attachment of the composite wall at its boundaries. Author (GRA)

N77-13549# Institute of Gas Technology, Chicago, Ill.
BURNER DESIGN CRITERIA FOR CONTROL OF NOx FROM NATURAL GAS COMBUSTION. VOLUME 2: RAW DATA AND EXPERIMENTAL RESULTS Final Report, Jun. 1973 - Sep. 1975
D. R. Shoffstall Jun. 1976 416 p
(Contract EPA-68-02-1360)
(PB-256806/1; EPA-600/2-76-098-b-Vol-2) Avail: NTIS HC A18/MF A01 CSCL 13A

Experiments were conducted with natural gas to determine the relationship between combustion aerodynamics and pollution emission characteristics of industrial burners. The procedure used to select the test burners is discussed. Detailed flame characterizations of baseline operations assembled from in-the-flame temperature, gas species and flow direction data analysis are included. Similar in-the-flame studies were made for control conditions which minimized emissions for each burner type. Raw data collected from the input/output trials are also included.

GRA

N77-13550# Skidmore, Owings and Merrill, Washington, D. C.
BONNEVILLE POWER ADMINISTRATION ELECTRIC ENERGY CONSERVATION STUDY Final Report
Jun. 1976 333 p refs
(Contract DI-14-03-6100N)
(PB-256766/7) Avail: NTIS HC A15/MF A01 CSCL 10B

The potential for conservation to reduce forecasted electric energy needs in the Pacific Northwest is analyzed. The report outlines energy savings and impacts for a variety of conservation strategies. Energy conservation is defined as improving the efficiency of energy use. None of the measures require curtailment of energy-using practices. The potential for conservation in the region ranges from 5 to 33 percent of the 1995 forecast demand. GRA

N77-13551# Exxon Research and Engineering Co., Linden, N.J. Government Research Lab.
CARBON OXIDATION CATALYST MECHANISM STUDY FOR FUEL CELLS Final Report, Oct. 1974 - Jun. 1975
Yen-Chi Pan Mar. 1976 69 p refs
(Contract EPA-68-02-1831)
(PB-256420/1; EXXON/GRU.2DYBA.75/715520; EPA-600/2-76-057) Avail: NTIS HC A04/MF A01 CSCL 10B

The electrocatalytic behavior of carbon and the reaction kinetics of oxygen reduction are discussed to determine whether any combination of conditions, (temperature, electrolyte concentration, and pH value) exist in which a carbon cathode could operate sufficiently well to be used in a practical fuel cell. A systematic examination of the electrocatalytic activity for oxygen reduction in various electrolytes was conducted, using a rotating ring-disk electrode. GRA

N77-13552# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.
WIND ENERGY CONVERSION Progress Report, 15 Jul. 1975 - 15 Feb. 1976
R. H. Miller, M. Martinez-Sanchez, J. Dugundji, E. Larrabee, and T. Humes 15 Feb. 1976 183 p refs
(Grant NSF AER-75-00826)
(PB-256198/3; ASRL-TR-184-2; NSF/RA-760160) Avail: NTIS HC A09/MF A01 CSCL 10B

Testing of a wind tunnel model and aeroelastic analyses indicate the scope of the problem involved in selecting a suitable speed for a wind turbine. It is proposed that, at least for conventional rotor type wind turbines, a constant tip speed rather than a constant ratio of tip speed to wind speed is a more satisfactory design solution. The penalty involved in maintaining constant tip speed was investigated in order to determine whether control should be considered for a constant speed or for variable speed (constant tip speed ratio) wind turbine. As a result of experience with aeroelastic analyses it was decided to concentrate on the constant speed configuration. Airloads in the presence of wind shear and gust were also investigated. GRA

N77-13553# Gilbert Associates, Inc., Reading, Pa.
DESIGN PHASE UTILITY ANALYSIS FOR GAS TURBINE AND COMBINED CYCLE PLANTS Final Report
P. A. Kadlec and O. R. Martins 12 Aug. 1976 78 p refs
(Contract FEA-CO-05-60575-00)

(PB-256665/1; GAI-1915; FEA/G-76/369) Avail: NTIS HC A05/MF A01 CSCL 10B

Analysis is made of factors, trends and effects related to the usage of gas turbine (GT) and combined cycle (CC) power plants for base, intermediate and peaking load service as compared to alternate fossil fuel units for both public and privately owned utilities. Future usage of GT and CC units to supply base, intermediate and peak load needs is predicted. The engineering advantages and disadvantages of CC and GT technologies are identified. A definition for combined cycle power plants is presented. GRA

N77-13554# Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

MARITIME AND CONSTRUCTION ASPECTS OF OCEAN THERMAL ENERGY CONVERSION (OTEC) PLANT SHIPS, DETAILED REPORT

W. H. Avery, R. W. Blevins, G. L. Dugger, and E. J. Francis Apr. 1976 232 p refs

(Contract MA-5-38054)

(PB-257444/0; APL/JHU-SR-76-1B; MA-RD-940-T76074) Avail: NTIS HC A11/MF A01 CSCL 10A

The development of Ocean Thermal Energy Conversion (OTEC) plant-ships to produce energy-intensive products at sea is considered. Such OTEC plant-ships would use the temperature difference between the warm surface layer and the cold deep layers of a tropical ocean to drive a heat engine to produce electric power that, in turn, would be used to produce ammonia, aluminum, liquid hydrogen, and/or other products. The construction, deployment, operation, and shipping support of these plant-ships are discussed. GRA

N77-13555# Federal Energy Administration, Washington, D.C.

FINAL ASSESSMENT OF THE ENVIRONMENTAL IMPACTS OF THE STATE ENERGY CONSERVATION PROGRAM (PUBLIC LAW 94-163, TITLE III, PART C, THE ENERGY POLICY AND CONSERVATION ACT)

Apr. 1976 92 p

(PB-256044/9; FEA/D-76/363) Avail: NTIS HC A05/MF A01 CSCL 10A

The Energy Policy and Conservation Act provides for a program to be administered by each state in which the State and Federal Governments may work in partnership to develop comprehensive energy conservation plans. An environmental analysis of the cumulative national impact of the State Energy Conservation Program is presented. Environmental impact data that can be employed by the states in assessing the environmental impacts of energy conservation measures which might be a part of their programs are also included. GRA

N77-13556# Northwestern Univ., Evanston, Ill. Technological Inst.

HEAT EXTRACTION FROM HOT DRY ROCK MASSES Progress Report, 1 Aug. 1975 - 31 Jan. 1976

J. Weertman, J. D. Achenbach, Z. P. Bazant, J. Dundurs, L. M. Keer, T. Mura, and S. Nemat-Nasser Apr. 1976 125 p refs

(Grant NSF AER-75-00187)

(PB-256775/8; NSF/RA-760181) Avail: NTIS HC A06/MF A01 CSCL 08I

The following topics are reported: (1) analytic study of crack growth and shape; (2) finite element solution of geothermal energy extraction; (3) fluid flow through cracks; (4) model experiments; and (5) seismic detection of hydraulically induced fractures. GRA

N77-13557# Army Construction Engineering Research Lab., Champaign, Ill.

METHOD FOR ESTIMATING SOLAR HEATING AND COOLING SYSTEM PERFORMANCE

Douglas C. Hittle, George N. Walton, and Donald F. Holshouser 1976 14 p refs

(AD-A026041) Avail: NTIS HC A02/MF A01 CSCL 13/1

During FY75 the Construction Engineering Research Laboratory, under funding from the Office of the Chief of Engineers, engaged in a research effort to develop a method for the preliminary determination of the feasibility of heating and cooling buildings with solar energy. The principal objective of the work effort was to provide a simple means for estimating the expected performance of a given solar heating and cooling system when applied to typical buildings in various regions of the country. GRA

N77-13566# National Enforcement Investigations Center, Denver, Colo.

CHARACTERIZATION AND EVALUATION OF WASTEWATER SOURCES UNITED STATES STEEL CORPORATION, CLAIRTON WORKS, PITTSBURGH, PENNSYLVANIA, 28-31 JANUARY 1976

May 1976 136 p refs Prepared in cooperation with EPA, Philadelphia, region 3

(PB-255586/0; EPA-330/2-76-025) Avail: NTIS HC A07/MF A01 CSCL 13B

The United States Steel Corporation (USSC) Clairton Works consists of a coke plant, chemical plant and steel plant. The facility is in the city of Clairton on the Monongahela River, about 29 km (18 mi) upstream of the confluence of the Ohio, Monongahela and Allegheny Rivers. The major activity at Clairton is the coking of coal and subsequent recovery of chemicals. The steel plant includes a blast furnace for either basic iron or ferromanganese production and four steel finishing mills. Wastewater is discharged daily into the Monongahela River through a number of outfalls. Several other outfalls discharge into Peters Creek, a tributary of the Monongahela River. A dye study was conducted on some of the outfalls during December 15-18, 1975 to determine if the USSC sampling locations are representative. In-plant monitoring was conducted during January 28-31, 1976. The results of the survey are summarized. GRA

N77-13569# Industrial Environmental Research Lab., Research Triangle Park, N. C.

PROCEEDINGS OF THE STATIONARY SOURCE COMBUSTION SYMPOSIUM. VOLUME 1. FUNDAMENTAL RESEARCH

Joshua S. Bowen and Robert E. Hall Jun. 1976 470 p refs Sponsored by EPA 3 Vol.

(PB-256320/3; EPA-600/2-76-152-a) Avail: NTIS HC A20/MF A01 CSCL 21B

The proceedings document the 37 presentations made during the Stationary Source Combustion Symposium held in Atlanta, Ga., September 24-26, 1975. Sponsored by the Combustion Research Branch of EPA's Industrial Environmental Research Laboratory, the symposium dealt with subjects related both to developing improved combustion technology for the reduction of air pollutant emissions from stationary sources, and to improving equipment efficiency. The symposium was intended to provide contractor, industrial, and Government representatives with the latest information on EPA in-house and contractor combustion research projects related to pollution control, with emphasis on reducing nitrogen oxides. GRA

N77-13570# Industrial Environmental Research Lab., Research Triangle Park, N. C.

PROCEEDINGS OF THE STATIONARY SOURCE COMBUSTION SYMPOSIUM. VOLUME 2. FUELS AND PROCESS RESEARCH AND DEVELOPMENT

Joshua S. Bowen and Robert E. Hall Jun. 1976 424 p refs Sponsored by EPA 3 Vol.

(PB-256321/1; EPA-600/2-76-152-b) Avail: NTIS CSCL 21B

Contents: Assessment of combustion and emission characteristics of methanol and other alternate fuels; Burner design criteria for control of pollutant emissions from natural gas flames; Integrated low emission residential furnace; The control of pollutant emissions from oil fired package boilers; Pilot scale investigation of catalytic combustion concepts for industrial and residential applications; The optimization of burner design parameters to reduce NOx formation in pulverized coal and heavy oil flames; Pilot scale investigation of combustion modification techniques for NOx control in industrial and utility boilers; Overfire air as an NOx control technique for tangential coal-fired boilers; Control of NOx formation in wall coal-fired boilers; The effect of additives in reducing particulate emissions from residual oil

combustion; System design for power generation from low Btu gas boilers. GRA

N77-13590*# Scientific Translation Service, Santa Barbara, Calif.
CROSS STRUCTURAL PLAN OF THE EARTH'S CRUST AND THE PROBLEM OF THE MANIFESTATION OF ITS PLUTONIC ELEMENTS ON THE SURFACE (TYAN-SHAN AND TURAN PLATE AS EXAMPLES)
V. I. Makarov and L. I. Solovyeva Washington NASA Apr. 1976 44 p refs Transl. into ENGLISH of the book "Perekrestnyy strukturnyy plan zemnoy kory i problema proyavleniya ego glubinnykh elementov no poverkhnosti (na primere Tyan-Shanya i turanskoy plity)" Moscow, Acad. Sci. USSR, 1975 p 1-50 (Contract NASw-2791)
(NASA-TT-F-16938) Avail: NTIS HC A03/MF A01 CSCL 08G

The plutonic structures of the earth's crust based on an analysis of its surface with the aid of orbital photographs are studied. It is found that space photography is very valuable in studying the substructure of the earth's crust. The possibility of distinguishing genetically diverse components of the geochemical spectrum of the earth's surface may have far-reaching consequences in fossil fuel exploration. Author

N77-13798 Princeton Univ., N.J.
HYDROGEN ATOMS: RARE EARTH IONS: MAGNETIC RESONANCE STUDIES ON POLYCRYSTALLINE SOLIDS AND SURFACE SYSTEMS RELEVANT TO CATALYSIS AND OTHER ENERGY-RELATED RESEARCH Ph.D. Thesis
Lennox E. Iton 1976 444 p
Avail: Univ. Microfilms Order No. 76-23831

Electron Spin Resonance was applied to the study of diverse polycrystalline systems of interest in surface studies, catalysis, and energy-related research. Paramagnetic species investigated range from the small H atom, stabilized in solids, to the heavy rare earth ions, present in catalytically important solids; additionally, novel behavior in a cooperatively interacting magnetic system was observed. Dissert. Abstr.

N77-13841 Tennessee Univ., Knoxville.
ON THE NATURE OF FLUCTUATIONS IN AN OPEN CYCLE MAGNETOHYDRODYNAMIC GENERATOR Ph.D. Thesis
Mary Hall Scott 1976 170 p
Avail: Univ. Microfilms Order No. 76-24858

Several parameters considered to be of importance in the MHD generator were measured over a bandwidth large enough to encompass all significant frequency contributions. The first parameter measured was a signal proportional to the filtered plasma radiation and has significance in its relation to plasma temperature. The other parameters were all differential voltages measured between various electrodes in the generator but were obtained under different conditions. All the measured signals were analyzed within the framework of random process theory so that their respective time and frequency resolved behavior could be ascertained. On the basis of theoretical considerations, three models are advanced to describe the behavior observed experimentally. The relationships between the experimental and theoretical influences are discussed. Dissert. Abstr.

N77-13913*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
NASA OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY SUMMER WORKSHOP. VOLUME 4: POWER TECHNOLOGY PANEL Final Report
Aug. 1975 195 p Conducted at Madison College, Harrisonburg, Va., 3-16 Aug. 1975 Prepared jointly with Old Dominion Univ., Norfolk, Va. 11 Vol.
(Grant NsG-1186)
(NASA-TM-X-73964) Avail: NTIS HC A09/MF A01 CSCL 21H

Technology requirements in the areas of energy sources and conversion, power processing, distribution, conversion, and transmission, and energy storage are identified for space shuttle payloads. It is concluded that the power system technology currently available is adequate to accomplish all missions in the 1973 Mission Model, but that further development is needed to support space opportunities of the future as identified by users. Space experiments are proposed in the following areas: power generation in space, advanced photovoltaic energy converters, solar and nuclear thermoelectric technology, nickel-cadmium batteries, flywheels (mechanical storage), satellite-to-ground transmission and reconversion systems, and regenerative fuel cells. J.M.S.

N77-13922# Department of Transportation, Washington, D.C. Office of R and D Plans and Resources.
ANALYSIS OF FISCAL YEAR 1977 DOT PROGRAM BY POLICY AND RD AND D MANAGEMENT OBJECTIVES. PROGRAM LEVELS FOR FISCAL YEARS 1975, 1976, 1977, VOLUME 1 Management Report, 1975 - 1977
Jun. 1976 218 p 2 Vol.
(PB-255401/2; DOT-TST-76-69.1) Avail: NTIS HC A10/MF A01 CSCL 13B

The analysis of the DOT budget requests for fiscal year 1977 is presented in terms of its relationship to DOT policy and RD and D objectives. These objectives are: (1) modernize regulation and legislation, (2) increase efficiency and service, (3) improve safety and security, (4) lessen unfavorable environmental impacts, (5) minimize adverse impacts on energy constraints, and (6) increase knowledge base. The total budget of $14.1 billion contains $367.7 million for RD and D or about 2.6 percent of the total. GRA

N77-13976# American Airlines, Inc., New York.
FUTURE AIRCRAFT REQUIREMENTS: A NOTEBOOK OF AIRLINE THOUGHTS
Richard J. Linn *In* Md. Univ. Air Transportation for the 1980's, Jun. 1976 p 1-29 Presented at College Park, Md. 17 Feb. 1976
Avail: NTIS HC A17/MF A01

The economic condition of the air transportation industry and its effect on future technology in commercial aviation are discussed. L.S.

N77-13980# Pratt and Whitney Aircraft, East Hartford, Conn. Engineering Dept.
AIR TRANSPORT PROPULSION FOR THE 1980'S
J. W. Witherspoon *In* Md. Univ. Air Transportation for the 1980's, Jun. 1976 p 153-225 Presented at College Park, Md. 11 Nov. 1975
Avail: NTIS HC A17/MF A01

Turbofan engine technology is discussed for use in present and future wide-body aircraft. L.S.

N77-13984*# National Aeronautics and Space Administration, Washington, D.C.
AIR TRANSPORTATION BEYOND THE 1980'S
Gerald G. Kayten *In* Md. Univ. Air Transportation for the 1980's, Jun. 1976 p 353-380 refs Presented at College Park, Md. 20 Apr. 1976

Avail: NTIS HC A17/MF A01

An oral preview of the air transportation sections of the NASA Outlook for Aeronautics study report is presented. Now published, the study report covers military as well as civil aviation and also discusses the role of NASA in support of future developments. The study is based largely on inputs from industry, universities, and other government agencies. Author

N77-14016# Naval Postgraduate School, Monterey, Calif.
A STUDY OF THE FAILURE OF JOINTS IN COMPOSITE MATERIAL FUEL CELLS DUE TO HYDRAULIC RAM LOADING M.S. Thesis
Henry Speer Ezzard, Jr. Jun. 1976 81 p refs
(AD-A027258) HC A05/MF A01 CSCL 01/3

The objectives of this research were to show the relative importance of the transverse shearing forces, the bending moments, and the tensile forces produced by hydraulic ram loading on military aircraft fuel tank joint designs for composite materials, and to present fuel tank test section designs. With the use of a finite element analysis, it was shown that the transverse shearing

force may be major cause of attachment failure of composites, primarily by an unzipping or pull out mode of failure. It was also shown that failure criteria for transverse shearing stresses in composites are lacking. By comparing several specific aircraft design concepts, designs for a wing fuel test tank and a fuselage fuel test tank were selected. Simplicity, similarity to actual aircraft fuel tanks, and uniformity between experiments were primary considerations in the selection. Author (GRA)

N77-14029*# Boeing Commercial Airplane Co., Seattle, Wash. Dept. of Preliminary Design.
ENERGY CONSUMPTION CHARACTERISTICS OF TRANSPORTS USING THE PROP-FAN CONCEPT Final Report
Oct. 1976 147 p refs
(Contract NAS2-9104)
(NASA-CR-137937; D6-75780) Avail: NTIS HC A07/MF A01 CSCL 01C

The fuel saving and economic potentials of the prop-fan high-speed propeller concept were evaluated for twin-engine commercial transport airplanes designed for 3333.6 km range, 180 passengers, and Mach 0.8 cruise. A fuel saving of 9.7% at the design range was estimated for a prop-fan airplane having wing-mounted engines, while a 5.8% saving was estimated for a design having the engines mounted on the aft body. The fuel savings and cost were found to be sensitive to the propeller noise level and to aerodynamic drag effects due to wing-slipstream interaction. Uncertainties in these effects could change the fuel savings as much as + or - 50%. A modest improvement in direct operating cost (DOC) was estimated for the wing-mounted prop-fan at current fuel prices. This improvement could become substantial in the event of further relative increases in the price of oil. The improvement in DOC requires the achievement of the nominal fuel saving and reductions in propeller and gearbox maintenance costs relative to current experience. Author

N77-14030*# Boeing Commercial Airplane Co., Seattle, Wash. Dept. of Preliminary Design.
ENERGY CONSUMPTION CHARACTERISTICS OF TRANSPORTS USING THE PROP-FAN CONCEPT: SUMMARY REPORT Final Report
Nov. 1976 50 p refs
(Contract NAS2-9104)
(NASA-CR-137938; D6-75780) Avail: NTIS HC A03/MF A01 CSCL 01C
For abstract, see N77-14029.

N77-14193*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SOLAR CELL ARRAY DESIGN HANDBOOK, VOLUME 1
H. S. Rauschenbach Oct. 1976 496 p refs Prepared by TRW Defense and Space Systems Group, Redondo Beach, Calif. 2 Vol.
(Contracts NAS7-100; JPL-953913)
(NASA-CR-149364; JPL-SP-43-38-Vol-1) Avail: NTIS HC A21/MF A01 CSCL 22B

Twelve chapters discuss the following: historical developments, the environment and its effects, solar cells, solar cell filters and covers, solar cell and other electrical interconnections, blocking and shunt diodes, substrates and deployment mechanisms, material properties, design synthesis and optimization, design analysis, procurement, production and cost aspects, evaluation and test, orbital performance, and illustrative design examples. A comprehensive index permits rapid locating of desired topics. The handbook consists of two volumes: Volume 1 is of an expository nature while Volume 2 contains detailed design data in an appendix-like fashion. Volume 2 includes solar cell performance data, applicable unit conversion factors and physical constants, and mechanical, electrical, thermal optical, magnetic, and outgassing material properties. Extensive references are provided. Author

N77-14194*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SOLAR CELL ARRAY DESIGN HANDBOOK, VOLUME 2
Oct. 1976 251 p refs 2 Vol.
(Contract NAS7-100)
(NASA-CR-149365; JPL-SP-43-38-Vol-2) Avail: NTIS HC A12/MF A01 CSCL 22B
For abstract, see N77-14193.

N77-14271# RAND Corp., Santa Monica, Calif.
SOME COST, ENERGY, ENVIRONMENTAL, AND RESOURCE IMPLICATIONS OF SYNTHETIC FUELS PRODUCED FROM COAL FOR MILITARY AIRCRAFT
W. L. Stanley Feb. 1976 24 p refs
(AD-A026667; P-5578) Avail: NTIS HC A02/MF A01 CSCL 21/4

As the availability and economics of jet fuels derived from crude oil become less certain in the future, the United States Air Force will need to consider the implications of utilizing aviation fuels derived from alternative energy resources. This paper examines the most promising energy resource alternative to crude oil and the most attractive aviation fuels derivable from the resource alternatives, with emphasis on coal-based aviation fuels. The findings suggest that coal and oil shale are the most promising energy resource alternatives. A synthetic jet fuel similar to jet fuels in use today appears to be the most attractive aviation fuel derivable from coal, primarily because its production requires lower energy expenditures and results in a less costly fuel product than the other two major alternatives, liquid hydrogen and liquid methane, while offering attractive characteristics for aviation applications. Despite their attractive features, there are definite resource, capacity, and environmental constraints which could tend to limit the availability of synthetic jet fuels in the future. Author (GRA)

N77-14272# RAND Corp., Washington, D.C.
THE POTENTIAL OF LIQUID HYDROGEN AS A MILITARY AIRCRAFT FUEL
William T. Mikolowsky and Larry W. Noggle Feb. 1976 15 p refs
(AD-A026666; P-5577) Avail: NTIS HC A02/MF A01 CSCL 21/4

Liquid hydrogen does not appear to be attractive as a military aircraft fuel for the immediate future. In a wide variety of mission applications, liquid hydrogen is less cost-effective and less energy-effective than the available alternative. Indications are that synthetic jet-fuel is the most attractive alternative fuel for very large airplanes. At the least, this conclusion appears valid until coal reserves are substantially depleted. (Even for relatively high growth rates in coal consumption, domestic coal production is not likely to peak much before the second quarter of the 21st century). This conclusion is substantially strengthened when one realizes that airplanes using a conventional jet-fuel have the potential for a much greater payoff from advances in fuel-conserving aircraft technology. Furthermore, these conclusions prevailed despite our favorable assumptions toward liquid hydrogen in several important instances (e.g., aerial refueling). In summary, there is little, if any, potential for liquid hydrogen as a fuel for aircraft entering the Air Force inventory between now and the end of the century. GRA

N77-14374*# TRW Systems Group, Redondo Beach, Calif.
FLIGHT DATA ANALYSIS AND FURTHER DEVELOPMENT OF VARIABLE-CONDUCTANCE HEAT PIPES
J. E. Eninger, D. K. Edwards, and E. E. Luedke Nov. 1976 52 p refs
(Contract NAS2-8310)
(NASA-CR-137953; RR-2) Avail: NTIS HC A04/MF A01 CSCL 20D

The work focuses on the mathematical modeling of three critical mechanisms of heat-pipe operation: (1) the effect that excess liquid has on heat-pipe performance; (2) the calculation of the dryout limit of circumferential grooves; (3) an efficient mathematical model for the calculation of the viscous-inertial interaction in the vapor flow. These mathematical models are incorporated in the computer program GRADE II, which is described. Author

N77-14375*# TRW Defense and Space Systems Group, Redondo Beach Calif.
COMPUTER PROGRAM GRADE 2 FOR THE DESIGN AND ANALYSIS OF HEAT-PIPE WICKS

J. E. Eninger and D. K. Edwards Nov. 1976 114 p refs (Contract NAS2-8310)
(NASA-CR-137954; TRW-26263-6026-RU-00) Avail: NTIS HC A06/MF A01 CSCL 20D

This user's manual describes the revised version of the computer program GRADE(1), which designs and analyzes heat pipes with gradedporosity fibrous slab wicks. The revisions are: (1) automatic calculation of the minimum condenser-end stress that will not result in an excess-liquid puddle or a liquid slug in the vapor space; (2) numerical solution of the equations describing flow in the circumferential grooves to assess the burnout criterion; (3) calculation of the contribution of excess liquid in fillets and puddles to the heat-transport; (4) calculation of the effect of partial saturation on the wick performance; and (5) calculation of the effect of vapor flow, which includes viscousinertial interactions. Author

N77-14378# European Space Agency, Paris (France).
HEAT PIPES, VOLUME 2
Sep. 1976 205 p refs Proc. of the CNR 2d Intern. Conf., Bologna, 31 Mar. - 2 Apr. 1976; co-sponsored by AIAA, ESA and EURATOM
(ESA-SP-112-Vol-2) Avail: NTIS HC A10/MF A01

Topics dealt with are the following: gravity-assisted heat pipes, low temperature heat pipes, liquid metal heat pipes, heat pipe dynamics, variable conductance heat pipes, rotating heat pipes, heat pipe materials, evaporation heat transfer, terrestrial applications, zero gravity testing, and spacecraft applications

N77-14379 Perkin-Elmer Corp., Danbury, Conn. Optical Technology Div.
EXTENDED CRYOGENIC PERFORMANCE OF LOBAR WICK HEAT PIPE/RADIATOR
A. A. Cenkner, Jr., B. E. Nelson, and W. Petrie *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 683-697 refs

Two series of cryogenic-vacuum tests were performed as part of a continuing research program aimed at developing lightweight, reliable, and efficient Lobar Wick heat pipe/radiator or heat pipe/solid cryogen cooling systems for earth resource and meteorological spaceborne detectors. In the first series, a 640 cm long nitrogen heat pipe/radiator was tested from 74 to 116 K; pipe performance was isothermal to approximately 1 K. During the second, a thermal evaluation was made on the feasibility of converting a complex focal plane assembly into an integral part of a heat pipe cooling system. High power localized heating was applied along the 1.3 cm wide lip on an arc-shaped evaporator that was 42.4 cm long and 7.6 x 10.24 sq cm in cross section. Performance indicates that design goals of less than 0.5 K longitudinal and 1.0 K lateral gradients, with + or - 1 K temporal stability during transient loadings, can be achieved with power levels up to 20 watts. While no attempt was made to identify the upper heat transport limit of the Lobar Wick, 31.3 watts was successfully carried by nitrogen. Author (ESA)

N77-14380 Institute of Physics and Power Engineering, Obninsk (USSR).
OPERATION PECULIARITIES OF LOW TEMPERATURE HEAT PIPES WITH CRIMPED CAPILLARY STRUCTURE
M. I. Ivanovsky, Y. A. Ilyin, F. F. Kolgotin, V. I. Korneev, V. V. Privesentsev, B. I. Rybkin, V. I. Serbin, Y. Y. Sergeev, E. M. Sidorenko, and V. P. Sorokin *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 669-710 refs

The capillary structure considered is made of crimped metallic gauze. It can easily be manufactured and allows provision of a sufficiently high heat transfer in the heat pipe. Being non-uniform such a structure remains stable under certain conditions at underfilling with coolant. Some operational peculiarities of the heat pipes with crimped capillary structure, having two channels of different dimensions, were analyzed both theoretically and on the basis of experiments with various low temperature liquids. Author (ESA)

N77-14381 National Research Inst. for Machine Design, Bechovice (Czechoslovakia).
HEAT PIPES FOR THE TEMPERATURE RANGE FROM 200 TO 600 C
F. Polasek and P. Stulc *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 711-732 refs

Suitable working fluids for heat pipes in the temperature range 200 to 600 C were investigated for possible application to industry. Sulfur with addition, it was found, permits operation of the heat pipe in the whole range. Besides the favorable thermophysical properties of liquid sulfur, e.g. specific mass, evaporation heat, and surface tension, some properties rapidly change in the required temperature range, mostly the dynamic viscosity of the liquid phase. By using suitable additives (iodine) the basic reduction of the dynamic viscosity by three orders was obtained and thus extension of the working range to cover 200 to 600 C. ESA

N77-14383 Institute of Physics and Power Engineering, Obninsk (USSR).
SOME FEATURES OF START-UP OF ALKALI METAL HEAT PIPES
M. N. Ivanovsky, V. P. Sorokin, V. I. Subbotin, I. V. Yagodkin, and B. A. Tchulkov *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 741-750 refs

The starting features connected with both an incomplete filling of complex wicks and the formation of some bubbles were analyzed for sodium heat pipes. The influence of gas availability in a pipe on the working ability of the capillary structures is considered. ESA

N77-14384 Institute of Physics and Power Engineering, Obninsk (USSR).
INVESTIGATIONS OF NONSTEADY-STATE PROCESSES AT CRYOGENIC HEAT PIPE OPERATION
M. I. Ivanovsky, Y. A. Ilyin, V. I. Korneev, V. V. Privesentsev, V. I. Serbin, Y. Y. Sergeev, E. M. Sidorenko, and V. P. Sorokin *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 751-759 refs

Two problems are treated experimentally, i.e., dynamics of filling the capillary structure of heat pipes with fluid after drying out and capillary limitations for heat transfer under nonsteady thermal conditions. The experiments were performed on heat pipes with ammonia and Freon-22. An approximate analytical solution for the problem of filling the heat pipe capillary structure with coolant is obtained from analysis of Darcy's equation. Dynamics of the filling procedure are determined by design parameters of the heat pipe and thermophysical properties of the coolant as well as the density of the supplied heat flux, wall temperature superheating, and heat pipe position in the gravitational field. Author (ESA)

N77-14385 Indian Inst. of Tech., Madras. Dept. of Chemical Engineering.
TRANSFER FUNCTION ANALYSIS OF HEAT PIPES
A. Rajakumar and P. R. Krishnaswamy *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 761-772 refs

Dynamic characteristics of heat pipes are described in terms of frequency response through an unsteady-state model. A simplified model was established based on the following characteristics: heat conduction through the container wall, heat transfer in the liquid-filled wick, vaporization and condensation, vapor flow through the core, and liquid flow through the wick. For the purpose of the analysis a water heat pipe with floating boundary conditions was assumed. Detailed frequency domain dynamics of heat pipes were established quantitatively. The response curves are definitive in differentiating and describing the effects of system parameters on the dynamics. ESA

N77-14386 Naples Univ. (Italy). Inst. di Fisica Tecnica.
WETTING AND SURFACE PROPERTIES OF REFRIGERANTS TO BE USED IN HEAT PIPES
F. Reale and M. Cannaviello *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 773-792 refs

A simple and accurate method is presented for measuring surface properties of fluids, properties such as surface tension and other related quantities, e.g., contact angles of fluids to solid walls. Surface tension and contact angles are properties determining transport and capillary phenomena which take place in heat pipes. A number of measurements is reported for some organic coolants. ESA

N77-14387 National Research Inst. for Machine Design, Bechovice (Czechoslovakia).
HEAT PIPES WITH A NON-CONDENSABLE GAS AND THEIR APPLICATION IN NUCLEAR APPARATUS AND INSTRUMENTS
F. Polasek and P. Stulc *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 793-801 refs

Results of operating characteristic measurements are given for stainless steel heat pipes filled with H2O + Ar and Na + Ar. The stabilizing heat pipes were used as heat exchanging elements in irradiation capsule prototypes for structural materials testing in the nuclear reactor active zone and in the vacuum distilling unit of 100 l crude sodium capacity. ESA

N77-14388 McDonnell-Douglas Astronautics Co., Richland, Wash.
HEAT PIPES FOR THE TRANS-ALASKA PIPELINE
E. D. Waters *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 803-814 refs

The reason for cooling the support members of the above-ground portion of the trans-Alaska pipeline is discussed, along with studies that led to use of heat pipes for seasonal refrigeration of the permafrost. The physical and thermal characteristics of the heat pipes, which range from 9 to 23 m in length, are described. Manufacturing approaches to producing such pipes at rates of more than 500 units per day are discussed. Results of heat pipe installation in a segment of the pipeline during late 1974 and early 1975 are presented. Author (ESA)

N77-14389* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE INTERNATIONAL HEAT PIPE EXPERIMENT
Roy McIntosh, Stanford Ollendorf, Allan Sherman, and William Harwell (Grumman Aerospace Corp., Bethpage, N. Y.) *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 815-837 refs

CSCL 20D

On October 4, 1974, the International Heat Pipe Experiment was launched aboard a Black Brant sounding rocket from White Sands, New Mexico. The flight provided six min of near zero gravity during which a total of ten separate heat pipe experiments was performed. The fifteen heat pipes tested represent some of the latest American and European technology. This flight provided the first reported zero gravity data on cryogenic and flat plate vapor chamber heat pipes. Additionally, valuable design and engineering data were obtained on several other heat pipe configurations. The payload and several of its experiments are discussed. Author (ESA)

N77-14390 Societe Nationale Industrielle Aerospatiale, Cannes (France).
DEVELOPMENT OF SPACE APPLICATIONS OF HEAT PIPES AT AEROSPATIALE
I. Martinez, B. Moschetti, and J. P. Mathieu (SABCA) *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 839-863

Work on the development and application of conventional heat pipes and variable conductance heat pipes for spacecraft applications is surveyed. Heat pipes developed and tested permit covering a wide range of heat transfers from a few W x m to more than a hundred W x m. Calculation methods for systems including heat pipes were developed and confirmed by numerous tests. The wide choice of solutions described includes: milled structures with possible crimping/brazing of heat pipes on different materials: aluminum, beryllium; honeycomb structures with heat pipes; and segmented or continuous structures for variable conductance heat pipe systems. ESA

N77-14391 GEC-Marconi Electronics Ltd., Chelmsford (England). Research Lab.
HEAT PIPE AND SPACE RADIATOR DEVELOPMENTS
J. B. Goodacre and G. D. Griffiths (Marconi Space and Defence Systems Ltd., Portsmouth, Engl.) *In* ESA Heat Pipes, Vol. 2 Sep. 1976 p 865-872

Developments in connection with the manufacture of artery wick pipes are reported, mentioning the use of computer aided design. A study on the design of heat pipe radiators to be used onboard direct broadcasting communications satellites is also reported. ESA

N77-14393# California Univ., Livermore. Lawrence Livermore Lab.
MONITORING FLUID FLOW BY USING HIGH-FREQUENCY ELECTROMAGNETIC PROBING
R. J. Lytle, D. L. Laser, E. F. Laine, and J. D. Salisbury 5 Jan. 1976 54 p refs Sponsored by ERDA
(UCRL-51979) Avail: NTIS HC A04/MF A01

High frequency electromagnetic probing is proposed as a means of monitoring the rate and direction of flow of fluids injected into the ground. This method has potential for providing more detailed information than procedures presently used. The experimental technique, data reduction algorithms, test of concept experimental results, and a discussion of possible problems in using this technique are discussed. This technique has known applications in oil reservoir engineering, in situ coal gasification, and hydrology studies concerning underground storage of chemical wastes. ERA

N77-14486# Addis Translations International, Portola Valley, Calif.
HYBRID DRIVE WITH KINETIC ENERGY STORE AS VEHICLE DRIVE
H. Schreck and F. Torres Feb. 1976 18 p refs Transl. into ENGLISH of conf. paper from Tech. Univ., Aachen Presented at 2d Symp. on Low-Pollution Power-System Develop., Dusseldorf, Nov. 1974 Sponsored by ERDA Prepared for California Univ., Livermore. Lawrence Livermore Lab.
(UCRL-Trans-11018; Conf-741151) Avail: NTIS HC A02/MF A01

Conventional motor vehicles have very high fuel consumption when traveling in city traffic. The reason for this lies in the absence of energy regeneration during braking and in uneconomical part load consumption of the internal combustion engine. Fuel consumption can be reduced considerably by using a hybrid drive with a gyro component. Road tests show that the fuel consumption is reduced by 40 to 45 percent below that of transport vehicles with conventional engines. ERA

N77-14488# General Electric Co., Schenectady, N.Y. Gas Turbine Products Div.
HIGH TEMPERATURE GAS TURBINE ENGINE Annual Report for 1975
Saul M. Kaplan 30 Jan. 1976 95 p refs
(Contract E(49-18)-1765)
(FE-1765-8) Avail: NTIS HC A05/MF A01

Selection of materials to be tested and the preparation of test specimens of these have been completed. Coal feedstocks to be used for low-Btu gas tests and also requirements for both samples of these and acquisition of data during Initial Low-Btu Testing have also been completed. Test facility and test specimen arrangements for initial coal derived liquid fuel tests are complete and have been checked out; GE furnished test equipment for Initial Low-Btu Gas tests at ERDA/MERC will be delivered to ERDA/MERC by February 1. ERA

N77-14492# Southwest Research Inst., San Antonio, Tex.
A STUDY TO OBTAIN VERIFICATION OF LIQUID NATURAL GAS (LNG) TANK LOADING CRITERIA Final Technical Report, 11 Jun. 1973 - 2 Jun. 1975
R. L. Bass, J. C. Hokanson, and P. A. Cox 2 Jun. 1975 292 p refs
(Contract N00024-74-C-5136)

(AD-A025716; SSC-258) Avail: NTIS HC A13/MF A01 CSCL 13/4

A study of LNG tank loading criteria is presented that includes a survey and review of load criteria presently employed in the design of cargo tanks for LNG carriers. Motion and acceleration values as determined from these criteria are compared to ship motion calculations and available full-scale data. A comparison of LNG tank loads, as predicted by current classification society and regulatory agency criteria, is given along with recommended updated criteria in each of seventeen load categories. Model tests and fullscale measurement programs to provide adequate data for verification of load and acceleration criteria are also outlined. Author (GRA)

N77-14495# Aerospace Corp., El Segundo, Calif. Environment and Energy Conservation Div.

RESEARCH PLAN FOR ACHIEVING REDUCED AUTOMOTIVE ENERGY CONSUMPTION

Toru Iura, Wolfgang U. Roessler, and Herbert M. White Oct. 1975 375 p refs

(Grant NSF SIA-74-17662-A02)

(PB-255929/2; ATR-76(7467)-1; NSF/RA-760008) Avail: NTIS HC A16/MF A01 CSCL 21G

The types of engines considered include reciprocating and rotary spark ignition gasoline engines, stratified charge variants, and diesel engines. Also included is an assessment of the impact of the potential use of non-petroleum-based alternative fuels on modified or improved internal combustion engines and the research needed to support such future implementation. The plan defines needed work in the areas of combustion research, materials research, friction reduction, alternative fuels, engine controls, and diagnostic instrumentation research. Emphasis was placed on identification of near-term (to 1985) benefits. A summary of recent and ongoing research programs in the field is also included. GRA

N77-14528# Army Cold Regions Research and Engineering Lab., Hanover, N.H.

CONCRETE PLACING TECHNIQUES USED DURING THE CONSTRUCTION OF THE KASNOYARSK HYDROELECTRIC POWER PLANT

E. A. Dolginin Jul. 1976 17 p Transl. into ENGLISH from Gidrotekhn. Stroit., (USSR), no. 9, Sep. 1972 p 19-23

(AD-A026967; CRREL-TL-534) Avail: NTIS HC A02/MF A01 CSCL 13/2

The concrete Krasnoyarsk hydroelectric station dam, at its highest point 124 meters high, is approximately 1100 meters long and is located in a relatively narrow rocky canyon of the Yenesey River. The amount of concrete in the dam and hydroelectric station building is 5.5 million cubic meters. The concrete operations were accomplished under severe climatic conditions - the frost-free period was 102 days long and temperature ranged from -54 to 37C. Great requirements were levied on the concrete with regard to strength, imperviousness to water, cavitation resistance, cold resistance and fracturing resistance. This report discusses the construction problems and considerations. GRA

N77-14573# NUS Corp., Rockville, Md.

AVAILABILITY OF POTENTIAL COAL SUPPLY THROUGH 1985 BY QUALITY CHARACTERISTICS

Landy A. Stinnett, George W. Toth, Shirley C. Barber, Jeffrey B. Goodman, and Jasper Maltese Aug. 1976 121 p refs

(Contract FEA-CO-05-60574-00)

(PB-256680/0; NUS-1725; FEA/G-76/367) Avail: NTIS HC A06/MF A01 CSCL 21D

The availability of uncommitted low-sulfur coal was analyzed in terms of quantity, quality, and timeliness of production and uncommitted recoverable coal which is potentially available for production. The effects on coal availability of manpower, equipment, availability, economics, ownership, and regulations were considered implicitly by virtue of the responses received in the market survey. GRA

N77-14579 Committee on Science and Technology (U. S. House).

INVENTORY OF ENERGY RESEARCH AND DEVELOPMENT (1973 - 1975), VOLUME 5

Washington GPO 1976 160 p refs Rept. for Subcomm. on Energy Res., Development and Demonstration of Comm. on Sci. and Technol., 94th Congr. 2d Sess., Jan. 1976 Sponsored by ERDA and NSF Prepared by ORNL

(GPO-64-734) Avail: SOD HC $2.30

The survey measures the research and development (R and D) efforts to expand the sources of energy as well as R and D aimed at controlling the impact of energy production and use on the environment. These inventory studies afford an overview of the R and D being performed in every aspect of energy exploration, production, distribution, use, and conservation. Author

N77-14581* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ELECTRICALLY RECHARGEABLE REDOX FLOW CELL Patent

Lawrence H. Thaller, inventor (to NASA) Issued 7 Dec. 1976 6 p Filed 22 Aug. 1975 Supersedes N75-32586 (13 - 23, p 2938)

(NASA-Case-LEW-12220-1; US-Patent-3,996,064; US-Patent-Appl-SN-606891; US-Patent-Class-320-2; US-Patent-Class-429-23; US-Patent-Class-429-34) Avail: US Patent Office CSCL 10C

A bulk energy storage system is designed with an electrically rechargeable reduction-oxidation (REDOX) cell divided into two compartments by a membrane, each compartment containing an electrode. An anode fluid is directed through the first compartment at the same time that a cathode fluid is directed through the second compartment. Means are provided for circulating the anode and cathode fluids, and the electrodes are connected to an intermittent or non-continuous electrical source, which when operating, supplies current to a load as well as to the cell to recharge it. Ancillary circuitry is provided for disconnecting the intermittent source from the cell at prescribed times and for circulating the anode and cathode fluids according to desired parameters and conditions.

Official Gazette of the U.S. Patent Office

N77-14583 Utah State Univ., Logan.

A FERMENTATION PROCESS FOR CONVERTING PLANT MATERIALS INTO METHANE Ph.D. Thesis

Somayajula Chalapati Sarma 1976 182 p

Avail: Univ. Microfilms Order No. 76-25631

A fermentation procedure for converting agricultural crops into methane was developed by dividing the conventional anaerobic process into two distinct stages. A digestor capable of fermenting plant materials into volatile fatty acids was developed. The problem of formation of scum layer often accompanied in fermentation of plant materials was totally eliminated, as well as mixing of the methane digestor. Volatile acids formed by the plant materials were found to be nutritionally adequate for methane bacteria. Methane production increased with increasing concentration of volatile fatty acids up to a limit of 8000 milligrams per liter. When the concentration of acids exceeded this limit, the pH rapidly declined as did the methane production. A perpetual energy converting system incorporating the fermentation processes developed is suggested as a substitute for fossil fuels in food production. Dissert. Abstr.

N77-14584*# North Carolina Science and Technology Research Center, Research Triangle Park.

SOLAR ASSISTED HEAT PUMPS: A POSSIBLE WAVE OF THE FUTURE

Frederick O. Smetana Washington Dec. 1976 24 p

(Contract NAS1-14208)

(NASA-CR-2771) Avail: NTIS HC A02/MF A01 CSCL 10A

With the higher costs of electric power and the widespread interest to use solar energy to reduce the national dependence on fossil fuels, heat pumps are examined to determine their suitability for use with solar energy systems. Author

N77-14585*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

NEW SEPARATORS FOR NICKEL-ZINC BATTERIES
Dean W. Sheibley Washington Dec. 1976 20 p refs
(NASA-TM-X-3465; E-8915) Avail: NTIS HC A02/MF A01 CSCL 10C

Flexible separators consisting of a substrate coated with a mixture of a polymer and organic and inorganic additives were cycle tested in nickel-zinc cells. By substituting a rubber-based resin for polyphenylene oxide in the standard inorganic-organic separator, major improvements in both cell life and flexibility were made. Substituting newsprint for asbestos as the substrate shows promise for use on the zinc electrode and reduces separator cost. The importance of ample electrolyte in the cells was noted. Cycle lives and the characteristics of these flexible, low-cost separators were compared with those of a standard microporous polypropylene separator. Author

N77-14586*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ANALYSIS OF INFORMATION SYSTEMS FOR HYDROPOWER OPERATIONS: EXECUTIVE SUMMARY
Robert L. Sohn, Leonard Becker, John Estes, David Simonett, and William Yeh Sep. 1976 48 p
(Contract NAS7-100)
(NASA-CR-149342; JPL-5040-43; RTOP-777-30-01) Avail: NTIS HC A03/MF A01 CSCL 10B

An analysis was performed of the operations of hydropower systems, with emphasis on water resource management, to determine how aerospace derived information system technologies can effectively increase energy output. Better utilization of water resources was sought through improved reservoir inflow forecasting based on use of hydrometeorologic information systems with new or improved sensors, satellite data relay systems, and use of advanced scheduling techniques for water release. Specific mechanisms for increased energy output were determined, principally the use of more timely and accurate short term (0-7 days) inflow information to reduce spillage caused by unanticipated dynamic high inflow events. The hydrometeorologic models used in predicting inflows were examined in detail to determine the sensitivity of inflow prediction accuracy to the many variables employed in the models, and the results were used to establish information system requirements. Sensor and data handling system capabilities were reviewed and compared to the requirements, and an improved information system concept was outlined. Author

N77-14587# Sandia Labs., Albuquerque, N.Mex.
SYNERGISTIC EFFECTS OF SHADOWING ON A SOLAR COLLECTOR MATRIX
David O. Lee and Walter P. Schimmel, Jr. Apr. 1976 89 p refs
(Contract AT(29-1)-789)
(SAND-76-0012) Avail: NTIS HC A05/MF A01

An analytical expression for the shadowing of a collector by adjacent units is presented as a function of collector location, spacing, and orientation. Hourly variations of solar input, as well as the seasonal effects of the solar zenith angle, were considered. An axial temperature analysis was employed, through use of the shadowing expression, to determine the output of a linear focused solar collector when shadowed by adjacent collectors. Outputs for several spacing configurations were presented for a north/south oriented collector field. Calculations were based on fixed-tilt east/west tracking systems. The effect of the time of day on the collector output was included for the equinoxes and solstices for Albuquerque, N. M. ERA

N77-14592# Argonne National Lab., Ill.
EXPLAINING ENERGY: A MANUAL OF NON-STYLE FOR THE ENERGY OUTSIDER WHO WANTS IN
Lee Schipper (Calif. Univ., Berkeley) Jan. 1976 75 p refs Sponsored by ERDA
(LBL-4458; ERG-76-04) Avail: NTIS HC A04/MF A01

A guide or outline of the most asked about, controversial, and basic characteristics of energy systems was assembled. The parameters of supply, demand, environmental impact, growth, conservation, future energy sources, research and development, and certain socio-political issues form the basis of all discussions of energy. Nuclear fission and fusion, fossil fuels, solar energy, and geothermal energy are the most promising sources that are receiving attention at present. Information is included on obtaining material at little or no cost from Congressional committees, government bureaus, the Government Printing Office, industry and lobby groups, environmental organizations, and research institutions. References in the bibliography citing 834 items emphasize the use of energy choices, through many of the general references form the framework of standard energy forecasts and methodology. Author (ERA)

N77-14593# General Electric Co., Schenectady, N.Y.
ECONOMIC AND TECHNICAL FEASIBILITY STUDY OF COMPRESSED AIR STORAGE Final Report
Mar. 1976 402 p refs
(Contract E(11-1)-2559)
(COO-2559-1) Avail: NTIS HC A18/MF A01

The economic and technical feasibility of compressed air energy storage (CAES) is presented. The application of underground air storage with combustion turbines was the primary issue. A general assessment of the technical alternatives, economic characteristics and the institutional constraints associated with underground storage of compressed air for utility peaking application was carried out. Potential barrier problems were identified, and the incentive for the implementation of compressed air storage was defined. The conceptual design of a CAES plant employing storage in an aquifer and that of a plant employing storage in a conventionally excavated cavern employing a water leg to maintain constant pressure are shown. Recommendations for further work, as well as directions of future turbomachinery development, are made. Compressed air storage is technically feasible for off-peak energy storage, and, depending on site conditions, CAES plants may be favored over simple cycle turbine plants to meet peak demands. Author (ERA)

N77-14594# Institute for Energy Analysis, Oak Ridge, Tenn.
IEA ENERGY SIMULATION MODEL: A FRAMEWORK FOR LONG-RANGE US ENERGY ANALYSIS
Charles E. Whittle, David B. Reister, Ernest G. Silver, J. Frederick Weinhold, S. Basheer Ahmed, Harry E. Davitian, H. G. MacPherson, and Alfred M. Perry Jan. 1976 160 p refs
(Contract ERDA-14-01-0001-1699)
(ORAU-125; IEA-75-1) Avail: NTIS HC A08/MF A01

A model was developed for simulating plausible U. S. energy supplies and demands for the last part of this century and the early part of the 21st century. This model was intended to give policy makers a means of comparing various possible futures for energy supplies and demands and for determining which combinations allow a feasible match between the projected demands and the available domestic supplies. Demand functions were generated for each of the energy carriers (electricity, liquids, gases, and solids) by examining the industrial, residential and commercial, and transportation demand sectors in terms of their component activities. Supply functions have been generated independently for each of the energy carriers based on the best available data and estimates for the fossil fuels, uranium, hydroelectricity, geothermal heat, and solar energy and on present knowledge and projections about extraction and conversion technology. ERA

N77-14595# Northwestern Univ., Evanston, Ill.
INTERFACIAL EFFECTS IN THE RECOVERY OF RESIDUAL OIL BY DISPLACEMENT: STUDIES AT NORTHWESTERN UNIVERSITY Annual Report, 1 Mar. 1975 - 29 Feb. 1976
J. C. Slattery and A. A. Kovitz Feb. 1976 47 p refs
(Contract E(34-1)-0019)
(COO-0019-5) Avail: NTIS HC A03/MF A01

A static analysis of a single irregular pore partially filled with residual oil was performed. There is a critical value for the pressure drop over this pore below which the residual oil cannot be displaced but instead will assume a static configuration. The pore was idealized by saying that its radius is a sinusoidal function of axial position. It was recognized that the pressure drop across the pore under static conditions is a function of the pore geometry, the volume of the oil segment, the position of the oil segment in the pore, the crude oil--water interfacial tension, the advancing contact angle, and the receding contact angle. ERA

N77-14596# California Univ., Livermore. Lawrence Livermore Lab.
REACTIVITY OF OIL SHALE CARBONACEOUS RESIDUE WITH OXYGEN AND CARBON DIOXIDE
R. G. Mallon and R. L. Braun 23 Apr. 1976 36 p refs Presented at the 9th Oil Shale Symp., Golden, Colo., 29 - 30 Apr. 1976
(Contract W-7405-eng-48)
(UCRL-77829; Conf-760443-1) Avail: NTIS HC A03/MF A01

The reactivity of char was investigated by experiments on individual blocks of oil shade with a controlled temperature and gas environment. The results illustrated that the char-O2 reaction rate was by the rate of O2 diffusion. The effective diffusivity of O2 increased with the square of the kerogen concentration of the raw shale, as predicted by theoretical considerations. However, the measured diffusivities were appreciably greater than theoretical. The difference was attributed to the network of small cracks that developed during the early part of the retorting process. The results also clearly demonstrated another important mechanism for consumption of char within the oil shale block: the *reaction of char with the CO2 produced from the decomposition* of dolomite and calcite. ERA

N77-14597# United Technologies Corp., South Windsor, Conn. Power Systems Div.
NATIONAL BENEFITS ASSOCIATED WITH COMMERCIAL APPLICATION OF FUEL CELL POWERPLANTS
27 Feb. 1976 67 p Sponsored by ERDA
(ERDA-76-54) Avail: NTIS HC A04/MF A01

Major privately sponsored research and technology efforts, now in progress, are aimed at developing the fuel cell for utility industry applications. These efforts, supported by both electric industry and gas industry elements, are developing the fuel cells for two major areas of application. In the first application, multimegawatt fuel cell powerplants would be dispersed within electric utility networks to complement large-scale systems and provide for the generation needs of small private and public utilities. In the second mode, smaller size fuel cells would be sited at building locations to provide integrated electric and thermal service for commercial and industrial complexes. With continued funding of planned programs, utility application of the fuel cell could result within this decade. The application opportunities for first generation fuel cell powerplants were outlined, improvements that these systems can offer in comparison with conventional electric generation techniques were quantified, and, in the context of a range of potential deployment scenarios, the benefits to the nation as a result of these improvements were quantified. ERA

N77-14600# Oklahoma Univ., Norman. School of Chemical Engineering and Materials Science.
RESOURCE UTILIZATION EFFICIENCY IMPROVEMENT OF GEOTHERMAL BINARY CYCLES, PHASE 1 Semiannual Progress Report, 15 Jun. - 15 Dec. 1975
K. E. Starling, L. W. Fish, K. Z. Iqbal, and D. Yieh 1975 299 p refs
(Contract E(40-1)-4944)
(ORO-4944-3) Avail: NTIS HC A13/MF A01

A description of the geothermal binary cycle and procedures for cycle thermodynamic analysis focusing on the question of resource utilization are discussed. General and specific criteria for preliminary selection of working fluids and operating conditions for binary cycles are considered in terms of equipment and working fluid costs and resource utilization efficiency. Steps are given for preliminary binary cycle design computations. Preliminary evaluations of alternative pure working fluid, ideal thermodynamic cycles are illustrated. The development of the working fluid mixture thermodynamic cycle, GEO I, using the improved versions of previously developed thermodynamic properties routines was the first of several significant accomplishments. ERA

N77-14601# Los Alamos Scientific Lab., N.Mex.
GEOTHERMAL ENERGY FOR ELECTRICAL AND NONELECTRICAL APPLICATIONS
J. W. Tester and S. L. Milora 1976 10 p refs Presented at 16th Ann. ASME Symp. on Energy Alternatives, Albuquerque, N. Mex., 26 Feb. 1976
(Contract W-7405-eng-36)
(LA-UR-76-418; Conf-760215-3) Avail: NTIS HC A02/MF A01

The utilization of geothermal fluids ranging in temperature from 100 to 300 C is discussed from a thermodynamic and an economic viewpoint. Nonaqueous working fluids are evaluated for possible use in sub- and supercritical Rankine power generating cycles, and are compared to more conventional steam flashing cycles. Criteria are presented for determining performance based on the cycle's effectiveness in utilizing the geothermal fluid. Working fluid thermodynamic properties are used to correlate optimum cycle performance at given geothermal fluid temperatures. A generalized method for expressing turbine exhaust end sizes is developed. The geothermal resource potential of the United States for both natural hydrothermal systems and artificially stimulated, dry hot rock systems is discussed. The economics of generating power and of direct utilization for space and process heating applications are compared with fossil fuel *and nuclear energy sources.* Author (ERA)

N77-14602# Battelle Pacific Northwest Labs., Richland, Wash.
ECONOMICS OF GEOTHERMAL ELECTRICITY GENERATION FROM HYDROTHERMAL RESOURCES
C. H. Bloomster and C. A. Knutsen 23 Apr. 1976 46 p refs
(Contract E(45-1)-1830)
(BNWL-1989) Avail: NTIS HC A03/MF A01

The most important factors affecting the economics of geothermal electricity production are the wellhead temperature or enthalpy, the well flow rate, and the cost of the wells. The capital cost of the powerplant is significant, but not highly sensitive to these resource characteristics. The optimum geothermal plant size will remain small, usually in the 50-100 MWe range. Therefore, the opportunities for achieving significant cost reductions through economies of scale are small. The steam and binary power cycles are closely competitive; the binary cycle appears better when the brine temperature is below 200-230 C, and the flashed steam cycle appears better above this range. Geothermal electricity production is capital intensive; over 75 percent of the generation costs are fixed costs related to capital investment. Technological advances are needed to reduce costs from marginal geothermal resources and thus to stimulate geothermal energy development. Significant reduction in power costs would be achieved by reducing well drilling costs, stimulating well flow rates, reducing power-plant capital costs, increasing powerplant efficiency and utilization, and developing more effective exploration techniques for locating and assessing high-quality resources. Author (ERA)

N77-14603# Bechtel Corp., San Francisco, Calif.
ELECTRIC POWER GENERATION USING GEOTHERMAL BRINE RESOURCES FOR A PROOF-OF-CONCEPT FACILITY
1976 262 p refs
(Grant NSF AER-74-19931)
(NSF/RA/N-75-049) Avail: NTIS HC A12/MF A01

The initial phase of a proof of concept project to establish the technical, environmental, and economic feasibility of utilizing hot brine resources for electric energy production and other industrial applications is reported. Included are the following: summary, conclusions, and recommendations; site selection; Heber site description; development of design bases for an experimental facility and a 10 MWe(Net) generating unit; description of facilities; safety analysis environmental considerations; implementation plan and schedule; and conceptual capital cost estimate. ERA

N77-14604# California Univ., Livermore. Lawrence Livermore Lab.
LLL-SOHIO SOLAR PROCESS HEAT PROJECT. REPORT NO. 3: LLL SOLAR ENERGY GROUP
W. C. Dickinson, A. F. Clark, A. Iantuono, R. E. Parsons, D. V. Chakedis, W. G. Gensler, and W. L. Ahlgren 1 Apr. 1976

29 p refs
(Contract W-7405-eng-48)
(UCID-16630-3) Avail: NTIS HC A03/MF A01

A shallow solar pond prototype facility was built and operated in New Mexico. The facility consists of three 11.5 ft x 200 ft shallow solar ponds, cold and hot water storage reservoirs, and instrumentation to measure the performance of the ponds as solar thermal collectors. The basic theory of shallow ponds is described and compared with the performance of the New Mexico ponds to similar ponds. Agreement of calculated and experimental values of daily collected heat is better than 10 percent. The annual average collection efficiency for the ponds is close to 50 percent, corresponding to an annual collection of between, 0.25 and 0.30 MBtu/sq ft collector. We found that the annual collected heat would be reduced by only about 10 percent if the ponds were operated 9 months of the year. ERA

N77-14605# Aerojet Nuclear Co., Idaho Falls, Idaho.
GEOTHERMAL R AND D PROJECT REPORT Technical Report, 1 Oct. - 30 Dec. 1975
Apr. 1976 48 p refs
(Contract E(10-1)-1375)
(ANCR-1283) Avail: NTIS HC A03/MF A01

The Idaho National Engineering Laboratory geothermal research and development project is conducting two major geothermal development efforts: (1) a project aimed at medium temperature (approximately 300 F) utilization to produce electricity with supplemental direct thermal use of the energy; and (2) a low temperature (approximately 170 F) space heating project. The first effort was progressed in the field to the successful drilling of two deep geothermal wells providing flows of the desired temperature in the Raft River Valley of south central Idaho. The second program involves the heating of government buildings and a university campus at Boise, Idaho. ERA

N77-14606# Army Construction Engineering Research Lab., Champaign, Ill.
INTERIM FEASIBILITY ASSESSMENT METHOD FOR SOLAR HEATING AND COOLING OF ARMY BUILDINGS Final Report
Doug Hittle, D. Holshouser, and G. Walton May 1976 54 p refs
(DA Proj. 4A7-63734-DT-08)
(AD-A026588; CERL-TR-E-91) Avail: NTIS HC A04/MF A01 CSCL 13/1

This report discusses design considerations for heating and cooling buildings with solar energy. General criteria are provided for selecting the components and configuration of such a system. The report presents parametric computer simulation studies for two buildings of typical construction at five locations in the United States. Hourly building heating and cooling loads were computed for each building at each site using the National Bureau of Standards Load Determining Program (NBSLD) and hourly weather data. Using these loads, hourly simulation studies were performed to determine the effects of collector type, collector area, collector tilt angle, thermal energy storage tank volume, and heat exchanger effectiveness on simulated solar heating and cooling system performance. The results of more than 200 one-year solar system simulations are presented. In addition, a dimensionless graph and methodology are provided which can be used to estimate solar heating and cooling system performance for buildings and sites other than those studied. The report provides an explanation and an example of an approach for determining the life cycle cost of a solar-equipped building as compared to a conventional installation. Descriptions of the NBSLD program and the solar heating and cooling simulation program are provided. Author (GRA)

N77-14607# Naval Postgraduate School, Monterey, Calif.
SOLID STATE APPLICATIONS OF DIRECT ENERGY CONVERSION AND HEAT PUMPING FOR A SMALL AUTOMOTIVE VEHICLE Ph.D. Thesis
Thomas Constantine Tsoukalas Sep. 1975 142 p refs
(AD-A026321) Avail: NTIS HC A07/MF A01 CSCL 13/1

The feasibility of solid state application for electrical power generation and heat pumping in small automotive vehicles has been examined. A new geometric configuration for the thermoelectric couple was introduced and the heat flow problem has been solved analytically in detail. The obtained results appeared promising for future developments in this area. Author (GRA)

N77-14608# Federal Energy Administration, Washington, D.C. Office of Policy and Analysis.
WEEKLY PETROLEUM STATISTICS REPORTS, 1974-1975
Aug. 1976 493 p
(PB-255920/1; FEA/B-76/335) Avail: NTIS HC A21/MF A01 CSCL 21D

A complete collection of 46 issues of the Weekly Petroleum Statistics Report, beginning April 4, 1974 and ending May 24, 1974. The weekly reports contain reporting by all petroleum refiners, bulk terminal operators and importers of their domestic petroleum receipts, imports, operating rates, production of each major petroleum product and stock levels. GRA

N77-14609# National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.
ENERGY EQUIVALENTS FOR CURRENT AND PROSPECTIVE AUTOMOTIVE FUELS IN CANADA
D. B. Coveney, M. J. Friend, and G. M. Shulhan Feb. 1976 52 p refs Submitted for publication
(AD-A026195; DME-MD-53; NRC-15233; ISSN-0077-555X) Avail: NTIS HC A04/MF A01 CSCL 21/4

The report provides a first estimate of the comparative energy equivalents and the energy efficiencies of existing and prospective Canadian automotive fuels. GRA

N77-14610# Federal Energy Administration, Washington, D.C. Strategic Petroleum Reserve Office.
THE EXPLORATION, DEVELOPMENT, AND PRODUCTION OF NAVAL PETROLEUM RESERVE NUMBER 4
Aug. 1976 85 p ref
(PB-255947/4; FEA/S-76/330) Avail: NTIS HC A05/MF A01 CSCL 21D

The Naval Petroleum Reserves Production Act (NPRPA) mandates Government exploration of the Naval Petroleum Reserve Number 4 (NPR-4), but authorizes no development or production of petroleum discoveries. Obtaining the necessary legislative authority to lease, performing environmental impact studies, and setting a leasing procedure in motion will consume approximately 2 to 3 years. Recommendations for the development of NPR-4 petroleum reserves are presented. GRA

N77-14611# California Univ., Livermore. Lawrence Livermore Lab.
INDUSTRIAL PROCESS HEAT FROM SHALLOW SOLAR PONDS
A. F. Clark 1976 8 p refs Presented to the 2d Southeastern Conf. on Application of Solar Energy, Baton Rouge, La., 19-23 Apr. 1976
(Contract W-7405-eng-48)
(UCRL-77801; Conf-760423-1) Avail: NTIS HC A02/MF A01

A shallow solar pond is a black-bottomed body of water (4 inches) which will get hot in the sun. In the current applications the water is covered with a transparent plastic layer to prevent heat loss by evaporation, and another glazing is mounted above with an insulating dead air space in between to provide a greenhouse effect to trap the solar heat. Until used, the hot water is stored in a reservoir with sufficient insulation to prevent appreciable heat losses. ERA

N77-14630# Battelle Pacific Northwest Labs., Richland, Wash.
PRECIPITATION SCAVENGING OF FOSSIL-FUEL EFFLUENTS Final Report, 24 Jun. 1974 - 28 Nov. 1975
M. Terry Dana, Dennis R. Drewes, Donald W. Glover, and Jeremy M. Hales Jun. 1976 106 p refs
(Contract EPA-68-02-1729)
(PB-256649/5) Avail: NTIS HC A06/MF A01 CSCL 13B

A numerical model for predicting the precipitation scavenging of reactive pollutants from power plant plumes was developed. The model, called SMICK (Scavenging Model Incorporating Chemical Kinetics), calculates collection, liquid phase chemical

reaction, and desorption, if any, of multiple plume-bound pollutants as they interact with falling raindrops and are ultimately deposited on the surface. Calculations for any specific aqueous phase kinetics mechanism are performed with the model by expressing the mechanism in appropriate sub-routine form. The model was tested against field experiment data. GRA

N77-14631# ADAPT Service Corp., Reading, Mass.
EFFECT OF MECHANICAL COOLING DEVICES ON AMBIENT SALT CONCENTRATION Final Report, Feb. - Sep. 1975
Herbert E. Hunter Apr. 1976 142 p refs
(Contract EPA-68-03-2176)
(PB-256679/2; ADAPT-75-8; EPA-600/3-76-034) Avail: NTIS HC A07/MF A01 CSCL 13B

An analysis of the airborne salt concentration data collected during a demonstration of the salt water mechanical cooling devices at a nuclear power plant is presented. The data were analyzed using a family of empirical analysis programs which are based on the concept that empirical analysis is preceded by the development of an optimal (in the Karhunen Loeve sense) representation of the data. The analysis presented shows that the increase in the background salt concentration due to the cooling tower was less than the measurement accuracy of approximately three to five micrograms per cubic meter. GRA

N77-14638# Exxon Research and Engineering Co., Linden, N.J.
EVALUATION OF POLLUTION CONTROL IN FOSSIL FUEL CONVERSION PROCESSES Final Report, Jun. 1972 - Jan. 1976
E. M. Magee Apr. 1976 306 p refs
(Contract EPA-68-02-0629)
(PB-255842/7; EXXON/GRU.16DJ.76; EPA-600/2-76-101) Avail: NTIS HC A14/MF A01 CSCL 21D

The review gives an overview of work, between June 1972 and January 1976, on various environmental aspects of fossil fuels. Details of this work are presented in 14 reports published during this same period. The details include potential pollutants in fossil fuels; quantities of solid, liquid, and gaseous effluents from coal treatment and conversion to gaseous and liquid fuels; and an analytical test plan for coal conversion systems. The overview report discusses commonality and differences in the reviewed processes with emphasis on factors which might affect the environment when the processes are in commercial use. Due to the lack of a sufficient data base, data and research and development needs are also addressed. GRA

N77-14643# Industrial Environmental Research Lab., Research Triangle Park, N. C.
PROCEEDINGS OF THE STATIONARY SOURCE COMBUSTION SYMPOSIUM. VOLUME 3: FIELD TESTING AND SURVEYS Environmental Protection Technology Series
1976 476 p refs Presented at Atlanta, 24-26 Sep. 1975
(PB-257146/1; EPA-600/2-76-152-c-Vol-3) Avail: NTIS HC A21/MF A01 CSCL 13B

Contents: The effect of combustion modification on pollutants and equipment performance of power generation equipment; Analysis of gas-, oil-, and coal-fired utility boiler test data; Influence of combustion modifications on pollutant emissions from industrial boilers; Systems evaluation of the use of low-sulfur western coal in existing small- and intermediate-sized boilers; A survey of emissions control and combustion equipment data in industrial process heating; POM (Polycyclic Organic Matter) and particulate emissions from small commercial stoker-fired boilers; Concluding remarks. GRA

N77-14645# Research Triangle Inst., Research Triangle Park, N.C.
SECOND ENVIRONMENTAL ASPECTS OF FUEL CONVERSION TECHNOLOGY SYMPOSIUM Final Report
Franklin A. Ayer, comp. Jun. 1976 389 p refs Conf. Proceedings held at Hollywood, Florida, 15-18 Dec. 1975
(Contract EPA-68-02-1325)
(PB-257182/6; EPA-600/2-76-149) Avail: NTIS HC A17/MF A01 CSCL 13B

The main objective was to review and discuss environmentally related information in the field of fuel conversion technology. Specific topics were environmental problem definition, process technology, control technology, and process measurements. GRA

N77-14740# Nuclear Regulatory Commission, Washington, D.C. Office of Nuclear Reactor Regulation.
OCCUPATIONAL RADIATION EXPOSURE AT LIGHT WATER COOLED POWER REACTORS, 1969-1975
Thomas D. Murphy, Nadia J. Dayem, J. Stewart Bland, and Walter J. Pasciak Jun. 1976 25 p
(PB-257054/7; NUREG-0109) Avail: NTIS HC A02/MF A01 CSCL 06J

An updated compilation of occupational radiation exposures at commercial light water cooled power reactors for the years 1969 through 1975 is presented. The information is derived from reports submitted to the United States Nuclear Regulatory Commission in accordance with requirements of individual plant technical specifications. The MAN-REM/UNIT for all LWR's in 1975 is greater than the 1974 value. The cumulative average since 1969 continues to increase. No significant trend was indicated over the period of 1969-1975 in the mean value of MAN-REM/MEGAWATT-YEAR. GRA

N77-14939# Transportation Research Board, Washington, D.C.
TRISNET. DIRECTORY TO TRANSPORTATION RESEARCH INFORMATION RESOURCES
P. E. Irick and E. P. Pascal May 1976 69 p
(Contract DOT-OS-60072)
(PB-255172/9; DOT-TST-76-82) Avail: NTIS HC A04/MF A01 CSCL 05B

Entries for approximately 50 information resources whose services and products are generally available to the user community for transportation research information are given. They were prepared as an accessory for TRISNET (an evolving national network of transportation research information services). Two indexes are provided for the directory entries, an alphabetical index that is arrayed in the order of acronyms shown at the upper right hand corner of each entry page, and a classified index that locates directory entries in terms of subject orientation, geographical class, and types of available services and products. GRA

N77-14948# Argonne National Lab., Ill.
INVESTMENT PLANNING IN THE ENERGY SECTOR
E. Kahn, Mark Davidson, Arjun Makhijani, Philip Caesar, and S. M. Berman 1 Mar. 1976 105 p
(Contract W-7405-eng-48)
(LBL-4474) Avail: NTIS HC A06/MF A01

Consequences of investment decisions in the energy sector are examined. Various interpretations were offered to explain the break in historical energy consumption trends that began in 1974. Following an introductory section, configurations of electricity demand and utility investment behavior were analyzed that would lead to increasing costs and consequent effects on demand. Analytical model of electric utility investment, includes the basic equations for the model, application of the demand equation, the rate equation, and the projections for the coupling demand and rate equations. Some sectoral influences on utility demand and investment, a disaggregated analysis of electricity demand in three areas-residential demand, fuel substitution in high-temperature industrial processes, and by-product power generation in industry was undertaken. ERA

N77-14950# Mathematics and Computation Lab., Washington, D. C. Applied Economics Div.
THE INTERSECTORAL FEEDBACK MODEL Final Report
Teddy T. Su May 1976 118 p Sponsored by General Services Admin.
(PB-255859/1; GSA/FPA/MCL-TR-102) Avail: NTIS HC A06/MF A01 CSCL 05C

The economic impact of an industrial disruption was simulated. A computer simulation model was designed to measure changes in output and income for each sector. A series of repercussions, as reflected in backward and forward inpacts, was triggered by an exogenous change in demand for intermediate goods. Change

in value added or income causes change in demand for final goods. Relative changes in output were compared to determine the extent to which an industry is disrupted. GRA

N77-14955*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
PERFORMANCE CHARACTERISTICS OF A DIESEL ENGINE USING LOW- AND MEDIUM-ENERGY GASES AS A FUEL SUPPLEMENT (FUMIGATION)
Leo G. Monford Oct. 1976 23 p refs
(NASA-TM-X-58188; JSC-11404) Avail: NTIS HC A02/MF A01 CSCL 21A

The use of low- and medium-energy gases derived from solid waste is investigated. Gases that simulate those gases that could be derived from refuse were injected into the air inlet of a 298-kilowatt (400 horsepower) diesel engine as a fuel supplement. This process is called fumigation. Three different gases with thermal-energy contents of 6.11 MJ/cu m (164 Btu/cu ft), 18.1 MJ/cu m (485 Btu/cu ft), and 18.8 MJ/cu m (505 Btu/cu ft, respectively, were used at rates ranging as high as 20 percent of the normal fuel oil energy at four different engine load points. The test results indicated approximately 100 percent gas energy utilization with no observable deleterious effect on the engine. Author

N77-14957# Army Cold Regions Research and Engineering Lab., Hanover, N.H.
UTILITY DISTRIBUTION SYSTEMS IN ICELAND
H. W. C. Aamot May 1976 69 p
(DA Proj. 4A7-62719-AT-06)
(AD-A026956; CRREL-SR-76-5) Avail: NTIS HC A04/MF A01 CSCL 13/2

The study reports on new developments and special problems or solutions in water distribution systems, sewage collection systems, heat distribution and electric transmission systems in Iceland. Cold weather considerations are highlighted. For water and sewage transport, the use of ductile iron, concrete and plastic materials is reported. Utility lines are generally placed individually. Heat distribution with hot water from geothermal wells is mostly one-way piping. After heating, the water is discharged through the sewage system. Street heating is being expanded. With electric distribution, the use of self-supporting aerial cables is becoming popular because it is very cost-effective and reliable. Within the city, all distribution is under ground. Arcing of isolators on high voltage transmission lines due to salt from the ocean atmosphere is being reduced with silicone fluids. GRA

N77-14960# Arizona Univ., Tucson. Dept. of Nuclear Engineering.
FEASIBILITY STUDY OF A NUCLEAR POWER-SEWAGE TREATMENT SYSTEM FOR THE CONSERVATION AND RECLAMATION OF WATER RESOURCES
Rocco Fazzolare 1976 13 p refs
(Contract DI-14-31-0001-3503)
(PB-255630/6; W76-10614; OWRT-A-028-ARIZ(4)) Avail: NTIS HC A02/MF A01 CSCL 13B

A ferric-chloride, powdered activated carbon and an aluminum sulfate, powdered activated carbon physical chemical system were examined in a one-step process as a function of temperature. COD, suspended solids, turbidity and phosphorus removals were used to monitor performance. Significant improvement in pollutant removals was obtained at higher temperatures with the optimum results occurring between 50 and 60 C. Since urban wastewater flow and electric power usage are population-dependent and the system optimum treatment temperature coincides with waste heat characteristics, a combined power plant-wastewater system would generate recyclable water. GRA

N77-14981*# Hudson Inst., Inc., Croton-on-Hudson, N.Y.
DOMESTIC AND WORLD TRENDS (1980 - 2000) AFFECTING THE FUTURE OF AVIATION Final Report
Norman Friedman, William Overholt, John Thomas, and Anthony J. Wiener 1 Aug. 1975 104 p
(Contract NAS5-20852)
(NASA-CR-144838; HI-2210/3-RR) Avail: NTIS HC A05/MF A01 CSCL 01B

Variables affecting aviation in the United States during the last fifth of the twentieth century are studied. Estimates of relevant future developments are presented and their probable impact on the aviation industry in this country are identified. A series of key trends relating to economic, social, political, technological, ecological and environmental developments are identified and discussed with relation to their possible effects on aviation. From this analysis, a series of scenarios are developed representing an array of possibilities ranging from severe economic depression and high international tension on the one hand, to a world of detente which enjoys an unprecedented economic growth rate and relaxation of tensions on the other. A surprise free scenario is presented which represents the best judgment of the manner in which events will most probably develop and the effect on the aviation industry such developments will likely produce.
Author

N77-15007*# Lockheed-California Co., Burbank.
STUDY OF THE COST/BENEFIT TRADEOFFS FOR REDUCING THE ENERGY CONSUMPTION OF THE COMMERCIAL AIR TRANSPORTATION SYSTEM Final Report, Nov. 1974 - Mar. 1976
John P. Hopkins Aug. 1976 331 p refs
(Contract NAS2-8612)
(NASA-CR-137926; LR-27769-2) Avail: NTIS HC A15/MF A01 CSCL 05C

Practical means were assessed for achieving reduced fuel consumption in commercial air transportation. Five areas were investigated: current aircraft types, revised operational procedures, modifications to current aircraft, derivatives of current aircraft and new near-term fuel conservative aircraft. As part of a multiparticipant coordinated effort, detailed performance and operating cost data in each of these areas were supplied to the contractor responsible for the overall analysis of the cost/benefit tradeoffs for reducing the energy consumption of the domestic commercial air transportation system. A follow-on study was performed to assess the potential of an advanced turboprop transport aircraft concept. To provide a valid basis for comparison, an equivalent turbofan transport aircraft concept incorporating equal technology levels was also derived. The aircraft as compared on the basis of weight, size, fuel utilization, operational characteristics and costs. Author

N77-15008*# Lockheed-California Co., Burbank.
STUDY OF THE COST/BENEFIT TRADEOFFS FOR REDUCING THE ENERGY CONSUMPTION OF THE COMMERCIAL AIR TRANSPORTATION SYSTEM Summary Report, Nov. 1974 - Mar. 1976
John P. Hopkins and H. E. Wharton Aug. 1976 100 p
(Contract NAS2-8612)
(NASA-CR-137927; LR-27769-1) Avail: NTIS HC A05/MF A01 CSCL 05C

For abstract, see N77-15007.

N77-15037*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF CERAMIC COATING OF JT8D COMBUSTOR LINER ON MAXIMUM LINER TEMPERATURES AND OTHER COMBUSTOR PERFORMANCE PARAMETERS
Helmut F. Butze and Curt H. Liebert Dec. 1976 24 p refs
(NASA-TM-X-73581; E-9043) Avail: NTIS HC A02/MF A01 CSCL 21E

The effect of ceramic coating of a JT8D combustor liner was investigated at simulated cruise and takeoff conditions with two fuels of widely different aromatic contents. Substantial decreases in maximum liner temperatures and flame radiation values were obtained with the ceramic-coated liner. Small reductions in exhaust gas smoke concentrations were observed with the ceramic-coated liner. Other performance parameters such as combustion efficiency and emissions of unburned hydrocarbons, CO, and NOx were not affected significantly. No deterioration of the ceramic coating was observed after about 6 hours of cyclic operation including several startups and shutdowns. Author

N77-15043*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
STUDY OF UNCONVENTIONAL AIRCRAFT ENGINES DESIGNED FOR LOW ENERGY CONSUMPTION
R. E. Neitzel, R. Hirschkron, and R. P. Johnston Dec. 1976 165 p refs
(Contract NAS3-19519)
(NASA-CR-135136; R76AEG597) Avail: NTIS HC A08/MF A01 CSCL 21E

A study of unconventional engine cycle concepts, which may offer significantly lower energy consumption than conventional subsonic transport turbofans, is described herein. A number of unconventional engine concepts were identified and parametrically studied to determine their relative fuel-saving potential. Based on results from these studies, regenerative, geared, and variable-boost turbofans, and combinations thereof, were selected along with advanced turboprop cycles for further evaluation and refinement. Preliminary aerodynamic and mechanical designs of these unconventional engine configurations were conducted and mission performance was compared to a conventional, direct-drive turofan reference engine. Consideration is given to the unconventional concepts, and their state of readiness for application. Areas of needed technology advancement are identified. Author

N77-15121# Naval Research Lab., Washington, D.C. Strength of Metals Branch.
IGNITION OF FLAMMABLE GASES IN CRUDE-OIL TANKERS AS A RESULT OF METAL FRACTURE Final Report
W. A. Affens and E. A. Lange 29 Jun. 1976 15 p refs
(NRL Proj. C01-03A)
(AD-A027411; NRL-8013) Avail: NTIS HC A02/MF A01 CSCL 13/12

A literature search and an energy analysis have shown that the energies generated and the temperatures developed by metal fracture are not sufficient to ignite a flammable mixture of hydrocarbon vapor and air directly. It was concluded from this study that if metal fracture were to be a cause of ignition, it would be by an indirect process. The most likely cause of ignition resulting from metal fracture would be due to frictional impact or friction of fractured metal structural members with each other or with other objects. It was also concluded that normal impact (without friction) or single rubbings would not generate sufficient energy for ignition unless friction sparks also resulted. Friction sparks are more likely to cause ignition if highly pyrophoric metals are present. It was also concluded that adiabatic compression is a possible source of ignition in the case of ship collisions.
Author (GRA)

N77-15208*+ National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BIBLIOGRAPHY ON LIQUEFIED NATURAL GAS (LNG) SAFETY
Paul M. Ordin Apr. 1976 654 p
(NASA-TM-X-73408; E-8715) Avail: NTIS HC A99 CSCL 21D

Approximately 600 citations concerning safety of liquefied natural gas and liquid methane are presented. Each entry includes the title, author, abstract, source, description of figures, key references, and major descriptors for retrieving the document. An author index is provided as well as an index of descriptors.
Author

N77-15210# National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.
PRODUCTION OF A HYDROCARBON-TYPE SYNTHETIC FUEL FROM WOOD
L. Gardner Sep. 1976 14 p refs
(NRC-15638; MP-71; ISSN-0077-555X) Avail: NTIS HC A02/MF A01

A theoretical study of the production of fuels from wood via pyrolysis and the Fischer-Tropsch synthesis was made. The results indicate that although technically feasible the production of such a fuel is financially and energy-wide uneconomical.
Author

N77-15212# Committee on Aeronautical and Space Sciences (U. S. Senate).
ALTERNATIVE FUELS FOR AVIATION
Washington GPO 1976 187 p refs Hearings before Subcomm. on Aerospace Technol. and Natl. Needs of Comm. on Aeronaut. and Space Sci., 94th Congr., 2d Sess., 27-28 Sep. 1976
(GPO-78-544) Avail: SOD HC $1.90

Research and progress in the development of alternative fuels for aviation are discussed. The impact of using nonoptimum synthetic hydrocarbon based fuels on aeronautical structures and the cost of commercial airfares is explored. A.H.

N77-15213# California Univ., Irvine.
JP-4 AND JP-9 FUEL TOXICITY STUDIES USING WATER FISH AND AUFWUCHS Annual Research Report, 1 Jun. 1974 - 31 May 1975
Stephen Klein, Robert Cooper, and David Jenkins Jun. 1976 69 p refs
(Contract F33615-73-C-4059; AF Proj. 6302)
(AD-A027594; AMRL-TR-76-50) Avail: NTIS HC A04/MF A01 CSCL 21/5

This report contains the results of research efforts concerned with defining the effects of potential environmental contamination resulting from the use of certain Air Force materials on fresh water fish and aufwuchs. Materials evaluated include RJ-4, RJ-5, Methylcyclohexane, JP-9 and JP-4. Techniques for exposing organisms to those substances are discussed and the results of such exposures are presented. Author (GRA)

N77-15220# Naval Ship Research and Development Center, Bethesda, Md. Ship Performance Dept.
HYDRODYNAMIC EQUILIBRIUM CONDITIONS FOR AG(EH) MAIN STRUT-POD FOIL SYSTEM USING FLAP INCIDENCE CONTROL
D. W. Coder and B. B. Wisler, Jr. Jun. 1976 44 p refs
(AD-A027521; SPD-332-03; DTNSRDC-SPD-332-03) Avail: NTIS HC A03/MF A01 CSCL 13/10

The power requirements for hydrofoil craft control systems has been a subject of recent concern as the U.S. Navy considers larger and larger craft. Four hydrofoil configurations were investigated theoretically to determine power requirements to control a hydrofoil ship similar to the AG(EH) in a random sea, and a pivoted foil with leading-edge tab was found to consume the least power. To determine whether this configuration would actually consume the least power, a 1/12-scale model was examined for equilibrium flap/foil angle conditions (stable flying situations) of the fully-wetted case. A passive control system comprised of mechanical linkages was used with the model to obtain steady-flow, fully-wetted conditions. The results of this experiment are discussed. GRA

N77-15347*# Rockwell International Corp., Canoga Park, Calif. Space Div.
DEVELOPMENT OF THERMAL CONTROL METHODS FOR SPECIALIZED COMPONENTS AND SCIENTIFIC INSTRUMENTS AT VERY LOW TEMPERATURES (FOLLOW-ON) Final Report, 31 Mar. - 30 Nov. 1976
J. P. Wright and D. E. Wilson Nov. 1976 103 p refs
(Contract NAS8-31324)
(NASA-CR-150152; SD-76-SA-0230) Avail: NTIS HC A06/MF A01 CSCL 14B

Many payloads currently proposed to be flown by the space shuttle system require long-duration cooling in the 3 to 200 K temperature range. Common requirements also exist for certain DOD payloads. Parametric design and optimization studies are reported for multistage and diode heat pipe radiator systems designed to operate in this temperature range. Also optimized are ground test systems for two long-life passive thermal control concepts operating under specified space environmental conditions. The ground test systems evaluated are ultimately intended to evolve into flight test qualification prototypes for early shuttle flights. Author

N77-15401# General Electric Co., Schenectady, N.Y. Gas Turbine Products Div.

HIGH TEMPERATURE GAS TURBINE ENGINE COMPONENT MATERIALS TESTING PROGRAM Quarterly Technical Progress Report, 28 Sep. 1975 - 2 Jan. 1976
S. M. Kaplan 15 Jan. 1976 65 p
(Contract E(49-18)-1765)
(FE-1765-7; QTPR-2) Avail: NTIS HC A04/MF A01

Selection of materials to be tested and the preparation of test specimens of these have been completed. Coal feedstocks to be used for low Btu gas tests and also requirements for both samples of these and acquisition of data during initial low Btu gas testing have also been completed. Test facility and test specimen arrangements for initial coal-derived liquid fuel tests are complete and have been checked out. ERA

N77-15409# Military Academy, West Point, N.Y. Dept. of Engineering.
EFFECTS OF A THERMAL REACTOR ON THE ENERGY EFFICIENCY OF A TURBOCHARGED, STRATIFIED CHARGE ENGINE
Oleh B. Koropey and Paul J. Kern 1976 15 p refs
(AD-A026059) Avail: NTIS HC A02/MF A01 CSCL 21/7

Since 1963 the United States Army Tank Automotive Command (USATACOM) and Texaco Incorporated have been developing a fuel efficient, multi-fuel, low specific emission engine. In the last phase of the project high specific power has been sought through turbocharging. Based on prior work a project under the auspices of the Dean's Office for Scientific Research at the United States Military Academy was initiated in the Department of Engineering. The objective was to assess the effect of a thermal reactor on the turbocharged version of the Texaco Controlled Combustion System (TCCS) L141 through analytical and experimental techniques. A thermal reactor is considered contrary to good turbocharged exhaust system design due to internal baffles, large cross sectional area, and long flow path; however, it was felt that a reactor might extract some additional work from the gases to offset these aspects. GRA

N77-15484 Arizona Univ., Tucson.
THE OPTICAL PROPERTIES OF CHROMIUM OXIDE FILMS AND THE HIGH TEMPERATURE STABILIZATION OF SILVER FILMS FOR PHOTOTHERMAL SOLAR ENERGY CONVERSION Ph.D. Thesis
Robert Edward Hahn 1976 235 p
Avail: Univ. Microfilms Order No. 76-28196

The structure and optical properties of reactively evaporated chromium oxide films and of the stabilization of thin silver films against agglomeration at elevated temperatures were investigated. The importance of these investigations lies in the extension of thin film technology to the fabrication of spectrally selective surfaces for efficient absorption and retention of incident flux in photothermal solar energy conversion. A series of chromium oxide films were deposited by the reactive evaporation of chromium in air or oxygen bleeds. The agglomeration of thin silver films on Pyrex and stainless steel substrates was studied and techniques were examined to prevent or control the phenomenon during the chemical vapor deposition of silicon-pn-silver coatings for photothermal conversion. Dissert. Abstr.

N77-15485 Wisconsin Univ., Madison.
A DESIGN PROCEDURE FOR SOLAR HEATING SYSTEMS Ph.D. Thesis
Sanford Alan Klein 1976 350 p
Avail: Univ. Microfilms Order No. 76-20673

A general transient system computer simulation program, TRNSYS, and 'f-charts', which form the basis of a general design procedure for solar heating systems were developed. The important dimensionless variables of solar heating systems are identified and simulations are used to develop a correlation between these variables and long-term system performance. The correlation, presented in both analytic and graphical form, is referred to as an 'f-chart'. The result is a simple method requiring monthly average meteorological data which can be used to estimate the long-term thermal performance of solar heating systems as a function of the major system design parameters. Combined with costs and meteorological data for the location in question, the f-chart provides a method to determine the economically optimum solar heating system design. Dissert. Abstr.

N77-15486*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SATELLITE POWER SYSTEM: ENGINEERING AND ECONOMIC ANALYSIS SUMMARY
Nov. 1976 282 p refs
(NASA-TM-X-73344) Avail: NTIS HC A13/MF A01 CSCL 10A

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. Author

N77-15487*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE CORRELATIONS OF FIVE SOLAR COLLECTORS TESTED SIMULTANEOUSLY OUTDOORS
Dean R. Miller 1976 26 p Presented at the Joint Conf. of the Intern. Solar Energy Soc. and the Solar Energy Soc. of Canada, Winnipeg, Canada, 15-20 Aug. 1976
(NASA-TM-X-73546; E-8982) Avail: NTIS HC A03/MF A01 CSCL 10A

Collector thermal efficiency, and efficiency degradation with time were measured for 5 flat-plate solar collectors tested simultaneously in an outdoor solar collector test facility. Results indicate that by using collector performance parameters which account for diffuse isolation, outdoor data recorded on cloud days can be used as a measure of performance, as long as the ratio of direct to total insolation exceeds approximately 0.6. These outdoor results also show good agreement with thermal efficiency data obtained indoors in a solar simulator. Significant efficiency degradation occurred on only one of the five collectors exposed to outdoor conditions for a period of one to two years. Author

N77-15489*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A PERFORMANCE EVALUATION OF VARIOUS COATINGS, SUBSTRATE MATERIALS, AND SOLAR COLLECTOR SYSTEMS
F. J. Dolan Sep. 1976 85 p refs
(NASA-TM-X-73355) Avail: NTIS HC A05/MF A01 CSCL 10A

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 as are schematics and pictures of test equipment and test hardware. Author

N77-15491*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
RESULTS FROM THE IMP-J VIOLET SOLAR CELL EXPERIMENT AND VIOLET CELL BALLOON FLIGHTS
Edward M. Gaddy Washington Dec. 1976 9 p refs
(NASA-TN-D-8393; G-7702F4) Avail: NTIS HC A02/MF A01 CSCL 10A

The Interplanetary Monitoring Platform-J violet solar cell experiment was flown in an orbit with mild thermal cycling and low hard-particle radiation. The results of the experiment show that violet cells degrade at about the same rate as conventional cells in such an orbit. Balloon flight measurements show that

violet solar cells produce approximately 20% more power than conventional cells. Author

N77-15492*# Spectrolab, Inc., Sylmar, Calif.
DEMONSTRATION OF THE FEASIBILITY OF AUTOMATED SILICON SOLAR CELL FABRICATION Final Report
J. Thornhill and W. E. Taylor Aug. 1976 54 p
(Contract NAS3-18566)
(NASA-CR-135095; Rept-3884-FR) Avail: NTIS HC A04/MF A01 CSCL 10A

An analysis of estimated costs indicate that for an annual output of 4,747,000 hexagonal cells (38 mm. on a side) a total factory cost of $0.866 per cell could be achieved. For cells with 14% efficiency at AMO intensity (1353 watts per square meter), this annual production rate is equivalent to 3,373 kilowatts and a manufacturing cost of $1.22 per watt of electrical output. A laboratory model of such a facility was operated to produce a series of demonstration runs, producing hexagonal cells, 2 x 2 cm cells and 2 x 4 cm cells. Author

N77-15494*# ECON, Inc., Princeton, N.J.
SPACE-BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS STUDY. VOLUME 1: EXECUTIVE SUMMARY Interim Report
George A. Hazelrigg, Jr. 30 Jun. 1976 38 p
(Contract NAS8-31308)
(NASA-CR-150146; Rept-76-145-2-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 10A

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. Author

N77-15495*# Grumman Aerospace Corp., Bethpage, N.Y.
SPACE-BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS STUDY. VOLUME 2: ENGINEERING ANALYSIS OF ORBITAL SYSTEMS Interim report
30 Jun. 1976 373 p refs
(Contract NAS8-31308)
(NASA-CR-150147; Rept-76-145-2-Vol-2) Avail: NTIS HC A16/MF A01 CSCL 10A

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

N77-15496*# ECON, Inc., Princeton, N.J.
SPACE-BASED SOLAR POWER CONVERSION AND DELIVERY SYSTEMS STUDY. VOLUME 3: ECONOMIC ANALYSIS OF SPACE-BASED SOLAR POWER SYSTEMS Interim Report
George A. Hazelrigg, Jr. 30 Jun. 1976 169 p refs
(Contract NAS8-31308)
(NASA-CR-150148; Rept-76-145-2-Vol-3; IR-2) Avail: NTIS HC A08/MF A01 CSCL 10A

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. Author

N77-15497*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ANALYSIS OF INFORMATION SYSTEMS FOR HYDRO-POWER OPERATIONS
Robert L. Sohn, Leonard Becker, John Estes, David Simonett, and William W.-G. Yeh Sep. 1976 336 p refs
(Contract NAS7-100)
(NASA-CR-149373; JPL-5040-44; RTOP-777-30-01) Avail: NTIS HC A15/MF A01 CSCL 10C

The operations of hydropower systems were analyzed with emphasis on water resource management, to determine how aerospace derived information system technologies can increase energy output. Better utilization of water resources was sought through improved reservoir inflow forecasting based on use of hydrometeorologic information systems with new or improved sensors, satellite data relay systems, and use of advanced scheduling techniques for water release. Specific mechanisms for increased energy output were determined, principally the use of more timely and accurate short term (0-7 days) inflow information to reduce spillage caused by unanticipated dynamic high inflow events. The hydrometeorologic models used in predicting inflows were examined to determine the sensitivity of inflow prediction accuracy to the many variables employed in the models, and the results used to establish information system requirements. Sensor and data handling system capabilities were reviewed and compared to the requirements, and an improved information system concept outlined. Author

N77-15498# Hittman Associates, Inc., Columbia, Md.
COMPARATIVE EVALUATION OF SOLAR HEATING ALTERNATIVES
H. M. Curran and M. Miller 1976 9 p refs Presented at 2d Southeastern Conf. on Appl. of Solar Energy, Baton Rouge, La., 21-23 Apr. 1976
(Contract E(11-1)-2703)
(COO-2703-2; Conf-760423-2) Avail: NTIS HC A02/MF A01

An analysis of alternative approaches to the use of solar energy for heating applications is presented. Three heat pump configurations were considered as alternatives to direct heat exchange. These were two configurations of a vapor compression heat pump driven by a solar-powered Rankine engine and a solar-powered absorption heat pump which used the heat of condensation in the Rankine cycle as part of the input to the thermal load. ERA

N77-15499# California Univ., Livermore. Lawrence Livermore Lab.
PYROLYSIS OF OIL SHALE: THE EFFECTS OF THERMAL HISTORY ON OIL YIELD
N. D. Stout, G. J. Koskinas, J. H. Raley, S. D. Santor, R. J. Opila, and A. J. Rothman 27 Apr. 1976 32 p refs Presented at 9th Oil Shale Symp., Golden, Colo., 29-30 Apr. 1976
(Contract W-7405-eng-48)
(UCRL-77831; Conf-760443-2) Avail: NTIS HC A03/MF A01

The effect of thermal history on the oil yield of a powdered, 22-gallon-per-ton Colorado shale was studied by heating to test temperature at Fischer assay rate, holding a test temperature for varying times up to 33 d, and finally heating to 500 C at 12 C/min. Test temperatures covered the range of 150 to 450 C. Both autogenous and inert sweep gas atmospheres were used. Under autogenous atmospheres at test temperatures of 250 C or below, yields obtained were 100 percent of Fischer assay. Heating at 300 to 425 C resulted in yield losses, maximizing at 19 percent after a 33 d exposure at 350 C. Yield losses were accompanied by increased char in the retorted shale and

by production of oil that was lower in density and nitrogen content, and higher in hydrogen. In the inert gas sweep experiments, increasing flow rates gave increased oil yields, approaching 100 percent assay. Author (ERA)

N77-15500# Braun (C. F.) and Co., Alhambra, Calif.
COAL GASIFICATION COMMERCIAL CONCEPTS: GAS COST GUIDELINES
R. Skamser Jan. 1976 39 p
(Contract E(49-18)-1235)
(FE-1235-1) Avail: NTIS HC A03/MF A01

The manufacture of synthetic natural gas from coal is discussed. Information and procedures required to calculate, on a consistent basis, the cost of producing high-Btu pipeline quality gas from coal using the design basis for the gasification plants is included. Coal analyses, unit prices (as of January 1, 1976), environmental requirements, plant size, equipment design guides, and equations for gas costs are provided using either utility or private investor financing. The cost of gas is determined primarily by the plant investment which is obtained from estimates of the installed cost of equipment. Methods of estimating vary with the agency or organization performing the work and are therefore not included in this procedure. These variations in estimating methods employed could result in gas costs significantly different from those developed here. However, if the cost estimates of installed equipment are developed by a neutral and reputable contractor experienced in building large industrial facilities, the results should be comparable. ERA

N77-15501# Foster Wheeler Corp., Livingston, N.J.
DEVELOPMENT WORK FOR AN ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION FROM COAL DIRECTED TOWARD A COMMERCIAL GASIFICATION GENERATING PLANT, PHASE 2 Quarterly Progress Report, Oct. - Dec. 1975
Apr. 1976 35 p
(Contract E(49-18)-1521)
(FE-1521-13) Avail: NTIS HC A03/MF A01

Efforts involved test runs of the proposed coal pulverizing and drying equipment. Solids feeding systems were investigated. Material balances (flows) during startup were calculated. Computer calculations on the water wash and sour water stripping tower, the sulfur removal process (Selexol) and the sulfur recovery system are given. Specifications for various support facilities and environmental protection installations were issued. Work continued on the conceptual design of a commercial plant, especially with respect to cold flow model tests and computer calculations of effects of transients in the system, including the gas-cleanup system. Author (ERA)

N77-15502# Parsons (Ralph M.) Co., Pasadena, Calif.
PRELIMINARY DESIGN SERVICES COAL CONSERVATION DEMONSTRATION PLANTS Annual Report, Jan. - Dec. 1975
Mar. 1976 108 p
(Contract E(49-18)-1775)
(FE-1775-3; Rept-114) Avail: NTIS HC A06/MF A01

Key objectives and progress in preliminary conceptual plant design and economic evaluations for advanced technology coal conversion complexes are reported. Major effort centered on development of conceptual designs to produce both clean liquid fuels and SNG using Oil/Gas and Fischer-Tropsch technologies. The Oil/Gas concept uses modified SRC hydroliquefaction combined with production of significant co-product SNG. Liquid production rates are approximately 80,000 and 50,000 barrels per day respectively. A procedure for rapid economic comparison of process alternates was adopted; the procedure and representative quantitative results are presented. Detailed analysis of process step efficiencies resulted in predicted increased thermal efficiencies; expected efficiency for each design is expected to be in the 70-75 percent range. Author (ERA)

N77-15503# Carnegie-Mellon Univ., Pittsburgh, Pa.
CATALYTIC SYNTHESIS OF GASEOUS HYDROCARBONS Quarterly Report, Sep. - Nov. 1975
A. L. Dent Dec. 1975 49 p
(Contract E(49-18)-1814)
(FE-1814-2) Avail: NTIS HC A03/MF A01

The objectives of this program are to develop improved catalyst systems for preparation of gaseous hydrocarbons from coal-derived mixtures of CO and H2, and to develop a fundamental understanding of methanation and Fischer-Tropsch syntheses. To accomplish the first objective, two versatile catalytic reactor units (CRU-1 and CRU-2) were designed to screen a variety of Fe(-), Co(-), and Ni(-) based catalysts. During a report period, work was devoted primarily to the areas of equipment assembly, preliminary catalyst screening tests, and preliminary mechanistic studies. Improved temperature flexibility of CRU-1 was achieved by modification of the reactor's furnace and preheater. Electrical components were completed and installed in CRU-2, three nondispersive ir analyzers were mounted and tested, and the gas chromatographic system was assembled. A training program utilizing olefin hydrogenation was undertaken to prepare for the initial tests of a typical Fischer-Tropsch catalyst in CRU-1. Finally poor quality ir spectra of Ni aerosols prompted a detailed modeling of the aerosol-generation method. ERA

N77-15504# Sandia Corp., Albuquerque, N.Mex.
BRANCHED THERMOCOUPLE CIRCUITS IN UNDERGROUND COAL GASIFICATION EXPERIMENTS
R. P. Reed 1976 12 p refs Presented at the 22d Intern. Instr. of the Instr. Soc. of Am., San Diego, Calif., 25 May 1976 Sponsored by ERDA
(SAND-75-5910; Conf-760513-5) Avail: NTIS HC A02/MF A01

The theory of branched thermocouple circuits is presented, their use in subsurface coal gasification experiments is described, and the need for diagnostic measurements in the interpretation of data made indefinite by noise content is illustrated. ERA

N77-15505# Lummus Co., New York.
HOT AND DRY CHAR LET DOWN SYSTEM FOR THE SYNTHANE DEMONSTRATION PLANT, PHASE 1 Final Report
31 Oct. 1975 71 p refs
(Contract E(36-2)-0058)
(PERC-0058-4) Avail: NTIS HC A04/MF A01

A program to design, simulation test and fabricate a commercially scaleable system to discharge dry char from the synthane pilot plant at as high a temperature as possible is discussed. Engineering designs are presented. Author (ERA)

N77-15506# American Cyanamid Co., Bound Brook, N.J. Chemical Research Div.
CONCEPT FOR FLUIDIZED BED COMBUSTION OF CONSOL CHAR USING A CLOSED-CYCLE HELIUM POWER PLANT WITH AN ESTIMATE OF THE PRICE OF ELECTRIC POWER Final Report
A. Himmelblau and J. Norton Apr. 1976 113 p
(Contract E(49-18)-2201)
(ERDA-76-69; FE-2201-4) Avail: NTIS HC A06/MF A01

The Consol process for making synthetic crude oil from coal produces char as a by-product which can be burned in a fluidized bed. Instead of using steam as the working fluid, helium was chosen, since a higher working temperature may allow a higher cycle efficiency. To develop a competent design required solution of a heat exchanger network designed to introduce as much heat as possible into the closed helium cycle. A computer model to generate flowsheets and cost data from specified inputs was developed. The net efficiency of the best design was only about 33.5 percent, since about 17.9 percent of the heat input to the cycle is used to calcine dolomite used to remove S in the fluidized bed. Lowering the amount of dolomite required or regenerating dolomite would be methods to improve the efficiency. Although the efficiency of the helium cycle is lower than that for a conventional coal-fired steam plant, the capital cost is lower (about $370/kW). ERA

N77-15507# Gilbert Associates, Inc., Reading, Pa.
PARTICIPATING SURVEILLANCE SERVICES FOR ELECTRIC POWER PROGRAM. COAL CONVERSION AND

UTILIZATION: DIRECT COMBUSTION OF COAL-90e, ADVANCED POWER-90f. SUMMARY FOR ERDA ANNUAL REPORT, CY 1975
Mar. 1976 7 p refs
(Contract E(49-18)-1236)
(FE-1236-4) Avail: NTIS HC A02/MF A01

Efforts in providing technical and engineering services to ERDA by way of surveillance, evaluation, technical and economic review and recommendations are reported. These efforts were mainly in the area of combustion and fluidized-bed combustion of coal, but included also the high temperature gas turbine program, closed cycle inert gas and alkali metal systems, advanced heat exchangers, etc. New proposals, modifications, extensions, etc. of such work were also evaluated for technical and economic feasibility, commercial application potential and estimate of time required for useful results. Specific studies and reports are described briefly. Plans for continued work are given. ERA

N77-15508# California Univ., Livermore. Lawrence Livermore Lab.
ENERGY AND TECHNOLOGY REVIEW
R. B. Carr Feb. 1976 28 p refs
(Contract W-7405-eng-48)
(UCID-52000-76-2) Avail: NTIS HC A03/MF A01

A high stability space frame to support the 20 beam Shiva laser system within exacting tolerances is described. Studies of small scale self focusing and whole beam distortion on Cyclops enabled one to control these nonlinear propagation phenomena and improve beam brightness. A new form of spectroscopy provides important experimental data on the excited states of uranium. ERA

N77-15509# Hanford Engineering Development Lab., Richland, Wash.
ECONOMIC ANALYSIS OF THE NEED FOR ADVANCED POWER SOURCES
R. W. Hardie and R. P. Omberg 14 Nov. 1975 17 p refs Presented at Am. Nucl. Soc. 1975 Winter Meeting, San Francisco, 16-21 Nov. 1975
(Contract AT(45-1)-2170)
(HEDL-SA-989; Conf-751101-77) Avail: NTIS HC A02/MF A01

The economic need for an advanced power source, be it fusion, solar, or some other concept, is considered. However, calculations were also performed assuming abandonment of the LMFBR program, so breeder benefits are a by-product of this study. The model used was the ALPS linear programming system for forecasting optimum power growth patterns. Total power costs were calculated over a planning horizon from 1975 to 2041 and discounted at 7 1/2 percent. The benefit of a particular advanced power source is simply the reduction in total power cost resulting from its introduction. Since data concerning advanced power sources (APS) are speculative, parametric calculations varying introduction dates and capital costs about a hypothetical APS plant were performed. Calculations were also performed without the LMFBR to determine the effect of the breeder on the benefits of an advanced power source. ERA

N77-15510# RAND Corp., Santa Monica, Calif.
POSSIBLE EFFECTS OF NUCLEAR INITIATIVE ON SUPPLY AND USE OF ELECTRICITY IN CALIFORNIA
Deane N. Morris Dec. 1975 20 p Presented at the Hearings on the Calif. Nucl. Safeguards Initiative; sponsored by the Assembly Comm. on Resources, Land Use and Energy
(AD-A026582; P-5547) Avail: NTIS HC A02/MF A01 CSCL 10/2

This report was prepared for presentation at the hearings on the California Nuclear Safeguards Initiative held by the Assembly Committee on Resources, Land Use and Energy. Rand recently completed a study for this committee on the future sources and uses of energy in California, and identified and discussed the major energy policy issues facing the state. Among many other issues, questions of electricity use and generation alternatives were addressed in the study. This testimony is based on the results of that work. GRA

N77-15511# Office of Naval Research, London (England).
ENERGY AND PHYSICS: GENERAL CONFERENCE OF THE EUROPEAN PHYSICAL SOCIETY
Roy F. Potter 7 Jun. 1976 17 p Third Conf. held in Bucharest, Romania, 9-12 Sep. 1975
(AD-A026962; ONRL-C-14-76) Avail: NTIS HC A02/MF A01 CSCL 10/1

This report covers portions of most of the plenary sessions including the opening session of the Conference, Physics and Energy; Energy Strategies; Maturity of Nuclear Energy; Use of Solar Energy; New Goals and Challenges; Photochemistry; Thermonuclear Research; Energy, Dissipation and Structure; Transport and Storage of Energy. Other sessions covered are on solar energy use, transport and storage of energy and energy research strategies. GRA

N77-15512# Naval Ship Research and Development Center, Annapolis, Md. Propulsion and Auxiliary Systems Dept.
ALUMINUM-BASED ANODES FOR UNDERWATER FUEL CELLS: A PHASE REPORT Research and Development Report, Jul. - Dec. 1971
H. B. Urbach and M. C. Cervi Jun. 1976 29 p
(AD-A026405; PAS-76-5) Avail: NTIS HC A03/MF A01 CSCL 10/2

The anodic properties of various aluminum alloys were studied potentiostatically with measurement of hydrogen evolution and potential. Also, an aluminum-oxygen fuel cell was examined for its polarization behavior. Hydrogen evolution at the aluminum anode represents a serious loss of efficiency, since the metal is consumed without delivery of power to the external circuit. The lowest rate of anodic hydrogen evolution at any given potential was measured on high-purity aluminum; since impurities tend to increase the rate of hydrogen evolution. Temperature studies on aluminum fuel cells indicate that power efficiency drops severely over 50 C. At 50 C, power efficiencies exceeding 50% at a power density of 100 A/sq ft (108 mA/sq cm) were obtained. At 175 and 225 A/sq ft (188 and 242 mA/sq cm), the power efficiency dropped to 40% and 30%, respectively. Freon may be circulated through the fuel cell during periods of reduced or no load to diminish the hydrogen self-discharge with no adverse effects after restarting. The aluminum-seawater system exhibits high-energy density, but it is rather inactive. Aluminum-lithium alloys coupled with seawater appear to be more desirable systems than those of pure aluminum because of their higher reactivity (power density), higher specific energy, and self-activating properties (no caustic inventory required). Author (GRA)

N77-15517# Army Mobility Equipment Research and Development Center, Fort Belvoir, Va.
SURFACE RESEARCH FOR DEVELOPMENT OF NEW ELECTROCATALYSTS FOR ACID ELECTROLYTE FUEL CELLS
Johann A. Joebstl 1976 15 p refs
(AD-A026053) Avail: NTIS HC A02/MF A01 CSCL 10/2

The mechanisms of selected electrochemical reactions are very similar to the mechanisms of the appropriate heterogeneous catalytic gas reactions. Therefore heterogeneous catalytic reactions can be utilized to screen materials for their potential applicability as electrocatalysts in fuel cells. Similarly, surface research on supported catalysts supplies invaluable information of the chemical interaction between catalyst and substrate and thus furthers the development of electrocatalysts with increased temperature stability. Author (GRA)

N77-15518# Army Mobility Equipment Research and Development Center, Fort Belvoir, Va.
AN IMPROVED ELECTROLYTE FOR DIRECT OXIDATION FUEL CELLS
Grayson W. Walker, Richard V. Lawrence, and Alayne A. Adams 1976 14 p refs
(AD-A026164) Avail: NTIS HC A02/MF A01 CSCL 10/3

This technological base of the modern Army is heavily dependent on electrical power generation for its sophisticated weapons, communications and detection systems. The diversity of such systems has resulted in no single power generation system being suitable for all applications. The engine generator

and secondary battery have long been the mainstays for field generator sets, with dependability and ease of transportation being two of their more important characteristics. With the increasing trend toward equipment mobility and the development of new sensitive intrusion and detection devices, which must operate in remote locations, undetected by the enemy, as well as in command areas, new emphasis is being placed on silence, efficiency and long term life capabilities. The fuel cell, and in particular the direct oxidation fuel cell, has the capability of meeting the electrical power requirements for low power applications. GRA

N77-15519# Army Electronics Command, Fort Monmouth, N.J. Electronics Technology and Devices Lab.
COMPOSITE MATERIAL STRUCTURES FOR THERMOPHOTOVOLTAIC CONVERSION RADIATOR
G. Guazzoni and E. Kittl Sep. 1975 27 p refs
(DA Proj. 1T1-61102-A-34A)
(AD-A026859; ECOM-4351) Avail: NTIS HC A03/MF A01 CSCL 10/2

This report covers the experimental work on the testing and evaluation of disk-shaped erbium oxide radiator samples fabricated by die pressing and plasma spray coating techniques. This investigation was performed to provide performance parameters on the utilization of these specimen structure compositions as improved radiator structures for thermophotovoltaic energy conversion applications. Author (GRA)

N77-15520# California Univ., Riverside. Inst. of Geophysics and Planetary Physics.
COOPERATIVE GEOCHEMICAL RESOURCE ASSESSMENT OF THE MESA GEOTHERMAL SYSTEM Final Report
Tyler B. Coplen Mar. 1976 118 p refs
(Contract DI-14-06-300-2479)
(PB-257225/3; IGPP-UCR-76-1) Avail: NTIS HC A06/MF A01 CSCL 08I

In order to effectively develop this geothermal resource the Bureau of Reclamation began conducting a reservoir analysis study in 1972. Information was obtained about water rock interactions and about the hydrogeology of this system. In particular, data pertinent to the quantity of water flowing past each gram of sediment was obtained by using stable isotope studies of oxygen, carbon and hydrogen. GRA

N77-15521# Army Facilities Engineering Support Agency, Fort Belvoir, Va.
DUAL PURPOSE NUCLEAR POWER PLANTS FOR MILITARY INSTALLATIONS
Anthony V. Nida and Gary S. Stewart 1976 14 p refs
(AD-A026141) Avail: NTIS HC A02/MF A01 CSCL 18/5

The authors have found evidence that the nuclear total energy system is technically feasible and capable of economically serving the utility needs of military installations. The recovery of thermal energy from a direct-cycle high-temperature gas-cooled reactor would result in significant reductions in thermal emissions and air pollution and aid in the conservation of fossil-fuel resources. Provision of electricity and thermal energy from a nuclear energy center should be considered for total energy systems in appropriately sized urban communities. This concept will accrue the greatest benefits in areas where air quality degradation is to be kept to a minimum and where dependable fuel supply must be guaranteed. GRA

N77-15523# Federal Energy Administration, Washington, D.C. Office of Oil and Gas.
TRENDS IN REFINERY CAPACITY AND UTILIZATION: PETROLEUM REFINERIES IN THE UNITED STATES; FOREIGN REFINERY EXPORTING CENTERS
E. L. Peer and F. V. Marsik Jun. 1976 47 p
(PB-256966/3; FEA/G-75/710) Avail: NTIS HC A03/MF A01 CSCL 07A

Data concerning actual and planned refinery capacities are presented for refineries in the U.S., Caribbean area, Middle East, Eastern Canada, Italy, and Singapore. Net exportable capacities are given through 1979. GRA

N77-15524# National Bureau of Standards, Washington, D.C. Center for Building Technology.
THE STRUCTURE OF BUILDING SPECIFICATIONS
Steven J. Fenves (Carnegie-Mellon Univ., Pittsburgh, Pa.), Kirk Rankin, and K. Tejuja Hotchand Sep. 1976 85 p refs
(PB-257581/9; NBS-BSS-90; LC-76-26695) Avail: NTIS HC A05/MF A01 CSCL 13A

A scientific basis is provided for the formulation and expression of performance standards and specifications and for explicit attention to performance in procedural and prescriptive standards and specifications. The provisions of the NBS developed interim performance criteria for solar heating and combined heating/cooling systems and dwellings, a performance specification, are classified in terms of the physical entities addressed, the attributes of the built environment, and the properties which group together particular physical entities which may be subject to similar dysfunctions. GRA

N77-15525# National Bureau of Standards, Washington, D.C. Solar Energy Program.
INTERMEDIATE MINIMUM PROPERTY STANDARDS FOR SOLAR HEATING AND DOMESTIC HOT WATER SYSTEMS Interim Report
Apr. 1976 173 p refs Sponsored by HUD
(PB-257086/9; NBSIR-76-1059) Avail: NTIS HC A08/MF A01 CSCL 13A

Standards for the use of solar heating and domestic hot water systems in residential applications are presented. The standards were developed for application in numerous housing programs of the Department of Housing and Urban Development. To the greatest extent possible, these standards are based on current state-of-the-art practice and on nationally recognized standards including the MPS and the HUD interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings. GRA

N77-15527# Department of Housing and Urban Development, Washington, D.C.
RAPID GROWTH FROM ENERGY PROJECTS: IDEAS FOR STATE AND LOCAL ACTION. A PROGRAM GUIDE
Apr. 1976 66 p refs Prepared in cooperation with the Federal Energy Admin., Washington, D.C.
(PB-257374/9; HUD-CPD-140; FEA/G-76/394) Avail: NTIS HC A04/MF A01 CSCL 10A

The purposes of this publication are: to show what the community impacts of energy projects are likely to be; to share ideas for action among communities, based on actual experiences; and to point out sources of help - for information planning and financial assistance. GRA

N77-15528# Electric Power Research Inst., Palo Alto, Calif. Nuclear Power Div.
NUCLEAR UNIT PRODUCTIVITY ANALYSIS
Melvin E. Lapides Aug. 1976 73 p refs
(PB-257553/8; EPRI-SR-46) Avail: NTIS HC A04/MF A01 CSCL 18E

Licensing, procurement and operations evaluations of generation units involve assessments of unit safety, reliability, availability and productivity. The safety assessments are characterized by a well-developed methodology and by conservative regulatory decrees in areas where data uncertainties may exist. The remaining assessments draw on a lesser developed methodology with no convenient options for dealing with recognized data shortcomings. GRA

N77-15533# California Univ., Livermore. Lawrence Livermore Lab. Biomedical and Environmental Research Div.
OVERVIEW OF THE IMPERIAL VALLEY ENVIRONMENTAL PROJECT
L. R. Anspaugh, ed. and P. L. Phelps, ed. 8 Apr. 1976 14 p Presented to the Natl. Geothermal Conf., Palm Springs, Calif., 19-22 Apr. 1976
(Contract W-7405-eng-48)
(UCID-17067; Conf-760450-1) Avail: NTIS HC A02/MF A01

A long-term project to acquire complete understanding of the environmental quality in the Imperial Valley of California

was initiated to ensure that the development of geothermal resources proceeds on an environmentally sound basis. Consequently, the Imperial Valley Environmental Project (IVP) is committed to an intensive and comprehensive study designed to establish an environmental baseline for the Imperial Valley as well as to develop an understanding of the environmental and other effects associated with development of geothermal resources. The IVP is organized into seven main study sections, which when taken together cover all the significant issues and concerns. The sections are: Air Quality; Water Quality; Ecosystem Quality, (Soil, Plants, Animals, etc.); Subsidence and Induced Seismicity; Health Effects; Socio-Economics; and an Integrated Assessment. Author (ERA)

N77-15539# Kentucky Univ., Lexington. Inst. for Mining and Minerals Research.
HOT FUEL GAS DESULFURIZATION
J. T. Shrodt and O. J. Hahn May 1976 35 p refs
(PB-257036/4; IMMR15-PD11-76) Avail: NTIS HC A03/MF A01 CSCL 07A

The scope of the hot fuel gas desulfurization problem is summarized. The levels of impurities found in coal-derived fuel gases, and the tolerances of gas turbines for these are presented. Two conceptual schemes for recovering energy from low Btu gases subject to high and low temperature desulfurization were compared. The basic concept of the IMMR hot ash desulfurization process, its chemistry and theoretical maximum efficiency were carefully examined. Finally, desulfurization results obtained in both fixed and fluidized beds of gasifier ash held at 800 to 1,500 F are presented and discussed. GRA

N77-15540# Army Engineer Waterways Experiment Station, Vicksburg, Miss. Environmental Effects Lab.
POLLUTANT POTENTIAL OF RAW AND CHEMICALLY FIXED HAZARDOUS INDUSTRIAL WASTES AND FLUE GAS DESULFURIZATION SLUDGES Interim Report, Jan. - Aug. 1975
J. L. Mahloch, D. E. Averett, and M. J. Bartos, Jr. Cincinnati, Ohio EPA Jul. 1976 120 p refs
(Grant EPA-IAG-D4-0569)
(PB-256691/7; EPA-600/2-76-182) Avail: NTIS HC A06/MF A01 CSCL 13B

The potential environmental impact of raw sludge disposal is examined, and the technical merits of sludge fixation as a disposal pretreatment process are assessed. Both objectives are being accomplished by leachate testing, which can be evaluated by comparison to the raw sludges, and by durability testing, which reflects the environmental stability of the fixed products. Major points of discussion are the methods for physical and chemical analyses, documentation of the various sludge fixation processes, and the physical and chemical data that are presently available. GRA

N77-15541# Coordinating Research Council, Inc., New York.
COOPERATIVE STUDY OF HEAVY DUTY DIESEL EMISSION MEASUREMENT METHODS Final Report
Jul. 1976 88 p refs
(PB-257137/0; CRC-487; CRC-APRAC-CAPI-1-64-10) Avail: NTIS HC A05/MF A01 CSCL 13B

A cooperative test program was conducted to evaluate the technical aspects of a proposed EPA recommended heavy-duty diesel instrumentation and test procedure. The primary emphasis was on NO and NOx measurement methods and instrumentation. CO, CO2 and HC measurements were made by two participants using complete sampling and analysis systems. The various NOx instrument configurations used included vacuum and positive pressure chemiluminescent analyzers. GRA

N77-15550# Midwest Research Inst., Kansas City, Mo.
PERFORMANCE OF EMISSION CONTROL DEVICES ON BOILERS FIRING MUNICIPAL SOLID WASTE AND OIL Final Report, Jul. 1975 - Jun. 1976
J. B. Galeski and M. P. Schrag Jul. 1976 128 p refs
(Contract EPA-68-02-1324)
(PB-257136/2; EPA-600/2-76-209) Avail: NTIS HC A07/MF A01 CSCL 21D

Particulate flue gas loadings were estimated for combined firing of shredded municipal waste (MSW) and oil, using existing data on particulate emissions from oil-fired electric utility boilers and from waterwall (steam generating) incinerators firing either waste or waste-plus-coal/oil auxiliary fuel. Control device performance was estimated for several planned oil/MSW resource recovery systems. On the basis of these estimates, installed particulate emission controls, designed for coal, are predicted to be significantly less efficient for control of particulate emissions from combined firing of oil/MSW. Anticipated control difficulties result mostly from high particulate loadings, high flue gas volumes, fine particulates, relatively low particle density, and relatively high fractions of carbonaceous low-resistivity particulate. GRA

N77-15845# Stanford Univ., Calif. Dept. of Mechanical Engineering.
ABSTRACTS: 1976 AFOSR CONTRACTORS' MEETING ON MHD POWER GENERATION AND LASERS
4 May 1976 58 p Conf. held in Stanford, Calif., 3-4 May, 1976
(Contract F44620-76-C-0024; AF Proj. 6813; AF Proj. 9752)
(AD-A027654; AFOSR-76-0171TR) Avail: NTIS HC A04/MF A01 CSCL 10/2

The report consists of a collection of abstracts of the numerous research progress reports given by AFOSR contractors and of invited papers from other governmental agencies and contractors. These papers presented over a two-day period comprised the 1976 annual contractors meeting on MHD electric power generation and lasers. The principal investigators and their organizational association are also identified. GRA

N77-15919# Midwest Research Inst., Kansas City, Mo.
FINE SHREDDING OF MUNICIPAL SOLID WASTE Final Report, Jun. 1975 - Jun. 1976
K. P. Ananth and J. Shum Jul. 1976 71 p refs
(Contract EPA-68-02-1324)
(PB-257105/7; EPA-600/2-76-208) Avail: NTIS HC A04/MF A01 CSCL 13B

Equipment used for municipal solid waste (MSW) size reduction and its performance and cost are discussed. Of the 11 basic equipment types used for shredding MSW, only hammermills and grinders find wide application. An evaluation of available hammermill and grinder performance data indicates that: their specific energy consumption is indpendent of throughput for the same product size distributions and feed characteristics (power, however, is a function of throughput); higher shaft speeds produce finer size distributions and require more energy for the same throughputs; smaller grate spacings (exit clearances) produce finer particles; and for constant feed and shredder operating conditions, specific energy consumption is a minimum at 30-40% refuse moisture content. GRA

N77-15923# National Bureau of Standards, Washington, D.C.
INTEGRATING COMMUNITY UTILITIES FOR RESOURCE CONSERVATION Final Report
John R. Schaefgen 1976 9 p refs Presented at 3d Natl. Conf. on Complete Water Reuse: Symbiosis as a Means of Abatement for Multi-Media Pollution, Cincinnati, 27-30 Jun. 1976 p 53-59 Sponsored in part by HUD
(PB-256898/8) Avail: NTIS HC A02/MF A01 CSCL 10A

A Modular Integrated Utility System (MIUS) provides the utility services of electrical power, space heating and cooling, potable water heating, solid waste processing, sanitary sewage treatment, potable water treatment, and the site distribution, collection, and disposal functions attendant thereto. MIUS facilities are constructed on a community scale to achieve the maximum symbiotic effects from process integration. The MIUS approach to utility services can conserve energy, reduce environmental degradation, and permit greater flexibility in intensive land development at a competitive cost. This report briefly discusses the characteristics and benefits of MIUS facilities. GRA

N77-15930# Wisconsin Univ., Madison. Engineering Experiment Station.
INCREASED FUEL ECONOMY IN TRANSPORTATION

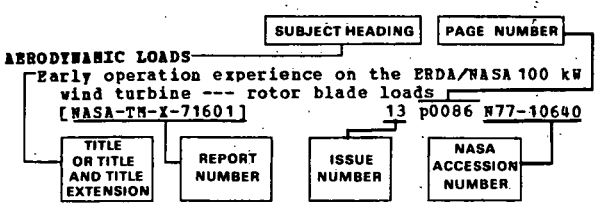
SYSTEMS BY USE OF ENERGY MANAGEMENT - SECOND YEAR'S PROGRAM Final Report, Dec. 1975

N. H. Beachley and A. A. Frank Dec. 1975 239 p

(Contract DOT-OS-30112)
(PB-257177/6; DOT-TST-76-57) Avail: NTIS HC A11/MF A01 CSCL 13F

Design and analytic evaluation of experimental vehicles equipped with a flywheel energy management powerplant were considered. An energy storage flywheel was employed to permit more efficient fuel utilization. Modeling techniques that permit the accurate prediction of transient emissions from an automobile over any driving cycle, and the fuel-saving potential of relatively straightforward changes to transmissions and drivetrain systems were explored. GRA

Typical Subject Index Listing



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A

ABIOGENESIS
Chemical evolution of photosynthesis
13 p0071 A77-18898

ABSORBENTS
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106

ABSORPTION
Survey of absorption refrigeration systems
13 p0078 A77-19105

ABSORPTION SPECTRA
Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range
13 p0069 A77-18496

ABSORPTION SPECTROSCOPY
Measurements of Sc I gf-values --- absorption spectroscopy using heat pipe oven
13 p0058 A77-16270

ABSTRACTS
Abstracts: 1976 AFOSR Contractors' meeting on MHD Power Generation and Lasers
[AD-A027654] 13 p0133 N77-15845

AC GENERATORS
Alternating photoelectrochemical converters
13 p0077 A77-19093

ACCELERATED LIFE TESTS
Test and evaluation of the Navy half-watt RTG --- Radioisotope Thermoelectric Generator
13 p0042 A77-12853

ACIDITY
Evolution of atmospheric pollution /high acidity and black fumes/ in France during 1975
13 p0002 A77-10670

ACIDS
Surface research for development of new electrocatalysts for acid electrolyte fuel cells
[AD-A026053] 13 p0131 N77-15517

ACOUSTIC PROPERTIES
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668

ACOUSTIC VELOCITY
Study of the properties of heat pipes with liquid-metal heat-transfer agents in low-temperature regimes
13 p0046 A77-13243

ACOUSTICS
Advances in engineering science, volume 3
[NASA-CP-2001-VOL-3] 13 p0084 N77-10305

ADDITIVES
Study of the ionization of the additive in MHD installations
13 p0002 A77-10424
Fuels and fuel additives for highway vehicles and their combustion products. Guide to evaluation of their potential effects on health
[PB-254088/8] 13 p0084 N77-10222
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529

AERIAL PHOTOGRAPHY
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121
Use of radar in geology
13 p0018 A77-12256

AERODYNAMIC CHARACTERISTICS
Study of unconventional aircraft engines designed for low energy consumption
[NASA-CR-135136] 13 p0127 N77-15043

AERODYNAMIC COEFFICIENTS
Aerodynamics of the Darrieus rotor
13 p0050 A77-14559

AERODYNAMIC CONFIGURATIONS
Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575

AERODYNAMIC DRAG
Wind tunnel investigation of devices to reduce bus aerodynamic drag
[AIAA PAPER 77-307] 13 p0066 A77-18232

AERODYNAMIC LOADS
Early operation experience on the ERDA/NASA 100 kW wind turbine --- rotor blade loads
[NASA-TM-X-71601] 13 p0086 N77-10640

AERODYNAMICS
Aerodynamics as a subway design parameter
13 p0070 A77-18721

AERONAUTICAL ENGINEERING
Aircraft fuel conservation technology. Task force report, September 10, 1975
[NASA-TM-X-74295] 13 p0093 N77-11055

AERONAUTICS
National Meeting on Air and Space Law, 7th, Universidad Nacional de Cordoba, Cordoba and La Falda, Argentina, August 13-16, 1975, Proceedings
13 p0053 A77-15050

AEROSOLS
Aerosol formation during coal combustion - Condensation of sulfates and chlorides on flyash
13 p0054 A77-15778
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715

AEROSPACE ENGINEERING
OTEC - Aerospace and ocean engineering in partnership --- Ocean Thermal Energy Conversion
[AIAA PAPER 77-296] 13 p0066 A77-18227

AEROSPACE INDUSTRY
Legal and economic prerequisites to space industrialization
[IAF PAPER ISL-76-29] 13 p0004 A77-10968
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981

AEROSPACE SYSTEMS
Gas turbine electric powerplants
[AIAA PAPER 77-346] 13 p0066 A77-18254

AEROTHERMODYNAMICS
Aerothermic power plant with artificial cyclone
13 p0077 A77-19098

AFRICA
Formulation of energy policies - The case of West Africa
13 p0080 A77-19124

AIR CONDITIONING
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665
Cooling arrays of circuit cards using heat pipes and forced air diffusers
13 p0031 A77-12766
A unique Rankine-cycle heat pump system
13 p0036 A77-12799
Thermal energy storage for heating and air conditioning
13 p0057 A77-16206
Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia
13 p0078 A77-19110
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran --- Heating, Ventilating and Air Conditioning
13 p0078 A77-19111
Preliminary design data for a solar house in Riyadh, Saudi Arabia
13 p0078 A77-19112
Solar hot water systems application to the solar building test facility and the Tech House
13 p0084 N77-10342
CCMS solar energy pilot study solar heating and cooling systems in buildings
[UMD-4908-5] 13 p0088 N77-10657
A location matrix plan for the residential solar heating and cooling demonstration program. Volume 1: Findings and recommendations
[PB-253784/3] 13 p0089 N77-10673
Hybrid simulation of solar HVAC system for house retro-fit design
[PB-252608/5] 13 p0090 N77-10676
National program for solar heating and cooling (residential and commercial applications)
[ERDA-23A] 13 p0098 N77-11540
Temperature distribution of a hot water storage tank in a simulated solar heating and cooling system
[NASA-TM-X-73549] 13 p0106 N77-12521
Evaluation of the air-to-air heat pump for residential space conditioning
[PB-255652/0] 13 p0108 N77-12545

AIR CONDITIONING EQUIPMENT
The assurance of the heat supply with respect to the primary energy use in the case of heating and air conditioning installations
13 p0009 A77-11270
Experimental evaluation of the University of Florida solar powered ammonia/water absorption air conditioning system
13 p0039 A77-12823
Short and long term comparison of solar absorption air-conditioning system performance using real and synthetic weather data
13 p0039 A77-12824
Optimizing solar cooling systems
13 p0047 A77-13502
Energy and environmental considerations in extending heat pump applications
13 p0062 A77-17058
Measured performance of a 3 ton LiBr absorption water chiller and its effect on cooling system operation
[NASA-TM-X-73496] 13 p0105 N77-12518
Method for estimating solar heating and cooling system performance
[AD-A026041] 13 p0116 N77-13557

AIR COOLING
Cooling arrays of circuit cards using heat pipes and forced air diffusers
13 p0031 A77-12766
A 2-MW electric arc generator with porous cooling of the interelectrode insert
13 p0049 A77-13831
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638

AIR POLLUTION
Evolution of atmospheric pollution /high acidity and black fumes/ in France during 1975
13 p0002 A77-10670
The fuel approach to control emissions from aircraft
[IAP PAPER 76-111] 13 p0003 A77-10911
Sulphur pollution and emission charges
13 p0005 A77-11033
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
Compilation of an inventory for particulate emissions in Belgium
13 p0009 A77-11271
Air cleanup and energy management
13 p0010 A77-11302
Clean air protection and industrial development
13 p0010 A77-11303
Application of the Stretford process for H2S abatement at the Geysers geothermal power plant
13 p0029 A77-12743
The conservation of air purity and its effect on the energy economy
13 p0049 A77-13811
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890
Aerosol formation during coal combustion - Condensation of sulfates and chlorides on flyash
13 p0054 A77-15778
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780
Assessing low sulfur coal resources in Montana and Wyoming
13 p0058 A77-16374
Production of atmospheric nitrous oxide by combustion
13 p0061 A77-16922
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295
Organization of long range transport of air pollution monitoring in Europe
13 p0071 A77-18754
General Motors Sulfate Dispersion Experiment - Assessment of the EPA HIWAY model
13 p0071 A77-18882
Desulfurization of flue gases with iron/III/ oxide on porous carrier material - Theoretical and experimental investigation concerning the modelling of semicontinuous solid bed reactors with gas-solid reactions --- German book
13 p0080 A77-19184
Protocol to characterize gaseous emissions as a function of fuel and additive composition
[PB-253363/6] 13 p0084 N77-10221
Fuels and fuel additives for highway vehicles and their combustion products. Guide to evaluation of their potential effects on health
[PB-254088/8] 13 p0084 N77-10222
Mathematical simulation and empirical determination of the aerochemical and thermal atmospheric pollution resulting from energy conversion processes
[DLR-IB-553-75/1] 13 p0091 N77-10700
The proceedings of the NOx Control Technology Seminar
[PB-253661/3] 13 p0092 N77-10707
Growth effects of major land use projects. Volume 2: Compilation of land use based emission factors
[PB-255302/2] 13 p0092 N77-10709
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California
[PB-254449/2] 13 p0092 N77-10720
Reductant gases for flue gas desulfurization systems
[PB-254168/8] 13 p0092 N77-10722
Compilation of air pollutant emission factors. Supplement
[PB-254274/4] 13 p0093 N77-10731

Field test sampling/analytical strategies and implementation cost estimates: Coal gasification and flue gas desulfurization
[PB-254166/2] 13 p0101 N77-11581
An evaluation of high altitude engine modification devices (econo-kit)
[PB-255556/3] 13 p0101 N77-11589
Investigation and assessment of light-duty-vehicle evaporative emission sources and control
[PB-255813/8] 13 p0102 N77-11603
A bioenvironmental study of emissions from refuse derived fuel
[AD-A024661] 13 p0110 N77-12571
Air quality considerations in transportation planning: Findings and recommendations on transportation control planning, phase 2
[PB-256424/3] 13 p0110 N77-12576
Laws and regulations affecting coal with summaries of Federal, State, and local laws and regulations pertaining to air and water pollution control, reclamation, diligence and health and safety, part 1
[PB-255927/6] 13 p0110 N77-12592
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597
Laboratory analysis of solvent refined coal
[PB-255550/6] 13 p0110 N77-12598
Automotive gas turbine fuel control
[NASA-CASE-LEW-12785-1] 13 p0113 N77-13426
Burner design criteria for control of NOx from natural gas combustion. Volume 2: Raw data and experimental results
[PB-256806/1] 13 p0115 N77-13549
Proceedings of the Stationary Source Combustion Symposium. Volume 1. Fundamental research
[PB-256320/3] 13 p0116 N77-13569
Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570
Evaluation of pollution control in fossil fuel conversion processes
[PB-255842/7] 13 p0125 N77-14638
Proceedings of the Stationary Source Combustion Symposium. Volume 3: Field Testing and Surveys
[PB-257146/1] 13 p0125 N77-14643
Second Environmental Aspects of Fuel Conversion Technology Symposium
[PB-257182/6] 13 p0125 N77-14645
Hot fuel gas desulfurization
[PB-257036/4] 13 p0133 N77-15539
Performance of emission control devices on boilers firing municipal solid waste and oil
[PB-257136/2] 13 p0133 N77-15550

AIR QUALITY
The conservation of air purity and its effect on the energy economy
13 p0049 A77-13811
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719
The air quality and economic implications of supplementary control systems in Illinois --- considering electric power plant fuels
[PB-255699/1] 13 p0101 N77-11588

AIR TRAFFIC CONTROL
LH2 airport requirements study
[NASA-CR-2700] 13 p0083 N77-10032

AIR TRANSPORTATION
Air transportation energy efficiency - Alternatives and implications
[SAWE PAPER 1124] 13 p0016 A77-12192
Transport of the future and the tasks of science
13 p0048 A77-13643
Air transportation and fuel consumption
13 p0051 A77-14563
LTA - Recent developments --- Lighter Than Air ships
13 p0061 A77-17021
Regulatory reform of air transportation
[AIAA PAPER 77-276] 13 p0065 A77-18215
The future of air transportation - Economic association considerations
[AIAA PAPER 77-286] 13 p0065 A77-18222
Our amazing air transportation system /AIAA-SAE William Littlewood Memorial Lecture/ --- civil aviation aircraft historical overview
[AIAA PAPER 77-356] 13 p0067 A77-18260
Baseline energy forecasts and analysis of alternative strategies for airline fuel conservation
[PB-255351/9] 13 p0091 N77-10690
Future aircraft requirements: A notebook of airline thoughts
13 p0117 N77-13976
Air transport propulsion for the 1980's
13 p0117 N77-13980
Air transportation beyond the 1980's
13 p0117 N77-13984
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137926] 13 p0126 N77-15007
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008

AIRBORNE EQUIPMENT
LTA - Recent developments --- Lighter Than Air ships
13 p0061 A77-17021
Tracking pollutants from a distance
13 p0067 A77-18370

AIRCRAFT CONFIGURATIONS
The next-generation subsonic transport
[SAWE PAPER 1127] 13 p0016 A77-12195

AIRCRAFT DESIGN
Estimating procedures associated with aircraft modifications
[SAWE PAPER 1101] 13 p0016 A77-12181
Application of advanced technology to future long-range aircraft
[SAWE PAPER 1126] 13 p0016 A77-12194
The next-generation subsonic transport
[SAWE PAPER 1127] 13 p0016 A77-12195
Hypersonic technology-approach to an expanded program
13 p0051 A77-14597
Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575
Technical highlights in general aviation
[AIAA PAPER 77-312] 13 p0066 A77-18237
Our amazing air transportation system /AIAA-SAE William Littlewood Memorial Lecture/ --- civil aviation aircraft historical overview
[AIAA PAPER 77-356] 13 p0067 A77-18260
The pay-off for advanced technology in commercial aircraft design and operation
13 p0071 A77-19012
The dynamics of STOL /The Daniel and Florence Guggenheim Lecture/ --- utility aircraft for short haul service in remote areas
[ICAS PAPER 76-01] 13 p0081 A77-19247

AIRCRAFT ENGINES
Equation solution accuracy in calculating jet engine characteristics
13 p0020 A77-12502
Application of simulation studies to the design and improvement of fuel control systems for aviation turbine engines
13 p0054 A77-15798
Pressure ratio optimization criteria in aircraft turbojet-engines design
13 p0062 A77-17258
Variable geometry for high performance aircraft engines
13 p0062 A77-17264
A combined cycle with a partial-oxidation reactor
13 p0062 A77-17534
Theoretical aspects of optimization of aviation gas turbine engine design variables
13 p0063 A77-17762
Bosch technical instruction. Gasoline injection D and L-jetronic
[NASA-TT-F-17111] 13 p0095 N77-11399
Auxiliary power system for activity cooled aircraft
[NASA-CASE-LAR-11626-1] 13 p0103 N77-12332
Cost/benefit assessment of the application of composite materials to subsonic commercial transport engines
[NASA-TM-X-73557] 13 p0111 N77-13064
Air transport propulsion for the 1980's
13 p0117 N77-13980

Study of unconventional aircraft engines designed for low energy consumption
[NASA-CR-135136] 13 p0127 N77-15043

AIRCRAFT EQUIPMENT
A study of the failure of joints in composite material fuel cells due to hydraulic ram loading
[AD-A027258] 13 p0117 N77-14016

AIRCRAFT FUEL SYSTEMS
The fuel approach to control emissions from aircraft
[IAF PAPER 76-111] 13 p0003 A77-10911
Aircraft fuel conservation technology. Task force report, September 10, 1975
[NASA-TM-X-74295] 13 p0093 N77-11055
Reduction of gaseous pollutant emissions from gas turbine combustors using hydrogen-enriched jet fuel
[NASA-CR-149146] 13 p0094 N77-11198

AIRCRAFT FUELS
Air transportation energy efficiency - Alternatives and implications
[SAWE PAPER 1124] 13 p0016 A77-12192
Survey of hydrogen energy application projects
13 p0033 A77-12778
Air transportation and fuel consumption
13 p0051 A77-14563
Liquid hydrogen as propellant for commercial aircraft
[DGLR PAPER 76-188] 13 p0059 A77-16534
Fuel consumption of civil jet transport aircraft
13 p0062 A77-17234
Regulatory reform of air transportation
[AIAA PAPER 77-276] 13 p0065 A77-18215
Hydrogen-fueled subsonic aircraft: A perspective
13 p0084 N77-10344
The potential of liquid hydrogen as a military aircraft fuel
[AD-A026666] 13 p0118 N77-14272
Alternative fuels for aviation
[GPO-78-544] 13 p0127 N77-15212

AIRCRAFT INDUSTRY
Air transportation beyond the 1980's
13 p0117 N77-13984

AIRCRAFT PERFORMANCE
Concorde - Endurance flights results
13 p0016 A77-12114
Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575
A simplified method in flight test techniques for the determination of the range performance of jet aircraft
13 p0060 A77-16600

AIRCRAFT STRUCTURES
Advanced helicopter structural design investigation. Volume 1: Investigation of advanced structural component design concepts
[AD-A024662] 13 p0102 N77-12052

AIRFOIL PROFILES
Comparative wind tunnel investigation of sail profiles for windmills
[VTH-191] 13 p0111 N77-13012

AIRLINE OPERATIONS
The future of air transportation - Economic association considerations
[AIAA PAPER 77-286] 13 p0065 A77-18222
Our amazing air transportation system /AIAA-SAE William Littlewood Memorial Lecture/ --- civil aviation aircraft historical overview
[AIAA PAPER 77-356] 13 p0067 A77-18260
The pay-off for advanced technology in commercial aircraft design and operation
13 p0071 A77-19012
The seat belt light is on --- airline industry economic assessment and forecasts
13 p0080 A77-19175
An exploratory study to determine the integrated technological air transportation system ground requirements of liquid-hydrogen-fueled subsonic, long-haul civil air transports
[NASA-CR-2699] 13 p0083 N77-10033

AIRPORT LIGHTS
Emergency power plant of rapid availability for the Berlin-Tegel airport
13 p0001 A77-10324

AIRPORT PLANNING
Electric power supply in the case of airports. I
13 p0061 A77-16742
LH2 airport requirements study
[NASA-CR-2700] 13 p0083 N77-10032

AIRSHIPS
Ultralightweight solar array for Naval Sea Control Systems
13 p0040 A77-12828
LTA - Recent developments --- Lighter Than Air ships
13 p0061 A77-17021

ALASKA
The exploration, development and production of Naval petroleum reserve number 4
[PB-256714/7] 13 p0113 N77-13516
Heat pipes for the trans-Alaska pipeline
13 p0120 N77-14388

ALCOHOLS
Survey of alcohol fuel technology, volume 1
[PB-256007/6] 13 p0112 N77-13232
Survey of alcohol fuel technology, Volume 2
[PB-256008/4] 13 p0112 N77-13233

ALKALI METALS
Alkali metal space power technology applicable to national energy research and development
[AIAA PAPER 77-289] 13 p0065 A77-18223
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383

ALKALIES
Air electrodes for H2-air fuel cells with alkali electrolyte
13 p0065 A77-18196

ALKALINE BATTERIES
Evaluation of potassium titanate as a component of alkaline fuel cell matrices
[NASA-TM-D-8341] 13 p0094 N77-11175
New separators for nickel-zinc batteries
[NASA-TM-X-3465] 13 p0121 N77-14585

ALLOYS
Metalhydrides
[OUEL-1146/76] 13 p0094 N77-11158

ALUMINUM
Aluminum-based anodes for underwater fuel cells: A phase report
[AD-A026405] 13 p0131 N77-15512

ALUMINUM ALLOYS
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107

AMBIENT TEMPERATURE
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924

AMMONIA
Survey of absorption refrigeration systems
13 p0078 A77-19105
Heat pipe materials compatibility
[NASA-CR-135069] 13 p0103 N77-12182
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552
Investigations of nonsteady-state processes at cryogenic heat pipe operation --- filled with ammonia and Freon-22
13 p0119 N77-14384

AMPLIFIERS
Shaping of laser pulses in an amplifying system receiving input signals with a variable spectrum
13 p0053 A77-15237

ANAEROBES
Solar SNG - Large-scale production of SNG by anaerobic digestion of specially grown plant matter --- Synthetic Natural Gas
13 p0021 A77-12671

ANNUAL VARIATIONS
The influence of subsurface energy storage on seasonal temperature variations
13 p0067 A77-18351

ANODES
Aluminum-based anodes for underwater fuel cells: A phase report
[AD-A026405] 13 p0131 N77-15512

ANTARCTIC REGIONS
Atmospheric carbon dioxide variations at the South Pole
13 p0067 A77-18439

ANTENNA ARRAYS
Microwave transmission system for space power
13 p0014 A77-11818

ANTIREFLECTION COATINGS
Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range
13 p0069 A77-18496
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
Meeting electric power needs with photovoltaic power systems
13 p0076 A77-19091
Optimized selective coatings for solar collectors
[NASA-TM-X-73498] 13 p0097 N77-11529
Low reflectivity solar cells
[AD-A025922] 13 p0108 N77-12539
ARGON
Heat pipes with a non-condensable gas and their application in nuclear apparatus and instruments
13 p0120 N77-14387
ARGON ISOTOPES
The nature and characteristics of the distribution of helium and argon isotopes in the geothermal waters of the Kuril Islands and Kamchatka
13 p0048 A77-13589
ARGON PLASMA
Non-equilibrium MHD power generation using non-seeded argon plasma
13 p0004 A77-11022
ARMED FORCES
Some cost, energy, environmental, and resource implications of synthetic fuels produced from coal for military aircraft
[AD-A026667] 13 p0118 N77-14271
ASHES
Clean air protection and industrial development
13 p0010 A77-11303
ASSAYING
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499
ATMOSPHERIC ATTENUATION
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568
ATMOSPHERIC CIRCULATION
Aerothermic power plant with artificial cyclone
13 p0077 A77-19098
ATMOSPHERIC COMPOSITION
Atmospheric carbon dioxide variations at the South Pole
13 p0067 A77-18439
ATMOSPHERIC HEAT BUDGET
Energetics of the midlatitude thermosphere
13 p0012 A77-11492
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568
ATMOSPHERIC HEATING
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568
The influence of subsurface energy storage on seasonal temperature variations
13 p0067 A77-18351
ATMOSPHERIC MODELS
The influence of subsurface energy storage on seasonal temperature variations
13 p0067 A77-18351
Wind power prediction models
[NASA-CR-149235] 13 p0105 N77-12509
ATMOSPHERIC MOISTURE
Electric energy from atmospheric water vapor
13 p0077 A77-19097
ATMOSPHERIC PHYSICS
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780
ATMOSPHERIC TEMPERATURE
The influence of subsurface energy storage on seasonal temperature variations
13 p0067 A77-18351
Aerothermic power plant with artificial cyclone
13 p0077 A77-19098
ATS
The ATS-6 power system - Hardware implementation and orbital performance
13 p0040 A77-12831
ATTITUDE STABILITY
Nuclear-powered Hysat spacecraft: Comparative design study
[ERDA-SNS-3063-8] 13 p0094 N77-11108
AUTOMATIC CONTROL
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
Personal rapid transit research conducted at the Aerospace Corporation
[PB-256846/7] 13 p0111 N77-12946
Automotive gas turbine fuel control
[NASA-CASE-LEW-12785-1] 13 p0113 N77-13426
AUTOMATION
Demonstration of the feasibility of automated silicon solar cell fabrication
[NASA-CR-135095] 13 p0129 N77-15492
AUTOMOBILE ENGINES
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665
Application of a shunt motor and a 2 cylinder gasoline engine as a hybrid drive for an automobile
13 p0025 A77-12703
Electric vehicle performance with alternate batteries
13 p0025 A77-12707
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
Alternate fuel capability of Rankine cycle engines
13 p0036 A77-12801
Self-starting, intrinsically controlled Stirling engine
13 p0041 A77-12844
Noise mechanism separation and design considerations for low tip-speed, axial-flow fans
13 p0046 A77-13339
High-temperature ceramics for automobile gas turbines. II
13 p0063 A77-17591
General Motors Sulfate Dispersion Experiment - Assessment of the EPA HIWAY model
13 p0071 A77-18882
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715
Ceramic materials and components for small automotive gas turbine engine
[AD-A025472] 13 p0095 N77-11417
An evaluation of high altitude engine modification devices (econo-kit)
[PB-255556/3] 13 p0101 N77-11589
Investigation and assessment of light-duty-vehicle evaporative emission sources and control
[PB-255813/8] 13 p0102 N77-11603
Emissions and performance of catalysts for gas turbine catalytic combustors
[NASA-TM-X-73543] 13 p0104 N77-12406
Increased fuel economy in transportation systems by use of energy management: Second year's program. Executive summary
[PB-256117/3] 13 p0108 N77-12536
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495
Effects of a thermal reactor on the energy efficiency of a turbocharged, stratified charge engine
[AD-A026059] 13 p0128 N77-15409
AUTOMOBILE FUELS
Onboard hydrogen generation for automobiles
13 p0020 A77-12663
The performance of hydrogen-injected reciprocating engines
13 p0033 A77-12780
Performance of a hydrogen-powered transit vehicle
13 p0033 A77-12781
Air, water, nuclear power make gasoline
13 p0045 A77-12935
An alternative fuel for cars --- hydrogen production and storage
13 p0050 A77-14530
Evolution of the concept of the automobile from the standpoint of saving energy
13 p0051 A77-14562

Alternate fuels for road vehicles of the future
13 p0051 A77-14584
Fuels and fuel additives for highway vehicles and their combustion products. Guide to evaluation of their potential effects on health
[PB-254088/8] 13 p0084 N77-10222
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534
Survey of alcohol fuel technology, volume 1
[PB-256007/6] 13 p0112 N77-13232
Survey of alcohol fuel technology, Volume 2
[PB-256008/4] 13 p0112 N77-13233
Energy equivalents for current and prospective automotive fuels in Canada
[AD-A026195] 13 p0124 N77-14609

AUTOMOBILES
The fuel efficiency potential of a flywheel hybrid vehicle for urban driving
13 p0020 A77-12664
Solid state applications of direct energy conversion and heat pumping for a small automotive vehicle
[AD-A026321] 13 p0124 N77-14607

AUXILIARY POWER SOURCES
Emergency power plant of rapid availability for the Berlin-Tegel airport
13 p0001 A77-10324
Auxiliary power system for activity cooled aircraft
[NASA-CASE-LAR-11626-1] 13 p0103 N77-12332
Possible effects of nuclear initiative on supply and use of electricity in California
[AD-A026582] 13 p0131 N77-15510

AUXILIARY PROPULSION
NASA electric propulsion program
[AIAA PAPER 76-1068] 13 p0045 A77-13033

AVALANCHE DIODES
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261

AVIONICS
Estimating procedures associated with aircraft modifications
[SAWE PAPER 1101] 13 p0016 A77-12181

AXIAL FLOW
Axial conduction in a flat-plate solar collector
13 p0068 A77-18447

B

BALLOON FLIGHT
Results from the IMP-J violet solar cell experiment and violet cell balloon flights
[NASA-TN-D-8393] 13 p0128 N77-15491

BAND STRUCTURE OF SOLIDS
Operation of ITO/Si heterojunction solar cells
13 p0014 A77-11762
Symposium on the Fundamental Optical Properties of Solids Relevant to Solar Energy Conversion
[PB-256615/6] 13 p0108 N77-12538

BEDS (PROCESS ENGINEERING)
Low-Btu gasification of coal by Atomics International's molten salt process
13 p0023 A77-12687
Hydrocarbon fuels from oil shale
13 p0023 A77-12692
Desulfurization of flue gases with iron/III/ oxide on porous carrier material - Theoretical and experimental investigation concerning the modelling of semicontinuous solid bed reactors with gas-solid reactions --- German book
13 p0080 A77-19184

BERYLLIUM HYDRIDES
Advanced fuels for inertial confinement --- in laser fusion
13 p0061 A77-17016

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13 p0002 A77-10615
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13 p0054 A77-15799
Survey of alcohol fuel technology, Volume 2
[PB-256008/4] 13 p0112 N77-13233
Inventory of energy research and development (1973 - 1975), volume 1
[GPO-64-734-VOL-1] 13 p0113 N77-13525
Inventory of energy research and development (1973 - 1975), volume 2
[GPO-64-734-VOL-2] 13 p0113 N77-13526
Inventory of energy research and development (1973 - 1975), volume 3
[GPO-64-734-VOL-3] 13 p0113 N77-13527
Inventory of energy research and development (1973 - 1975), volume 4
[GPO-64-734-VOL-4] 13 p0113 N77-13528
Bibliography on Liquefied Natural Gas (LNG) safety
[NASA-TM-X-73408] 13 p0127 N77-15208

BINARY FLUIDS
Investigation of heat exchanger flow arrangement on performance and cost in a geothermal binary cycle
13 p0029 A77-12746

BIOASSAY
JP-4 and JP-9 fuel toxicity studies using water fish and aufwuchs
[AD-A027594] 13 p0127 N77-15213

BIODEGRADATION
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577

BIOLOGICAL EFFECTS
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295

BIOLOGICAL EVOLUTION
The palirrhotrophic origin of energy metabolism --- chemiosmotic precursor to phototropism in estuarine cellular organisms
13 p0064 A77-17895

BIOMASS ENERGY PRODUCTION
The long-range prospects for solar-derived fuels
13 p0017 A77-12240
Solar SNG - Large-scale production of SNG by anaerobic digestion of specially grown plant matter --- Synthetic Natural Gas
13 p0021 A77-12671
Solar energy collection by bioconversion
13 p0021 A77-12672
Nuclear power for the production of synthetic fuels and feedstocks
13 p0035 A77-12790
Solar energy utilization - The photochemical approach
13 p0075 A77-19076
Formulation of energy policies - The case of West Africa
13 p0080 A77-19124

BIOSPHERE
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295

BITUMENS
Catalytic coal liquefaction using synthesis gas
13 p0059 A77-16473

BLACK BRANT SOUNDING ROCKETS
The International Heat Pipe Experiment --- Black Brant sounding rocket payload zero gravity experiment
13 p0120 N77-14389

BOILERS
Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions
13 p0008 A77-11162
Steam station repowering - A near-term method of energy conservation
13 p0022 A77-12679
Alternate fuel capability of Rankine cycle engines
13 p0036 A77-12801
Study of the feasibility of federal procurement of fuels produced from solid wastes
[PB-255695/9] 13 p0096 N77-11513
Assessment of the impact of proposed thermal effluent guidelines for the steam electric power industry
[PB-255937/5] 13 p0110 N77-12587
Design phase utility analysis for gas turbine and combined cycle plants
[PB-256665/1] 13 p0115 N77-13553
Performance of emission control devices on boilers firing municipal solid waste and oil
[PB-257136/2] 13 p0133 N77-15550

BOLIVIA
The 29950 Earth Resource Technology Satellite (ERTS-A) sensor data for mineral resource sector development and regional land use survey, March - August 1976 --- Bolivia
[E77-10028] 13 p0096 N77-11491
BOUNDARY LAYER FLOW
Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream
13 p0001 A77-10423
Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels
13 p0046 A77-13242
BOUNDARY LAYER SEPARATION
Boundary-layer separation from the electrode wall of an MHD generator
13 p0048 A77-13711
BOUNDARY LAYERS
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666
BRAYTON CYCLE
A conceptual design study of closed Brayton cycle gas turbines for fusion power generation
13 p0022 A77-12676
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678
Closed Brayton cycle using hydrogen as a work fluid
[BNL-20899] 13 p0085 N77-10542
BRAZIL
Solar energy prospects for electric power generation in Brazil
13 p0037 A77-12805
BREEDER REACTORS
Environment and energy production after the year 2000
13 p0056 A77-16203
BROMIDES
Measured performance of a 3 ton LiBr absorption water chiller and its effect on cooling system operation
[NASA-TM-X-73496] 13 p0105 N77-12518
BUBBLES
VBP heat pipes for energy storage --- Vapor Bubble Pumping
13 p0032 A77-12767
BUILDINGS
Optimal thermal insulation as an investment-computational problem
13 p0009 A77-11268
Detailed geographic analysis of residential energy consumption
13 p0043 A77-12864
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran --- Heating, Ventilating and Air Conditioning
13 p0078 A77-19111
Preliminary design data for a solar house in Riyadh, Saudi Arabia
13 p0078 A77-19112
Application of solar heat to buildings in Austria
13 p0079 A77-19114
Environmentally designed housing incorporating solar energy
13 p0079 A77-19115
Solar hot water systems application to the solar building test facility and the Tech House
13 p0084 N77-10342
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
Waste heat vs conventional systems for greenhouse environmental control: An economic assessment
[ORNL/TM-5069] 13 p0088 N77-10656
CCMS solar energy pilot study solar heating and cooling systems in buildings
[UMD-4908-5] 13 p0088 N77-10657
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire
[PB-254179/5] 13 p0091 N77-10687
Commercial building unitary heat pump system with solar heating
[PB-255488/9] 13 p0099 N77-11551
Definition study for photovoltaic residential prototype system
[NASA-CR-135039] 13 p0113 N77-13532
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606
The structure of building specifications
[PB-257581/9] 13 p0132 N77-15524
Intermediate minimum property standards for solar heating and domestic hot water systems
[PB-257086/9] 13 p0132 N77-15525
BURNERS
Burner design criteria for control of NOx from natural gas combustion. Volume 2: Raw data and experimental results
[PB-256806/1] 13 p0115 N77-13549
BUTANES
Petroleum market shares. Report on sales of propane to ultimate consumers, 1975
[PB-255624/9] 13 p0108 N77-12540

C

CADMIUM SULFIDES
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
Theoretical prospects of the CdS-Cu2S solar cell
[PB-252409/8] 13 p0089 N77-10672
Cadmium stannate selective optical films for solar energy applications
[PB-254879/0] 13 p0090 N77-10678
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications
[PB-255646/2] 13 p0109 N77-12551
CADMIUM TELLURIDES
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
CALIFORNIA
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California
[PB-254449/2] 13 p0092 N77-10720
Wind power prediction models
[NASA-CR-149235] 13 p0105 N77-12509
California energy outlook
[UCRL-5196-REV-1] 13 p0106 N77-12525
Temperature effects of crude oil in the upper intertidal zone
[PB-255956/5] 13 p0110 N77-12581
Possible effects of nuclear initiative on supply and use of electricity in California
[AD-A026582] 13 p0131 N77-15510
Overview of the Imperial Valley environmental project
[UCID-17067] 13 p0132 N77-15533
CALORIMETERS
Calorimetry of large solar concentrators
13 p0038 A77-12814
Differential scanning calorimetry studies on coal. II - Hydrogenation of coals
13 p0070 A77-18583
CANADA
Can Canada harness the wind
13 p0053 A77-15047
Mandatory Canadian crude oil allocation regulations
[PB-255319/6] 13 p0096 N77-11509
Research and development for Canadian nuclear power
[AECL-5314] 13 p0097 N77-11533
Energy equivalents for current and prospective automotive fuels in Canada
[AD-A026195] 13 p0124 N77-14609
CAPILLARY TUBES
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380

CARBON COMPOUNDS
Electric current from the direct conversion of low molecular weight C,H,O-compounds
13 p0055 A77-15814

CARBON DIOXIDE
Air, water, nuclear power make gasoline
13 p0045 A77-12935
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295
Atmospheric carbon dioxide variations at the South Pole
13 p0067 A77-18439
Reactivity of oil shale carbonaceous residue with oxygen and carbon dioxide
[UCRL-77829] 13 p0123 N77-14596

CARBON ISOTOPES
Isotopic characterization of Illinois natural gas
13 p0113 N77-13484

CARBON MONOXIDE
COSTEAM: Low-rank coal liquefaction - An updated analysis
13 p0045 A77-12934
Catalytic coal liquefaction using synthesis gas
13 p0059 A77-16473
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380

CARBON 14
Cooperative geochemical resource assessment of the Mesa Geothermal system
[PB-257225/3] 13 p0132 N77-15520

CARBONATES
Evaporation of solution droplets in a high-temperature medium --- potassium carbonate MHD flow properties
13 p0046 A77-13254
Reactivity of oil shale carbonaceous residue with oxygen and carbon dioxide
[UCRL-77829] 13 p0123 N77-14596

CARGO AIRCRAFT
Application of advanced technology to future long-range aircraft
[SAWE PAPER 1126] 13 p0016 A77-12194

CASSEGRAIN OPTICS
A Cassegrain system for solar radiation
13 p0063 A77-17561

CATALYSIS
Catalytic coal gasification for SNG production --- Synthetic Natural Gas
13 p0022 A77-12683
Catalytic coal liquefaction using synthesis gas
13 p0059 A77-16473
The electron factor in catalysis on metals electrocatalysis on non-metallic surfaces
[PB-256264/3] 13 p0103 N77-12166

CATALYSTS
Titanium-containing Raney nickel catalyst for hydrogen electrodes in alkaline fuel cell systems
13 p0064 A77-18019
Emissions and performance of catalysts for gas turbine catalytic combustors
[NASA-TM-X-73543] 13 p0104 N77-12406
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529
Manufacturing and evaluation of phthalocyanines as catalysts for fuel cells
[BMFT-FB-T-76-25] 13 p0114 N77-13540
Catalytic synthesis of gaseous hydrocarbons
[PE-1814-2] 13 p0130 N77-15503
Surface research for development of new electrocatalysts for acid electrolyte fuel cells
[AD-A026053] 13 p0131 N77-15517

CATALYTIC ACTIVITY
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815

CATHODES
Study of cathode spots in the presence of slag films on the electrodes of an open-cycle MHD generator
13 p0053 A77-15005

CELL ANODES
Electrically rechargeable REDOX flow cell
[NASA-CASE-LEW-12220-1] 13 p0121 N77-14581

CELLS (BIOLOGY)
The palirrhotrophic origin of energy metabolism --- chemiosmotic precursor to phototropism in estuarine cellular organisms
13 p0064 A77-17895

CENTRAL ATLANTIC REGION (US)
Identification and analysis of mid-Atlantic onshore OCS impact
[PB-254925/1] 13 p0096 N77-11516

CERAMIC COATINGS
Effect of ceramic coating of JT8D combustor liner on maximum liner temperatures and other combustor performance parameters
[NASA-TM-X-73581] 13 p0126 N77-15037

CERAMICS
High-temperature ceramics for automobile gas turbines. II
13 p0063 A77-17591
Ceramic materials and components for small automotive gas turbine engine
[AD-A025472] 13 p0095 N77-11417

CESIUM DIODES
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361

CHALCOGENIDES
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917

CHANNEL FLOW
Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels
13 p0046 A77-13242
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668

CHEMICAL ANALYSIS
Theoretical, numerical, and physical techniques for characterizing power plant plumes
[PB-253099/6] 13 p0101 N77-11599
Fuel contaminants. Volume 1: Chemistry
[PB-256020/9] 13 p0103 N77-12231

CHEMICAL COMPOSITION
Organization of long range transport of air pollution monitoring in Europe
13 p0071 A77-18754

CHEMICAL ENERGY
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666
Thermochemical energy storage systems
13 p0028 A77-12738
Production of chemical energy carriers by non-expandable energy sources --- solar energy electrolysis, photolysis, and thermochemical cycles
[DLR-FB-76-32] 13 p0114 N77-13541

CHEMICAL ENGINEERING
Design analyses of a methane-based chemical heat pipe
13 p0028 A77-12737

CHEMICAL EVOLUTION
Chemical evolution of photosynthesis
13 p0071 A77-18898

CHEMICAL EXPLOSIONS
Thermal explosion of moving reacting fluids of variable viscosity
13 p0052 A77-14980

CHEMICAL PROPERTIES
The influence of the properties of coals on their conversion into clean fuels
13 p0009 A77-11245

CHEMICAL REACTIONS
Study of the ionization of the additive in MHD installations
13 p0002 A77-10424
Thermochemical energy storage systems
13 p0028 A77-12738
Energy storage via calcium hydride production
13 p0032 A77-12774
Hydrogen production from water by means of chemical cycles
13 p0058 A77-16471

CHEMICAL REACTORS
Hydrogen production by the steam-iron process
13 p0023 A77-12688
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689

A combined cycle with a partial-oxidation reactor
13 p0062 A77-17534
Catalytic synthesis of gaseous hydrocarbons
[FE-1814-2] 13 p0130 N77-15503
CHEMILUMINESCENCE
Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer
13 p0062 A77-17541
CHLORIDES
Aerosol formation during coal combustion - Condensation of sulfates and chlorides on flyash
13 p0054 A77-15778
CHROMIUM OXIDES
The optical properties of chromium oxide films and the high temperature stabilization of silver films for photothermal solar energy conversion
13 p0128 N77-15484
CIRCUIT RELIABILITY
Cooling arrays of circuit cards using heat pipes and forced air diffusers
13 p0031 A77-12766
CITIES
Evolution of atmospheric pollution /high acidity and black fumes/ in France during 1975
13 p0002 A77-10670
Assessing the relationship between urban form and travel requirements: A literature review and conceptual framework
[PB-254988/9] 13 p0102 N77-11923
CIVIL AVIATION
Our amazing air transportation system /AIAA-SAE William Littlewood Memorial Lecture/ --- civil aviation aircraft historical overview
[AIAA PAPER 77-356] 13 p0067 A77-18260
The seat belt light is on --- airline industry economic assessment and forecasts
13 p0080 A77-19175
Future aircraft requirements: A notebook of airline thoughts
13 p0117 N77-13976
Air transport propulsion for the 1980's
13 p0117 N77-13980
CLEAN ENERGY
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
Evaluation of coal liquefaction efficiency based on various ranks
13 p0009 A77-11244
The influence of the properties of coals on their conversion into clean fuels
13 p0009 A77-11245
Solids gasification for gas turbine fuel 100 and 300 Btu gas
13 p0022 A77-12685
Low-Btu gasification of coal by Atomics International's molten salt process
13 p0023 A77-12687
CLEANING
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4P)] 13 p0112 N77-13235
CLIMBING FLIGHT
Best-range flight conditions for cruise-climb flight of a jet aircraft
13 p0085 N77-10379
CLOSED CYCLES
System studies of coal fired-closed cycle MHD for central station power plants
13 p0034 A77-12786
Closed Brayton cycle using hydrogen as a work fluid
[BNL-20899] 13 p0085 N77-10542
CLOUD COVER
A method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds --- for solar collector design
13 p0019 A77-12412
COAL
The availability of fuels for power plants
13 p0010 A77-11316
Assessing low sulfur coal resources in Montana and Wyoming
13 p0058 A77-16374
Production of atmospheric nitrous oxide by combustion
13 p0061 A77-16922

National Emissions Data Systems (NEDS) fuel use report, 1973
[PB-253908/8] 13 p0083 N77-10220
Development of signal processing algorithms for ultrasonic detection of coal seam interfaces
[NASA-CR-150024] 13 p0085 N77-10610
The long-run marginal costs of energy
[PB-252504/6] 13 p0085 N77-10625
The supply of coal in the long run: The case of eastern deep coal
[PB-252642/4] 13 p0086 N77-10626
Underground coal mining: An assessment of technology
[PB-255726/2] 13 p0093 N77-10974
Methanol from coal fuel and other applications
[ORAU-126] 13 p0094 N77-11200
Applying computer-drawn maps of geologic data to analysis of mining problems
[PB-255497/0] 13 p0096 N77-11518
The air quality and economic implications of supplementary control systems in Illinois --- considering electric power plant fuels
[PB-255699/1] 13 p0101 N77-11588
An application of ERTS technology to the evaluation of coal strip mining and reclamation in the northern Great Plains
[NASA-CR-149208] 13 p0104 N77-12486
Laws and regulations affecting coal with summaries of Federal, State, and local laws and regulations pertaining to air and water pollution control, reclamation, diligence and health and safety, part 1
[PB-255927/6] 13 p0110 N77-12592
Laboratory analysis of solvent refined coal
[PB-255550/6] 13 p0110 N77-12598
Availability of potential coal supply through 1985 by quality characteristics
[PB-256680/0] 13 p0121 N77-14573
COAL GASIFICATION
Energy and the gas industry
13 p0005 A77-11032
Remote sensing of an underground coal-burn cavity with a wide-band induction system
13 p0007 A77-11050
Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology
13 p0008 A77-11241
Catalytic coal gasification for SNG production --- Synthetic Natural Gas
13 p0022 A77-12683
Recovery of inaccessible coal reserves by in situ gasification
13 p0022 A77-12686
Low-Btu gasification of coal by Atomics International's molten salt process
13 p0023 A77-12687
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689
Diversification as an energy conservation strategy
13 p0027 A77-12725
The potential of the heat pipe in coal gasification processes
13 p0031 A77-12763
Heat pipes for fluid-bed gasification of coal - Metallurgical condition of heat pipes after tests in process environment
13 p0031 A77-12764
The commercial production of hydrogen by the K-T process
13 p0032 A77-12769
Hydrogen separation and compression through hydride formation and dissociation by low-level heat
13 p0032 A77-12770
Underground gasification of coal: A National Coal Board reappraisal. 1976 --- Book
13 p0044 A77-12926
Combination power plants for improved utilization of fossil fuels
13 p0045 A77-12939
Combined cycles and refined coal --- gasification plant using high temperature gas turbines
13 p0058 A77-16249
Water requirements for an integrated SNG plant and mine operation
13 p0060 A77-16651

Superalloys for advanced energy systems
13 p0061 A77-16824
Differential scanning calorimetry studies on coal. II - Hydrogenation of coals
13 p0070 A77-18583
Gasification of coal and its future aspects regarding the use of heat from high-temperature nuclear reactors
[INIS-MF-1965] 13 p0084 N77-10228
Advanced coal gasification system for electric power generation --- pollution monitoring
[FE-1514-176] 13 p0088 N77-10653
Handbook of gasifiers and gas treatment systems
[FE-1772-11] 13 p0088 N77-10658
Underground fuel gasification
[UCRL-TRANS-10998] 13 p0088 N77-10659
Reductant gases for flue gas desulfurization systems
[PB-254168/8] 13 p0092 N77-10722
Computer modeling of coal gasification reactors
[FE-1770-4] 13 p0093 N77-10812
Basic studies of coal pyrolysis and hydrogasification
[PB-254878/2] 13 p0096 N77-11511
Problems and solutions in the use of coal analyses
[FE-0390-1] 13 p0097 N77-11535
The use of an interactive energy model for technology assessment with special reference to underground coal gasification
[PB-255543/1] 13 p0098 N77-11545
Draft environmental assessment of application by ERDA for a special land use permit for use of public lands in Wyoming for in situ coal gasification experiments
[UCID-17011] 13 p0100 N77-11572
Environmental impact studies related to underground coal gasification
[TID-27003] 13 p0100 N77-11573
Field test sampling/analytical strategies and implementation cost estimates: Coal gasification and flue gas desulfurization
[PB-254166/2] 13 p0101 N77-11581
Preliminary economics and comment: In-situ gasification of coal for power and SNG
[PB-256034/0] 13 p0109 N77-12554
Outlook for research and development in the underground gasification of coal
[PB-256155/3] 13 p0109 N77-12555
High temperature gas turbine engine
[FE-1765-8] 13 p0120 N77-14488
Evaluation of pollution control in fossil fuel conversion processes
[PB-255842/7] 13 p0125 N77-14638
Coal gasification commercial concepts: Gas cost guidelines
[FE-1235-1] 13 p0130 N77-15500
Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant, phase 2
[FE-1521-13] 13 p0130 N77-15501
Preliminary design services coal conservation demonstration plants
[FE-1775-3] 13 p0130 N77-15502
Catalytic synthesis of gaseous hydrocarbons
[FE-1814-2] 13 p0130 N77-15503
Branched thermocouple circuits in underground coal gasification experiments
[SAND-75-5910] 13 p0130 N77-15504
Hot and dry char let down system for the Synthane demonstration plant, phase 1
[PERC-0058-4] 13 p0130 N77-15505

COAL LIQUEFACTION
Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology
13 p0008 A77-11241
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243
Evaluation of coal liquefaction efficiency based on various ranks
13 p0009 A77-11244
The influence of the properties of coals on their conversion into clean fuels
13 p0009 A77-11245
Comparative economics for the Arthur D. Little extractive coking process --- coal liquefaction
13 p0022 A77-12684
A preliminary engineering assessment of jet fuel production from domestic coal and shale derived oils
13 p0023 A77-12690
COSTEAM: Low-rank coal liquefaction - An updated analysis
13 p0045 A77-12934
Startup solvent selection for the liquefaction of lignite
13 p0059 A77-16472
Catalytic coal liquefaction using synthesis gas
13 p0059 A77-16473
A laboratory evaluation of precoat filtration parameters for the solvent refined coal process
13 p0059 A77-16474
Mechanisms of coal particle dissolution
13 p0059 A77-16475
The storage of energy in future energy supply systems
[DGLR PAPER 76-182] 13 p0059 A77-16533
Fractionation and structural characterization of coal liquids
13 p0069 A77-18582
Coal liquefaction with soluble transition-metal complexes
13 p0070 A77-18584
Basic studies of coal pyrolysis and hydrogasification
[PB-254878/2] 13 p0096 N77-11511
Problems and solutions in the use of coal analyses
[FE-0390-1] 13 p0097 N77-11535
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230
Fuel contaminants. Volume 1: Chemistry
[PB-256020/9] 13 p0103 N77-12231
Some cost, energy, environmental, and resource implications of synthetic fuels produced from coal for military aircraft
[AD-A026667] 13 p0118 N77-14271
High temperature gas turbine engine
[FE-1765-8] 13 p0120 N77-14488
Evaluation of pollution control in fossil fuel conversion processes
[PB-255842/7] 13 p0125 N77-14638
Second Environmental Aspects of Fuel Conversion Technology Symposium
[PB-257182/6] 13 p0125 N77-14645
Preliminary design services coal conservation demonstration plants
[FE-1775-3] 13 p0130 N77-15502

COAL UTILIZATION
Energy and the coal industry
13 p0005 A77-11030
Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology
13 p0008 A77-11241
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
The economics of coal supply - The state of the art
13 p0013 A77-11523
Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/
13 p0013 A77-11524
The significance of coal in the future energy picture
13 p0018 A77-12247
Hydrogen production by the steam-iron process
13 p0023 A77-12688
MHD power generation - 1976 Status Report --- coal-fired design
13 p0033 A77-12782
Investigation of direct coal-fired MHD power generation
13 p0034 A77-12783
Liquid-metal magnetohydrodynamic system evaluation --- coal-fired designs
13 p0034 A77-12784
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
System studies of coal fired-closed cycle MHD for central station power plants
13 p0034 A77-12786

Is nuclear energy economically viable --- competition with coal
13 p0045 A77-12933
COSTEAM: Low-rank coal liquefaction - An updated analysis
13 p0045 A77-12934
MHD - Energy transformation by burning coal
13 p0045 A77-12940
Scientific-technological problems of the development of a fuel-energy complex in the USSR
13 p0051 A77-14703
Aerosol formation during coal combustion - Condensation of sulfates and chlorides on flyash
13 p0054 A77-15778
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780
A summary of the ECAS MHD power plant results
[NASA-TM-X-73491] 13 p0086 N77-10642
Underground coal mining: An assessment of technology
[PB-255726/2] 13 p0093 N77-10974
Implementing coal utilization provisions of Energy Supply and Environmental Coordination Act
[PB-255855/9] 13 p0109 N77-12549
Participating surveillance services for electric power program. Coal conversion and utilization: Direct combustion of coal-90e, advanced power-90f. Summary for ERDA annual report, CY 1975
[FE-1236-4] 13 p0130 N77-15507

COATINGS
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
A performance evaluation of various coatings, substrate materials, and solar collector systems
[NASA-TM-X-73355] 13 p0128 N77-15489

COKE
Comparative economics for the Arthur D. Little extractive coking process --- coal liquefaction
13 p0022 A77-12684

COLORADO
An engineering feasibility study of using low temperature geothermal sources in Colorado
13 p0031 A77-12762

COMBAT
Report of the Army Scientific Advisory Panel Ad Hoc Group on fire-safe fuels
[AD-A023763] 13 p0095 N77-11208

COMBUSTIBLE FLOW
Thermal explosion of moving reacting fluids of variable viscosity
13 p0052 A77-14980

COMBUSTION
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506

COMBUSTION CHAMBERS
Reduction of gaseous pollutant emissions from gas turbine combustors using hydrogen-enriched jet fuel
[NASA-CR-149146] 13 p0094 N77-11198
Effect of ceramic coating of JT8D combustor liner on maximum liner temperatures and other combustor performance parameters
[NASA-TM-X-73581] 13 p0126 N77-15037

COMBUSTION EFFICIENCY
Emissions and performance of catalysts for gas turbine catalytic combustors
[NASA-TM-X-73543] 13 p0104 N77-12406
Participating surveillance services for electric power program. Coal conversion and utilization: Direct combustion of coal-90e, advanced power-90f. Summary for ERDA annual report, CY 1975
[FE-1236-4] 13 p0130 N77-15507

COMBUSTION PRODUCTS
Study of the ionization of the additive in MHD installations
13 p0002 A77-10424
Sulphur pollution and emission charges
13 p0005 A77-11033
Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions
13 p0008 A77-11162
Controlled tipping of combustion residues
13 p0008 A77-11175
Compilation of an inventory for particulate emissions in Belgium
13 p0009 A77-11271
Clean air protection and industrial development
13 p0010 A77-11303
Aerosol formation during coal combustion - Condensation of sulfates and chlorides on flyash
13 p0054 A77-15778
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780
Production of atmospheric nitrous oxide by combustion
13 p0061 A77-16922
Fuels and fuel additives for highway vehicles and their combustion products. Guide to evaluation of their potential effects on health
[PB-254088/8] 13 p0084 N77-10222
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
Proceedings of the Stationary Source Combustion Symposium. Volume 1. Fundamental research
[PB-256320/3] 13 p0116 N77-13569
Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570
Proceedings of the Stationary Source Combustion Symposium. Volume 3: Field Testing and Surveys
[PB-257146/1] 13 p0125 N77-14643

COMMERCE
Weekly petroleum statistics reports, 1974-1975
[PB-255920/1] 13 p0124 N77-14608

COMMERCIAL AIRCRAFT
Liquid hydrogen as propellant for commercial aircraft
[DGLR PAPER 76-188] 13 p0059 A77-16534
The pay-off for advanced technology in commercial aircraft design and operation
13 p0071 A77-19012
Cost/benefit assessment of the application of composite materials to subsonic commercial transport engines
[NASA-TM-X-73557] 13 p0111 N77-13064
Future aircraft requirements: A notebook of airline thoughts
13 p0117 N77-13976
Air transport propulsion for the 1980's
13 p0117 N77-13980
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137926] 13 p0126 N77-15007
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008

COMMERCIAL ENERGY
Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations
13 p0028 A77-12736
Geothermal energy in Hawaii - Hydrothermal systems
13 p0029 A77-12741
Electric utility companies and geothermal power
13 p0031 A77-12759
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran --- Heating, Ventilating and Air Conditioning
13 p0078 A77-19111
Water pumping - A practical application of solar energy
13 p0079 A77-19117
National Emissions Data Systems (NEDS) fuel use report, 1973
[PB-253908/8] 13 p0083 N77-10220
National benefits associated with commercial application of fuel cell powerplants
[ERDA-76-54] 13 p0123 N77-14597

COMMUNICATION SATELLITES
Power source requirements of electric propulsion systems used for north-south stationkeeping of communication satellites
13 p0040 A77-12833
The nuclear spinner for Satcom applications --- comparing nuclear and solar power supplies
13 p0041 A77-12838

UK, T5 ion engine thrust vector control considerations
[AIAA PAPER 76-1064] 13 p0045 A77-13030
Status of development and application of gas-stabilized heat-pipe radiators
[DGLR PAPER 76-192] 13 p0060 A77-16557

COMMUNICATIONS TECHNOLOGY SATELLITE
Preliminary report on the CTS transient event counter performance through the 1976 spring eclipse season
[NASA-TM-X-73487] 13 p0083 N77-10116
Test program for transmitter experiment package and heat pipe system for the communications technology satellite
[NASA-TM-X-3455] 13 p0095 N77-11268

COMPATIBILITY
Heat pipe materials compatibility
[NASA-CR-135069] 13 p0103 N77-12182

COMPOSITE MATERIALS
Software aspects of super composites --- composition selection to meet user requirements
13 p0053 A77-15301
Cost/benefit assessment of the application of composite materials to subsonic commercial transport engines
[NASA-TM-X-73557] 13 p0111 N77-13064
A study of the failure of joints in composite material fuel cells due to hydraulic ram loading
[AD-A027258] 13 p0117 N77-14016
Composite material structures for thermophotovoltaic conversion radiator
[AD-A026859] 13 p0132 N77-15519

COMPOSITE STRUCTURES
High-speed flywheels as possible energy storage devices in the future
13 p0056 A77-15856

COMPRESSED AIR
Compressed air energy storage - A near term option for utility application
13 p0027 A77-12727
Economic and technical feasibility study of compressed air storage
[COO-2559-1] 13 p0122 N77-14593

COMPRESSIBILITY EFFECTS
Hydrogen as a fuel in compression ignition engines
13 p0071 A77-19932

COMPRESSIBLE BOUNDARY LAYER
Boundary-layer separation from the electrode wall of an MHD generator
13 p0048 A77-13711

COMPRESSORS
A hydride compressor
13 p0046 A77-13336

COMPUTER PROGRAMMING
Development of signal processing algorithms for ultrasonic detection of coal seam interfaces
[NASA-CR-150024] 13 p0085 N77-10610

COMPUTER PROGRAMS
Software aspects of super composites --- composition selection to meet user requirements
13 p0053 A77-15301
Planning models for the assessment of advanced energy storage systems
13 p0105 N77-12504
A design procedure for solar heating systems
13 p0128 N77-15485
Cooperative study of heavy duty diesel emission measurement methods
[PB-257137/0] 13 p0133 N77-15541

COMPUTER TECHNIQUES
Directory of Federal energy data sources: Computer products and recurring publications
[PB-254163/9] 13 p0093 N77-10941
Applying computer-drawn maps of geologic data to analysis of mining problems
[PB-255497/0] 13 p0096 N77-11518

COMPUTERIZED DESIGN
Design principles for solar and wind power installations
13 p0015 A77-11922
Heat pipe heat exchanger design considerations
13 p0031 A77-12765
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822
Software aspects of super composites --- composition selection to meet user requirements
13 p0053 A77-15301
Arrays of fixed flat-plate solar energy collectors - Performance comparisons for differing individual component orientations
13 p0068 A77-18449

COMPUTERIZED SIMULATION
Equation solution accuracy in calculating jet engine characteristics
13 p0020 A77-12502
Modeling residential energy use
13 p0027 A77-12726
Economic optimization of binary fluid cycle power plants for geothermal systems
13 p0029 A77-12744
The use of program GEOTHM to design and optimize geothermal power cycles
13 p0031 A77-12758
The potential national benefits of geothermal electrical energy production from hydrothermal resources in the West
13 p0031 A77-12760
Alternative strategies for implementing silicon-ribbon technology for photovoltaic applications
13 p0039 A77-12819
Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials
13 p0068 A77-18444
A new method for collector field optimization --- computerized simulation of solar tower facility
13 p0074 A77-19070
Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia
13 p0078 A77-19110
Hybrid simulation of solar HVAC system for house retro-fit design
[PB-252608/5] 13 p0090 N77-10676
A simulation analysis of US energy demand, supply, and prices
[PB-254314/8] 13 p0090 N77-10680
Computer modeling of coal gasification reactors
[FE-1770-4] 13 p0093 N77-10812
The use of an interactive energy model for technology assessment with special reference to underground coal gasification
[PB-255543/1] 13 p0098 N77-11545
Commercial building unitary heat pump system with solar heating
[PB-255488/9] 13 p0099 N77-11551
The intersectoral feedback model
[PB-255859/1] 13 p0125 N77-14950
A design procedure for solar heating systems
13 p0128 N77-15485

CONCENTRATORS
Ideal concentrators for finite sources and restricted exit angles --- parabolic solar collector
13 p0003 A77-10835
Vortex kinetic energy concentrator
13 p0044 A77-12870
Irradiation field formation on the receiver of 'precise' and 'unprecise' solar concentrators
13 p0057 A77-16209
High-efficiency solar concentrator
13 p0083 N77-10104
Attic concentrator type solar energy collector
[BNL-50493] 13 p0098 N77-11539

CONCORDE AIRCRAFT
Concorde - Endurance flights results
13 p0016 A77-12114

CONCRETES
Concrete placing techniques used during the construction of the kasnoyarsk hydroelectric power plant
[AD-A026967] 13 p0121 N77-14528

CONDENSING
An investigation of condensation heat transfer in a closed tube containing a soluble noncondensable gas
[NASA-CR-149095] 13 p0085 N77-10465

CONDUCTIVE HEAT TRANSFER
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321
Characteristic equations of unconcentrated flat solar cell panels
13 p0052 A77-14929

Axial conduction in a flat-plate solar collector
13 p0068 A77-18447
CONFERENCES
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[CONF-751228-P2] 13 p0087 N77-10646
Creating energy choices for the future
[CONF-751228-P1] 13 p0087 N77-10647
CCMS solar energy pilot study solar heating and cooling systems in buildings
[UMD-4908-5] 13 p0088 N77-10657
Energy: The policy planning framework in state governments. Volume 1: Summary report
[PB-254466/6] 13 p0089 N77-10665
Energy: The policy planning framework in state governments. Volume 2: Appendices
[PB-254467/4] 13 p0089 N77-10666
The proceedings of the NOx Control Technology Seminar
[PB-253661/3] 13 p0092 N77-10707
Meeting report: Advanced fossil fuels sector group
[PB-255117/4] 13 p0099 N77-11549
Societal implications of energy scarcity. Social and technological priorities in steady state and constricting systems
[PB-253097/0] 13 p0099 N77-11556
Proceedings of the Workshop on Modeling the Interrelationships between the Energy Sector and the General Economy
[PB-255696/7] 13 p0100 N77-11561
Conference report: Energy Conservation in Transportation and Construction
[PB-255857/5] 13 p0100 N77-11562
Research to anticipate environmental impacts of changing resource usage
[PB-256293/2] 13 p0101 N77-11602
The electron factor in catalysis on metals electrocatalysis on non-metallic surfaces
[PB-256264/3] 13 p0103 N77-12166
Proceedings of the Mineral Economics Symposium: Winning the high stakes at the critical commodity game
[PB-255607/4] 13 p0105 N77-12502
Conference proceedings, Energy from the Oceans, Fact or Fantasy
[PB-256093/6] 13 p0108 N77-12547
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597
Proceedings of the Stationary Source Combustion Symposium. Volume 1. Fundamental research
[PB-256320/3] 13 p0116 N77-13569
Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570
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[AD-A027654] 13 p0133 N77-15845
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Inventory of energy research and development (1973 - 1975), volume 1
[GPO-64-734-VOL-1] 13 p0113 N77-13525
Inventory of energy research and development (1973 - 1975), volume 2
[GPO-64-734-VOL-2] 13 p0113 N77-13526
Inventory of energy research and development (1973 - 1975), volume 3
[GPO-64-734-VOL-3] 13 p0113 N77-13527
Inventory of energy research and development (1973 - 1975), volume 4
[GPO-64-734-VOL-4] 13 p0113 N77-13528
Inventory of energy research and development (1973 - 1975), volume 5
[GPO-64-734] 13 p0121 N77-14579
Alternative fuels for aviation
[GPO-78-544] 13 p0127 N77-15212
CONSTRUCTION
Energy use in the contract construction industry
[PB-245422/1] 13 p0099 N77-11557
Energy use in the contract construction industry. Appendix A: Study methodology
[PB-245423/9] 13 p0099 N77-11558
Energy use in the contract construction industry. Appendix B: Assessment of construction equipment availability, energy requirements, and construction industry capacity to support Project Independence
[PB-245424/7] 13 p0100 N77-11559
Concrete placing techniques used during the construction of the kasnoyarsk hydroelectric power plant
[AD-A026967] 13 p0121 N77-14528
CONSTRUCTION MATERIALS
Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials
13 p0068 A77-18444
Optimizing the use of materials and energy in transportation construction
[PB-253713/2] 13 p0096 N77-11475
CONTACT POTENTIALS
Electric arc power collection for high-speed trains
13 p0060 A77-16594
CONTINENTAL SHELVES
Economic limits of OCS production wells
[PB-255320/4] 13 p0096 N77-11515
Identification and analysis of mid-Atlantic onshore OCS impact
[PB-254925/1] 13 p0096 N77-11516
CONTROL CONFIGURED VEHICLES
Hydrodynamic equilibrium conditions for AG(EH) main strut-pod foil system using flap incidence control
[AD-A027521] 13 p0127 N77-15220
CONTROL SIMULATION
Application of simulation studies to the design and improvement of fuel control systems for aviation turbine engines
13 p0054 A77-15798
CONTROLLED FUSION
Fusion power --- nuclear energy technology development
13 p0005 A77-11034
Muon catalysed fusion for pellet ignition
13 p0012 A77-11468
Current status of the magnetic fusion program
13 p0035 A77-12792
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
The prospect for fusion --- controlled nuclear fusion
13 p0058 A77-16357
Concept of a fusion burner
13 p0061 A77-17014

A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices
13 p0061 A77-17017
World survey of major facilities in controlled fusion research --- Book
13 p0067 A77-18264
Overview of the ERDA fusion power program
13 p0068 A77-18446

CONVECTIVE HEAT TRANSFER
Increase in the efficiency of heat and power systems using large artificial accumulators of heat
13 p0064 A77-17939
Construction of two-dimensional steady-state solution of equations of a nonequilibrium magnetized plasma
13 p0065 A77-18130

COOLANTS
Flight results of a cryogenic cooler designed for Meteosat
[IAF PAPER 76-210] 13 p0003 A77-10942

COOLING
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606

COOLING SYSTEMS
R&M - Today's heating and cooling vs. solar energy
13 p0002 A77-10482
Thermal evaluation of a house using a movable-insulation heating and cooling system
13 p0019 A77-12407
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665
Energy conservation potential of Modular Integrater Utility Systems /MIUS/
13 p0026 A77-12724
Solar-powered Rankine-cycle heat pump system
13 p0036 A77-12800
Optimizing solar cooling systems
13 p0047 A77-13502
Atlanta /Towns/ solar experiment - The lessons we learned
13 p0047 A77-13503
The Shenandoah Community Center - A total solar design concept
13 p0047 A77-13506
The problem of use of solar energy specific features of radiative, heat, and mass transfer in solar installations
13 p0057 A77-16204
Homeowner's guide to solar heating and cooling --- Book
13 p0062 A77-17525
Application of solar energy in the high-temperature range
13 p0063 A77-17636
Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity
13 p0073 A77-19057
Stationary solar concentrators for industrial heating and cooling
13 p0074 A77-19069
Survey of absorption refrigeration systems
13 p0078 A77-19105
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia
13 p0078 A77-19110
Auxiliary power system for activity cooled aircraft
[NASA-CASE-LAR-11626-1] 13 p0103 N77-12332
Measured performance of a 3 ton LiBr absorption water chiller and its effect on cooling system operation
[NASA-TM-X-73496] 13 p0105 N77-12518
Effect of mechanical cooling devices on ambient salt concentration
[PB-256679/2] 13 p0125 N77-14631

COPPER OXIDES
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088

COPPER SULFIDES
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
A sulfurization process for the preparation of photovoltaic Cu/x/S and CuInS2 thin films
13 p0076 A77-19087
Theoretical prospects of the CdS-Cu2S solar cell
[PB-252409/8] 13 p0089 N77-10672

CORROSION RESISTANCE
Development of sodium/sulfur-cells
13 p0026 A77-12716

COSMOLOGY
Space station systems analysis study. Part 1, volume 1: Executive study
[NASA-CR-151102] 13 p0094 N77-11084
Space station systems analysis study. Part 1, volume 2: Technical report
[NASA-CR-151103] 13 p0094 N77-11085

COST ANALYSIS
Energy in the household - Comparison of heating costs and prognosis concerning the consumption of energy until 1985
13 p0015 A77-12059
An analysis of electric vehicle mission, design, energy impact and cost
13 p0024 A77-12700
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
Solar thermal electric power plants - Their performance characteristics and total social costs
13 p0037 A77-12804
Performance and cost analysis of photovoltaic power systems for on-site residential applications
13 p0038 A77-12816
The consumer's cost of electricity from windmills
13 p0043 A77-12866
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
Life-cycle costs and solar energy
13 p0047 A77-13501
Cost aspects of solar energy - Selective and critical bibliography
13 p0054 A77-15799
Geothermal energy development
13 p0064 A77-17801
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719
Economic limits of OCS production wells
[PB-255320/4] 13 p0096 N77-11515
Field test sampling/analytical strategies and implementation cost estimates: Coal gasification and flue gas desulfurization
[PB-254166/2] 13 p0101 N77-11581
Coal gasification commercial concepts: Gas cost guidelines
[FE-1235-1] 13 p0130 N77-15500

COST EFFECTIVENESS
Making electricity from moderate temperature fluids --- geothermal sources
13 p0002 A77-10649
Energy from wastes
13 p0006 A77-11038
Principles of energy analysis
13 p0007 A77-11045
Energy: A radical redirection
13 p0010 A77-11275
The mysteries of nuclear programs --- energy conversion efficiency
13 p0011 A77-11337
Electricity and heat production - Energy efficiency versus cost efficiency
13 p0011 A77-11338
Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/
13 p0013 A77-11524
The Osmotic power plant
13 p0021 A77-12668
Solar SNG - Large-scale production of SNG by anaerobic digestion of specially grown plant matter --- Synthetic Natural Gas
13 p0021 A77-12671
Solar energy collection by bioconversion
13 p0021 A77-12672

Solar-powered Rankine-cycle heat pump system
13 p0036 A77-12800
The low cost high performance generator /LCHPG/ --- space Radioisotope Thermoelectric Generators
13 p0042 A77-12855
Life-cycle costs and solar energy
13 p0047 A77-13501
Windmills stage a comeback --- review
13 p0048 A77-13624
Some material considerations involved in the application of solar energy to electric power generation
13 p0049 A77-13739
Air transportation and fuel consumption
13 p0051 A77-14563
Studies and thoughts on nuclear reactor systems
13 p0055 A77-15800
Economic effectiveness of solar electric power stations
13 p0063 A77-17556
Nova Scotia seeks to cut oil bill for power generation
13 p0063 A77-17588
Solar photovoltaics - An aerospace technology
[AIAA PAPER 77-293] 13 p0065 A77-18225
Solar thermal power generation
13 p0077 A77-19095
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran --- Heating, Ventilating and Air Conditioning
13 p0078 A77-19111
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
Solid Polymer Electrolyte (SPE) fuel cell technology, program review, phase 2
[NASA-CR-150957] 13 p0097 N77-11532
Attic concentrator type solar energy collector
[BNL-50493] 13 p0098 N77-11539
Cost/benefit assessment of the application of composite materials to subsonic commercial transport engines
[NASA-TM-X-73557] 13 p0111 N77-13064
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137926] 13 p0126 N77-15007
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008

COST ESTIMATES
Investigation of heat exchanger flow arrangement on performance and cost in a geothermal binary cycle
13 p0029 A77-12746
Is nuclear energy economically viable --- competition with coal
13 p0045 A77-12933
Air, water, nuclear power make gasoline
13 p0045 A77-12935
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106
Personal rapid transit research conducted at the Aerospace Corporation
[PB-256846/7] 13 p0111 N77-12946
Electric power generation using geothermal brine resources for a proof-of-concept facility
[NSF/RA/N-75-049] 13 p0123 N77-14603

COST REDUCTION
The ERDA Photovoltaic Systems Definition Project
13 p0038 A77-12815
COSTEAM: Low-rank coal liquefaction - An updated analysis
13 p0045 A77-12934

COSTS
Some cost, energy, environmental, and resource implications of synthetic fuels produced from coal for military aircraft
[AD-A026667] 13 p0118 N77-14271

CRUDE OIL
Energy and the oil industry
13 p0005 A77-11031
World petroleum resources. IV - Probabilistic methods
13 p0012 A77-11342
Off-shore oil scenarios - Method and results
13 p0018 A77-12282
Thermal alteration of young kerogen in relation to petroleum genesis
13 p0053 A77-15044
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran --- Heating, Ventilating and Air Conditioning
13 p0078 A77-19111
National petroleum product supply and demand, 1976 - 1978
[PB-254969/9] 13 p0084 N77-10224
The long-run marginal costs of energy
[PB-252504/6] 13 p0085 N77-10625
Gasoline and distillate shortage situation: 1972-1976
[PB-253322/2] 13 p0089 N77-10670
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207
Mandatory Canadian crude oil allocation regulations
[PB-255319/6] 13 p0096 N77-11509
Economic limits of OCS production wells
[PB-255320/4] 13 p0096 N77-11515
User's guide to petroleum industry survey data type
[PB-256635/4] 13 p0098 N77-11544
A survey of salt deposits and salt caverns: Their relevance to the strategic petroleum reserve
[PB-255948/2] 13 p0105 N77-12500
Crude oil supply alternatives for the Northern Tier states
[PB-255991/2] 13 p0107 N77-12530
Crude supply alternatives for the Northern Tier states. Volume 1: Executive summary
[PB-255992/0] 13 p0107 N77-12531
Crude supply alternatives for the Northern Tier states. Volume 2: Technical report
[PB-255993/8] 13 p0107 N77-12532
Petroleum market shares. Report on sales of propane to ultimate consumers, 1975
[PB-255624/9] 13 p0108 N77-12540
Tests of oil recovery devices in broken ice fields, phase 2
[AD-A025748] 13 p0110 N77-12572
Temperature effects of crude oil in the upper intertidal zone
[PB-255956/5] 13 p0110 N77-12581
The exploration, development and production of Naval petroleum reserve number 4
[PB-256714/7] 13 p0113 N77-13516
Weekly petroleum statistics reports, 1974-1975
[PB-255920/1] 13 p0124 N77-14608
Ignition of flammable gases in crude-oil tankers as a result of metal fracture
[AD-A027411] 13 p0127 N77-15121
Trends in refinery capacity and utilization: Petroleum refineries in the United States; foreign refinery exporting centers
[PB-256966/3] 13 p0132 N77-15523

CRUISING FLIGHT
Fuel consumption of civil jet transport aircraft
13 p0062 A77-17234
Best-range flight conditions for cruise-climb flight of a jet aircraft
13 p0085 N77-10379

CRYOGENIC FLUID STORAGE
An exploratory study to determine the integrated technological air transportation system ground requirements of liquid-hydrogen-fueled subsonic, long-haul civil air transports
[NASA-CR-2699] 13 p0083 N77-10033

CRYOGENIC FLUIDS
Flight results of a cryogenic cooler designed for Meteosat
[IAF PAPER 76-210] 13 p0003 A77-10942
Magnetic suspension densimeter for measurements on fluids of cryogenic interest
13 p0007 A77-11093
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380

CRYOGENICS
Extended cryogenic performance of Lobar Wick heat pipe/radiator
13 p0119 N77-14379
Investigations of nonsteady-state processes at cryogenic heat pipe operation --- filled with ammonia and Freon-22
13 p0119 N77-14384

CRYSTAL DEFECTS
The silicon ribbon solar cell
13 p0076 A77-19083
CRYSTAL GROWTH
The silicon ribbon solar cell
13 p0076 A77-19083
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
CRYSTAL LATTICES
Intermetallic compounds - Background and results of twenty years of research
13 p0014 A77-11600
Some useful relationships between the physical and thermodynamic properties of metal hydrides
13 p0033 A77-12776
CRYSTAL STRUCTURE
Hydrogen atoms: Rare earth ions: Magnetic resonance studies on polycrystalline solids and surface systems relevant to catalysis and other energy-related research
13 p0117 N77-13798
CURRENT DENSITY
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107
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[PB-255623/1] 13 p0111 N77-12930
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An analysis of electric vehicle mission, design, energy impact and cost
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Solar cell array design handbook, volume 2
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Energy and the developing countries
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Report of the Army Scientific Advisory Panel Ad Hoc Group on fire-safe fuels [AD-A023763] 13 p0095 N77-11208
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A method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds --- for solar collector design 13 p0019 A77-12412
Computation of solar radiation design curves 13 p0072 A77-19049
DIGITAL SIMULATION
Performance of an annular cylindrical solar collector 13 p0073 A77-19059
DIRECT CURRENT
Pulsed energy conversion with a dc superconducting magnet 13 p0081 A77-19293
DIRECT POWER GENERATORS
Energy recovery from saline water by means of electrochemical cells 13 p0013 A77-11536
DISSOLVING
Mechanisms of coal particle dissolution 13 p0059 A77-16475
DISULFIDES
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide 13 p0025 A77-12706
DIURNAL VARIATIONS
Selection of optimal pan color for solar water heater 13 p0078 A77-19104
DIVIDERS
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements 13 p0028 A77-12735
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The overcoming of energy deficiencies with the aid of wind power 13 p0008 A77-11174
Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology 13 p0008 A77-11241
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Developments in solar energy utilisation in the United Kingdom 13 p0018 A77-12402
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Thermal evaluation of a house using a movable-insulation heating and cooling system 13 p0019 A77-12407
A method of testing for rating solar collectors based on thermal performance 13 p0019 A77-12408
A forced circulation system for solar water heating 13 p0019 A77-12413
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance 13 p0020 A77-12657
Modeling residential energy use 13 p0027 A77-12726
Thermal energy storage applied to residential heating systems 13 p0027 A77-12729
Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations 13 p0028 A77-12736
Geothermal studies in northern Nevada 13 p0029 A77-12742
Solar-powered Rankine-cycle heat pump system 13 p0036 A77-12800
New concepts in solar photovoltaic electric power systems design 13 p0038 A77-12817
An integrated photovoltaic/thermal High Intensity Solar Energy System /HISES/ concept for residential applications 13 p0039 A77-12818
A summary of solar heating and cooling of buildings /SHACOB/ - Phase I demonstration planning studies 13 p0039 A77-12821
Long term performance prediction of residential solar energy heating systems 13 p0039 A77-12822
Experimental evaluation of the University of Florida solar powered ammonia/water absorption air conditioning system 13 p0039 A77-12823
Detailed geographic analysis of residential energy consumption 13 p0043 A77-12864
Siting of wind driven apparatus 13 p0043 A77-12865
The consumer's cost of electricity from windmills 13 p0043 A77-12866
Scientific-technological problems of the development of a fuel-energy complex in the USSR 13 p0051 A77-14703
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Application of solar heat to buildings in Austria 13 p0079 A77-19114
Environmentally designed housing incorporating solar energy 13 p0079 A77-19115
Lumiducts for Ecopolis --- urban solar light collection and transmission system 13 p0079 A77-19116
Water pumping - A practical application of solar energy 13 p0079 A77-19117

DOMESTIC SATELLITE COMMUNICATIONS SYSTEMS
Satellite communications for off-shore oil operations using WESTAR
13 p0053 A77-15130
DRAG MEASUREMENT
Wind tunnel measurements of the tower shadow on models of the ERDA/NASA 100 KW wind turbine tower
[NASA-TM-X-73548] 13 p0114 N77-13534
DRAG REDUCTION
Wind tunnel investigation of devices to reduce bus aerodynamic drag
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Geothermal energy development
13 p0064 A77-17801
DROP TRANSFER
Evaporation of solution droplets in a high-temperature medium --- potassium carbonate MHD flow properties
13 p0046 A77-13254
DRY CELLS
Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells
13 p0025 A77-12713
Development status of lithium-silicon-iron sulfide load-leveling batteries
13 p0026 A77-12714
DRYING APPARATUS
Grain drying in stationary bins with solar heated air
13 p0019 A77-12411
DUCTED BODIES
Lumiducts for Ecopolis --- urban solar light collection and transmission system
13 p0079 A77-19116
DYNAMIC CHARACTERISTICS
Linear model of a dissipative PWM shunt regulator --- Pulse Width Modulation
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[DM-16] 13 p0114 N77-13539
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E

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Cross structural plan of the earth's crust and the problem of the manifestation of its plutonic elements on the surface (Tyan-Shan and Turan plate as examples)
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Energy analysis in modelling
13 p0007 A77-11047
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13 p0011 A77-11334
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Modeling residential energy use
13 p0027 A77-12726
An evaluation of the use of metal hydrides for solar thermal energy storage
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Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
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13 p0031 A77-12762
Benefits of hydrogen production research
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Economic optimization of the energy transport component of a large distributed solar power plant
13 p0037 A77-12807
An integrated photovoltaic/thermal High Intensity Solar Energy System /HISES/ concept for residential applications
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Wind driven field modulated generator systems
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13 p0045 A77-12933
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ECONOMICS
Economics of depletable resources: Market forces and intertemporal bias
[PB-255623/] 13 p0111 N77-12930

EDDY VISCOSITY
Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels
13 p0046 A77-13242

EFFICIENCY
Resource utilization efficiency improvement of geothermal binary cycles, phase 1
[ORO-4944-3] 13 p0123 N77-14600

EFFLUENTS
Compilation of an inventory for particulate emissions in Belgium
13 p0009 A77-11271

EIGENVECTORS
Characteristic equations of unconcentrated flat solar cell panels
13 p0052 A77-14929

ELECTRIC ARCS
A 2-MW electric arc generator with porous cooling of the interelectrode insert
13 p0049 A77-13831
Electric arc power collection for high-speed trains
13 p0060 A77-16594

ELECTRIC AUTOMOBILES
Small electric vehicle considerations in view of performance and energy usage
13 p0024 A77-12698
An analysis of electric vehicle mission, design, energy impact and cost
13 p0024 A77-12700
Selection of driving cycles for electric vehicles of the 1990's
13 p0024 A77-12702
Application of a shunt motor and a 2 cylinder gasoline engine as a hybrid drive for an automobile
13 p0025 A77-12703
Baseline test data for the EVA electric vehicle --- low energy consumption automobiles
13 p0025 A77-12704
Electric vehicle performance with alternate batteries
13 p0025 A77-12707
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
Economic and social impact of solar powered transportation systems
13 p0079 A77-19120

ELECTRIC BATTERIES
New electrochemical current sources
13 p0020 A77-12650

ELECTRIC CURRENT
Electric current from the direct conversion of low molecular weight C,H,O-compounds
13 p0055 A77-15814

ELECTRIC ENERGY STORAGE
Large-scale electrical power generation and storage
13 p0006 A77-11039
Dependability of wind energy generators with short-term energy storage
13 p0046 A77-13323
The potential for application of energy storage capacity on electric utility systems in the United States. I
13 p0054 A77-15625
Problems of energy storage in solar power stations
13 p0063 A77-17555
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201
The Redox flow system for solar photovoltaic energy storage
[NASA-TM-X-73562] 13 p0106 N77-12522
Electrically rechargeable REDOX flow cell
[NASA-CASE-LEW-12220-1] 13 p0121 N77-14581

ELECTRIC GENERATORS
Emergency power plant of rapid availability for the Berlin-Tegel airport
13 p0001 A77-10324
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
Optimisation of current source operation in pulse mode --- for electrochemical generators
[IAF PAPER 76-255] 13 p0003 A77-10952

Energy conservation potential of Modular Integrater Utility Systems /MIUS/
13 p0026 A77-12724
Limiting capabilities with respect to electric power generation of a pulsed MHD generator operating at a resistive load
13 p0064 A77-17917
Electric energy from atmospheric water vapor
13 p0077 A77-19097
Geothermal energy for power generation
[LA-UR-76-369] 13 p0087 N77-10650
A study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255658/7] 13 p0115 N77-13542
A study of implant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255659/5] 13 p0115 N77-13543
Electric power generation using geothermal brine resources for a proof-of-concept facility
[NSF/RA/N-75-049] 13 p0123 N77-14603
Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant, phase 2
[FE-1521-13] 13 p0130 N77-15501
Composite material structures for thermophotovoltaic conversion radiator
[AD-A026859] 13 p0132 N77-15519

ELECTRIC MOTOR VEHICLES
Load leveling with electric vehicles in the urban environment
13 p0024 A77-12701
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706
Electric vehicle performance with alternate batteries
13 p0025 A77-12707
Development status of lithium-silicon-iron sulfide load-leveling batteries
13 p0026 A77-12714
Electric vehicle batteries - Opportunities for materials improvement
13 p0049 A77-13736
Some studies on sodium/sulfur cells
13 p0055 A77-15813

ELECTRIC POWER
Photovoltaic and thermal energy conversion for solar powered satellites
[IAF PAPER 76-117] 13 p0003 A77-10913
Satellite power systems for large-scale power generation
[IAF PAPER 76-118] 13 p0003 A77-10914
Higher electric power use reduces energy consumption for same gross national product
13 p0011 A77-11334
The mysteries of nuclear programs --- energy conversion efficiency
13 p0011 A77-11337
Characteristic aspects of the evolution of the French electric balance in 1975
13 p0012 A77-11340
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
Is nuclear energy economically viable --- competition with coal
13 p0045 A77-12933
The potential for application of energy storage capacity on electric utility systems in the United States. I
13 p0054 A77-15625
Electric energy from atmospheric water vapor
13 p0077 A77-19097
Heating a building by means of solar and electrical energy
13 p0078 A77-19113
Electric energy supply alternatives for New York. Phase 2: An appraisal of electrical energy alternatives available to the State of New York
[PB-249881/4] 13 p0101 N77-11575
Planning models for the assessment of advanced energy storage systems
13 p0105 N77-12504
Inventory of energy research and development (1973 - 1975), volume 2
[GPO-64-734-VOL-2] 13 p0113 N77-13526
Electric power generation using geothermal brine resources for a proof-of-concept facility
[NSF/RA/N-75-049] 13 p0123 N77-14603
Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant, phase 2
[FE-1521-13] 13 p0130 N77-15501

ELECTRIC POWER PLANTS
Performance theory of diagonal conducting wall MHD generators
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Making electricity from moderate temperature fluids --- geothermal sources
13 p0002 A77-10649
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13 p0006 A77-11039
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13 p0006 A77-11042
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13 p0010 A77-11316
Nuclear power - Compared to what --- energy alternatives for electric power generation
13 p0017 A77-12234
The significance of coal in the future energy picture
13 p0018 A77-12247
The Osmotic power plant
13 p0021 A77-12668
Steam station repowering - A near-term method of energy conservation
13 p0022 A77-12679
Energy conservation with advanced power generating systems
13 p0026 A77-12723
Underground storage of off-peak power
13 p0027 A77-12728
Storage in oil of off-peak thermal energy from large power stations
13 p0027 A77-12730
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Economic optimization of binary fluid cycle power plants for geothermal systems
13 p0029 A77-12744
The economic generation of electricity from moderate temperature geothermal resources
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13 p0030 A77-12751
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
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13 p0037 A77-12806
Windowed versus windowless solar energy cavity receivers
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New concepts in solar photovoltaic electric power systems design
13 p0038 A77-12817
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13 p0044 A77-12874
Combination power plants for improved utilization of fossil fuels
13 p0045 A77-12939

MHD - Energy transformation by burning coal
13 p0045 A77-12940
A hydride compressor
13 p0046 A77-13336
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
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Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
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13 p0049 A77-13739
Problems of energy storage in solar power stations
13 p0063 A77-17555
Economic effectiveness of solar electric power stations
13 p0063 A77-17556
Nova Scotia seeks to cut oil bill for power generation
13 p0063 A77-17588
Increase in the efficiency of heat and power systems using large artificial accumulators of heat
13 p0064 A77-17939
Gas turbine electric powerplants
[AIAA PAPER 77-346] 13 p0066 A77-18254
A summary of the ECAS MHD power plant results
[NASA-TM-X-73491] 13 p0086 N77-10642
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[PB-255697/5] 13 p0100 N77-11563
Theoretical, numerical, and physical techniques for characterizing power plant plumes
[PB-253099/6] 13 p0101 N77-11599
Physical and biological aspects of thermal pollution in sea water --- forecasting electric power production in Italy
[ISS-L-75/14] 13 p0109 N77-12560
Assessment of the impact of proposed thermal effluent guidelines for the steam electric power industry
[PB-255937/5] 13 p0110 N77-12587
Laboratory analysis of solvent refined coal
[PB-255550/6] 13 p0110 N77-12598
Assessment of power system security under load uncertainty
13 p0112 N77-13324
Design phase utility analysis for gas turbine and combined cycle plants
[PB-256665/1] 13 p0115 N77-13553
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships, detailed report
[PB-257444/0] 13 p0116 N77-13554
National benefits associated with commercial application of fuel cell powerplants
[ERDA-76-54] 13 p0123 N77-14597
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630
Proceedings of the Stationary Source Combustion Symposium. Volume 3: Field Testing and Surveys
[PB-257146/1] 13 p0125 N77-14643
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506
Economic analysis of the need for advanced power sources
[HEDL-SA-989] 13 p0131 N77-15509
An improved electrolyte for direct oxidation fuel cells
[AD-A026164] 13 p0131 N77-15518

ELECTRIC POWER SUPPLIES
Superflywheel energy storage and nonsynchronous AC/DC/AC electric transmission supplements power system operation
13 p0002 A77-10638
Solar energy --- conversion technology assessment
13 p0006 A77-11037
The overcoming of energy deficiencies with the aid of wind power
13 p0008 A77-11174
Electricity and heat production - Energy efficiency versus cost efficiency
13 p0011 A77-11338
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
Electric utility companies and geothermal power
13 p0031 A77-12759
The potential national benefits of geothermal electrical energy production from hydrothermal resources in the West
13 p0031 A77-12760
Comparison of candidate solar array maximum power utilization approaches --- for spacecraft propulsion
13 p0041 A77-12836
KIPS - Kilowatt Isotope Power System --- for use in satellites
13 p0041 A77-12837
SNAP 19 Viking RTG mission performance
13 p0041 A77-12840
Fuel cells --- electrochemical energy conversion
13 p0055 A77-15804
Some studies on sodium/sulfur cells
13 p0055 A77-15813
Electric arc power collection for high-speed trains
13 p0060 A77-16594
Electric power supply in the case of airports. I
13 p0061 A77-16742
Solar thermal power generation
13 p0077 A77-19095
Economic and social impact of solar powered transportation systems
13 p0079 A77-19120
Costs of alternative sources of electricity
[PB-255765/0] 13 p0107 N77-12528
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications
[PB-255646/2] 13 p0109 N77-12551
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948
Participating surveillance services for electric power program. Coal conversion and utilization: Direct combustion of coal-90e, advanced power-90f. Summary for ERDA annual report, CY 1975
[PE-1236-4] 13 p0130 N77-15507
Possible effects of nuclear initiative on supply and use of electricity in California
[AD-A026582] 13 p0131 N77-15510
Integrating community utilities for resource conservation
[PB-256898/8] 13 p0133 N77-15923

ELECTRIC POWER TRANSMISSION
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
Assessment of power system security under load uncertainty
13 p0112 N77-13324

ELECTRIC PROPULSION
Power source requirements of electric propulsion systems used for north-south stationkeeping of communication satellites
13 p0040 A77-12833
NASA electric propulsion program
[AIAA PAPER 76-1068] 13 p0045 A77-13033
Electric vehicle batteries - Opportunities for materials improvement
13 p0049 A77-13736

ELECTRIC PULSES
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293

ELECTRIC ROCKET ENGINES
Status of SERT 2 thrusters and spacecraft 1976
[NASA-TM-X-73501] 13 p0083 N77-10149

ELECTRICAL ENGINEERING
Transport systems guarantee efficient utilization of energy resources
13 p0053 A77-15048

ELECTRICAL PROPERTIES
Air electrodes for H2-air fuel cells with alkali electrolyte
13 p0065 A77-18196
ELECTRICAL RESISTANCE
Reducing grain-boundary effects in polycrystalline silicon solar cells
13 p0014 A77-11761
An analysis of silicon solar cell parameters for terrestrial applications
13 p0076 A77-19081
ELECTRICITY
Geothermal energy for electrical and nonelectrical applications
[LA-UR-76-418] 13 p0123 N77-14601
ELECTROCATALYSTS
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815
Fuel cell assemblies with an acidic electrolyte
13 p0055 A77-15816
Air electrodes for H2-air fuel cells with alkali electrolyte
13 p0065 A77-18196
A comparison of porous silver catalysts in oxygen electrodes of alkaline fuel cells
13 p0067 A77-18350
The electron factor in catalysis on metals electrocatalysis on non-metallic surfaces
[PB-256264/3] 13 p0103 N77-12166
Carbon oxidation catalyst mechanism study for fuel cells
[PB-256420/1] 13 p0115 N77-13551
Surface research for development of new electrocatalysts for acid electrolyte fuel cells
[AD-A026053] 13 p0131 N77-15517
ELECTROCHEMICAL CELLS
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107
Energy recovery from saline water by means of electrochemical cells
13 p0013 A77-11536
New electrochemical current sources
13 p0020 A77-12650
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666
Energy conversion via photoelectrolysis
13 p0021 A77-12667
Electrochemical power and hydrogen generation from high temperature electrolytic cells
13 p0025 A77-12709
Development of compact lithium/iron disulfide electrochemical cells
13 p0026 A77-12715
The theory of hydrogen production in a photoelectrochemical cell
13 p0075 A77-19075
Alternating photoelectrochemical converters
13 p0077 A77-19093
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201
ELECTROCHEMISTRY
Fuel cells --- electrochemical energy conversion
13 p0055 A77-15804
A comparison of porous silver catalysts in oxygen electrodes of alkaline fuel cells
13 p0067 A77-18350
Research on electrochemical energy conversion systems
[AD-A023689] 13 p0090 N77-10681
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529
ELECTRODES
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107
Advances in component technology for nickel-zinc cells
13 p0025 A77-12710
Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells
13 p0025 A77-12713
Advanced thermionic converter development
13 p0043 A77-12862
A new hydrogen storage electrode
13 p0047 A77-13539
Diffuse thermal model of electrode erosion for MHD generators
13 p0049 A77-14319
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817
Air electrodes for H2-air fuel cells with alkali electrolyte
13 p0065 A77-18196
A comparison of porous silver catalysts in oxygen electrodes of alkaline fuel cells
13 p0067 A77-18350
ELECTRODYNAMICS
Influence of various losses on the characteristics of high-power MHD generators
13 p0046 A77-13258
ELECTROLYSIS
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666
Hydrogen from solar energy via water electrolysis
13 p0032 A77-12771
Energy storage via calcium hydride production
13 p0032 A77-12774
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791
Hydrogen production using solar radiation
13 p0048 A77-13540
The storage of energy in future energy supply systems
[DGLR PAPER 76-182] 13 p0059 A77-16533
Prospects for hydrogen production by water electrolysis to be competitive with conventional methods
[BNL-20877] 13 p0087 N77-10648
Production of chemical energy carriers by non-expandable energy sources --- solar energy electrolysis, photolysis, and thermochemical cycles
[DLR-FB-76-32] 13 p0114 N77-13541
ELECTROLYTES
Solid Polymer Electrolyte (SPE) fuel cell technology, program review, phase 2
[NASA-CR-150957] 13 p0097 N77-11532
Semiconductor-electrolyte photovoltaic energy converter
[PB-252837/0] 13 p0099 N77-11548
Surface research for development of new electrocatalysts for acid electrolyte fuel cells
[AD-A026053] 13 p0131 N77-15517
An improved electrolyte for direct oxidation fuel cells
[AD-A026164] 13 p0131 N77-15518
ELECTROLYTIC CELLS
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108
Electrochemical power and hydrogen generation from high temperature electrolytic cells
13 p0025 A77-12709
Advances in component technology for nickel-zinc cells
13 p0025 A77-12710
Development of sodium/sulfur-cells
13 p0026 A77-12716
Sodium/sulphur battery development in the United Kingdom
13 p0026 A77-12717
Some studies on sodium/sulfur cells
13 p0055 A77-15813
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815
Fuel cell assemblies with an acidic electrolyte
13 p0055 A77-15816
Investigation of a TiO2/electrolyte solar cell and the photocatalytic water decomposition
13 p0077 A77-19094
New separators for nickel-zinc batteries
[NASA-TM-X-3465] 13 p0121 N77-14585
ELECTROLYTIC POLARIZATION
Near-uv photon efficiency in a TiO2 electrode - Application to hydrogen production from solar energy
13 p0015 A77-11947

ELECTROMAGNETIC MEASUREMENT
Remote sensing of an underground coal-burn cavity with a wide-band induction system
13 p0007 A77-11050
ELECTROMAGNETIC RADIATION
Monitoring fluid flow by using high-frequency electromagnetic probing
[UCRL-51979] 13 p0120 N77-14393
ELECTROMECHANICS
A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices
13 p0061 A77-17017
ELECTROMOTIVE FORCES
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
ELECTRON ENERGY
Construction of two-dimensional steady-state solution of equations of a nonequilibrium magnetized plasma
13 p0065 A77-18130
ELECTRON IRRADIATION
Radiation effects on high efficiency silicon solar cells
13 p0064 A77-18072
ELECTRON PARAMAGNETIC RESONANCE
Hydrogen atoms: Rare earth ions: Magnetic resonance studies on polycrystalline solids and surface systems relevant to catalysis and other energy-related research
13 p0117 N77-13798
ELECTRON TRANSITIONS
Measurements of Sc I gf-values --- absorption spectroscopy using heat pipe oven
13 p0058 A77-16270
ELECTRONIC CONTROL
Bosch technical instruction. Gasoline injection D and L-jetronic
[NASA-TT-F-17111] 13 p0095 N77-11399
ELECTRONIC EQUIPMENT
Cooling arrays of circuit cards using heat pipes and forced air diffusers
13 p0031 A77-12766
ELECTROSTATICS
Electrostatic properties of JP-5 jet fuel from alternate sources
[AD-A025684] 13 p0103 N77-12232
EMERGENCIES
Emergency power plant of rapid availability for the Berlin-Tegel airport
13 p0001 A77-10324
EMITTANCE
Study of emittance distribution along the walls of a cellular low-loss cell in the case of a base surface with arbitrary emission indicatrix
13 p0069 A77-18495
ENCAPSULATING
Encapsulation of solar cell modules
13 p0076 A77-19092
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
ENERGY ABSORPTION
Progress in development and application of selective surfaces --- for solar collectors
13 p0072 A77-19052
Temperature optimization for power production of infinite heat transfer solar absorbers
13 p0073 A77-19055
ENERGY ABSORPTION FILMS
Plastics for solar-energy collectors. II - Typical operational data and model parameters, functional diagrams, optimization of layer thicknesses
13 p0009 A77-11269
Photovoltaic conversion of solar energy
13 p0058 A77-16368
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
Cadmium stannate selective optical films for solar energy applications
[PB-254879/0] 13 p0090 N77-10678
ENERGY BUDGETS
Characteristic aspects of the evolution of the French electric balance in 1975
13 p0012 A77-11340

ENERGY CONSERVATION
The energy problem and the earth's fuel situation
13 p0004 A77-11027
Energy consumption and conservation in the United States
13 p0005 A77-11028
Total energy systems --- electric power generation with heat recovery
13 p0006 A77-11042
Optimal thermal insulation as an investment-computational problem
13 p0009 A77-11268
Air cleanup and energy management
13 p0010 A77-11302
Electricity and heat production - Energy efficiency versus cost efficiency
13 p0011 A77-11338
Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/
13 p0013 A77-11524
Air transportation energy efficiency - Alternatives and implications
[SAWE PAPER 1124] 13 p0016 A77-12192
Baseline test data for the EVA electric vehicle --- low energy consumption automobiles
13 p0025 A77-12704
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
Energy conservation with advanced power generating systems
13 p0026 A77-12723
Energy conservation potential of Modular Integrater Utility Systems /MIUS/
13 p0026 A77-12724
Diversification as an energy conservation strategy
13 p0027 A77-12725
Industrial energy conservation through integration of thermal energy storage into process energy dynamics
13 p0028 A77-12733
An advanced energy conservation technology program; Proceedings of the Intersociety Workshop Conference, Airlie House, Va., March 24-26, 1976
13 p0045 A77-12928
Evolution of the concept of the automobile from the standpoint of saving energy
13 p0051 A77-14562
Energy recovery in railway and road transportation
13 p0051 A77-14564
Energy and environmental impacts of materials alternatives - An assessment of quantitative understanding
13 p0070 A77-18738
Improved use of energy --- through waste and solar energy utilization
13 p0079 A77-19123
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
Analysis of state solar energy options
[PB-254730/5] 13 p0091 N77-10688
Aircraft fuel conservation technology. Task force report, September 10, 1975
[NASA-TM-X-74295] 13 p0093 N77-11055
Conference report: Energy Conservation in Transportation and Construction
[PB-255857/5] 13 p0100 N77-11562
Assessing the relationship between urban form and travel requirements: A literature review and conceptual framework
[PB-254988/9] 13 p0102 N77-11923
California energy outlook
[UCRL-5196-REV-1] 13 p0106 N77-12525
A study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255658/7] 13 p0115 N77-13542
A study of implant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255659/5] 13 p0115 N77-13543
Bonneville power administration electric energy conservation study
[PB-256766/7] 13 p0115 N77-13550

Final assessment of the environmental impacts of the State Energy Conservation Program (Public law 94-163, Title III, part C, The Energy Policy and Conservation Act)
[PB-256044/9] 13 p0116 N77-13555
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495
Second Environmental Aspects of Fuel Conversion Technology Symposium
[PB-257182/6] 13 p0125 N77-14645
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137926] 13 p0126 N77-15007
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008
Study of unconventional aircraft engines designed for low energy consumption
[NASA-CR-135136] 13 p0127 N77-15043
Effects of a thermal reactor on the energy efficiency of a turbocharged, stratified charge engine
[AD-A026059] 13 p0128 N77-15409
Integrating community utilities for resource conservation
[PB-256898/8] 13 p0133 N77-15923

ENERGY CONSUMPTION
Energy consumption and conservation in the United States
13 p0005 A77-11028
Principles of energy analysis
13 p0007 A77-11045
The availability of fuels for power plants
13 p0010 A77-11316
Higher electric power use reduces energy consumption for same gross national product
13 p0011 A77-11334
Characteristic aspects of the evolution of the French electric balance in 1975
13 p0012 A77-11340
Energy in the household - Comparison of heating costs and prognosis concerning the consumption of energy until 1985
13 p0015 A77-12059
The significance of coal in the future energy picture
13 p0018 A77-12247
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance
13 p0020 A77-12657
Small electric vehicle considerations in view of performance and energy usage
13 p0024 A77-12698
An analysis of electric vehicle mission, design, energy impact and cost
13 p0024 A77-12700
New concepts in solar photovoltaic electric power systems design
13 p0038 A77-12817
Detailed geographic analysis of residential energy consumption
13 p0043 A77-12864
Energy consumption in various modes of transportation
13 p0050 A77-14561
A linear economic model of fuel and energy use in the United States. Volume 1: Model Description and results
[PB-252485/8] 13 p0088 N77-10662
A linear economic model of fuel and energy in the United States. Volume 2: Submodels and data
[PB-252486/6] 13 p0089 N77-10663
Summary of EPA energy policy analysis
[PB-253361/0] 13 p0089 N77-10669
A simulation analysis of US energy demand, supply, and prices
[PB-254314/8] 13 p0090 N77-10680
Energy-economy relationships
[PB-255171/1] 13 p0099 N77-11552
Energy information activities at the FEA
[PB-253962/5] 13 p0099 N77-11553
Energy use in the contract construction industry
[PB-245422/1] 13 p0099 N77-11557
Review of energy forecasting methodologies and assumptions
[PB-255170/3] 13 p0107 N77-12526
Historical fuels and energy consumption data, 1960 - 1972, United States by states and census districts east of the Mississippi
[PB-255176/0] 13 p0112 N77-13229
Historical fuels and energy consumption data, 1960 - 1972, United States by states and census districts west of the Mississippi
[PB-255177/8] 13 p0112 N77-13230
Bonneville power administration electric energy conservation study
[PB-256766/7] 13 p0115 N77-13550
Energy consumption characteristics of transports using the prop-fan concept
[NASA-CR-137937] 13 p0118 N77-14029
Energy consumption characteristics of transports using the prop-fan concept: Summary report
[NASA-CR-137938] 13 p0118 N77-14030
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948
Hydrodynamic equilibrium conditions for AG(EH) main strut-pod foil system using flap incidence control
[AD-A027521] 13 p0127 N77-15220
Coal gasification commercial concepts: Gas cost guidelines
[FE-1235-1] 13 p0130 N77-15500
Possible effects of nuclear initiative on supply and use of electricity in California
[AD-A026582] 13 p0131 N77-15510

ENERGY CONVERSION
Aspects of energy conversion; Proceedings of the Summer School, Lincoln College, Oxford, England, July 14-25, 1975
13 p0004 A77-11026
Dutchess County, NY moves towards pyrolysis --- of solid wastes with fuel recovery
13 p0010 A77-11298
Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volumes 1 & 2
13 p0020 A77-12662
Transient performance characteristics of a high temperature distributed solar collector field
13 p0037 A77-12810
Fuel cells --- electrochemical energy conversion
13 p0055 A77-15804
The palirrhotrophic origin of energy metabolism --- chemiosmotic precursor to phototropism in estuarine cellular organisms
13 p0064 A77-17895
Underground fuel gasification
[UCRL-TRANS-10998] 13 p0088 N77-10659
Direct solar energy conversion for large scale terrestrial use --- using CdS/Cu2S solar cell
[PB-252539/2] 13 p0089 N77-10674
Research on electrochemical energy conversion systems
[AD-A023689] 13 p0090 N77-10681
Mathematical simulation and empirical determination of the aerochemical and thermal atmospheric pollution resulting from energy conversion processes
[DLR-IB-553-75/1] 13 p0091 N77-10700
Methanol from coal fuel and other applications
[ORAU-126] 13 p0094 N77-11200
Problems and solutions in the use of coal analyses
[FE-0390-1] 13 p0097 N77-11535
Mechanical thermal motor
[NASA-CASE-MFS-23062-1] 13 p0104 N77-12402
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552
Inventory of energy research and development (1973 - 1975), volume 1
[GPO-64-734-VOL-1] 13 p0113 N77-13525
Inventory of energy research and development (1973 - 1975), volume 4
[GPO-64-734-VOL-4] 13 p0113 N77-13528
A fermentation process for converting plant materials into methane
13 p0121 N77-14583
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594

Solid state applications of direct energy conversion and heat pumping for a small automotive vehicle
[AD-A026321] 13 p0124 N77-14607
Energy and Physics: General Conference of the European Physical Society
[AD-A026962] 13 p0131 N77-15511
Surface research for development of new electrocatalysts for acid electrolyte fuel cells
[AD-A026053] 13 p0131 N77-15517

ENERGY CONVERSION EFFICIENCY

Superflywheel energy storage and nonsynchronous AC/DC/AC electric transmission supplements power system operation
13 p0002 A77-10638
On black solar cells or the tetrahedral texturing of a silicon surface
13 p0004 A77-11000
Solar energy --- conversion technology assessment
13 p0006 A77-11037
Total energy systems --- electric power generation with heat recovery
13 p0006 A77-11042
Environmental aspects of energy conversion and use
13 p0006 A77-11044
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
Evaluation of coal liquefaction efficiency based on various ranks
13 p0009 A77-11244
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
The mysteries of nuclear programs --- energy conversion efficiency
13 p0011 A77-11337
Electricity and heat production - Energy efficiency versus cost efficiency
13 p0011 A77-11338
Reducing grain-boundary effects in polycrystalline silicon solar cells
13 p0014 A77-11761
Some features of the operation of a solar installation acting as a low-temperature source of heat for a heat pump
13 p0015 A77-11924
Near-uv photon efficiency in a TiO2 electrode - Application to hydrogen production from solar energy
13 p0015 A77-11947
Synthetic fuels - Prices, prospects, and prior art
13 p0017 A77-12236
A method of testing for rating solar collectors based on thermal performance
13 p0019 A77-12408
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666
Energy conversion via photoelectrolysis
13 p0021 A77-12667
Solar energy collection by bioconversion
13 p0021 A77-12672
A conceptual design study of closed Brayton cycle gas turbines for fusion power generation
13 p0022 A77-12676
Electric vehicle performance with alternate batteries
13 p0025 A77-12707
Electrochemical power and hydrogen generation from high temperature electrolytic cells
13 p0025 A77-12709
Production of methane using offshore wind energy
13 p0026 A77-12722
Energy conservation with advanced power generating systems
13 p0026 A77-12723
The economic generation of electricity from moderate temperature geothermal resources
13 p0030 A77-12749
Comparison of geothermal power conversion cycles
13 p0030 A77-12750
Power production from high temperature geothermal waters
13 p0030 A77-12751

The potential of the heat pipe in coal gasification processes
13 p0031 A77-12763
Thermionic topping for central station power plants
13 p0034 A77-12787
Thermionic topping of a steam power plant
13 p0034 A77-12789
Comparative performance of solar thermal power generation concepts
13 p0036 A77-12803
Collector field optimization for a solar thermal electric power plant
13 p0038 A77-12811
A fixed collector employing reversible vee-trough concentrator and a vacuum tube receiver for high temperature solar energy systems
13 p0038 A77-12813
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction
13 p0042 A77-12850
The low cost high performance generator /LCHPG/ --- space Radioisotope Thermoelectric Generators
13 p0042 A77-12855
Advanced thermionic converter development
13 p0043 A77-12862
A new generation scheme for large wind energy conversion systems
13 p0043 A77-12868
Wind driven field modulated generator systems
13 p0044 A77-12869
An advanced energy conservation technology program; Proceedings of the Intersociety Workshop Conference, Airlie House, Va., March 24-26, 1976
13 p0045 A77-12928
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up --- utilizing Stirling engine
13 p0051 A77-14580
Effect of optical properties of a surface exposed to solar radiation on the radiation balance
13 p0052 A77-14928
Optimization of the geometry of switching buses for thermoelements in thermoelectric generators
13 p0052 A77-14951
Energy: Conversion and utilization --- Book
13 p0052 A77-14957
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665
Investigation of two-phase liquid-metal magnetohydrodynamic power systems
13 p0057 A77-16212
Combined cycles and refined coal --- gasification plant using high temperature gas turbines
13 p0058 A77-16249
Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters
13 p0058 A77-16324
Geothermal energy as a source of electric power: Thermodynamic and economic design criteria --- Book
13 p0060 A77-16623
Theoretical maximum for energy from direct and diffuse sunlight
13 p0064 A77-17845
Radiation effects on high efficiency silicon solar cells
13 p0064 A77-18072
Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials
13 p0068 A77-18444
Axial conduction in a flat-plate solar collector
13 p0068 A77-18447
Use of Lexan and Kapton honeycombs to increase solar collector efficiency
13 p0068 A77-18448

Arrays of fixed flat-plate solar energy collectors - Performance comparisons for differing individual component orientations
13 p0068 A77-18449
The lensed high-voltage vertical multijunction solar cell
13 p0069 A77-18489
New analysis of a high-voltage vertical multijunction solar cell
13 p0069 A77-18490
Progress in development and application of selective surfaces --- for solar collectors
13 p0072 A77-19052
Temperature optimization for power production of infinite heat transfer solar absorbers
13 p0073 A77-19055
Procedure for characterizing flat plate solar collectors
13 p0073 A77-19056
Termosole flat plate collectors
13 p0073 A77-19058
Solar water heater using hardened black polythene pipe absorbers
13 p0073 A77-19060
Periodically adjustable concentrators adapted to solar cell panels
13 p0074 A77-19068
An analysis of silicon solar cell parameters for terrestrial applications
13 p0076 A77-19081
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088
Photovoltaic systems using sunlight concentration
13 p0076 A77-19089
Meeting electric power needs with photovoltaic power systems
13 p0076 A77-19091
Investigation of a TiO2/electrolyte solar cell and the photocatalytic water decomposition
13 p0077 A77-19094
Energy considerations in HHE power systems --- Heliohydroelectric and Helioelectrolytic systems
13 p0077 A77-19099
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
Selection of optimal pan color for solar water heater
13 p0078 A77-19104
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
Application of solar heat to buildings in Austria
13 p0079 A77-19114
New frontiers in solar and other energy options
13 p0079 A77-19118
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293
Evaluation of flat-plate collector efficiency under controlled conditions in a solar simulator [NASA-TM-X-73520]
13 p0097 N77-11530
Solid Polymer Electrolyte (SPE) fuel cell technology, program review, phase 2 [NASA-CR-150957]
13 p0097 N77-11532
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships [PB-255639/7]
13 p0109 N77-12552
Standardized performance tests of collectors of solar thermal energy - A flat-plate copper collector with parallel mylar striping [NASA-TM-X-73553]
13 p0114 N77-13535

ENERGY DISTRIBUTION
Radiant-vector distribution in the radiant field of a parabolocylindric concentrator
13 p0015 A77-11920
Power resource estimate of ocean surface waves
13 p0071 A77-18790
Utility facilities in transportation corridors [PB-255635/5]
13 p0093 N77-10970

ENERGY POLICY
The energy problem and the earth's fuel situation
13 p0004 A77-11027
Energy and the developing countries
13 p0006 A77-11043
Environmental aspects of energy conversion and use
13 p0006 A77-11044

Principles of energy analysis
13 p0007 A77-11045
Energy: Mathematics and models; Proceedings of the Conference, Alta, Utah, July 7-11, 1975
13 p0008 A77-11233
The assurance of the heat supply with respect to the primary energy use in the case of heating and air conditioning installations
13 p0009 A77-11270
Energy: A radical redirection
13 p0010 A77-11275
The availability of fuels for power plants
13 p0010 A77-11316
Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/
13 p0013 A77-11524
A methodical approach concerning energy supply problems
13 p0016 A77-12062
Nuclear power - Compared to what --- energy alternatives for electric power generation
13 p0017 A77-12234
The shaping of our needs in mineral raw materials and sources for meeting those needs --- Hungarian survey
13 p0017 A77-12246
The significance of coal in the future energy picture
13 p0018 A77-12247
Off-shore oil scenarios - Method and results
13 p0018 A77-12282
Law and solar energy systems - Legal impediments and inducements to solar energy systems
13 p0018 A77-12401
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance
13 p0020 A77-12657
An energy center in Sri Lanka --- UN rural energy development program
13 p0021 A77-12669
Oil shale development
13 p0023 A77-12693
Diversification as an energy conservation strategy
13 p0027 A77-12725
Economic and engineering implications of the Project Independence 1985 geothermal energy output goal and the associated sensitivity analysis
13 p0029 A77-12745
Electric utility companies and geothermal power
13 p0031 A77-12759
The conservation of air purity and its effect on the energy economy
13 p0049 A77-13811
Scientific-technological problems of the development of a fuel-energy complex in the USSR
13 p0051 A77-14703
Energy: Conversion and utilization --- Book
13 p0052 A77-14957
The reprocessing of nuclear fuels
13 p0055 A77-15807
Perspectives for world energy production
13 p0056 A77-16202
Environment and energy production after the year 2000
13 p0056 A77-16203
Overview of the ERDA fusion power program
13 p0068 A77-18446
Formulation of energy policies - The case of West Africa
13 p0080 A77-19124
A system model for the investigation of alternative energy strategies --- German book
13 p0080 A77-19181
High-efficiency solar concentrator
13 p0083 N77-10104
The potential and economics of enhanced oil recovery [PB-254991/3]
13 p0086 N77-10633
Transportation energy conservation data book [ORNL-5198]
13 p0086 N77-10643
Utilization of geothermal energy [UTIAS-REVIEW-40]
13 p0087 N77-10644
Creating energy choices for the future. Public meeting on A National Plan for Energy Research, Development, and Demonstration [CONF-751228-P2]
13 p0087 N77-10646
Creating energy choices for the future [CONF-751228-P1]
13 p0087 N77-10647

Prospects for hydrogen production by water electrolysis to be competitive with conventional methods
[BNL-20877] 13 p0087 N77-10648
Advanced coal gasification system for electric power generation --- pollution monitoring
[FE-1514-176] 13 p0088 N77-10653
Waste heat vs conventional systems for greenhouse environmental control: An economic assessment
[ORNL/TM-5069] 13 p0088 N77-10656
Energy fact book 1975. Parts 1-5: Appendixes A-H
[AD-A023010] 13 p0089 N77-10664
Energy: The policy planning framework in state governments. Volume 1: Summary report
[PB-254466/6] 13 p0089 N77-10665
Energy: The policy planning framework in state governments. Volume 2: Appendices
[PB-254467/4] 13 p0089 N77-10666
Summary of EPA energy policy analysis
[PB-253361/0] 13 p0089 N77-10669
Gasoline and distillate shortage situation: 1972-1976
[PB-253322/2] 13 p0089 N77-10670
Analysis of state solar energy options
[PB-254730/5] 13 p0091 N77-10688
Baseline energy forecasts and analysis of alternative strategies for airline fuel conservation
[PB-255351/9] 13 p0091 N77-10690
Mandatory Canadian crude oil allocation regulations
[PB-255319/6] 13 p0096 N77-11509
Identification and analysis of mid-Atlantic onshore OCS impact
[PB-254925/1] 13 p0096 N77-11516
Multi-year time frame optimization of power systems with fossil, nuclear, hydro, pumped storage and peaking units
13 p0096 N77-11525
National program for solar heating and cooling (residential and commercial applications)
[ERDA-23A] 13 p0098 N77-11540
Mathematics for energy
[PB-252463/5] 13 p0098 N77-11543
Energy information activities at the FEA
[PB-253962/5] 13 p0099 N77-11553
Societal implications of energy scarcity. Social and technological priorities in steady state and constricting systems
[PB-253097/0] 13 p0099 N77-11556
Proceedings of the Workshop on Modeling the Interrelationships between the Energy Sector and the General Economy
[PB-255696/7] 13 p0100 N77-11561
Electric energy supply alternatives for New York. Phase 2: An appraisal of electrical energy alternatives available to the State of New York
[PB-249881/4] 13 p0101 N77-11575
Research to anticipate environmental impacts of changing resource usage
[PB-256293/2] 13 p0101 N77-11602
Future scenarios for urban transportation
[PB-255349/3] 13 p0102 N77-11930
Crude supply alternatives for the Northern Tier states. Volume 1: Executive summary
[PB-255992/0] 13 p0107 N77-12531
Crude supply alternatives for the Northern Tier states. Volume 2: Technical report
[PB-255993/8] 13 p0107 N77-12532
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534
Implementing coal utilization provisions of Energy Supply and Environmental Coordination Act
[PB-255855/9] 13 p0109 N77-12549
Inventory of energy research and development (1973 - 1975), volume 1
[GPO-64-734-VOL-1] 13 p0113 N77-13525
Inventory of energy research and development (1973 - 1975), volume 2
[GPO-64-734-VOL-2] 13 p0113 N77-13526
Inventory of energy research and development (1973 - 1975), volume 3
[GPO-64-734-VOL-3] 13 p0113 N77-13527
Inventory of energy research and development (1973 - 1975), volume 4
[GPO-64-734-VOL-4] 13 p0113 N77-13528
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533
Final assessment of the environmental impacts of the State Energy Conservation Program (Public law 94-163, Title III, part C, The Energy Policy and Conservation Act)
[PB-256044/9] 13 p0116 N77-13555
Some cost, energy, environmental, and resource implications of synthetic fuels produced from coal for military aircraft
[AD-A026667] 13 p0118 N77-14271
Inventory of energy research and development (1973 - 1975), volume 5
[GPO-64-734] 13 p0121 N77-14579
Industrial process heat from shallow solar ponds
[UCRL-77801] 13 p0124 N77-14611
Participating surveillance services for electric power program. Coal conversion and utilization: Direct combustion of coal-90e, advanced power-90f. Summary for ERDA annual report, CY 1975
[FE-1236-4] 13 p0130 N77-15507
Rapid growth from energy projects: Ideas for state and local action. A program guide
[PB-257374/9] 13 p0132 N77-15527
Nuclear unit productivity analysis
[PB-257553/8] 13 p0132 N77-15528

ENERGY REQUIREMENTS

Energy use in industry
13 p0005 A77-11029
Energy and the coal industry
13 p0005 A77-11030
Energy and the oil industry
13 p0005 A77-11031
Energy and the gas industry
13 p0005 A77-11032
Energy and the developing countries
13 p0006 A77-11043
Methods of energy analysis
13 p0007 A77-11046
Energy analysis in modelling
13 p0007 A77-11047
The overcoming of energy deficiencies with the aid of wind power
13 p0008 A77-11174
The wind and its effect on the heating requirements
13 p0009 A77-11266
Energy in the household - Comparison of heating costs and prognosis concerning the consumption of energy until 1985
13 p0015 A77-12059
A methodical approach concerning energy supply problems
13 p0016 A77-12062
The long-range prospects for solar energy
13 p0017 A77-12237
Load leveling with electric vehicles in the urban environment
13 p0024 A77-12701
Modeling residential energy use
13 p0027 A77-12726
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements
13 p0028 A77-12735
Economic and engineering implications of the Project Independence 1985 geothermal energy output goal and the associated sensitivity analysis
13 p0029 A77-12745
Benefits of hydrogen production research
13 p0032 A77-12768
Power source requirements of electric propulsion systems used for north-south stationkeeping of communication satellites
13 p0040 A77-12833
Energy and environment post-2000
13 p0050 A77-14560
Perspectives for world energy production
13 p0056 A77-16202
Electric power supply in the case of airports. I
13 p0061 A77-16742
The future importance of solar energy for the supply of the German Federal Republic with energy
13 p0070 A77-18597
Hydel and solar power for Pakistan --- hydroelectric power
13 p0079 A77-19121

The contribution of nuclear technology toward the solution of energy problems
[INIS-MF-1867] 13 p0100 N77-11565
California energy outlook
[UCRL-5196-REV-1] 13 p0106 N77-12525
Review of energy forecasting methodologies and assumptions
[PB-255170/3] 13 p0107 N77-12526
Net energy from nuclear power
[PB-254059/9] 13 p0107 N77-12527
Hydrodynamic equilibrium conditions for AG(EH) main strut-pod foil system using flap incidence control
[AD-A027521] 13 p0127 N77-15220
Economic analysis of the need for advanced power sources
[HEDL-SA-989] 13 p0131 N77-15509

ENERGY SOURCES
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
Energy from solid wastes --- Book
13 p0003 A77-10698
Environmental aspects of energy conversion and use
13 p0006 A77-11044
The availability of fuels for power plants
13 p0010 A77-11316
Primary energy sources for hydrogen production
13 p0011 A77-11335
Electricity and heat production - Energy efficiency versus cost efficiency
13 p0011 A77-11338
The solution of the garbage problem: New proposals for the utilization of refuse - Proposals and suggestions --- materials recycling and energy production facilities
13 p0015 A77-12061
Photosynthesis as a resource for energy and materials
13 p0017 A77-12233
The shaping of our needs in mineral raw materials and sources for meeting those needs --- Hungarian survey
13 p0017 A77-12246
The significance of coal in the future energy picture
13 p0018 A77-12247
Diversification as an energy conservation strategy
13 p0027 A77-12725
Geothermal studies in northern Nevada
13 p0029 A77-12742
NASA thermionic-conversion program
13 p0043 A77-12863
Wind-power generation on a large scale - A design idea
13 p0050 A77-14531
Energy: Conversion and utilization --- Book
13 p0052 A77-14957
Energy research for physicists
13 p0054 A77-15350
Perspectives for world energy production
13 p0056 A77-16202
Nova Scotia seeks to cut oil bill for power generation
13 p0063 A77-17588
Geothermal energy in Saudi Arabia and its use in connection with solar energy
13 p0079 A77-19122
The long-run marginal costs of energy
[PB-252504/6] 13 p0085 N77-10625
Creating energy choices for the future
[CONF-751228-P1] 13 p0087 N77-10647
ERDA energy information data base: Magnetic tape description
[TID-4581-R3] 13 p0102 N77-11695
Crude oil supply alternatives for the Northern Tier states
[PB-255991/2] 13 p0107 N77-12530
Implementing coal utilization provisions of Energy Supply and Environmental Coordination Act
[PB-255855/9] 13 p0109 N77-12549
Inventory of energy research and development (1973 - 1975), volume 1
[GPO-64-734-VOL-1] 13 p0113 N77-13525
Inventory of energy research and development (1973 - 1975), volume 4
[GPO-64-734-VOL-4] 13 p0113 N77-13528

ENERGY STORAGE
Superflywheel energy storage and nonsynchronous AC/DC/AC electric transmission supplements power system operation
13 p0002 A77-10638
Energy storage --- quality, duration, methods and forms
13 p0006 A77-11040
Compressed air energy storage - A near term option for utility application
13 p0027 A77-12727
Underground storage of off-peak power
13 p0027 A77-12728
Storage in oil of off-peak thermal energy from large power stations
13 p0027 A77-12730
Thermal energy storage for solar power plants
13 p0027 A77-12731
Seasonal storage of thermal energy in water in the underground --- reservoirs
13 p0028 A77-12734
VBP heat pipes for energy storage --- Vapor Bubble Pumping
13 p0032 A77-12767
Energy storage via calcium hydride production
13 p0032 A77-12774
Metal hydrides of improved heat transfer characteristics
13 p0033 A77-12775
Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage
13 p0033 A77-12777
Survey of hydrogen energy application projects
13 p0033 A77-12778
Performance and cost analysis of photovoltaic power systems for on-site residential applications
13 p0038 A77-12816
A new hydrogen storage electrode
13 p0047 A77-13539
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543
An alternative fuel for cars --- hydrogen production and storage
13 p0050 A77-14530
High-speed flywheels as possible energy storage devices in the future
13 p0056 A77-15856
Thermal energy storage for heating and air conditioning
13 p0057 A77-16206
The storage of energy in future energy supply systems
[DGLR PAPER 76-182] 13 p0059 A77-16533
Energy storage in orbital and interplanetary missions
[DGLR PAPER 76-189] 13 p0059 A77-16551
Electric arc power collection for high-speed trains
13 p0060 A77-16594
The influence of subsurface energy storage on seasonal temperature variations
13 p0067 A77-18351
Solar production of hydrogen as a means of storing solar energy
13 p0075 A77-19072
On the storage of solhydrogen
13 p0075 A77-19073
Storage of solar energy in the form of potential hydraulic energy
13 p0075 A77-19078
Survey of high temperature thermal energy storage
[SAND-75-8063] 13 p0088 N77-10655
Underground pumped storage research priorities
[PB-254413/8] 13 p0089 N77-10667
Planning models for the assessment of advanced energy storage systems
13 p0105 N77-12504
Economic and technical feasibility study of compressed air storage
[COO-2559-1] 13 p0122 N77-14593
Increased fuel economy in transportation systems by use of energy management - second year's program
[PB-257177/6] 13 p0133 N77-15930

ENERGY TECHNOLOGY
The options for using the sun
13 p0001 A77-10318

Satellite power systems for large-scale power generation
[IAF PAPER 76-118] 13 p0003 A77-10914
Energy and the coal industry
13 p0005 A77-11030
Energy and the oil industry
13 p0005 A77-11031
Energy and the gas industry
13 p0005 A77-11032
Fusion power --- nuclear energy technology development
13 p0005 A77-11034
Geothermal energy --- conversion technology development
13 p0005 A77-11035
The atmosphere and the oceans as energy sources
13 p0005 A77-11036
Solar energy --- conversion technology assessment
13 p0006 A77-11037
Energy from wastes
13 p0006 A77-11038
Large-scale electrical power generation and storage
13 p0006 A77-11039
Energy storage --- quality, duration, methods and forms
13 p0006 A77-11040
The hydrogen economy --- production and applications
13 p0006 A77-11041
Total energy systems --- electric power generation with heat recovery
13 p0006 A77-11042
Energy and the developing countries
13 p0006 A77-11043
Methods of energy analysis
13 p0007 A77-11046
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108
The overcoming of energy deficiencies with the aid of wind power
13 p0008 A77-11174
Energy: Mathematics and models; Proceedings of the Conference, Alta, Utah, July 7-11, 1975
13 p0008 A77-11233
Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology
13 p0008 A77-11241
Plastics for solar-energy collectors. I - General aspects, hot-water collectors, design variants
13 p0009 A77-11267
Plastics for solar-energy collectors. II - Typical operational data and model parameters, functional diagrams, optimization of layer thicknesses
13 p0009 A77-11269
Energy: A radical redirection
13 p0010 A77-11275
Dutchess County, NY moves towards pyrolysis --- of solid wastes with fuel recovery
13 p0010 A77-11298
Estimating wind power feasibility
13 p0010 A77-11315
Submarine geothermal resources
13 p0010 A77-11322
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
Primary energy sources for hydrogen production
13 p0011 A77-11335
The world's oil resources. V - Recovery rates
13 p0012 A77-11343
Problems involved in improving the industrial fuel and energy balance
13 p0012 A77-11347
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497
Locating interesting geothermal areas in the Tuscany region /Italy/ by geochemical and isotopic methods
13 p0013 A77-11498
Prospects for solar energy utilization in Iran - Photothermal methods
13 p0013 A77-11532
Energy recovery from saline water by means of electrochemical cells
13 p0013 A77-11536
Microwave transmission system for space power
13 p0014 A77-11818

Design principles for solar and wind power installations
13 p0015 A77-11922
Optimization criteria for solar and wind power systems
13 p0015 A77-11923
Coming - Solar power plants
13 p0016 A77-12125
Nuclear power - Compared to what --- energy alternatives for electric power generation
13 p0017 A77-12234
Synthetic fuels - Prices, prospects, and prior art
13 p0017 A77-12236
The long-range prospects for solar energy
13 p0017 A77-12237
The long-range prospects for solar-derived fuels
13 p0017 A77-12240
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
Developments in solar energy utilisation in the United Kingdom
13 p0018 A77-12402
The solar water heater industry in South Florida - History and projections
13 p0018 A77-12403
A cylindrical blackbody solar energy receiver
13 p0018 A77-12404
Solar water pump for lift irrigation
13 p0019 A77-12406
Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings. Volumes 1 & 2
13 p0020 A77-12662
The fuel efficiency potential of a flywheel hybrid vehicle for urban driving
13 p0020 A77-12664
The Osmotic power plant
13 p0021 A77-12668
An energy center in Sri Lanka --- UN rural energy development program
13 p0021 A77-12669
Comparative economics for the Arthur D. Little extractive coking process --- coal liquefaction
13 p0022 A77-12684
Solids gasification for gas turbine fuel 100 and 300 Btu gas
13 p0022 A77-12685
Recovery of inaccessible coal reserves by in situ gasification
13 p0022 A77-12686
Low-Btu gasification of coal by Atomics International's molten salt process
13 p0023 A77-12687
Design of a 100 BPD pilot plant to convert methanol to gasoline using the Mobil process
13 p0023 A77-12691
Hydrocarbon fuels from oil shale
13 p0023 A77-12692
In situ combustion of Michigan oil shale - Current field studies
13 p0024 A77-12695
Retorting of single oil shale blocks with nitrogen and air
13 p0024 A77-12696
Application of a shunt motor and a 2 cylinder gasoline engine as a hybrid drive for an automobile
13 p0025 A77-12703
Baseline test data for the EVA electric vehicle --- low energy consumption automobiles
13 p0025 A77-12704
Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells
13 p0025 A77-12713
Development status of lithium-silicon-iron sulfide load-leveling batteries
13 p0026 A77-12714
Sodium/sulphur battery development in the United Kingdom
13 p0026 A77-12717
Storage in oil of off-peak thermal energy from large power stations
13 p0027 A77-12730
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732

Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations
13 p0028 A77-12736
Design analyses of a methane-based chemical heat pipe
13 p0028 A77-12737
Thermochemical energy storage systems
13 p0028 A77-12738
An evaluation of the use of metal hydrides for solar thermal energy storage
13 p0028 A77-12739
Geothermal energy in Hawaii - Hydrothermal systems
13 p0029 A77-12741
Geothermal powered heat pumps to produce process heat
13 p0030 A77-12754
Direct applications of geothermal energy
13 p0030 A77-12755
The utilization and economics of low temperature geothermal water for space heating
13 p0030 A77-12756
Extracting energy from hydraulically-fractured geothermal reservoirs
13 p0030 A77-12757
The use of program GEOTHM to design and optimize geothermal power cycles
13 p0031 A77-12758
The potential national benefits of geothermal electrical energy production from hydrothermal resources in the West
13 p0031 A77-12760
Prerequisites for military/civilian geopressured geothermal resource development
13 p0031 A77-12761
An engineering feasibility study of using low temperature geothermal sources in Colorado
13 p0031 A77-12762
The potential of the heat pipe in coal gasification processes
13 p0031 A77-12763
Benefits of hydrogen production research
13 p0032 A77-12768
The commercial production of hydrogen by the K-T process
13 p0032 A77-12769
Hydrogen separation and compression through hydride formation and dissociation by low-level heat
13 p0032 A77-12770
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
MHD power generation - 1976 Status Report --- coal-fired design
13 p0033 A77-12782
System studies of coal fired-closed cycle MHD for central station power plants
13 p0034 A77-12786
Nuclear power for the production of synthetic fuels and feedstocks
13 p0035 A77-12790
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791
Current status of the magnetic fusion program
13 p0035 A77-12792
PACER - A practical fusion power concept
13 p0035 A77-12793
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
Radiolytic hydrogen production from a laser fusion system
13 p0035 A77-12795
Isotope heat source for dynamic power systems
13 p0036 A77-12796
Heat pipe nuclear reactor for space power
13 p0036 A77-12797
Solar powered organic Rankine cycle engines - Characteristics and costs
13 p0036 A77-12798
A unique Rankine-cycle heat pump system
13 p0036 A77-12799
Solar energy prospects for electric power generation in Brazil
13 p0037 A77-12805
The role of simulation in the development of solar-thermal energy conversion systems
13 p0037 A77-12809
Collector field optimization for a solar thermal electric power plant
13 p0038 A77-12811
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
A fixed collector employing reversible vee-trough concentrator and a vacuum tube receiver for high temperature solar energy systems
13 p0038 A77-12813
Alternative strategies for implementing silicon-ribbon technology for photovoltaic applications
13 p0039 A77-12819
Experimental evaluation of the University of Florida solar powered ammonia/water absorption air conditioning system
13 p0039 A77-12823
Transportation options for solar power satellites
13 p0040 A77-12829
ERDA's Bicentennial Thermionic Research and Technology Program
13 p0042 A77-12861
NASA thermionic-conversion program
13 p0043 A77-12863
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
Vortex kinetic energy concentrator
13 p0044 A77-12870
Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines
13 p0044 A77-12871
Design consideration for the Darrieus rotor --- wind turbines
13 p0044 A77-12872
Operational experience with small wind units
13 p0044 A77-12873
An experimental 200 kW vertical axis wind turbine for the Magdalen Islands
13 p0044 A77-12874
Underground gasification of coal: A National Coal Board reappraisal. 1976 --- Book
13 p0044 A77-12926
An advanced energy conservation technology program; Proceedings of the Intersociety Workshop Conference, Airlie House, Va., March 24-26, 1976
13 p0045 A77-12928
MHD - Energy transformation by burning coal
13 p0045 A77-12940
The U-240 cyclotron --- review of systems and processes
13 p0046 A77-13151
Dependability of wind energy generators with short-term energy storage
13 p0046 A77-13323
A hydride compressor
13 p0046 A77-13336
Life-cycle costs and solar energy
13 p0047 A77-13501
Optimizing solar cooling systems
13 p0047 A77-13502
Atlanta /Towns/ solar experiment - The lessons we learned
13 p0047 A77-13503
Feasibility of a satellite solar power station /SSPS/
13 p0047 A77-13504
Evaluating a solar energy concentrator
13 p0047 A77-13505
The Shenandoah Community Center - A total solar design concept
13 p0047 A77-13506
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Windmills stage a comeback --- review
13 p0048 A77-13624
Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
13 p0049 A77-13728

Some material considerations involved in the application of solar energy to electric power generation
13 p0049 A77-13739
Energy and environment post-2000
13 p0050 A77-14560
Energy consumption in various modes of transportation
13 p0050 A77-14561
Characteristics of a system for transmitting concentrated solar radiation
13 p0051 A77-14578
Energetic calculation of the concentrating capacity of paraboloidal facets
13 p0051 A77-14579
Calculation of the radiation entering a 'hot box' type solar set-up
13 p0051 A77-14581
Scientific-technological problems of the development of a fuel-energy complex in the USSR
13 p0051 A77-14703
Satellite solar power stations and energy relay satellites
13 p0052 A77-14901
Energy: Conversion and utilization --- Book
13 p0052 A77-14957
Can Canada harness the wind
13 p0053 A77-15047
Utilization of solar power - A new departure
13 p0053 A77-15049
Energy research for physicists
13 p0054 A77-15350
The potential for application of energy storage capacity on electric utility systems in the United States. I
13 p0054 A77-15625
Cost aspects of solar energy - Selective and critical bibliography
13 p0054 A77-15799
Studies and thoughts on nuclear reactor systems
13 p0055 A77-15800
Geothermal sources and their utilization
13 p0055 A77-15803
Energy research in the UK
13 p0055 A77-15812
Geothermal power - The 'sleeper' in the energy race
13 p0056 A77-15845
Water power in the immediate future
13 p0056 A77-15850
Possibilities for utilizing wind energy
13 p0056 A77-15853
Space solar power - An available energy source
13 p0056 A77-15946
Future energy production systems: Heat and mass transfer processes. Volume 1 --- Book
13 p0056 A77-16201
Heat and mass transfer for solar energy utilization
13 p0057 A77-16205
Hydrogen production using nuclear heat
13 p0057 A77-16211
Combined cycles and refined coal --- gasification plant using high temperature gas turbines
13 p0058 A77-16249
New England wind power...coastal or mountain
13 p0058 A77-16250
The prospect for fusion --- controlled nuclear fusion
13 p0058 A77-16357
Hydrogen production from water by means of chemical cycles
13 p0058 A77-16471
The storage of energy in future energy supply systems
[DGLR PAPER 76-182] 13 p0059 A77-16533
Windmills change direction --- British system utilizing offshore windmills and depleted North Sea fields
13 p0060 A77-16620
Potentialities and limitations of the utilization of wind machines
13 p0061 A77-16787
Superalloys for advanced energy systems
13 p0061 A77-16824
Energy and environmental considerations in extending heat pump applications
13 p0062 A77-17058
Homeowner's guide to solar heating and cooling --- Book
13 p0062 A77-17525
Fossil energy research and development in ERDA
13 p0063 A77-17551
Problems of energy storage in solar power stations
13 p0063 A77-17555
Application of solar energy in the high-temperature range
13 p0063 A77-17636
Geothermal energy development
13 p0064 A77-17801
Increase in the efficiency of heat and power systems using large artificial accumulators of heat
13 p0064 A77-17939
Alkali metal space power technology applicable to national energy research and development
[AIAA PAPER 77-289] 13 p0065 A77-18223
Solar power satellites - Opportunity and challenge
[AIAA PAPER 77-291] 13 p0065 A77-18224
The application of aerospace technology to solar thermal electric power generation
[AIAA PAPER 77-294] 13 p0065 A77-18226
OTEC - Aerospace and ocean engineering in partnership --- Ocean Thermal Energy Conversion
[AIAA PAPER 77-296] 13 p0066 A77-18227
Gas turbine electric powerplants
[AIAA PAPER 77-346] 13 p0066 A77-18254
Perspectives on Satellite Solar Power
[AIAA PAPER 77-352] 13 p0066 A77-18257
Parametric studies of the thermal trap flat plate collector
13 p0068 A77-18443
Overview of the ERDA fusion power program
13 p0068 A77-18446
Coal liquefaction with soluble transition-metal complexes
13 p0070 A77-18584
The future importance of solar energy for the supply of the German Federal Republic with energy
13 p0070 A77-18597
A solar house with heat pipe collectors
13 p0070 A77-18598
Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volumes 1 & 2
13 p0072 A77-19043
Performance of an annular cylindrical solar collector
13 p0073 A77-19059
Solar water heater using hardened black polythene pipe absorbers
13 p0073 A77-19060
Solergy collector concept --- immobile reflective surface for solar collection using spiral concentrator
13 p0073 A77-19061
Double-reflection solar energy concentrators
13 p0074 A77-19067
Periodically adjustable concentrators adapted to solar cell panels
13 p0074 A77-19068
Stationary solar concentrators for industrial heating and cooling
13 p0074 A77-19069
Cylindrical mirror collector field
13 p0074 A77-19071
Solar production of hydrogen as a means of storing solar energy
13 p0075 A77-19072
Photovoltaic effect applications
13 p0075 A77-19080
Photovoltaic systems using sunlight concentration
13 p0076 A77-19089
Double-faced silicon solar cell system
13 p0076 A77-19090
Electric energy from atmospheric water vapor
13 p0077 A77-19097
The two enemies of industrial development of solar energy - Simplicity and economy
13 p0078 A77-19109
Heating a building by means of solar and electrical energy
13 p0078 A77-19113
New frontiers in solar and other energy options
13 p0079 A77-19118
Improved use of energy --- through waste and solar energy utilization
13 p0079 A77-19123

The role of solar energy in developing nations - The perspectives in Mali
13 p0080 A77-19125
Research at the EURATOM-CCR Center --- on solar energy
13 p0080 A77-19126
Solar energy in Switzerland
13 p0080 A77-19127
National petroleum product supply and demand, 1976 - 1978
[PB-254969/9] 13 p0084 N77-10224
Advances in engineering science, volume 3
[NASA-CP-2001-VOL-3] 13 p0084 N77-10305
Solar power arrays for the concentration of energy
[COO-2699-2] 13 p0087 N77-10651
Energy fact book 1975. Parts 1-5: Appendixes A-H
[AD-A023010] 13 p0089 N77-10664
Directory of Federal energy data sources: Computer products and recurring publications
[PB-254163/9] 13 p0093 N77-10941
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201
A basis for analyzing prospective power generation in terms of environmental management and energy use
13 p0096 N77-11526
Electric energy supply alternatives for New York. Phase 2: An appraisal of electrical energy alternatives available to the State of New York
[PB-249881/4] 13 p0101 N77-11575
Inventory of energy research and development (1973 - 1975), volume 1
[GPO-64-734-VOL-1] 13 p0113 N77-13525
Inventory of energy research and development (1973 - 1975), volume 2
[GPO-64-734-VOL-2] 13 p0113 N77-13526
Inventory of energy research and development (1973 - 1975), volume 3
[GPO-64-734-VOL-3] 13 p0113 N77-13527
Inventory of energy research and development (1973 - 1975), volume 4
[GPO-64-734-VOL-4] 13 p0113 N77-13528
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556
Solar cell array design handbook, volume 1
[NASA-CR-149364] 13 p0118 N77-14193
Solar cell array design handbook, volume 2
[NASA-CR-149365] 13 p0118 N77-14194
Explaining energy: A manual of non-style for the energy outsider who wants in
[LBL-4458] 13 p0122 N77-14592

ENERGY TRANSFER
Geothermal energy --- conversion technology development
13 p0005 A77-11035
Energy and Physics: General Conference of the European Physical Society
[AD-A026962] 13 p0131 N77-15511

ENGINE COOLANTS
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665

ENGINE DESIGN
Equation solution accuracy in calculating jet engine characteristics
13 p0020 A77-12502
Heat-pipe regenerator for gas turbine engine
13 p0020 A77-12528
A conceptual design study of closed Brayton cycle gas turbines for fusion power generation
13 p0022 A77-12676
Comparison of geothermal power conversion cycles
13 p0030 A77-12750
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines
13 p0033 A77-12779
Performance of a hydrogen-powered transit vehicle
13 p0033 A77-12781
The Stirling engine - Engineering considerations in view of future needs
13 p0041 A77-12842
Self-starting, intrinsically controlled Stirling engine
13 p0041 A77-12844
Evolution of the concept of the automobile from the standpoint of saving energy
13 p0051 A77-14562
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up --- utilizing Stirling engine
13 p0051 A77-14580
Application of simulation studies to the design and improvement of fuel control systems for aviation turbine engines
13 p0054 A77-15798
Pressure ratio optimization criteria in aircraft turbojet-engines design
13 p0062 A77-17258
Variable geometry for high performance aircraft engines
13 p0062 A77-17264
Theoretical aspects of optimization of aviation gas turbine engine design variables
13 p0063 A77-17762
Analysis of parameters and characteristics of a bypass turbojet engine operating in a cycle with stepwise heat removal
13 p0063 A77-17765
Hydrogen as a fuel in compression ignition engines
13 p0071 A77-18932

ENGINE PARTS
High-temperature ceramics for automobile gas turbines. II
13 p0063 A77-17591
High temperature gas turbine engine component materials testing program
[PE-1765-7] 13 p0127 N77-15401

ENGINE TESTS
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
Noise mechanism separation and design considerations for low tip-speed, axial-flow fans
13 p0046 A77-13339
Performance characteristics of a diesel engine using low- and medium-energy gases as a fuel supplement (fumigation)
[NASA-TM-X-58188] 13 p0126 N77-14955

ENGINEERING
Advances in engineering science, volume 3
[NASA-CP-2001-VOL-3] 13 p0084 N77-10305

ENTRAINMENT
Investigation of performance limits in axial groove heat pipes
[NASA-CR-137912] 13 p0095 N77-11340

ENVIRONMENT EFFECTS
Studies and thoughts on nuclear reactor systems
13 p0055 A77-15800
Environment and energy production after the year 2000
13 p0056 A77-16203
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295
Relative hazard of nuclear power stations and fossil-fuel power stations to the environment
13 p0067 A77-18323
Energy and environmental impacts of materials alternatives - An assessment of quantitative understanding
13 p0070 A77-18738
Fuels and fuel additives for highway vehicles and their combustion products. Guide to evaluation of their potential effects on health
[PB-254088/8] 13 p0084 N77-10222
Summary of EPA energy policy analysis
[PB-253361/0] 13 p0089 N77-10669
Final assessment of the environmental impacts of the State Energy Conservation Program (Public law 94-163, Title III, part C, The Energy Policy and Conservation Act)
[PB-256044/9] 13 p0116 N77-13555
Overview of the Imperial Valley environmental project
[UCID-17067] 13 p0132 N77-15533

ENVIRONMENT MANAGEMENT
Controlled tipping of combustion residues
13 p0008 A77-11175
The exploration, development, and production of Naval Petroleum Reserve Number 4
[PB-255947/4] 13 p0124 N77-14610

ENVIRONMENT MODELS
General Motors Sulfate Dispersion Experiment - Assessment of the EPA HIWAY model
13 p0071 A77-18882

Advances in engineering science, volume 3
[NASA-CP-2001-VOL-3] 13 p0084 N77-10305
ENVIRONMENT POLLUTION
Environmental aspects of energy conversion and use
13 p0006 A77-11049
Energy and environment post-2000
13 p0050 A77-14560
Tracking pollutants from a distance
13 p0067 A77-18370
ENVIRONMENT PROTECTION
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
Clean air protection and industrial development
13 p0010 A77-11303
The conservation of air purity and its effect on the energy economy
13 p0049 A77-13811
Draft environmental assessment of application by ERDA for a special land use permit for use of public lands in Wyoming for in situ coal gasification experiments
[UCID-17011] 13 p0100 N77-11572
Environmental impact studies related to undergroupd coal gasification
[TID-27003] 13 p0100 N77-11573
Research to anticipate environmental impacts of changing resource usage
[PB-256293/2] 13 p0101 N77-11602
ENVIRONMENTAL ENGINEERING
Environmentally designed housing incorporating solar energy
13 p0079 A77-19115
Solar heating projects at the Institute for Environmental Research --- in Austria
13 p0079 A77-19119
Waste heat vs conventional systems for greenhouse environmental control: An economic assessment
[ORNL/TM-5069] 13 p0088 N77-10656
ENVIRONMENTAL MONITORING
Utilization of remote sensing techniques to detect land use effects on wildland water quality
13 p0071 A77-18984
Methods in environmental sampling for radionuclides
[UCRL-77722] 13 p0091 N77-10697
Coal gasification commercial concepts: Gas cost guidelines
[FE-1235-1] 13 p0130 N77-15500
ENVIRONMENTAL QUALITY
Overview of the Imperial Valley environmental project
[UCID-17067] 13 p0132 N77-15533
ENVIRONMENTAL SURVEYS
Baseline energy forecasts and analysis of alternative strategies for airline fuel conservation
[PB-255351/9] 13 p0091 N77-10690
Identification and analysis of mid-Atlantic onshore OCS impact
[PB-254925/1] 13 p0096 N77-11516
Strategic petroleum reserve
[PB-255476/4] 13 p0098 N77-11546
Crude supply alternatives for the Northern Tier states. Volume 1: Executive summary
[PB-255992/0] 13 p0107 N77-12531
Crude supply alternatives for the Northern Tier states. Volume 2: Technical report
[PB-255993/8] 13 p0107 N77-12532
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534
Outlook for research and development in the underground gasification of coal
[PB-256155/3] 13 p0109 N77-12555
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597
Second Environmental Aspects of Fuel Conversion Technology Symposium
[PB-257182/6] 13 p0125 N77-14645
EPITAXY
Schottky solar cells on thin epitaxial silicon
13 p0047 A77-13509
Analysis of epitaxial drift field N on P silicon solar cells
[NASA-TM-X-73563] 13 p0106 N77-12523
EPOXY RESINS
Encapsulation of solar cell modules
13 p0076 A77-19092
EQUIPMENT SPECIFICATIONS
Tests of oil recovery devices in broken ice fields, phase 2
[AD-A025748] 13 p0110 N77-12572
Development of thermal control methods for specialized components and scientific instruments at very low temperatures (follow-on)
[NASA-CR-150152] 13 p0127 N77-15347
EROSION
Diffuse thermal model of electrode erosion for MHD generators
13 p0049 A77-14319
ETCHING
On black solar cells or the tetrahedral texturing of a silicon surface
13 p0004 A77-11000
EVAPORATION
Evaporation of solution droplets in a high-temperature medium --- potassium carbonate MHD flow properties
13 p0046 A77-13254
EVAPORATIVE COOLING
The problem of use of solar energy specific features of radiative, heat, and mass transfer in solar installations
13 p0057 A77-16204
EXHAUST GASES
General Motors Sulfate Dispersion Experiment - Assessment of the EPA HIWAY model
13 p0071 A77-18882
Protocol to characterize gaseous emissions as a function of fuel and additive composition
[PB-253363/6] 13 p0084 N77-10221
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715
Reduction of gaseous pollutant emissions from gas turbine combustors using hydrogen-enriched jet fuel
[NASA-CR-149146] 13 p0094 N77-11198
An evaluation of high altitude engine modification devices (econo-kit)
[PB-255556/3] 13 p0101 N77-11589
Investigation and assessment of light-duty-vehicle evaporative emission sources and control
[PB-255813/8] 13 p0102 N77-11603
Emissions and performance of catalysts for gas turbine catalytic combustors
[NASA-TM-X-73543] 13 p0104 N77-12406
The impact of JP-4/JP-8 conversion on aircraft engine exhaust emissions
[AD-A026546] 13 p0112 N77-13234
Pollutant potential of raw and chemically fixed hazardous industrial wastes and flue gas desulfurization sludges
[PB-256691/7] 13 p0133 N77-15540
Cooperative study of heavy duty diesel emission measurement methods
[PB-257137/0] 13 p0133 N77-15541
EXOTHERMIC REACTIONS
Differential scanning calorimetry studies on coal. II - Hydrogenation of coals
13 p0070 A77-18583
EXPLORER 50 SATELLITE
Results from the IMP-J violet solar cell experiment and violet cell balloon flights
[NASA-TN-D-8393] 13 p0128 N77-15491
EXTERNAL COMBUSTION ENGINES
Alternate fuel capability of Rankine cycle engines
13 p0036 A77-12801
EXTRATERRESTRIAL MATTER
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890

F

FABRICATION
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells
13 p0025 A77-12713

Alternative strategies for implementing silicon-ribbon technology for photovoltaic applications
13 p0039 A77-12819
Design and fabrication of solar concentrators
13 p0074 A77-19062
Deposition of polycrystalline silicon solar cells
13 p0076 A77-19082
Double-faced silicon solar cell system
13 p0076 A77-19090
Testing and fabrication of solar absorbers for the D5A' satellite
[CNES-NT-37] 13 p0111 N77-13110

FAIL-SAFE SYSTEMS
Emergency power plant of rapid availability for the Berlin-Tegel airport
13 p0001 A77-10324
Electric power supply in the case of airports. I
13 p0061 A77-16742

FAR ULTRAVIOLET RADIATION
Energetics of the midlatitude thermosphere
13 p0012 A77-11492

FARM CROPS
A fermentation process for converting plant materials into methane
13 p0121 N77-14583

FAST NUCLEAR REACTORS
Heat pipe nuclear reactor for space power
13 p0036 A77-12797

FEASIBILITY ANALYSIS
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673
An engineering feasibility study of using low temperature geothermal sources in Colorado
13 p0031 A77-12762
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
Feasibility of a satellite solar power station /SSPS/
13 p0047 A77-13504
Solar power satellites - Opportunity and challenge
[AIAA PAPER 77-291] 13 p0065 A77-18224
Study of the feasibility of federal procurement of fuels produced from solid wastes
[PB-255695/9] 13 p0096 N77-11513
The feasibility of solar energy usage on Red River Army Depot
[AD-A025119] 13 p0108 N77-12535
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606

FEDERAL BUDGETS
Analysis of fiscal year 1977 DOT program by policy and RD and D management objectives. Program levels for fiscal years 1975, 1976, 1977, volume 1
[PB-255401/2] 13 p0117 N77-13922

FEEDBACK CONTROL
The intersectoral feedback model
[PB-255859/1] 13 p0125 N77-14950

FERMENTATION
Energy from wastes
13 p0006 A77-11038
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673
A fermentation process for converting plant materials into methane
13 p0121 N77-14583

FIBERS
Computer program grade 2 for the design and analysis of heat-pipe wicks
[NASA-CR-137954] 13 p0118 N77-14375

FILTRATION
A laboratory evaluation of precoat filtration parameters for the solvent refined coal process
13 p0059 A77-16474

FINITE DIFFERENCE THEORY
A two-dimensional finite difference solution for the transient thermal behavior of tubular solar collector
13 p0083 N77-10105

FIRE PREVENTION
Risk management of liquefied natural gas installations
13 p0002 A77-10451
Report of the Army Scientific Advisory Panel Ad Hoc Group on fire-safe fuels
[AD-A023763] 13 p0095 N77-11208

FISHES
JP-4 and JP-9 fuel toxicity studies using water fish and aufwuchs
[AD-A027594] 13 p0127 N77-15213

FISSION PRODUCTS
The reprocessing of nuclear fuels
13 p0055 A77-15807

FLAMMABLE GASES
Ignition of flammable gases in crude-oil tankers as a result of metal fracture
[AD-A027411] 13 p0127 N77-15121

FLAT PLATES
Parametric studies of the thermal trap flat plate collector
13 p0068 A77-18443
Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials
13 p0068 A77-18444
Axial conduction in a flat-plate solar collector
13 p0068 A77-18447
Arrays of fixed flat-plate solar energy collectors - Performance comparisons for differing individual component orientations
13 p0068 A77-18449
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
Procedure for characterizing flat plate solar collectors
13 p0073 A77-19056
Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity
13 p0073 A77-19057
Termosole flat plate collectors
13 p0073 A77-19058
Evaluation of flat-plate collector efficiency under controlled conditions in a solar simulator
[NASA-TM-X-73520] 13 p0097 N77-11530
Flat-plate solar collector handbook. A survey of principles, technical data and evaluation results
[UCID-17086] 13 p0105 N77-12506
Standardized performance tests of collectors of solar thermal energy - A flat-plate copper collector with parallel mylar striping
[NASA-TM-X-73553] 13 p0114 N77-13535
Standardized performance tests of collectors of solar thermal energy: An evacuated flatplate copper collector with a serpentine flow distribution
[NASA-TM-X-73415] 13 p0114 N77-13536

FLAT SURFACES
Standard-size facets for the reflecting surface of a solar concentrator
13 p0063 A77-17557

FLIGHT CHARACTERISTICS
A simplified method in flight test techniques for the determination of the range performance of jet aircraft
13 p0060 A77-16600

FLIGHT CONDITIONS
Best-range flight conditions for cruise-climb flight of a jet aircraft
13 p0085 N77-10379

FLIGHT OPTIMIZATION
Energy storage in orbital and interplanetary missions
[DGLR PAPER 76-189] 13 p0059 A77-16551

FLIGHT TESTS
Flight results of a cryogenic cooler designed for Meteosat
[IAF PAPER 76-210] 13 p0003 A77-10942
Concorde - Endurance flights results
13 p0016 A77-12114
Hypersonic technology-approach to an expanded program
13 p0051 A77-14597
Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575

A simplified method in flight test techniques for the determination of the range performance of jet aircraft
13 p0060 A77-16600
FLOW CHARACTERISTICS
Influence of various losses on the characteristics of high-power MHD generators
13 p0046 A77-13258
FLOW RESISTANCE
Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide
13 p0058 A77-16213
FLOW VELOCITY
The influence of the Reynolds number on the profiles of velocity and concentration in free jets of different density
13 p0069 A77-18500
FLUES
Field test sampling/analytical strategies and implementation cost estimates: Coal gasification and flue gas desulfurization
[PB-254166/2] 13 p0101 N77-11581
FLUID FLOW
Transient behavior of solid sensible heat thermal storage units for solar energy systems
13 p0057 A77-16208
Monitoring fluid flow by using high-frequency electromagnetic probing
[UCRL-51979] 13 p0120 N77-14393
FLUIDIZED BED PROCESSORS
Hydrogen production by the steam-iron process
13 p0023 A77-12688
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689
Fluidized bed heat exchangers for geothermal applications
13 p0029 A77-12748
Heat pipes for fluid-bed gasification of coal - Metallurgical condition of heat pipes after tests in process environment
13 p0031 A77-12764
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
Superalloys for advanced energy systems
13 p0061 A77-16824
Computer modeling of coal gasification reactors
[FE-1770-4] 13 p0093 N77-10812
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506
FLYWHEELS
Superflywheel energy storage and nonsynchronous AC/DC/AC electric transmission supplements power system operation
13 p0002 A77-10638
The fuel efficiency potential of a flywheel hybrid vehicle for urban driving
13 p0020 A77-12664
High-speed flywheels as possible energy storage devices in the future
13 p0056 A77-15856
Increased fuel economy in transportation systems by use of energy management: Second year's program. Executive summary
[PB-256117/3] 13 p0108 N77-12536
FORECASTING
The seat belt light is on --- airline industry economic assessment and forecasts
13 p0080 A77-19175
Future scenarios for urban transportation
[PB-255349/3] 13 p0102 N77-11930
Bonneville power administration electric energy conservation study
[PB-256766/7] 13 p0115 N77-13550
FOSSIL FUELS
Fossil energy research and development in ERDA
13 p0063 A77-17551
Relative hazard of nuclear power stations and fossil-fuel power stations to the environment
13 p0067 A77-18323
Minerals in the US economy: Ten-year supply-demand profiles for mineral and fuel commodities
[PB-252994/9] 13 p0085 N77-10624
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California
[PB-254449/2] 13 p0092 N77-10720
Strategic petroleum reserve
[PB-255476/4] 13 p0098 N77-11546
Meeting report: Advanced fossil fuels sector group
[PB-255117/4] 13 p0099 N77-11549
Fuel contaminants. Volume 1: Chemistry
[PB-256020/9] 13 p0103 N77-12231
Proceedings of the Mineral Economics Symposium: Winning the high stakes at the critical commodity game
[PB-255607/4] 13 p0105 N77-12502
Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630
FRACTIONATION
Fractionation and structural characterization of coal liquids
13 p0069 A77-18582
FRACTURE MECHANICS
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556
FRANCE
Characteristic aspects of the evolution of the French electric balance in 1975
13 p0012 A77-11340
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591
FREE JETS
The influence of the Reynolds number on the profiles of velocity and concentration in free jets of different density
13 p0069 A77-18500
FRENCH SATELLITES
Testing and fabrication of solar absorbers for the D5A' satellite
[CNES-NT-37] 13 p0111 N77-13110
FREON
Investigations of nonsteady-state processes at cryogenic heat pipe operation --- filled with ammonia and Freon-22
13 p0119 N77-14384
FREQUENCY MULTIPLIERS
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
FREQUENCY RESPONSE
Spectral response of a laterally illuminated p-n junction --- as photodetector or photovoltaic energy converter
13 p0062 A77-17478
FUEL CAPSULES
Advanced fuels for inertial confinement --- in laser fusion
13 p0061 A77-17016
FUEL CELLS
Energy conservation with advanced power generating systems
13 p0026 A77-12723
Fuel cells --- electrochemical energy conversion
13 p0055 A77-15804
Electric current from the direct conversion of low molecular weight C,H,O-compounds
13 p0055 A77-15814
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815
Fuel cell assemblies with an acidic electrolyte
13 p0055 A77-15816
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817
Research on electrochemical energy conversion systems
[AD-A023689] 13 p0090 N77-10681
Fuel cell stacks
[AD-A024216] 13 p0090 N77-10684

Evaluation of potassium titanate as a component of alkaline fuel cell matrices
[NASA-TN-D-8341] 13 p0094 N77-11175
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380
Solid Polymer Electrolyte (SPE) fuel cell technology, program review, phase 2
[NASA-CR-150957] 13 p0097 N77-11532
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529
Manufacturing and evaluation of phthalocyanines as catalysts for fuel cells
[BMFT-FB-T-76-25] 13 p0114 N77-13540
Hydraulic ram effect on composite fuel cell entry walls
[AD-A024832] 13 p0115 N77-13548
Carbon oxidation catalyst mechanism study for fuel cells
[PB-256420/1] 13 p0115 N77-13551
A study of the failure of joints in composite material fuel cells due to hydraulic ram loading
[AD-A027258] 13 p0117 N77-14016
National benefits associated with commercial application of fuel cell powerplants
[ERDA-76-54] 13 p0123 N77-14597
Aluminum-based anodes for underwater fuel cells: A phase report
[AD-A026405] 13 p0131 N77-15512
Surface research for development of new electrocatalysts for acid electrolyte fuel cells
[AD-A026053] 13 p0131 N77-15517
An improved electrolyte for direct oxidation fuel cells
[AD-A026164] 13 p0131 N77-15518

FUEL COMBUSTION

Sulphur pollution and emission charges
13 p0005 A77-11033
Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions
13 p0008 A77-11162
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
Proceedings of the Stationary Source Combustion Symposium. Volume 1. Fundamental research
[PB-256320/3] 13 p0116 N77-13569
Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570

FUEL CONSUMPTION

The fuel approach to control emissions from aircraft
[IAF PAPER 76-111] 13 p0003 A77-10911
Equation solution accuracy in calculating jet engine characteristics
13 p0020 A77-12502
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
Air transportation and fuel consumption
13 p0051 A77-14563
Scientific-technological problems of the development of a fuel-energy complex in the USSR
13 p0051 A77-14703
Fuel consumption of civil jet transport aircraft
13 p0062 A77-17234
Contribution of the heat carried by solar radiation to the thermal balance of a room during the cold season and its effect on domestic fuel consumption
13 p0063 A77-17558
Theoretical aspects of optimization of aviation gas turbine engine design variables
13 p0063 A77-17762
Analysis of parameters and characteristics of a bypass turbojet engine operating in a cycle with stepwise heat removal
13 p0063 A77-17765
Regulatory reform of air transportation
[AIAA PAPER 77-276] 13 p0065 A77-18215
National Emissions Data Systems (NEDS) fuel use report, 1973
[PB-253908/8] 13 p0083 N77-10220
A linear economic model of fuel and energy use in the United States. Volume 1: Model Description and results
[PB-252485/8] 13 p0088 N77-10662
Gasoline and distillate shortage situation: 1972-1976
[PB-253322/2] 13 p0089 N77-10670
Baseline energy forecasts and analysis of alternative strategies for airline fuel conservation
[PB-255351/9] 13 p0091 N77-10690
Optimizing the use of materials and energy in transportation construction
[PB-253713/2] 13 p0096 N77-11475
Societal implications of energy scarcity. Social and technological priorities in steady state and constricting systems
[PB-253097/0] 13 p0099 N77-11556
Energy use in the contract construction industry
[PB-245422/1] 13 p0099 N77-11557
Energy use in the contract construction industry. Appendix A: Study methodology
[PB-245423/9] 13 p0099 N77-11558
Energy use in the contract construction industry. Appendix B: Assessment of construction equipment availability, energy requirements, and construction industry capacity to support Project Independence
[PB-245424/7] 13 p0100 N77-11559
An evaluation of high altitude engine modification devices (econo-kit)
[PB-255556/3] 13 p0101 N77-11589
California energy outlook
[UCRL-5196-REV-1] 13 p0106 N77-12525
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534
Increased fuel economy in transportation systems by use of energy management: Second year's program. Executive summary
[PB-256117/3] 13 p0108 N77-12536
Historical fuels and energy consumption data, 1960 - 1972, United States by states and census districts east of the Mississippi
[PB-255176/0] 13 p0112 N77-13229
Historical fuels and energy consumption data, 1960 - 1972, United States by states and census districts west of the Mississippi
[PB-255177/8] 13 p0112 N77-13230
Hybrid drive with kinetic energy store as vehicle drive
[UCRL-TRANS-11018] 13 p0120 N77-14486
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137926] 13 p0126 N77-15007
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008
Study of unconventional aircraft engines designed for low energy consumption
[NASA-CR-135136] 13 p0127 N77-15043
Alternative fuels for aviation
[GPO-78-544] 13 p0127 N77-15212
Increased fuel economy in transportation systems by use of energy management - second year's program
[PB-257177/6] 13 p0133 N77-15930

FUEL CONTAMINATION

Fuel contaminants. Volume 1: Chemistry
[PB-256020/9] 13 p0103 N77-12231

FUEL CONTROL

Application of simulation studies to the design and improvement of fuel control systems for aviation turbine engines
13 p0054 A77-15798
Automotive gas turbine fuel control
[NASA-CASE-LEW-12785-1] 13 p0113 N77-13426

FUEL INJECTION

The performance of hydrogen-injected reciprocating engines
13 p0033 A77-12780

Bosch technical instruction. Gasoline injection D and L-jetronic
[NASA-TT-F-17111] 13 p0095 N77-11399
FUEL OILS
Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions 13 p0008 A77-11462
COSTEAM: Low-rank coal liquefaction - An updated analysis 13 p0045 A77-12934
Production of atmospheric nitrous oxide by combustion 13 p0061 A77-16922
Crude oil supply alternatives for the Northern Tier states
[PB-255991/2] 13 p0107 N77-12530
Performance of emission control devices on boilers firing municipal solid waste and oil
[PB-257136/2] 13 p0133 N77-15550
FUEL PUMPS
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements 13 p0028 A77-12735
FUEL SYSTEMS
Alternate fuel capability of Rankine cycle engines 13 p0036 A77-12801
Protocol to characterize gaseous emissions as a function of fuel and additive composition
[PB-253363/6] 13 p0084 N77-10221
FUEL TANKS
Liquid hydrogen as propellant for commercial aircraft
[DGLR PAPER 76-188] 13 p0059 A77-16534
Ignition of flammable gases in crude-oil tankers as a result of metal fracture
[AD-A027411] 13 p0127 N77-15121
FUEL-AIR RATIO
Burner design criteria for control of NOx from natural gas combustion. Volume 1: Data analysis and summary of conclusions
[PB-254167/0] 13 p0091 N77-10686
FUELS
Study of the feasibility of federal procurement of fuels produced from solid wastes
[PB-255695/9] 13 p0096 N77-11513
FUSION REACTORS
Fusion power --- nuclear energy technology development 13 p0005 A77-11034
Muon catalysed fusion for pellet ignition 13 p0012 A77-11468
Current status of the magnetic fusion program 13 p0035 A77-12792
PACER - A practical fusion power concept 13 p0035 A77-12793
The migma high energy advanced fuel direct conversion fusion power plant 13 p0035 A77-12794
Concept of a fusion burner 13 p0061 A77-17014
World survey of major facilities in controlled fusion research --- Book 13 p0067 A77-18264
Heat transfer problems associated with laser fusion 13 p0068 A77-18441

G

GARBAGE
The solution of the garbage problem: New proposals for the utilization of refuse - Proposals and suggestions --- materials recycling and energy production facilities 13 p0015 A77-12061
GAS ANALYSIS
Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer 13 p0062 A77-17541
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715
Cooperative study of heavy duty diesel emission measurement methods
[PB-257137/0] 13 p0133 N77-15541
GAS COMPOSITION
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597
GAS COOLED FAST REACTORS
Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide 13 p0058 A77-16213
GAS DETECTORS
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380
GAS DISSOCIATION
Hydrogen separation and compression through hydride formation and dissociation by low-level heat 13 p0032 A77-12770
Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide 13 p0058 A77-16213
Hydrogen production from water by means of chemical cycles 13 p0058 A77-16471
GAS EVOLUTION
Gas release during long-term operation of heat pipes 13 p0050 A77-14328
GAS FLOW
Investigation of gas-controlled heat pipes with reservoirs of constant and variable volume 13 p0050 A77-14327
GAS GENERATORS
Onboard hydrogen generation for automobiles 13 p0020 A77-12663
Energy conversion via photoelectrolysis 13 p0021 A77-12667
Hydrogen production by the steam-iron process 13 p0023 A77-12688
Operation of the Westinghouse Coal Gasification Process Development Unit 13 p0023 A77-12689
Electrochemical power and hydrogen generation from high temperature electrolytic cells 13 p0025 A77-12709
Hydrogen production using solar radiation 13 p0048 A77-13540
Hydrogen production via thermochemical cycles based on sulfur chemistry 13 p0048 A77-13541
An alternative fuel for cars --- hydrogen production and storage 13 p0050 A77-14530
Hydrogen-rich gas generator
[NASA-CASE-NPO-13560-1] 13 p0086 N77-10636
GAS INJECTION
Performance characteristics of a diesel engine using low- and medium-energy gases as a fuel supplement (fumigation)
[NASA-TM-X-58188] 13 p0126 N77-14955
GAS IONIZATION
Study of the ionization of the additive in MHD installations 13 p0002 A77-10424
GAS JETS
The influence of the Reynolds number on the profiles of velocity and concentration in free jets of different density 13 p0069 A77-18500
GAS MIXTURES
Hydrogen-rich gas generator
[NASA-CASE-NPO-13560-1] 13 p0086 N77-10636
GAS PRESSURE
Pressure drawdown and buildup analyses in geothermal reservoirs 13 p0030 A77-12753
GAS REACTORS
Desulfurization of flue gases with iron/III/ oxide on porous carrier material - Theoretical and experimental investigation concerning the modelling of semicontinuous solid bed reactors with gas-solid reactions --- German book 13 p0080 A77-19184
GAS RECOVERY
Fuel gas recovery from controlled landfilling of municipal wastes 13 p0070 A77-18739
GAS SPECTROSCOPY
Measurements of Sc I gf-values --- absorption spectroscopy using heat pipe oven 13 p0058 A77-16270

GAS TEMPERATURE
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924
GAS TRANSPORT
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
GAS TURBINE ENGINES
Evolution of thermal traction - From the diesel engine to the gas turbine
13 p0004 A77-10976
Heat-pipe regenerator for gas turbine engine
13 p0020 A77-12528
A conceptual design study of closed Brayton cycle gas turbines for fusion power generation
13 p0022 A77-12676
Steam station repowering - A near-term method of energy conservation
13 p0022 A77-12679
Compressed air energy storage - A near term option for utility application
13 p0027 A77-12727
Combined cycles and refined coal --- gasification plant using high temperature gas turbines
13 p0058 A77-16249
High-temperature ceramics for automobile gas turbines. II
13 p0063 A77-17591
Theoretical aspects of optimization of aviation gas turbine engine design variables
13 p0063 A77-17762
Gas turbine electric powerplants
[AIAA PAPER 77-346] 13 p0066 A77-18254
Ceramic materials and components for small automotive gas turbine engine
[AD-A025472] 13 p0095 N77-11417
Emissions and performance of catalysts for gas turbine catalytic combustors
[NASA-TM-X-73543] 13 p0104 N77-12406
High temperature gas turbine engine
[PE-1765-8] 13 p0120 N77-14488
High temperature gas turbine engine component materials testing program
[PE-1765-7] 13 p0127 N77-15401
GAS TURBINES
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
Solids gasification for gas turbine fuel 100 and 300 Btu gas
13 p0022 A77-12685
Combination power plants for improved utilization of fossil fuels
13 p0045 A77-12939
A combined cycle with a partial-oxidation reactor
13 p0062 A77-17534
Reduction of gaseous pollutant emissions from gas turbine combustors using hydrogen-enriched jet fuel
[NASA-CR-149146] 13 p0094 N77-11198
Automotive gas turbine fuel control
[NASA-CASE-LEW-12785-1] 13 p0113 N77-13426
Design phase utility analysis for gas turbine and combined cycle plants
[PB-256665/1] 13 p0115 N77-13553
Proceedings of the Stationary Source Combustion Symposium. Volume 3: Field Testing and Surveys
[PB-257146/1] 13 p0125 N77-14643
GASEOUS FUELS
Fuel gas recovery from controlled landfilling of municipal wastes
13 p0070 A77-18739
GASIFICATION
Solids gasification for gas turbine fuel 100 and 300 Btu gas
13 p0022 A77-12685
GASOLINE
Design of a 100 BPD pilot plant to convert methanol to gasoline using the Mobil process
13 p0023 A77-12691
Air, water, nuclear power make gasoline
13 p0045 A77-12935
Gasoline and distillate shortage situation: 1972-1976
[PB-253322/2] 13 p0089 N77-10670
GENERAL AVIATION AIRCRAFT
Technical highlights in general aviation
[AIAA PAPER 77-312] 13 p0066 A77-18237
GEOCHEMISTRY
The utility of waters from the high-temperature areas in Iceland for space heating as determined by their chemical composition
13 p0012 A77-11496
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497
Locating interesting geothermal areas in the Tuscany region /Italy/ by geochemical and isotopic methods
13 p0013 A77-11498
The nature and characteristics of the distribution of helium and argon isotopes in the geothermal waters of the Kuril Islands and Kamchatka
13 p0048 A77-13589
Cooperative geochemical resource assessment of the Mesa Geothermal system
[PB-257225/3] 13 p0132 N77-15520
GEOLOGICAL SURVEYS
Remote sensing of an underground coal-burn cavity with a wide-band induction system
13 p0007 A77-11050
World oil resources. III - The geological analogy method
13 p0012 A77-11341
The utility of waters from the high-temperature areas in Iceland for space heating as determined by their chemical composition
13 p0012 A77-11496
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497
Locating interesting geothermal areas in the Tuscany region /Italy/ by geochemical and isotopic methods
13 p0013 A77-11498
Results of some geothermal studies in Singhbhum thrust belt, India
13 p0013 A77-11499
Use of radar in geology
13 p0018 A77-12256
In situ combustion of Michigan oil shale - Current field studies
13 p0024 A77-12695
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
GEOLOGY
The 29950 Earth Resource Technology Satellite (ERTS-A) sensor data for mineral resource sector development and regional land use survey, March - August 1976 --- Bolivia
[E77-10028] 13 p0096 N77-11491
GEOMORPHOLOGY
The 29950 Earth Resource Technology Satellite (ERTS-A) sensor data for mineral resource sector development and regional land use survey, March - August 1976 --- Bolivia
[E77-10028] 13 p0096 N77-11491
GEOTHERMAL ENERGY CONVERSION
Making electricity from moderate temperature fluids --- geothermal sources
13 p0002 A77-10649
Geothermal energy --- conversion technology development
13 p0005 A77-11035
Geothermal energy in Hawaii - Hydrothermal systems
13 p0029 A77-12741
Application of the Stretford process for H2S abatement at the Geysers geothermal power plant
13 p0029 A77-12743
Economic optimization of binary fluid cycle power plants for geothermal systems
13 p0029 A77-12744
Economic and engineering implications of the Project Independence 1985 geothermal energy output goal and the associated sensitivity analysis
13 p0029 A77-12745
Investigation of heat exchanger flow arrangement on performance and cost in a geothermal binary cycle
13 p0029 A77-12746
Direct contact heat exchangers for geothermal power plants
13 p0029 A77-12747

Fluidized bed heat exchangers for geothermal applications
13 p0029 A77-12748
The economic generation of electricity from moderate temperature geothermal resources
13 p0030 A77-12749
Comparison of geothermal power conversion cycles
13 p0030 A77-12750
Power production from high temperature geothermal waters
13 p0030 A77-12751
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
Geothermal powered heat pumps to produce process heat
13 p0030 A77-12754
Extracting energy from hydraulically-fractured geothermal reservoirs
13 p0030 A77-12757
The use of program GEOTHM to design and optimize geothermal power cycles
13 p0031 A77-12758
Electric utility companies and geothermal power
13 p0031 A77-12759
The potential national benefits of geothermal electrical energy production from hydrothermal resources in the West
13 p0031 A77-12760
Geothermal sources and their utilization
13 p0055 A77-15803
Geothermal power - The 'sleeper' in the energy race
13 p0056 A77-15845
A generalized indicator characterizing the hydrodynamics and heating efficiency of subterranean thermal circulation systems
13 p0058 A77-16306
Geothermal energy as a source of electric power: Thermodynamic and economic design criteria --- Book
13 p0060 A77-16623
Geothermal energy development
13 p0064 A77-17801
Geothermal energy for power generation
[LA-UR-76-369] 13 p0087 N77-10650
Geothermal energy for electrical and nonelectrical applications
[LA-UR-76-418] 13 p0123 N77-14601
Economics of geothermal electricity generation from hydrothermal resources
[BNWL-1989] 13 p0123 N77-14602
Geothermal R and D project report
[ANCR-1283] 13 p0124 N77-14605

GEOTHERMAL RESOURCES
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121
Submarine geothermal resources
13 p0010 A77-11322
The utility of waters from the high-temperature areas in Iceland for space heating as determined by their chemical composition
13 p0012 A77-11496
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497
Locating interesting geothermal areas in the Tuscany region /Italy/ by geochemical and isotopic methods
13 p0013 A77-11498
Results of some geothermal studies in Singhbhum thrust belt, India
13 p0013 A77-11499
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591
Seasonal storage of thermal energy in water in the underground --- reservoirs
13 p0028 A77-12734
Geothermal studies in northern Nevada
13 p0029 A77-12742
Economic optimization of binary fluid cycle power plants for geothermal systems
13 p0029 A77-12744
Pressure drawdown and buildup analyses in geothermal reservoirs
13 p0030 A77-12753
Direct applications of geothermal energy
13 p0030 A77-12755
Prerequisites for military/civilian geopressured geothermal resource development
13 p0031 A77-12761
An engineering feasibility study of using low temperature geothermal sources in Colorado
13 p0031 A77-12762
The nature and characteristics of the distribution of helium and argon isotopes in the geothermal waters of the Kuril Islands and Kamchatka
13 p0048 A77-13589
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
Geothermal energy as a source of electric power: Thermodynamic and economic design criteria --- Book
13 p0060 A77-16623
Geothermal energy development
13 p0064 A77-17801
Geothermal energy in Saudi Arabia and its use in connection with solar energy
13 p0079 A77-19122
Utilization of geothermal energy
[UTIAS-REVIEW-40] 13 p0087 N77-10644
Geothermal energy for power generation
[LA-UR-76-369] 13 p0087 N77-10650
Remote sensing of geothermic activities of the volcanoes Aetna, Stromboli and Vesuv by means of infra-red NOAA-VHRR-satellite data --- Italy
13 p0104 N77-12485
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556
Explaining energy: A manual of non-style for the energy outsider who wants in
[LBL-4458] 13 p0122 N77-14592
Resource utilization efficiency improvement of geothermal binary cycles, phase 1
[ORO-4944-3] 13 p0123 N77-14600
Economics of geothermal electricity generation from hydrothermal resources
[BNWL-1989] 13 p0123 N77-14602
Electric power generation using geothermal brine resources for a proof-of-concept facility
[NSF/RA/N-75-049] 13 p0123 N77-14603
Utility distribution systems in Iceland
[AD-A026956] 13 p0126 N77-14957
Cooperative geochemical resource assessment of the Mesa Geothermal system
[PB-257225/3] 13 p0132 N77-15520
Overview of the Imperial Valley environmental project
[UCID-17067] 13 p0132 N77-15533

GEYSERS
Application of the Stretford process for H2S abatement at the Geysers geothermal power plant
13 p0029 A77-12743
Geothermal power - The 'sleeper' in the energy race
13 p0056 A77-15845

GLOBAL AIR POLLUTION
Atmospheric carbon dioxide variations at the South Pole
13 p0067 A77-18439

GOVERNMENT/INDUSTRY RELATIONS
Analysis of state solar energy options
[PB-254730/5] 13 p0091 N77-10688

GRAIN BOUNDARIES
Reducing grain-boundary effects in polycrystalline silicon solar cells
13 p0014 A77-11761

GRAINS (FOOD)
Grain drying in stationary bins with solar heated air
13 p0019 A77-12411

GRAPHITE
Carbon oxidation catalyst mechanism study for fuel cells
[PB-256420/1] 13 p0115 N77-13551

GREAT BASIN (US)
Geothermal studies in northern Nevada
13 p0029 A77-12742

GREAT BRITAIN
Windmills change direction --- British system utilizing offshore windmills and depleted North Sea fields
13 p0060 A77-16620

GREENHOUSE EFFECT
Windowed versus windowless solar energy cavity receivers
13 p0037 A77-12808
GROUND STATIONS
Satellite communications for off-shore oil operations using WESTAR
13 p0053 A77-15130
GULF OF MEXICO
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890

H

HALITES
A survey of salt deposits and salt caverns: Their relevance to the strategic petroleum reserve
[PB-255948/2] 13 p0105 N77-12500
HALL GENERATORS
Performance theory of diagonal conducting wall MHD generators
13 p0001 A77-10202
HANDBOOKS
Handbook of gasifiers and gas treatment systems
[PE-1772-11] 13 p0088 N77-10658
Flat-plate solar collector handbook. A survey of principles, technical data and evaluation results
[UCID-17086] 13 p0105 N77-12506
Solar cell array design handbook, volume 1
[NASA-CR-149364] 13 p0118 N77-14193
Solar cell array design handbook, volume 2
[NASA-CR-149365] 13 p0118 N77-14194
HAWAII
Geothermal energy in Hawaii - Hydrothermal systems
13 p0029 A77-12741
HEALTH PHYSICS
Occupational radiation exposure at light water cooled power reactors, 1969-1975
[PB-257054/7] 13 p0125 N77-14740
HEAT BALANCE
Contribution of the heat carried by solar radiation to the thermal balance of a room during the cold season and its effect on domestic fuel consumption
13 p0063 A77-17558
HEAT EXCHANGERS
Heat-pipe regenerator for gas turbine engine
13 p0020 A77-12528
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678
Investigation of heat exchanger flow arrangement on performance and cost in a geothermal binary cycle
13 p0029 A77-12746
Direct contact heat exchangers for geothermal power plants
13 p0029 A77-12747
Fluidized bed heat exchangers for geothermal applications
13 p0029 A77-12748
Heat pipe heat exchanger design considerations
13 p0031 A77-12765
Analysis of parameters and characteristics of a bypass turbojet engine operating in a cycle with stepwise heat removal
13 p0063 A77-17765
Analysis of a heat pipe exchanger
13 p0112 N77-13355
Comparative evaluation of solar heating alternatives
[COO-2703-2] 13 p0129 N77-15498
HEAT FLUX
Optimal control of flow in low temperature solar heat collectors
13 p0019 A77-12409
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
Irradiation field formation on the receiver of 'precise' and 'unprecise' solar concentrators
13 p0057 A77-16209
HEAT GENERATION
Retorting of single oil shale blocks with nitrogen and air
13 p0024 A77-12696
Increase in the efficiency of heat and power systems using large artificial accumulators of heat
13 p0064 A77-17939
Performance of two fixed-mirror solar concentrators for process heat
13 p0074 A77-19065
HEAT MEASUREMENT
Results of some geothermal studies in Singhbhum thrust belt, India
13 p0013 A77-11499
Calorimetry of large solar concentrators
13 p0038 A77-12814
HEAT PIPES
Heat-pipe regenerator for gas turbine engine
13 p0020 A77-12528
Design analyses of a methane-based chemical heat pipe
13 p0028 A77-12737
The potential of the heat pipe in coal gasification processes
13 p0031 A77-12763
Heat pipes for fluid-bed gasification of coal - Metallurgical condition of heat pipes after tests in process environment
13 p0031 A77-12764
Heat pipe heat exchanger design considerations
13 p0031 A77-12765
Cooling arrays of circuit cards using heat pipes and forced air diffusers
13 p0031 A77-12766
VBP heat pipes for energy storage --- Vapor Bubble Pumping
13 p0032 A77-12767
Heat pipe nuclear reactor for space power
13 p0036 A77-12797
Economic optimization of the energy transport component of a large distributed solar power plant
13 p0037 A77-12807
Study of the properties of heat pipes with liquid-metal heat-transfer agents in low-temperature regimes
13 p0046 A77-13243
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326
Investigation of gas-controlled heat pipes with reservoirs of constant and variable volume
13 p0050 A77-14327
Gas release during long-term operation of heat pipes
13 p0050 A77-14328
Heat pipe theory and practice --- Book
13 p0052 A77-14825
Measurements of Sc I gf-values --- absorption spectroscopy using heat pipe oven
13 p0058 A77-16270
Status of development and application of gas-stabilized heat-pipe radiators
[DGLR PAPER 76-192] 13 p0060 A77-16557
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924
A solar house with heat pipe collectors
13 p0070 A77-18598
An investigation of condensation heat transfer in a closed tube containing a soluble noncondensable gas
[NASA-CR-149095] 13 p0085 N77-10465
Test program for transmitter experiment package and heat pipe system for the communications technology satellite
[NASA-TM-X-3455] 13 p0095 N77-11268
Investigation of performance limits in axial groove heat pipes
[NASA-CR-137912] 13 p0095 N77-11340
Heat pipe materials compatibility
[NASA-CR-135069] 13 p0103 N77-12182
Analysis of a heat pipe exchanger
13 p0112 N77-13355
Flight data analysis and further development of variable-conductance heat pipes
[NASA-CR-137953] 13 p0118 N77-14374
Computer program grade 2 for the design and analysis of heat-pipe wicks
[NASA-CR-137954] 13 p0118 N77-14375

Heat pipes, volume 2 --- conference proceedings, Bologna, 31 Mar. - 2 Apr. 1976
[ESA-SP-112-VOL-2] 13 p0119 N77-14378
Extended cryogenic performance of Lobar Wick heat pipe/radiator
13 p0119 N77-14379
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Heat pipes for the temperature range from 200 to 600 C --- noting sulfur with iodine additive as working fluid
13 p0119 N77-14381
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383
Investigations of nonsteady-state processes at cryogenic heat pipe operation --- filled with ammonia and Freon-22
13 p0119 N77-14384
Transfer function analysis of heat pipes
13 p0119 N77-14385
Wetting and surface properties of refrigerants to be used in heat pipes --- surface tension and wall contact angles
13 p0119 N77-14386
Heat pipes with a non-condensable gas and their application in nuclear apparatus and instruments
13 p0120 N77-14387
Heat pipes for the trans-Alaska pipeline
13 p0120 N77-14388
The International Heat Pipe Experiment --- Black Brant sounding rocket payload zero gravity experiment
13 p0120 N77-14389
Development of space applications of heat pipes at Aerospatiale
13 p0120 N77-14390
Heat pipe and space radiator developments
13 p0120 N77-14391
Development of thermal control methods for specialized components and scientific instruments at very low temperatures (follow-on)
[NASA-CR-150152] 13 p0127 N77-15347

HEAT PUMPS

Some features of the operation of a solar installation acting as a low-temperature source of heat for a heat pump
13 p0015 A77-11924
Geothermal powered heat pumps to produce process heat
13 p0030 A77-12754
A unique Rankine-cycle heat pump system
13 p0036 A77-12799
Solar-powered Rankine-cycle heat pump system
13 p0036 A77-12800
Energy and environmental considerations in extending heat pump applications
13 p0062 A77-17058
Commercial building unitary heat pump system with solar heating
[PB-255488/9] 13 p0099 N77-11551
Evaluation of the air-to-air heat pump for residential space conditioning
[PB-255652/0] 13 p0108 N77-12545
Solar assisted heat pumps: A possible wave of the future
[NASA-CR-2771] 13 p0121 N77-14584
Solid state applications of direct energy conversion and heat pumping for a small automotive vehicle
[AD-A026321] 13 p0124 N77-14607
Comparative evaluation of solar heating alternatives
[COO-2703-2] 13 p0129 N77-15498

HEAT RADIATORS

Development of thermal control methods for specialized components and scientific instruments at very low temperatures (follow-on)
[NASA-CR-150152] 13 p0127 N77-15347
Composite material structures for thermophotovoltaic conversion radiator
[AD-A026859] 13 p0132 N77-15519

HEAT RESISTANT ALLOYS

Superalloys for advanced energy systems
13 p0061 A77-16824

HEAT SOURCES

Electricity and heat production - Energy efficiency versus cost efficiency
13 p0011 A77-11338
Some features of the operation of a solar installation acting as a low-temperature source of heat for a heat pump
13 p0015 A77-11924
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678
Hydrogen separation and compression through hydride formation and dissociation by low-level heat
13 p0032 A77-12770
Isotope heat source for dynamic power systems
13 p0036 A77-12796
Development of a small radioisotopic heat source
13 p0042 A77-12852
Spherical radioisotope thermoelectric generators - An approach to high specific power devices
13 p0042 A77-12857
Geothermal sources and their utilization
13 p0055 A77-15803
Application of solar energy in the high-temperature range
13 p0063 A77-17636

HEAT STORAGE

Thermal energy storage applied to residential heating systems
13 p0027 A77-12729
Storage in oil of off-peak thermal energy from large power stations
13 p0027 A77-12730
Thermal energy storage for solar power plants
13 p0027 A77-12731
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732
Industrial energy conservation through integration of thermal energy storage into process energy dynamics
13 p0028 A77-12733
Thermochemical energy storage systems
13 p0028 A77-12738
An evaluation of the use of metal hydrides for solar thermal energy storage
13 p0028 A77-12739
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
VBP heat pipes for energy storage --- Vapor Bubble Pumping
13 p0032 A77-12767
Short and long term comparison of solar absorption air-conditioning system performance using real and synthetic weather data
13 p0039 A77-12824
Thermal energy storage for heating and air conditioning
13 p0057 A77-16206
Transient behavior of solid sensible heat thermal storage units for solar energy systems
13 p0057 A77-16208
A central solar energy utilization system
13 p0057 A77-16210
Increase in the efficiency of heat and power systems using large artificial accumulators of heat
13 p0064 A77-17939
Parametric studies of the thermal trap flat plate collector
13 p0068 A77-18443
An inflatable solar concentrator for a high temperature storage system
13 p0074 A77-19064
Design and performance of thermal storage water tank
13 p0075 A77-19079
Two component thermal energy storage material
[PB-252592/1] 13 p0090 N77-10675
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689
Outdoor performance results for NBS Round Robin collector no. 1
[NASA-TM-X-73547] 13 p0106 N77-12520
Temperature distribution of a hot water storage tank in a simulated solar heating and cooling system
[NASA-TM-X-73549] 13 p0106 N77-12521

HEAT TRANSFER
Heat transfer - A review of 1975 literature
13 p0002 A77-10615
Performance analysis of a cylindrical parabolic focusing collector and comparison with experimental results
13 p0019 A77-12410
Central station solar electric power using liquid metal heat transport
13 p0037 A77-12806
Future energy production systems: Heat and mass transfer processes. Volume 1 --- Book
13 p0056 A77-16201
Heat and mass transfer for solar energy utilization
13 p0057 A77-16205
Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide
13 p0058 A77-16213
A generalized indicator characterizing the hydrodynamics and heating efficiency of subterranean thermal circulation systems
13 p0058 A77-16306
Heat transfer problems associated with laser fusion
13 p0068 A77-18441
Temperature optimization for power production of infinite heat transfer solar absorbers
13 p0073 A77-19055
An investigation of condensation heat transfer in a closed tube containing a soluble noncondensable gas
[NASA-CR-149095] 13 p0085 N77-10465
Selected aspects of waste heat management
[PB-254401/3] 13 p0109 N77-12568
The structure of building specifications
[PB-257581/9] 13 p0132 N77-15524
HEAT TRANSFER COEFFICIENTS
Investigation of heat exchanger flow arrangement on performance and cost in a geothermal binary cycle
13 p0029 A77-12746
Direct contact heat exchangers for geothermal power plants
13 p0029 A77-12747
Metal hydrides of improved heat transfer characteristics
13 p0033 A77-12775
Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters
13 p0058 A77-16324
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924
HEAT TRANSMISSION
Geothermal R and D project report
[ANCR-1283] 13 p0124 N77-14605
HEAT TREATMENT
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577
HEATING
The wind and its effect on the heating requirements
13 p0009 A77-11266
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
Evaluation of the air-to-air heat pump for residential space conditioning
[PB-255652/0] 13 p0108 N77-12545
HEATING EQUIPMENT
R&M - Today's heating and cooling vs. solar energy
13 p0002 A77-10482
The assurance of the heat supply with respect to the primary energy use in the case of heating and air conditioning installations
13 p0009 A77-11270
The utility of waters from the high-temperature areas in Iceland for space heating as determined by their chemical composition
13 p0012 A77-11496
Energy in the household - Comparison of heating costs and prognosis concerning the consumption of energy until 1985
13 p0015 A77-12059
The solar water heater industry in South Florida - History and projections
13 p0018 A77-12403
Thermal evaluation of a house using a movable-insulation heating and cooling system
13 p0019 A77-12407
A method of testing for rating solar collectors based on thermal performance
13 p0019 A77-12408
Grain drying in stationary bins with solar heated air
13 p0019 A77-12411
A forced circulation system for solar water heating
13 p0019 A77-12413
Energy conservation potential of Modular Integrater Utility Systems /MIUS/
13 p0026 A77-12724
Thermal energy storage applied to residential heating systems
13 p0027 A77-12729
Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations
13 p0028 A77-12736
Direct applications of geothermal energy
13 p0030 A77-12755
The utilization and economics of low temperature geothermal water for space heating
13 p0030 A77-12756
Practical aspects of solar heating - A review of materials use in solar heating applications
13 p0049 A77-13743
Calculation of the radiation entering a 'hot box' type solar set-up
13 p0051 A77-14581
Utilization of solar power - A new departure
13 p0053 A77-15049
Energy and environmental considerations in extending heat pump applications
13 p0062 A77-17058
Homeowner's guide to solar heating and cooling --- Book
13 p0062 A77-17525
Development of a mobile solar testing and recording /STAR/ system --- trailer for domestic hot water system testing
13 p0072 A77-19047
Stationary solar concentrators for industrial heating and cooling
13 p0074 A77-19069
Survey of absorption refrigeration systems
13 p0078 A77-19105
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235
HELICOPTER DESIGN
Advanced helicopter structural design investigation. Volume 1: Investigation of advanced structural component design concepts
[AD-A024662] 13 p0102 N77-12052
HELIUM
Helium resources of the United States, 1973
[PB-252473/4] 13 p0085 N77-10623
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506
HELIUM ISOTOPES
The nature and characteristics of the distribution of helium and argon isotopes in the geothermal waters of the Kuril Islands and Kamchatka
13 p0048 A77-13589
HIGH ALTITUDE BALLOONS
Ultralightweight solar array for Naval Sea Control Systems
13 p0040 A77-12828
HIGH FREQUENCIES
Monitoring fluid flow by using high-frequency electromagnetic probing
[UCRL-51979] 13 p0120 N77-14393
HIGH PASS FILTERS
Waveguide high pass filter for thermal conversion of solar energy
13 p0073 A77-19054
HIGH SPEED
High-speed flywheels as possible energy storage devices in the future
13 p0056 A77-15856
HIGH TEMPERATURE
Electrochemical power and hydrogen generation from high temperature electrolytic cells
13 p0025 A77-12709

Transient performance characteristics of a high temperature distributed solar collector field
13 p0037 A77-12810
Survey of high temperature thermal energy storage [SAND-75-8063] 13 p0088 N77-10655
High temperature gas turbine engine component materials testing program [PE-1765-7] 13 p0127 N77-15401

HIGH TEMPERATURE GAS COOLED REACTORS
Dual purpose nuclear power plants for military installations [AD-A026141] 13 p0132 N77-15521

HIGH TEMPERATURE GASES
Evaporation of solution droplets in a high-temperature medium --- potassium carbonate MHD flow properties
13 p0046 A77-13254
High temperature gas turbine engine [PE-1765-8] 13 p0120 N77-14488

HIGH TEMPERATURE NUCLEAR REACTORS
Energy storage via calcium hydride production
13 p0032 A77-12774
Environment and energy production after the year 2000
13 p0056 A77-16203
Gasification of coal and its future aspects regarding the use of heat from high-temperature nuclear reactors [INIS-MF-1965] 13 p0084 N77-10228

HIGH TEMPERATURE RESEARCH
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665

HIGH TEMPERATURE TESTS
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817

HIGH VOLTAGES
The lensed high-voltage vertical multijunction solar cell
13 p0069 A77-18489
New analysis of a high-voltage vertical multijunction solar cell
13 p0069 A77-18490
Reply to 'New analysis of a high-voltage vertical multijunction solar cell'
13 p0069 A77-18491

HIGHWAYS
Air quality considerations in transportation planning: Findings and recommendations on transportation control planning, phase 2 [PB-256424/3] 13 p0110 N77-12576

HONEYCOMB STRUCTURES
Use of Lexan and Kapton honeycombs to increase solar collector efficiency
13 p0068 A77-18448

HYDRAULIC EQUIPMENT
Hydraulic ram effect on composite fuel cell entry walls [AD-A024832] 13 p0115 N77-13548
A study of the failure of joints in composite material fuel cells due to hydraulic ram loading [AD-A027258] 13 p0117 N77-14016

HYDRIDES
Hydrogen separation and compression through hydride formation and dissociation by low-level heat
13 p0032 A77-12770

HYDROCARBON COMBUSTION
Burner design criteria for control of NOx from natural gas combustion. Volume 1: Data analysis and summary of conclusions [PB-254167/0] 13 p0091 N77-10686
Burner design criteria for control of NOx from natural gas combustion. Volume 2: Raw data and experimental results [PB-256806/1] 13 p0115 N77-13549

HYDROCARBON FUEL PRODUCTION
Hydrocarbon fuels from oil shale.
13 p0023 A77-12692
In situ combustion of Michigan oil shale - Current field studies
13 p0024 A77-12695
Retorting of single oil shale blocks with nitrogen and air
13 p0024 A77-12696
Nuclear power for the production of synthetic fuels and feedstocks
13 p0035 A77-12790

HYDROCARBON FUELS
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243
Evaluation of coal liquefaction efficiency based on various ranks
13 p0009 A77-11244
Fuel cell assemblies with an acidic electrolyte
13 p0055 A77-15816
Production of a hydrocarbon-type synthetic fuel from wood [NRC-15638] 13 p0127 N77-15210

HYDROCARBONS
Catalytic synthesis of gaseous hydrocarbons [PE-1814-2] 13 p0130 N77-15503

HYDRODYNAMIC EQUATIONS
Influence of various losses on the characteristics of high-power MHD generators
13 p0046 A77-13258

HYDROELECTRIC POWER STATIONS
Experience in putting the Kiskore hydroelectric power plant on line
13 p0010 A77-11301
Water power in the immediate future
13 p0056 A77-15850
Nova Scotia seeks to cut oil bill for power generation
13 p0063 A77-17588
Storage of solar energy in the form of potential hydraulic energy
13 p0075 A77-19078
Energy considerations in HHE power systems --- Heliohydroelectric and Helioelectrolytic systems
13 p0077 A77-19099
Hydel and solar power for Pakistan --- hydroelectric power
13 p0079 A77-19121
Multi-year time frame optimization of power systems with fossil, nuclear, hydro, pumped storage and peaking units
13 p0096 N77-11525
Concrete placing techniques used during the construction of the Kasnoyarsk hydroelectric power plant [AD-A026967] 13 p0121 N77-14528
Analysis of information systems for hydropower operations: Executive summary [NASA-CR-149342] 13 p0122 N77-14586
Analysis of information systems for hydropower operations [NASA-CR-149373] 13 p0129 N77-15497

HYDROFOIL CRAFT
Hydrodynamic equilibrium conditions for AG(EH) main strut-pod foil system using flap incidence control [AD-A027521] 13 p0127 N77-15220

HYDROGEN
Near-uv photon efficiency in a TiO2 electrode - Application to hydrogen production from solar energy
13 p0015 A77-11947
Catalytic coal liquefaction using synthesis gas
13 p0059 A77-16473
Closed Brayton cycle using hydrogen as a work fluid [BNL-20899] 13 p0085 N77-10542
Prospects for hydrogen production by water electrolysis to be competitive with conventional methods [BNL-20877] 13 p0087 N77-10648

HYDROGEN ATOMS
Hydrogen atoms: Rare earth ions: Magnetic resonance studies on polycrystalline solids and surface systems relevant to catalysis and other energy-related research
13 p0117 N77-13798

HYDROGEN COMPOUNDS
Electric current from the direct conversion of low molecular weight C,H,O-compounds
13 p0055 A77-15814

HYDROGEN FUELS
Onboard hydrogen generation for automobiles
13 p0020 A77-12663
Hydrogen production by the steam-iron process
13 p0023 A77-12688

Electrochemical power and hydrogen generation from high temperature electrolytic cells
13 p0025 A77-12709
Energy storage via calcium hydride production
13 p0032 A77-12774
Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage
13 p0033 A77-12777
Survey of hydrogen energy application projects
13 p0033 A77-12778
The performance of hydrogen-injected reciprocating engines
13 p0033 A77-12780
An alternative fuel for cars --- hydrogen production and storage
13 p0050 A77-14530
Liquid hydrogen as propellant for commercial aircraft
[DGLR PAPER 76-188] 13 p0059 A77-16534
Hydrogen as a fuel in compression ignition engines
13 p0071 A77-18932
An exploratory study to determine the integrated technological air transportation system ground requirements of liquid-hydrogen-fueled subsonic, long-haul civil air transports
[NASA-CR-2699] 13 p0083 N77-10033
Hydrogen-fueled subsonic aircraft: A perspective
13 p0084 N77-10344
Hydrogen-rich gas generator
[NASA-CASE-NPO-13560-1] 13 p0086 N77-10636

HYDROGEN OXYGEN ENGINES
Hydrogen as a fuel in compression ignition engines
13 p0071 A77-18932

HYDROGEN OXYGEN FUEL CELLS
Titanium-containing Raney nickel catalyst for hydrogen electrodes in alkaline fuel cell systems
13 p0064 A77-18019
Air electrodes for H2-air fuel cells with alkali electrolyte
13 p0065 A77-18196
A comparison of porous silver catalysts in oxygen electrodes of alkaline fuel cells
13 p0067 A77-18350

HYDROGEN SULFIDE
Application of the Stretford process for H2S abatement at the Geysers geothermal power plant
13 p0029 A77-12743

HYDROGEN-BASED ENERGY
The hydrogen economy --- production and applications
13 p0006 A77-11041
Primary energy sources for hydrogen production
13 p0011 A77-11335
Energy conversion via photoelectrolysis
13 p0021 A77-12667
Benefits of hydrogen production research
13 p0032 A77-12768
The commercial production of hydrogen by the K-T process
13 p0032 A77-12769
Hydrogen separation and compression through hydride formation and dissociation by low-level heat
13 p0032 A77-12770
Hydrogen from solar energy via water electrolysis
13 p0032 A77-12771
Experimental demonstration of an iron chloride thermochemical cycle for hydrogen production
13 p0032 A77-12772
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
Metal hydrides of improved heat transfer characteristics
13 p0033 A77-12775
Some useful relationships between the physical and thermodynamic properties of metal hydrides
13 p0033 A77-12776
Survey of hydrogen energy application projects
13 p0033 A77-12778
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines
13 p0033 A77-12779
Performance of a hydrogen-powered transit vehicle
13 p0033 A77-12781
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791

Radiolytic hydrogen production from a laser fusion system
13 p0035 A77-12795
A hydride compressor
13 p0046 A77-13336
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
A new hydrogen storage electrode
13 p0047 A77-13539
Hydrogen production using solar radiation
13 p0048 A77-13540
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543
Alternate fuels for road vehicles of the future
13 p0051 A77-14584
Hydrogen production using nuclear heat
13 p0057 A77-16211
Hydrogen production from water by means of chemical cycles
13 p0058 A77-16471
The storage of energy in future energy supply systems
[DGLR PAPER 76-182] 13 p0059 A77-16533
Solar production of hydrogen as a means of storing solar energy
13 p0075 A77-19072
On the storage of solhydrogen
13 p0075 A77-19073
Thermo-chemical production of hydrogen
13 p0075 A77-19074
The theory of hydrogen production in a photoelectrochemical cell
13 p0075 A77-19075
Solar energy utilization - The photochemical approach
13 p0075 A77-19076
The photosynthetic production of hydrogen
13 p0075 A77-19077
Will the large-scale production of hydrogen be part of the energy problem or part of its solution
[UCRL-76844] 13 p0087 N77-10652
Metalhydrides
[OUBL-1146/76] 13 p0094 N77-11158
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201

HYDROGENATION
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243
Evaluation of coal liquefaction efficiency based on various ranks
13 p0009 A77-11244
Startup solvent selection for the liquefaction of lignite
13 p0059 A77-16472
Differential scanning calorimetry studies on coal. II - Hydrogenation of coals
13 p0070 A77-18583
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230

HYDROGENOLYSIS
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791

HYDROGEOLOGY
Underground storage of off-peak power
13 p0027 A77-12728
Pressure drawdown and buildup analyses in geothermal reservoirs
13 p0030 A77-12753
Extracting energy from hydraulically-fractured geothermal reservoirs
13 p0030 A77-12757
Prerequisites for military/civilian geopressured geothermal resource development
13 p0031 A77-12761

HYPERSONIC AIRCRAFT
Hypersonic technology-approach to an expanded program
13 p0051 A77-14597

Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575

I

ICE NUCLEI
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780
ICELAND
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
Utility distribution systems in Iceland
[AD-A026956] 13 p0126 N77-14957
IDAHO
Geothermal R and D project report
[ANCR-1283] 13 p0124 N77-14605
IGNITION
Hydrogen as a fuel in compression ignition engines
13 p0071 A77-18932
IGNITION LIMITS
Thermal explosion of moving reacting fluids of variable viscosity
13 p0052 A77-14980
Ignition of flammable gases in crude-oil tankers as a result of metal fracture
[AD-A027411] 13 p0127 N77-15121
IGNITION SYSTEMS
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
ILLINOIS
The air quality and economic implications of supplementary control systems in Illinois --- considering electric power plant fuels
[PB-255699/1] 13 p0101 N77-11588
Isotopic characterization of Illinois natural gas
13 p0113 N77-13484
INCIDENT RADIATION
Computation of solar radiation design curves
13 p0072 A77-19049
INDEXES (DOCUMENTATION)
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
TRISNET. Directory to transportation research information resources
[PB-255172/9] 13 p0125 N77-14939
INDIUM ANTIMONIDES
Thin film solar acceptors
13 p0072 A77-19053
INDIUM SULFIDES
A sulfurization process for the preparation of photovoltaic Cu/x/S and CuInS2 thin films
13 p0076 A77-19087
INDUSTRIAL ENERGY
Energy consumption and conservation in the United States
13 p0005 A77-11028
Energy use in industry
13 p0005 A77-11029
Energy and the gas industry
13 p0005 A77-11032
Methods of energy analysis
13 p0007 A77-11046
Problems involved in improving the industrial fuel and energy balance
13 p0012 A77-11347
Industrial energy conservation through integration of thermal energy storage into process energy dynamics
13 p0028 A77-12733
An advanced energy conservation technology program; Proceedings of the Intersociety Workshop Conference, Airlie House, Va., March 24-26, 1976
13 p0045 A77-12928
The potential for application of energy storage capacity on electric utility systems in the United States. I
13 p0054 A77-15625
Stationary solar concentrators for industrial heating and cooling
13 p0074 A77-19069
The two enemies of industrial development of solar energy - Simplicity and economy
13 p0078 A77-19109
Energy use in the contract construction industry
[PB-245422/1] 13 p0099 N77-11557
A study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255658/7] 13 p0115 N77-13542
A study of implant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255659/5] 13 p0115 N77-13543
Industrial process heat from shallow solar ponds
[UCRL-77801] 13 p0124 N77-14611
The intersectoral feedback model
[PB-255859/1] 13 p0125 N77-14950
INDUSTRIAL PLANTS
Compilation of an inventory for particulate emissions in Belgium
13 p0009 A77-11271
Water requirements for an integrated SNG plant and mine operation
13 p0060 A77-16651
Superalloys for advanced energy systems
13 p0061 A77-16824
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships, detailed report
[PB-257444/0] 13 p0116 N77-13554
Characterization and evaluation of wastewater sources United States Steel Corporation, Clairton Works, Pittsburgh, Pennsylvania, 28-31 January 1976
[PB-255586/0] 13 p0116 N77-13566
INDUSTRIAL SAFETY
Laws and regulations affecting coal with summaries of Federal, State, and local laws and regulations pertaining to air and water pollution control, reclamation, diligence and health and safety, part 1
[PB-255927/6] 13 p0110 N77-12592
Occupational radiation exposure at light water cooled power reactors, 1969-1975
[PB-257054/7] 13 p0125 N77-14740
INDUSTRIAL WASTES
Energy from wastes
13 p0006 A77-11038
Clean air protection and industrial development
13 p0010 A77-11303
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780
Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer
13 p0062 A77-17541
Compilation of air pollutant emission factors. Supplement
[PB-254274/4] 13 p0093 N77-10731
Selected aspects of waste heat management
[PB-254401/3] 13 p0109 N77-12568
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[PB-255586/0] 13 p0116 N77-13566
Pollutant potential of raw and chemically fixed hazardous industrial wastes and flue gas desulfurization sludges
[PB-256691/7] 13 p0133 N77-15540
INDUSTRIES
User's guide to petroleum industry survey data type
[PB-256635/4] 13 p0098 N77-11544
Energy use in the contract construction industry. Appendix A: Study methodology
[PB-245423/9] 13 p0099 N77-11558
Energy use in the contract construction industry. Appendix B: Assessment of construction equipment availability, energy requirements, and construction industry capacity to support Project Independence
[PB-245424/7] 13 p0100 N77-11559
INFLATABLE STRUCTURES
An inflatable solar concentrator for a high temperature storage system
13 p0074 A77-19064
INFORMATION MANAGEMENT
Energy information activities at the FEA
[PB-253962/5] 13 p0099 N77-11553

Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497

INFORMATION SYSTEMS
Energy information activities at the FEA
[PB-253962/5] 13 p0099 N77-11553
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586
TRISNET. Directory to transportation research information resources
[PB-255172/9] 13 p0125 N77-14939

INFRARED REFLECTION
Waveguide high pass filter for thermal conversion of solar energy
13 p0073 A77-19054

INPUT/OUTPUT ROUTINES
The intersectoral feedback model
[PB-255859/1] 13 p0125 N77-14950

INSOLATION
Calculation of the radiation entering a 'hot box' type solar set-up
13 p0051 A77-14581
Survey of quantitative data on the solar energy and its spectra distribution
13 p0072 A77-19044
Autonomous station for the acquisition and concentration of heliometric data
13 p0072 A77-19046

INSTRUMENT COMPENSATION
Accelerated response of thermopile pyranometers
13 p0019 A77-12405

INSULATION
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638

INTERFACIAL TENSION
Interfacial effects in the recovery of residual oil by displacement: Studies at Northwestern University
[COO-0019-5] 13 p0122 N77-14595

INTERMETALLICS
Intermetallic compounds - Background and results of twenty years of research
13 p0014 A77-11600
Some useful relationships between the physical and thermodynamic properties of metal hydrides
13 p0033 A77-12776

INTERNAL COMBUSTION ENGINES
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
Onboard hydrogen generation for automobiles
13 p0020 A77-12663
Application of a shunt motor and a 2 cylinder gasoline engine as a hybrid drive for an automobile
13 p0025 A77-12703
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines
13 p0033 A77-12779
Hybrid drive with kinetic energy store as vehicle drive
[UCRL-TRANS-11018] 13 p0120 N77-14486
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495

INTERNATIONAL COOPERATION
The future of air transportation - Economic association considerations
[AIAA PAPER 77-286] 13 p0065 A77-18222

INTERNATIONAL LAW
National Meeting on Air and Space Law, 7th, Universidad Nacional de Cordoba, Cordoba and La Falda, Argentina, August 13-16, 1975, Proceedings
13 p0053 A77-15050

INTERPLANETARY TRANSFER ORBITS
Energy storage in orbital and interplanetary missions
[DGLR PAPER 76-189] 13 p0059 A77-16551

INVERTED CONVERTERS (DC TO AC)
Windmills stage a comeback --- review
13 p0048 A77-13624

INVESTMENTS
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948

ION ENGINES
UK, T5 ion engine thrust vector control considerations
[AIAA PAPER 76-1064] 13 p0045 A77-13030

IRAN
Prospects for solar energy utilization in Iran - Photothermal methods
13 p0013 A77-11532

IRON ALLOYS
Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage
13 p0033 A77-12777
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543

IRON CHLORIDES
Experimental demonstration of an iron chloride thermochemical cycle for hydrogen production
13 p0032 A77-12772

IRON COMPOUNDS
Development of compact lithium/iron disulfide electrochemical cells
13 p0026 A77-12715

IRON OXIDES
Desulfurization of flue gases with iron/III/ oxide on porous carrier material - Theoretical and experimental investigation concerning the modelling of semicontinuous solid bed reactors with gas-solid reactions --- German book
13 p0080 A77-19184

IRRIGATION
Solar water pump for lift irrigation
13 p0019 A77-12406

ISOTHERMAL LAYERS
Isothermal surface in a radiation field --- in solar thermal energy devices
13 p0014 A77-11918

ISOTOPE EFFECT
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497
Locating interesting geothermal areas in the Tuscany region /Italy/ by geochemical and isotopic methods
13 p0013 A77-11498

ISOTOPE SEPARATION
Energy and technology review
[UCID-52000-76-2] 13 p0131 N77-15508

ITALY
Remote sensing of geothermic activities of the volcanoes Aetna, Stromboli and Vesuv by means of infra-red NOAA-VHRR-satellite data --- Italy
13 p0104 N77-12485
Trends in refinery capacity and utilization: Petroleum refineries in the United States; foreign refinery exporting centers
[PB-256966/3] 13 p0132 N77-15523

J

JET AIRCRAFT
A simplified method in flight test techniques for the determination of the range performance of jet aircraft
13 p0060 A77-16600
Fuel consumption of civil jet transport aircraft
13 p0062 A77-17234
Best-range flight conditions for cruise-climb flight of a jet aircraft
13 p0085 N77-10379

JET ENGINE FUELS
A preliminary engineering assessment of jet fuel production from domestic coal and shale derived oils
13 p0023 A77-12690
An exploratory study to determine the integrated technological air transportation system ground requirements of liquid-hydrogen-fueled subsonic, long-haul civil air transports
[NASA-CR-2699] 13 p0083 N77-10033
National petroleum product supply and demand, 1976 - 1978
[PB-254969/9] 13 p0084 N77-10224
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230

Some cost, energy, environmental, and resource implications of synthetic fuels produced from coal for military aircraft
[AD-A026667] 13 p0118 N77-14271
JET ENGINES
Effect of ceramic coating of JT8D combustor liner on maximum liner temperatures and other combustor performance parameters
[NASA-TM-X-73581] 13 p0126 N77-15037
JET FLOW
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
The influence of the Reynolds number on the profiles of velocity and concentration in free jets of different density
13 p0069 A77-18500
JP-4 JET FUEL
The impact of JP-4/JP-8 conversion on aircraft engine exhaust emissions
[AD-A026546] 13 p0112 N77-13234
JP-4 and JP-9 fuel toxicity studies using water fish and aufwuchs
[AD-A027594] 13 p0127 N77-15213
JP-5 JET FUEL
Electrostatic properties of JP-5 jet fuel from alternate sources
[AD-A025684] 13 p0103 N77-12232
Evaluation of a JP-5 type fuel derived from oil shale
[AD-A025417] 13 p0112 N77-13231
JP-8 JET FUEL
The impact of JP-4/JP-8 conversion on aircraft engine exhaust emissions
[AD-A026546] 13 p0112 N77-13234
JUNCTION DIODES
Spectral response of a laterally illuminated p-n junction --- as photodetector or photovoltaic energy converter
13 p0062 A77-17478

K

KAPTON (TRADEMARK)
Use of Lexan and Kapton honeycombs to increase solar collector efficiency
13 p0068 A77-18448
KEROGEN
Thermal alteration of young kerogen in relation to petroleum genesis
13 p0053 A77-15044
KEROSENE
Evaluation of a JP-5 type fuel derived from oil shale
[AD-A025417] 13 p0112 N77-13231
KINETIC ENERGY
Superflywheel energy storage and nonsynchronous AC/DC/AC electric transmission supplements power system operation
13 p0002 A77-10638
Energy storage --- quality, duration, methods and forms
13 p0006 A77-11040
Hybrid drive with kinetic energy store as vehicle drive
[UCRL-TRANS-11018] 13 p0120 N77-14486
Energy equivalents for current and prospective automotive fuels in Canada
[AD-A026195] 13 p0124 N77-14609
KURILE ISLANDS
The nature and characteristics of the distribution of helium and argon isotopes in the geothermal waters of the Kuril Islands and Kamchatka
13 p0048 A77-13589

L

LAMINAR BOUNDARY LAYER
Boundary-layer separation from the electrode wall of an MHD generator
13 p0048 A77-13711
LAND USE
Utilization of remote sensing techniques to detect land use effects on wildland water quality
13 p0071 A77-18984
Growth effects of major land use projects. Volume 2: Compilation of land use based emission factors
[PB-255302/2] 13 p0092 N77-10709
The 29950 Earth Resource Technology Satellite (ERTS-A) sensor data for mineral resource sector development and regional land use survey, March - August 1976 --- Bolivia
[E77-10028] 13 p0096 N77-11491
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[UCID-17011] 13 p0100 N77-11572
Development of a multi-disciplinary ERTS user program in the state of Ohio
[E77-10045] 13 p0104 N77-12475
LANDSAT SATELLITES
An application of ERTS technology to the evaluation of coal strip mining and reclamation in the northern Great Plains
[NASA-CR-149208] 13 p0104 N77-12486
LANDSAT 1
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
LANTHANUM COMPOUNDS
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817
LASER APPLICATIONS
Energy and technology review
[UCID-52000-76-2] 13 p0131 N77-15508
Abstracts: 1976 AFOSR Contractors' meeting on MHD Power Generation and Lasers
[AD-A027654] 13 p0133 N77-15845
LASER FUSION
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
Radiolytic hydrogen production from a laser fusion system
13 p0035 A77-12795
Shaping of laser pulses in an amplifying system receiving input signals with a variable spectrum
13 p0053 A77-15237
Advanced fuels for inertial confinement --- in laser fusion
13 p0061 A77-17016
Heat transfer problems associated with laser fusion
13 p0068 A77-18441
LASER HEATING
Laser propulsion --- rocket heat engine design
[IAF PAPER 76-166] 13 p0003 A77-10931
LASER OUTPUTS
Shaping of laser pulses in an amplifying system receiving input signals with a variable spectrum
13 p0053 A77-15237
LATTICE PARAMETERS
The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction
13 p0042 A77-12850
LAW (JURISPRUDENCE)
Law and solar energy systems - Legal impediments and inducements to solar energy systems
13 p0018 A77-12401
Laws and regulations affecting coal with summaries of Federal, State, and local laws and regulations pertaining to air and water pollution control, reclamation, diligence and health and safety, part 1
[PB-255927/6] 13 p0110 N77-12592
LEAD SULFIDES
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
LEAD TELLURIDES
The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction
13 p0042 A77-12850
LEADING EDGES
Hydrodynamic equilibrium conditions for AG(EH) main strut-pod foil system using flap incidence control
[AD-A027521] 13 p0127 N77-15220

LEGAL LIABILITY
National Meeting on Air and Space Law, 7th, Universidad Nacional de Cordoba, Cordoba and La Palda, Argentina, August 13-16, 1975, Proceedings
13 p0053 A77-15050
LENS DESIGN
Evaluating a solar energy concentrator
13 p0047 A77-13505
LEXAN (TRADEMARK)
Use of Lexan and Kapton honeycombs to increase solar collector efficiency
13 p0068 A77-18448
LIFT
Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines
13 p0044 A77-12871
LIGHT AIRCRAFT
Study of small turbofan engines applicable to single-engine light airplanes
[NASA-CR-137944] 13 p0093 N77-11054
LIGHT WATER BREEDER REACTORS
Occupational radiation exposure at light water cooled power reactors, 1969-1975
[PB-257054/7] 13 p0125 N77-14740
LIGHTING EQUIPMENT
Lumiducts for Ecopolis --- urban solar light collection and transmission system
13 p0079 A77-19116
LIMESTONE
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497
LIMITS (MATHEMATICS)
Limiting mechanisms in MHD generator performance
[AD-A025949] 13 p0111 N77-12879
LINEAR PROGRAMMING
A linear economic model of fuel and energy use in the United States. Volume 1: Model Description and results
[PB-252485/8] 13 p0088 N77-10662
LINING PROCESSES
Effect of ceramic coating of JT8D combustor liner on maximum liner temperatures and other combustor performance parameters
[NASA-TM-X-73581] 13 p0126 N77-15037
LIQUEFIED NATURAL GAS
Risk management of liquefied natural gas installations
13 p0002 A77-10451
Ship steel weldments for low temperature service
[PB-256997/8] 13 p0103 N77-12203
A study to obtain verification of Liquid Natural Gas (LNG) tank loading criteria
[AD-A025716] 13 p0120 N77-14492
Bibliography on Liquefied Natural Gas (LNG) safety
[NASA-TM-X-73408] 13 p0127 N77-15208
LIQUID COOLING
Water requirements for an integrated SNG plant and mine operation
13 p0060 A77-16651
LIQUID HYDROGEN
Liquid hydrogen as propellant for commercial aircraft
[DGLR PAPER 76-188] 13 p0059 A77-16534
LH2 airport requirements study
[NASA-CR-2700] 13 p0083 N77-10032
An exploratory study to determine the integrated technological air transportation system ground requirements of liquid-hydrogen-fueled subsonic, long-haul civil air transports
[NASA-CR-2699] 13 p0083 N77-10033
The potential of liquid hydrogen as a military aircraft fuel
[AD-A026666] 13 p0118 N77-14272
LIQUID METALS
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
Central station solar electric power using liquid metal heat transport
13 p0037 A77-12806
Study of the properties of heat pipes with liquid-metal heat-transfer agents in low-temperature regimes
13 p0046 A77-13243
Investigation of two-phase liquid-metal magnetohydrodynamic power systems
13 p0057 A77-16212
LIQUID NITROGEN
Magnetic suspension densimeter for measurements on fluids of cryogenic interest
13 p0007 A77-11093
LIQUID SODIUM
Liquid-metal magnetohydrodynamic system evaluation --- coal-fired designs
13 p0034 A77-12784
Central station solar electric power using liquid metal heat transport
13 p0037 A77-12806
LIQUID-SOLID INTERFACES
Gas release during long-term operation of heat pipes
13 p0050 A77-14328
LITHIUM
Development of compact lithium/iron disulfide electrochemical cells
13 p0026 A77-12715
Measured performance of a 3 ton LiBr absorption water chiller and its effect on cooling system operation
[NASA-TM-X-73496] 13 p0105 N77-12518
LITHIUM ALLOYS
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107
LITHIUM COMPOUNDS
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706
LOADS (FORCES)
A study to obtain verification of Liquid Natural Gas (LNG) tank loading criteria
[AD-A025716] 13 p0120 N77-14492
LOCOMOTIVES
Evolution of thermal traction - From the diesel engine to the gas turbine
13 p0004 A77-10976
LONG TERM EFFECTS
Gas release during long-term operation of heat pipes
13 p0050 A77-14328
LOW TEMPERATURE
The utilization and economics of low temperature geothermal water for space heating
13 p0030 A77-12756
Development of thermal control methods for specialized components and scientific instruments at very low temperatures (follow-on)
[NASA-CR-150152] 13 p0127 N77-15347

M

MAGNETIC FIELD CONFIGURATIONS
PULSAR, an unconventional topping stage --- MHD generation with metallic armature produced magnetic flux compression
13 p0034 A77-12788
MAGNETIC MATERIALS
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890
MAGNETIC PUMPING
Supplementary plasma heating studies in the atomic energy commission, France
13 p0064 A77-17819
MAGNETIC RESONANCE
Hydrogen atoms: Rare earth ions: Magnetic resonance studies on polycrystalline solids and surface systems relevant to catalysis and other energy-related research
13 p0117 N77-13798
MAGNETIC SUSPENSION
Magnetic suspension densimeter for measurements on fluids of cryogenic interest
13 p0007 A77-11093
MAGNETOHYDRODYNAMIC FLOW
Non-equilibrium MHD power generation using non-seeded argon plasma
13 p0004 A77-11022
MAGNETOHYDRODYNAMIC GENERATORS
Performance theory of diagonal conducting wall MHD generators
13 p0001 A77-10202
Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream
13 p0001 A77-10423

Study of the ionization of the additive in MHD installations
13 p0002 A77-10424
Non-equilibrium MHD power generation using non-seeded argon plasma
13 p0004 A77-11022
Energy conservation with advanced power generating systems
13 p0026 A77-12723
MHD power generation - 1976 Status Report --- coal-fired design
13 p0033 A77-12782
Investigation of direct coal-fired MHD power generation
13 p0034 A77-12783
Liquid-metal magnetohydrodynamic system evaluation --- coal-fired designs
13 p0034 A77-12784
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
System studies of coal fired-closed cycle MHD for central station power plants
13 p0034 A77-12786
PULSAR, an unconventional topping stage --- MHD generation with metallic armature produced magnetic flux compression
13 p0034 A77-12788
MHD - Energy transformation by burning coal
13 p0045 A77-12940
Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels
13 p0046 A77-13242
Evaporation of solution droplets in a high-temperature medium --- potassium carbonate MHD flow properties
13 p0046 A77-13254
Influence of various losses on the characteristics of high-power MHD generators
13 p0046 A77-13258
Boundary-layer separation from the electrode wall of an MHD generator
13 p0048 A77-13711
Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
13 p0049 A77-13728
Diffuse thermal model of electrode erosion for MHD generators
13 p0049 A77-14319
Study of cathode spots in the presence of slag films on the electrodes of an open-cycle MHD generator
13 p0053 A77-15005
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668
Investigation of two-phase liquid-metal magnetohydrodynamic power systems
13 p0057 A77-16212
Schlieren measurements of a high density z-pinch
13 p0060 A77-16697
Limiting capabilities with respect to electric power generation of a pulsed MHD generator operating at a resistive load
13 p0064 A77-17917
Construction of two-dimensional steady-state solution of equations of a nonequilibrium magnetized plasma
13 p0065 A77-18130
A summary of the ECAS MHD power plant results
[NASA-TM-X-73491] 13 p0086 N77-10642
Costs of alternative sources of electricity
[PB-255765/0] 13 p0107 N77-12528
Limiting mechanisms in MHD generator performance
[AD-A025949] 13 p0111 N77-12879
On the nature of fluctuations in an open cycle magnetohydrodynamic generator
13 p0117 N77-13841
Abstracts: 1976 AFOSR Contractors' meeting on MHD Power Generation and Lasers
[AD-A027654] 13 p0133 N77-15845

MAGNETOHYDRODYNAMIC TURBULENCE
Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels
13 p0046 A77-13242
MAINTENANCE
R&M - Today's heating and cooling vs. solar energy
13 p0002 A77-10482
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines
13 p0033 A77-12779
MALI
The role of solar energy in developing nations - The perspectives in Mali
13 p0080 A77-19125
MAN ENVIRONMENT INTERACTIONS
Environmental aspects of energy conversion and use
13 p0006 A77-11044
MANAGEMENT METHODS
Energy: The policy planning framework in state governments. Volume 1: Summary report
[PB-254466/6] 13 p0089 N77-10665
Energy: The policy planning framework in state governments. Volume 2: Appendices
[PB-254467/4] 13 p0089 N77-10666
Optimizing the use of materials and energy in transportation construction
[PB-253713/2] 13 p0096 N77-11475
MANAGEMENT PLANNING
Multi-year time frame optimization of power systems with fossil, nuclear, hydro, pumped storage and peaking units
13 p0096 N77-11525
MANAGEMENT SYSTEMS
Risk management of liquefied natural gas installations
13 p0002 A77-10451
MANUFACTURING
Demonstration of the feasibility of automated silicon solar cell fabrication
[NASA-CR-135095] 13 p0129 N77-15492
MAPPING
Applying computer-drawn maps of geologic data to analysis of mining problems
[PB-255497/0] 13 p0096 N77-11518
MARINE BIOLOGY
Conference proceedings, Energy from the Oceans, Fact or Fantasy
[PB-256093/6] 13 p0108 N77-12547
MARINE ENVIRONMENTS
Conference proceedings, Energy from the Oceans, Fact or Fantasy
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MARINE TECHNOLOGY
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[AIAA PAPER 77-296] 13 p0066 A77-18227
MARKET RESEARCH
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13 p0039 A77-12821
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[ICAS PAPER 76-01] 13 p0081 A77-19247
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[PB-255623/1] 13 p0111 N77-12930
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13 p0057 A77-16205
MATERIALS RECOVERY
The reprocessing of nuclear fuels
13 p0055 A77-15807

Energy and environmental impacts of materials alternatives - An assessment of quantitative understanding
13 p0070 A77-18738
Resource recovery technology for urban decision-makers
[PB-252458/5] 13 p0093 N77-10964

MATERIALS SCIENCE
Intermetallic compounds - Background and results of twenty years of research
13 p0014 A77-11600
Electric vehicle batteries - Opportunities for materials improvement
13 p0049 A77-13736

MATERIALS TESTS
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13 p0049 A77-13743

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13 p0080 A77-19181
Mathematical simulation and empirical determination of the aerochemical and thermal atmospheric pollution resulting from energy conversion processes
[DLR-IB-553-75/1] 13 p0091 N77-10700
Mathematics for energy
[PB-252463/5] 13 p0098 N77-11543
Flight data analysis and further development of variable-conductance heat pipes
[NASA-CR-137953] 13 p0118 N77-14374
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630

MCDONNELL DOUGLAS AIRCRAFT
The next-generation subsonic transport
[SAWE PAPER 1127] 13 p0016 A77-12195

MEASURING INSTRUMENTS
Cooperative study of heavy duty diesel emission measurement methods
[PB-257137/0] 13 p0133 N77-15541

MECHANICAL DRIVES
Self-starting, intrinsically controlled Stirling engine
13 p0041 A77-12844
Mechanical thermal motor
[NASA-CASE-MFS-23062-1] 13 p0104 N77-12402
Increased fuel economy in transportation systems by use of energy management: Second year's program. Executive summary
[PB-256117/3] 13 p0108 N77-12536

MECHANICAL PROPERTIES
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235

MESAS
Cooperative geochemical resource assessment of the Mesa Geothermal system
[PB-257225/3] 13 p0132 N77-15520

METABOLISM
The palirrhotrophic origin of energy metabolism --- chemiosmotic precursor to phototropism in estuarine cellular organisms
13 p0064 A77-17895

METAL FIBERS
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326

METAL HYDRIDES
An evaluation of the use of metal hydrides for solar thermal energy storage
13 p0028 A77-12739
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
Energy storage via calcium hydride production
13 p0032 A77-12774
Metal hydrides of improved heat transfer characteristics
13 p0033 A77-12775

Some useful relationships between the physical and thermodynamic properties of metal hydrides
13 p0033 A77-12776
Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage
13 p0033 A77-12777
Performance of a hydrogen-powered transit vehicle
13 p0033 A77-12781
A hydride compressor
13 p0046 A77-13336
Metalhydrides
[OUEL-1146/76] 13 p0094 N77-11158

METAL MATRIX COMPOSITES
Evaluation of potassium titanate as a component of alkaline fuel cell matrices
[NASA-TN-D-8341] 13 p0094 N77-11175

METAL OXIDES
Advanced thermionic converter development
13 p0043 A77-12862
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817

METAL PARTICLES
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890

METAL SURFACES
Gas release during long-term operation of heat pipes
13 p0050 A77-14328
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666

METAL VAPORS
Study of the properties of heat pipes with liquid-metal heat-transfer agents in low-temperature regimes
13 p0046 A77-13243
Measurements of Sc I gf-values --- absorption spectroscopy using heat pipe oven
13 p0058 A77-16270

METALLURGY
Heat pipes for fluid-bed gasification of coal - Metallurgical condition of heat pipes after tests in process environment
13 p0031 A77-12764

METALS
The role of recycling in conservation of metals and energy
13 p0061 A77-16825
The electron factor in catalysis on metals electrocatalysis on non-metallic surfaces
[PB-256264/3] 13 p0103 N77-12166

METEOROLOGICAL CHARTS
Siting of wind driven apparatus
13 p0043 A77-12865

METEOSAT SATELLITE
Flight results of a cryogenic cooler designed for Meteosat
[IAF PAPER 76-210] 13 p0003 A77-10942

METHANE
Solar energy collection by bioconversion
13 p0021 A77-12672
Production of methane using offshore wind energy
13 p0026 A77-12722
Design analyses of a methane-based chemical heat pipe
13 p0028 A77-12737
The potential of the heat pipe in coal gasification processes
13 p0031 A77-12763
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577
A fermentation process for converting plant materials into methane
13 p0121 N77-14583
Bibliography on Liquefied Natural Gas (LNG) safety
[NASA-TM-X-73408] 13 p0127 N77-15208

METHYL ALCOHOLS
Design of a 100 BPD pilot plant to convert methanol to gasoline using the Mobil process
13 p0023 A77-12691
Alternate fuels for road vehicles of the future
13 p0051 A77-14584
Methanol from coal fuel and other applications
[ORAU-126] 13 p0094 N77-11200

MICROMETEORITES
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890
MICROWAVE CIRCUITS
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
MICROWAVE EQUIPMENT
Captation and concentration of solar energy
13 p0074 A77-19063
MICROWAVE TRANSMISSION
Microwave transmission system for space power
13 p0014 A77-11818
Satellite solar power stations and energy relay satellites
13 p0052 A77-14901
Perspectives on Satellite Solar Power
[AIAA PAPER 77-352] 13 p0066 A77-18257
Space-to-earth power transmission system
[NASA-TM-X-73489] 13 p0105 N77-12517
MIDLATITUDE ATMOSPHERE
Energetics of the midlatitude thermosphere
13 p0012 A77-11492
MILITARY TECHNOLOGY
Prerequisites for military/civilian geopressured geothermal resource development
13 p0031 A77-12761
LTA - Recent developments --- Lighter Than Air ships
13 p0061 A77-17021
The potential of liquid hydrogen as a military aircraft fuel
[AD-A026666] 13 p0118 N77-14272
Dual purpose nuclear power plants for military installations
[AD-A026141] 13 p0132 N77-15521
MINERAL DEPOSITS
World oil resources. III - The geological analogy method
13 p0012 A77-11341
World petroleum resources. IV - Probabilistic methods
13 p0012 A77-11342
The shaping of our needs in mineral raw materials and sources for meeting those needs --- Hungarian survey
13 p0017 A77-12246
Recovery of inaccessible coal reserves by in situ gasification
13 p0022 A77-12686
In situ recovery of oil and minerals from Piceance Creek Basin oil shale
13 p0023 A77-12694
Assessing low sulfur coal resources in Montana and Wyoming
13 p0058 A77-16374
The supply of coal in the long run: The case of eastern deep coal
[PB-252642/4] 13 p0086 N77-10626
Proceedings of the Mineral Economics Symposium: Winning the high stakes at the critical commodity game
[PB-255607/4] 13 p0105 N77-12502
The exploration, development and production of Naval petroleum reserve number 4
[PB-256714/7] 13 p0113 N77-13516
MINERAL EXPLORATION
Energy analysis in modelling
13 p0007 A77-11047
MINERALS
Minerals in the US economy: Ten-year supply-demand profiles for mineral and fuel commodities
[PB-252994/9] 13 p0085 N77-10624
The 29950 Earth Resource Technology Satellite (ERTS-A) sensor data for mineral resource sector development and regional land use survey, March - August 1976 --- Bolivia
[E77-10028] 13 p0096 N77-11491
MINES (EXCAVATIONS)
The economics of coal supply - The state of the art
13 p0013 A77-11523
Underground coal mining: An assessment of technology
[PB-255726/2] 13 p0093 N77-10974
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380
MINING
Recovery of inaccessible coal reserves by in situ gasification
13 p0022 A77-12686
Applying computer-drawn maps of geologic data to analysis of mining problems
[PB-255497/0] 13 p0096 N77-11518
MIRRORS
Performance of two fixed-mirror solar concentrators for process heat
13 p0074 A77-19065
Cylindrical mirror collector field
13 p0074 A77-19071
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
MIS (SEMICONDUCTORS)
MIS silicon solar cells
13 p0001 A77-10174
MODAL RESPONSE
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
MODELS
Proceedings of the Workshop on Modeling the Interrelationships between the Energy Sector and the General Economy
[PB-255696/7] 13 p0100 N77-11561
MOJAVE DESERT (CA)
Wind power prediction models
[NASA-CR-149235] 13 p0105 N77-12509
MOLECULAR STRUCTURE
Fractionation and structural characterization of coal liquids
13 p0069 A77-18582
MONITORS
Monitoring fluid flow by using high-frequency electromagnetic probing
[UCRL-51979] 13 p0120 N77-14393
MONTANA
Assessing low sulfur coal resources in Montana and Wyoming
13 p0058 A77-16374
ERDA energy information data base: Magnetic tape description
[TID-4581-R3] 13 p0102 N77-11695
MOSAICS
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121
MOTOR VEHICLES
Alternate fuels for road vehicles of the future
13 p0051 A77-14584
Wind tunnel investigation of devices to reduce bus aerodynamic drag
[AIAA PAPER 77-307] 13 p0066 A77-18232
Hybrid drive with kinetic energy store as vehicle drive
[UCRL-TRANS-11018] 13 p0120 N77-14486
Increased fuel economy in transportation systems by use of energy management - second year's program
[PB-257177/6] 13 p0133 N77-15930
MOTORS
Mechanical thermal motor
[NASA-CASE-MFS-23062-1] 13 p0104 N77-12402
MULTIPHASE FLOW
Pressure drawdown and buildup analyses in geothermal reservoirs
13 p0030 A77-12753
MUONS
Muon catalysed fusion for pellet ignition
13 p0012 A77-11468

N

N-TYPE SEMICONDUCTORS
Effectiveness of heat-emitting coatings with variable degree of blackness
13 p0111 N77-12893
NASA PROGRAMS
Energy - Ecospace --- space law aspects of U.S. and U.S.S.R. solar power proposals
[IAF PAPER ISL-76-59] 13 p0004 A77-10970
NASA thermionic-conversion program
13 p0043 A77-12863
NASA electric propulsion program
[AIAA PAPER 76-1068] 13 p0045 A77-13033

NATURAL GAS
Energy and the gas industry
13 p0005 A77-11032
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance
13 p0020 A77-12657
Solar SNG - Large-scale production of SNG by anaerobic digestion of specially grown plant matter --- Synthetic Natural Gas
13 p0021 A77-12671
Catalytic coal gasification for SNG production --- Synthetic Natural Gas
13 p0022 A77-12683
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements
13 p0028 A77-12735
Helium resources of the United States, 1973
[PB-252473/4] 13 p0085 N77-10623
The long-run marginal costs of energy
[PB-252504/6] 13 p0085 N77-10625
Burner design criteria for control of NOx from natural gas combustion. Volume 1: Data analysis and summary of conclusions
[PB-254167/0] 13 p0091 N77-10686
User's guide to petroleum industry survey data type
[PB-256635/4] 13 p0098 N77-11544
Isotopic characterization of Illinois natural gas
13 p0113 N77-13484
Burner design criteria for control of NOx from natural gas combustion. Volume 2: Raw data and experimental results
[PB-256806/1] 13 p0115 N77-13549
NEUTRAL BEAMS
Supplementary plasma heating studies in the atomic energy commission, France
13 p0064 A77-17819
NEUTRON EMISSION
A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices
13 p0061 A77-17017
NEVADA
Geothermal studies in northern Nevada
13 p0029 A77-12742
NEW ENGLAND (US)
New England wind power...coastal or mountain
13 p0058 A77-16250
NEW HAMPSHIRE
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire
[PB-254179/5] 13 p0091 N77-10687
NEW YORK
Electric energy supply alternatives for New York. Phase 2: An appraisal of electrical energy alternatives available to the State of New York
[PB-249881/4] 13 p0101 N77-11575
NICKEL ALLOYS
Titanium-containing Raney nickel catalyst for hydrogen electrodes in alkaline fuel cell systems
13 p0064 A77-18019
NICKEL CADMIUM BATTERIES
Small space station electrical power system design concepts
13 p0040 A77-12835
NICKEL ZINC BATTERIES
Advances in component technology for nickel-zinc cells
13 p0025 A77-12710
New separators for nickel-zinc batteries
[NASA-TM-X-3465] 13 p0121 N77-14585
NITROGEN
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
NITROGEN DIOXIDE
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568
Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide
13 p0058 A77-16213
NITROGEN OXIDES
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer
13 p0062 A77-17541
Burner design criteria for control of NOx from natural gas combustion. Volume 1: Data analysis and summary of conclusions
[PB-254167/0] 13 p0091 N77-10686
The proceedings of the NOx Control Technology Seminar
[PB-253661/3] 13 p0092 N77-10707
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597
Burner design criteria for control of NOx from natural gas combustion. Volume 2: Raw data and experimental results
[PB-256806/1] 13 p0115 N77-13549
NITROUS OXIDES
Production of atmospheric nitrous oxide by combustion
13 p0061 A77-16922
NOAA SATELLITES
Remote sensing of geothermic activities of the volcanoes Aetna, Stromboli and Vesuv by means of infra-red NOAA-VHRR-satellite data --- Italy
13 p0104 N77-12485
NOISE GENERATORS
Noise mechanism separation and design considerations for low tip-speed, axial-flow fans
13 p0046 A77-13339
NONEQUILIBRIUM PLASMAS
Non-equilibrium MHD power generation using non-seeded argon plasma
13 p0004 A77-11022
Construction of two-dimensional steady-state solution of equations of a nonequilibrium magnetized plasma
13 p0065 A77-18130
NORTH AMERICA
Crude oil supply alternatives for the Northern Tier states
[PB-255991/2] 13 p0107 N77-12530
NORTHERN HEMISPHERE
Power resource estimate of ocean surface waves
13 p0071 A77-18790
NOZZLE FLOW
The influence of the Reynolds number on the profiles of velocity and concentration in free jets of different density
13 p0069 A77-18500
NUCLEAR ELECTRIC POWER GENERATION
PACER - A practical fusion power concept
13 p0035 A77-12793
The nuclear spinner for Satcom applications --- comparing nuclear and solar power supplies
13 p0041 A77-12838
Nuclear-powered Hysat spacecraft: Comparative design study
[ERDA-SNS-3063-8] 13 p0094 N77-11108
Costs of alternative sources of electricity
[PB-255765/0] 13 p0107 N77-12528
Nuclear unit productivity analysis
[PB-257553/8] 13 p0132 N77-15528
NUCLEAR ELECTRIC PROPULSION
ERDA's Bicentennial Thermionic Research and Technology Program
13 p0042 A77-12861
NUCLEAR ENERGY
Fusion power --- nuclear energy technology development
13 p0005 A77-11034
Problems involved in improving the industrial fuel and energy balance
13 p0012 A77-11347
Nuclear power - Compared to what --- energy alternatives for electric power generation
13 p0017 A77-12234
Is nuclear energy economically viable --- competition with coal
13 p0045 A77-12933
Air, water, nuclear power make gasoline
13 p0045 A77-12935
Environment and energy production after the year 2000
13 p0056 A77-16203

NUCLEAR FUELS
The reprocessing of nuclear fuels
13 p0055 A77-15807
Concept of a fusion burner
13 p0061 A77-17014
Advanced fuels for inertial confinement --- in laser fusion
13 p0061 A77-17016

NUCLEAR FUSION
PACER - A practical fusion power concept
13 p0035 A77-12793
Heat transfer problems associated with laser fusion
13 p0068 A77-18441
Energy and technology review
[UCID-52000-76-2] 13 p0131 N77-15508

NUCLEAR HEAT
Hydrogen production using nuclear heat
13 p0057 A77-16211

NUCLEAR POWER PLANTS
Methods of energy analysis
13 p0007 A77-11046
The mysteries of nuclear programs --- energy conversion efficiency
13 p0011 A77-11337
Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/
13 p0013 A77-11524
The reprocessing of nuclear fuels
13 p0055 A77-15807
Relative hazard of nuclear power stations and fossil-fuel power stations to the environment
13 p0067 A77-18323
Methods in environmental sampling for radionuclides
[UCRL-77722] 13 p0091 N77-10697
Characteristics of a first generation commercial fusion power plant
[GA-A-13661] 13 p0093 N77-10891
Net energy from nuclear power
[PB-254059/9] 13 p0107 N77-12527
Effect of mechanical cooling devices on ambient salt concentration
[PB-256679/2] 13 p0125 N77-14631
Feasibility study of a nuclear power-sewage treatment system for the conservation and reclamation of water resources
[PB-255630/6] 13 p0126 N77-14960
Dual purpose nuclear power plants for military installations
[AD-A026141] 13 p0132 N77-15521

NUCLEAR POWER REACTORS
Studies and thoughts on nuclear reactor systems
13 p0055 A77-15800
Research and development for Canadian nuclear power
[AECL-5314] 13 p0097 N77-11533

NUCLEAR REACTORS
Nuclear power for the production of synthetic fuels and feedstocks
13 p0035 A77-12790
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791
Alkali metal space power technology applicable to national energy research and development
[AIAA PAPER 77-289] 13 p0065 A77-18223
Will the large-scale production of hydrogen be part of the energy problem or part of its solution
[UCRL-76844] 13 p0087 N77-10652
The contribution of nuclear technology toward the solution of energy problems
[INIS-MF-1867] 13 p0100 N77-11565
Heat pipes with a non-condensable gas and their application in nuclear apparatus and instruments
13 p0120 N77-14387

NUCLEAR RESEARCH
World survey of major facilities in controlled fusion research --- Book
13 p0067 A77-18264

NUMERICAL CONTROL
Transport systems guarantee efficient utilization of energy resources
13 p0053 A77-15048

NUMERICAL WEATHER FORECASTING
The influence of subsurface energy storage on seasonal temperature variations
13 p0067 A77-18351

O

OCEAN BOTTOM
Submarine geothermal resources
13 p0010 A77-11322

OCEAN SURFACE
Power resource estimate of ocean surface waves
13 p0071 A77-18790

OCEAN THERMAL ENERGY CONVERSION
The atmosphere and the oceans as energy sources
13 p0005 A77-11036
Power production from high temperature geothermal waters
13 p0030 A77-12751
The utilization and economics of low temperature geothermal water for space heating
13 p0030 A77-12756
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
OTEC - Aerospace and ocean engineering in partnership --- Ocean Thermal Energy Conversion
[AIAA PAPER 77-296] 13 p0066 A77-18227
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships, detailed report
[PB-257444/0] 13 p0116 N77-13554

OCEANOGRAPHY
OTEC - Aerospace and ocean engineering in partnership --- Ocean Thermal Energy Conversion
[AIAA PAPER 77-296] 13 p0066 A77-18227

OFFSHORE ENERGY SOURCES
Off-shore oil scenarios - Method and results
13 p0018 A77-12282
Production of methane using offshore wind energy
13 p0026 A77-12722
Prerequisites for military/civilian geopressured geothermal resource development
13 p0031 A77-12761
Satellite communications for off-shore oil operations using WESTAR
13 p0053 A77-15130
Windmills change direction --- British system utilizing offshore windmills and depleted North Sea fields
13 p0060 A77-16620
Identification and analysis of mid-Atlantic onshore OCS impact
[PB-254925/1] 13 p0096 N77-11516

OHIO
Development of a multi-disciplinary ERTS user program in the state of Ohio
[E77-10045] 13 p0104 N77-12475

OIL EXPLORATION
Energy and the oil industry
13 p0005 A77-11031
A word on worldwide petroleum resources
13 p0011 A77-11336
Concerning world oil resources. II - Statistical logistic models /King Hubbert's models/
13 p0011 A77-11339
World petroleum resources. IV - Probabilistic methods
13 p0012 A77-11342
The world's oil resources. V - Recovery rates
13 p0012 A77-11343
Oil shale development
13 p0023 A77-12693
Satellite communications for off-shore oil operations using WESTAR
13 p0053 A77-15130
The 29950 Earth Resource Technology Satellite (ERTS-A) sensor data for mineral resource sector development and regional land use survey, March - August 1976 --- Bolivia
[E77-10028] 13 p0096 N77-11491
The exploration, development and production of Naval petroleum reserve number 4
[PB-256714/7] 13 p0113 N77-13516
The exploration, development, and production of Naval Petroleum Reserve Number 4
[PB-255947/4] 13 p0124 N77-14610

OIL FIELDS
World oil resources. III - The geological analogy method
13 p0012 A77-11341

Interfacial effects in the recovery of residual oil by displacement: Studies at Northwestern University
[COO-0019-5] 13 p0122 N77-14595
The exploration, development, and production of Naval Petroleum Reserve Number 4
[PB-255947/4] 13 p0124 N77-14610

OIL POLLUTION
Tests of oil recovery devices in broken ice fields, phase 2
[AD-A025748] 13 p0110 N77-12572
Temperature effects of crude oil in the upper intertidal zone
[PB-255956/5] 13 p0110 N77-12581

OIL RECOVERY
The world's oil resources. V - Recovery rates
13 p0012 A77-11343
In situ recovery of oil and minerals from Piceance Creek Basin oil shale
13 p0023 A77-12694
In situ combustion of Michigan oil shale - Current field studies
13 p0024 A77-12695
Retorting of single oil shale blocks with nitrogen and air
13 p0024 A77-12696
The potential and economics of enhanced oil recovery
[PB-254991/3] 13 p0086 N77-10633
Tests of oil recovery devices in broken ice fields, phase 2
[AD-A025748] 13 p0110 N77-12572
Interfacial effects in the recovery of residual oil by displacement: Studies at Northwestern University
[COO-0019-5] 13 p0122 N77-14595
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499

OIL SLICKS
Tests of oil recovery devices in broken ice fields, phase 2
[AD-A025748] 13 p0110 N77-12572

OILS
Storage in oil of off-peak thermal energy from large power stations
13 p0027 A77-12730

OPERATING TEMPERATURE
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924

OPERATIONAL HAZARDS
Relative hazard of nuclear power stations and fossil-fuel power stations to the environment
13 p0067 A77-18323

OPERATIONAL PROBLEMS
Experience in putting the Kiskore hydroelectric power plant on line
13 p0010 A77-11301
Nuclear unit productivity analysis
[PB-257553/8] 13 p0132 N77-15528

OPERATIONS RESEARCH
Trade-off analyses for multi-objective transportation plans
13 p0102 N77-11911
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497

OPTICAL COUPLING
Development of 20 percent efficient solar cell
[PB-255903/7] 13 p0108 N77-12548

OPTICAL PROPERTIES
Effect of optical properties of a surface exposed to solar radiation on the radiation balance
13 p0052 A77-14928
Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range
13 p0069 A77-18496
An inflatable solar concentrator for a high temperature storage system
13 p0074 A77-19064
Double-reflection solar energy concentrators
13 p0074 A77-19067
Symposium on the Fundamental Optical Properties of Solids Relevant to Solar Energy Conversion
[PB-256615/6] 13 p0108 N77-12538
The optical properties of chromium oxide films and the high temperature stabilization of silver films for photothermal solar energy conversion
13 p0128 N77-15484

OPTICAL TRACKING
Performance of two fixed-mirror solar concentrators for process heat
13 p0074 A77-19065

OPTICAL WAVEGUIDES
Characteristics of a system for transmitting concentrated solar radiation
13 p0051 A77-14578

OPTIMAL CONTROL
Optimal control of flow in low temperature solar heat collectors
13 p0019 A77-12409
A new method for collector field optimization --- computerized simulation of solar tower facility
13 p0074 A77-19070

OPTIMIZATION
Optimisation of current source operation in pulse mode --- for electrochemical generators
[IAF PAPER 76-255] 13 p0003 A77-10952
Optimization criteria for solar and wind power systems
13 p0015 A77-11923
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance
13 p0020 A77-12657
The use of program GEOTHM to design and optimize geothermal power cycles
13 p0031 A77-12758
Economic optimization of the energy transport component of a large distributed solar power plant
13 p0037 A77-12807
Collector field optimization for a solar thermal electric power plant
13 p0038 A77-12811
Optimizing solar cooling systems
13 p0047 A77-13502
Dual optimum aerodynamic design for a conventional windmill
13 p0048 A77-13704
Optimization of the geometry of switching buses for thermoelements in thermoelectric generators
13 p0052 A77-14951
Theoretical aspects of optimization of aviation gas turbine engine design variables
13 p0063 A77-17762
Optimized selective coatings for solar collectors
[NASA-TM-X-73498] 13 p0097 N77-11529

ORBITAL ASSEMBLY
The construction of satellite solar power stations from non-terrestrial materials
[AIAA PAPER 77-354] 13 p0066 A77-18259

ORBITAL MECHANICS
Space-based solar power conversion and delivery systems study. Volume 2: Engineering analysis of orbital systems
[NASA-CR-150147] 13 p0129 N77-15495

ORBITAL SPACE STATIONS
Space station systems analysis study. Part 1, volume 1: Executive study
[NASA-CR-151102] 13 p0094 N77-11084
Space station systems analysis study. Part 1, volume 2: Technical report
[NASA-CR-151103] 13 p0094 N77-11085

ORGANIC CHEMISTRY
Thermal alteration of young kerogen in relation to petroleum genesis
13 p0053 A77-15044

ORGANIC COMPOUNDS
Organic Rankine Cycle Engine development and solar energy utilization
13 p0077 A77-19096

ORGANIC MATERIALS
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673
Startup solvent selection for the liquefaction of lignite
13 p0059 A77-16472

ORGANIC WASTES (FUEL CONVERSION)
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673

Fuel gas recovery from controlled landfilling of municipal wastes
13 p0070 A77-18739
A bioenvironmental study of emissions from refuse derived fuel
[AD-A024661] 13 p0110 N77-12571
OSMOSIS
The Osmotic power plant
13 p0021 A77-12668
The palirrhotrophic origin of energy metabolism --- chemiosmotic precursor to phototropism in estuarine cellular organisms
13 p0064 A77-17895
OXIDATION
A combined cycle with a partial-oxidation reactor
13 p0062 A77-17534
Carbon oxidation catalyst mechanism study for fuel cells
[PB-256420/1] 13 p0115 N77-13551
OXIDATION-REDUCTION REACTIONS
The Redox flow system for solar photovoltaic energy storage
[NASA-TM-X-73562] 13 p0106 N77-12522
An improved electrolyte for direct oxidation fuel cells
[AD-A026164] 13 p0131 N77-15518
OXIDE FILMS
Operation of ITO/Si heterojunction solar cells
13 p0014 A77-11762
Study of cathode spots in the presence of slag films on the electrodes of an open-cycle MHD generator
13 p0053 A77-15005
OXYGEN COMPOUNDS
Electric current from the direct conversion of low molecular weight C,H,O-compounds
13 p0055 A77-15814
OZONE
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568

P

P-N JUNCTIONS
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916
Spectral response of a laterally illuminated p-n junction --- as photodetector or photovoltaic energy converter
13 p0062 A77-17478
An analysis of silicon solar cell parameters for terrestrial applications
13 p0076 A77-19081
PAKISTAN
Hydel and solar power for Pakistan --- hydroelectric power
13 p0079 A77-19121
PARABOLIC REFLECTORS
Ideal concentrators for finite sources and restricted exit angles --- parabolic solar collector
13 p0003 A77-10835
Radiant-vector distribution in the radiant field of a parabolocylindric concentrator
13 p0015 A77-11920
Calculations on an optimized faceted solar concentrator
13 p0015 A77-11921
Performance analysis of a cylindrical parabolic focusing collector and comparison with experimental results
13 p0019 A77-12410
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
Double-reflection solar energy concentrators
13 p0074 A77-19067
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
PARABOLOID MIRRORS
Energetic calculation of the concentrating capacity of paraboloidal facets
13 p0051 A77-14579
Standard-size facets for the reflecting surface of a solar concentrator
13 p0063 A77-17557
A Cassegrain system for solar radiation
13 p0063 A77-17561
Design and fabrication of solar concentrators
13 p0074 A77-19062
An inflatable solar concentrator for a high temperature storage system
13 p0074 A77-19064
PARAFFINS
Two component thermal energy storage material
[PB-252592/1] 13 p0090 N77-10675
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689
PARAMETRIC FREQUENCY CONVERTERS
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
PARTIAL PRESSURE
Investigation of gas-controlled heat pipes with reservoirs of constant and variable volume
13 p0050 A77-14327
PARTICLE EMISSION
Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions
13 p0008 A77-11162
PARTICLE SIZE DISTRIBUTION
Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions
13 p0008 A77-11162
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890
PARTICULATE SAMPLING
Compilation of an inventory for particulate emissions in Belgium
13 p0009 A77-11271
PASSENGER AIRCRAFT
Application of advanced technology to future long-range aircraft
[SAWE PAPER 1126] 13 p0016 A77-12194
PASSIVITY
Heat pipe materials compatibility
[NASA-CR-135069] 13 p0103 N77-12182
PATENT APPLICATIONS
Auxiliary power system for activity cooled aircraft
[NASA-CASE-LAR-11626-1] 13 p0103 N77-12332
PAYLOADS
The International Heat Pipe Experiment --- Black Brant sounding rocket payload zero gravity experiment
13 p0120 N77-14389
PENNSYLVANIA
Application of LANDSAT-2 data to the implementation and enforcement of the Pennsylvania Surface Mining Conservation and Reclamation Act
[E77-10007] 13 p0085 N77-10590
Characterization and evaluation of wastewater sources United States Steel Corporation, Clairton Works, Pittsburgh, Pennsylvania, 28-31 January 1976
[PB-255586/0] 13 p0116 N77-13566
PERFORMANCE PREDICTION
Performance theory of diagonal conducting wall MHD generators
13 p0001 A77-10202
Solar thermal electric power plants - Their performance characteristics and total social costs
13 p0037 A77-12804
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822
A simplified method in flight test techniques for the determination of the range performance of jet aircraft
13 p0060 A77-16600
Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials
13 p0068 A77-18444
Axial conduction in a flat-plate solar collector
13 p0068 A77-18447

Arrays of fixed flat-plate solar energy collectors - Performance comparisons for differing individual component orientations
13 p0068 A77-18449
General Motors Sulfate Dispersion Experiment - Assessment of the EPA HIWAY model
13 p0071 A77-18882
Performance of an annular cylindrical solar collector
13 p0073 A77-19059
Investigation of performance limits in axial groove heat pipes
[NASA-CR-137912] 13 p0095 N77-11340
Method for estimating solar heating and cooling system performance
[AD-A026041] 13 p0116 N77-13557

PERFORMANCE TESTS
A method of testing for rating solar collectors based on thermal performance
13 p0019 A77-12408
Selection of driving cycles for electric vehicles of the 1990's
13 p0024 A77-12702
Baseline test data for the EVA electric vehicle --- low energy consumption automobiles
13 p0025 A77-12704
A unique Rankine-cycle heat pump system
13 p0036 A77-12799
Comparative performance of solar thermal power generation concepts
13 p0036 A77-12803
Design and performance of thermal storage water tank
13 p0075 A77-19079
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
Standardized performance tests of collectors of solar thermal energy - A flat-plate copper collector with parallel mylar striping
[NASA-TM-X-73553] 13 p0114 N77-13535
Standardized performance tests of collectors of solar thermal energy: An evacuated flatplate copper collector with a serpentine flow distribution
[NASA-TM-X-73415] 13 p0114 N77-13536
Effect of ceramic coating of JT8D combustor liner on maximum liner temperatures and other combustor performance parameters
[NASA-TM-X-73581] 13 p0126 N77-15037

PERTURBATION THEORY
Perturbation analysis of second-order effects in kinetics of oil-shale pyrolysis
13 p0070 A77-18585

PHASE TRANSFORMATIONS
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689

PHOSPHORIC ACID
Fuel cell stacks
[AD-A024216] 13 p0090 N77-10684

PHOTOCHEMICAL REACTIONS
Photosynthesis as a resource for energy and materials
13 p0017 A77-12233
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666
Chemical evolution of photosynthesis
13 p0071 A77-18898
The theory of hydrogen production in a photoelectrochemical cell
13 p0075 A77-19075
Solar energy utilization - The photochemical approach
13 p0075 A77-19076
The photosynthetic production of hydrogen
13 p0075 A77-19077
Photochemical conversion of solar energy
[PB-255703/1] 13 p0090 N77-10685

PHOTOCONDUCTIVE CELLS
Utilization of solar power - A new departure
13 p0053 A77-15049

PHOTODIODES
Spectral response of a laterally illuminated p-n junction --- as photodetector or photovoltaic energy converter
13 p0062 A77-17478

PHOTOELECTRIC CELLS
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108
The theory of hydrogen production in a photoelectrochemical cell
13 p0075 A77-19075
Alternating photoelectrochemical converters
13 p0077 A77-19093

PHOTOELECTRICITY
Energy conversion via photoelectrolysis
13 p0021 A77-12667

PHOTOINTERPRETATION
Use of radar in geology
13 p0018 A77-12256
Cross structural plan of the earth's crust and the problem of the manifestation of its plutonic elements on the surface (Tyan-Shan and Turan plate as examples)
[NASA-TT-F-16938] 13 p0117 N77-13590

PHOTOLYSIS
Production of chemical energy carriers by non-expandable energy sources --- solar energy electrolysis, photolysis, and thermochemical cycles
[DLR-FB-76-32] 13 p0114 N77-13541

PHOTOMAPPING
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121

PHOTOMETERS
Solar power array for the concentration of energy. Task 2: Modifications to a specular photometer
[COO-2699-3] 13 p0098 N77-11538

PHOTOMICROGRAPHY
Mechanisms of coal particle dissolution
13 p0059 A77-16475

PHOTOSYNTHESIS
Photosynthesis as a resource for energy and materials
13 p0017 A77-12233
Chemical evolution of photosynthesis
13 p0071 A77-18898
The photosynthetic production of hydrogen
13 p0075 A77-19077

PHOTOVOLTAIC CELLS
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916
Photovoltaic conversion of solar energy
13 p0058 A77-16368
The lensed high-voltage vertical multijunction solar cell
13 p0069 A77-18489
New analysis of a high-voltage vertical multijunction solar cell
13 p0069 A77-18490
Reply to 'New analysis of a high-voltage vertical multijunction solar cell'
13 p0069 A77-18491
Photovoltaic effect applications
13 p0075 A77-19080
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088
Double-faced silicon solar cell system
13 p0076 A77-19090
Photochemical conversion of solar energy
[PB-255703/1] 13 p0090 N77-10685
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
The Redox flow system for solar photovoltaic energy storage
[NASA-TM-X-73562] 13 p0106 N77-12522
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications
[PB-255646/2] 13 p0109 N77-12551
Definition study for photovoltaic residential prototype system
[NASA-CR-135039] 13 p0113 N77-13532
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533

PHOTOVOLTAIC CONVERSION
Photovoltaic and thermal energy conversion for solar powered satellites
[IAF PAPER 76-117] 13 p0003 A77-10913
The ERDA Photovoltaic Systems Definition Project 13 p0038 A77-12815
Performance and cost analysis of photovoltaic power systems for on-site residential applications 13 p0038 A77-12816
New concepts in solar photovoltaic electric power systems design 13 p0038 A77-12817
An integrated photovoltaic/thermal High Intensity Solar Energy System /HISES/ concept for residential applications 13 p0039 A77-12818
Alternative strategies for implementing silicon-ribbon technology for photovoltaic applications 13 p0039 A77-12819
Spectral response of a laterally illuminated p-n junction --- as photodetector or photovoltaic energy converter 13 p0062 A77-17478
A sulfurization process for the preparation of photovoltaic Cu/x/S and $CuInS_2$ thin films 13 p0076 A77-19087
Photovoltaic systems using sunlight concentration 13 p0076 A77-19089
Status of the ERDA/NASA photovoltaic tests and applications project
[NASA-TM-X-73567] 13 p0114 N77-13537
Composite material structures for thermophotovoltaic conversion radiator
[AD-A026859] 13 p0132 N77-15519
PHOTOVOLTAIC EFFECT
Photovoltaic effect applications 13 p0075 A77-19080
Meeting electric power needs with photovoltaic power systems 13 p0076 A77-19091
Investigation of a TiO2/electrolyte solar cell and the photocatalytic water decomposition 13 p0077 A77-19094
PHTHALOCYANIN
Manufacturing and evaluation of phthalocyanines as catalysts for fuel cells
[BMFT-FB-T-76-25] 13 p0114 N77-13540
PHYSICAL CHEMISTRY
Feasibility study of a nuclear power-sewage treatment system for the conservation and reclamation of water resources
[PB-255630/6] 13 p0126 N77-14960
PHYSICAL PROPERTIES
The influence of the properties of coals on their conversion into clean fuels 13 p0009 A77-11245
Theoretical, numerical, and physical techniques for characterizing power plant plumes
[PB-253099/6] 13 p0101 N77-11599
PILOT PLANTS
Design of a 100 BPD pilot plant to convert methanol to gasoline using the Mobil process 13 p0023 A77-12691
PIPE FLOW
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements 13 p0028 A77-12735
PIPELINES
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements 13 p0028 A77-12735
Utility facilities in transportation corridors
[PB-255635/5] 13 p0093 N77-10970
Heat pipes for the trans-Alaska pipeline 13 p0120 N77-14388
PISTON ENGINES
The performance of hydrogen-injected reciprocating engines 13 p0033 A77-12780
The Stirling engine - Engineering considerations in view of future needs 13 p0041 A77-12842
Hydrogen as a fuel in compression ignition engines 13 p0071 A77-18932
PISTON THEORY
Self-starting, intrinsically controlled Stirling engine 13 p0041 A77-12844
PLANTS (BOTANY)
Photosynthesis as a resource for energy and materials 13 p0017 A77-12233
A fermentation process for converting plant materials into methane 13 p0121 N77-14583
PLASMA CONDUCTIVITY
Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream 13 p0001 A77-10423
Study of the ionization of the additive in MHD installations 13 p0002 A77-10424
PLASMA CONTROL
Current status of the magnetic fusion program 13 p0035 A77-12792
The prospect for fusion --- controlled nuclear fusion 13 p0058 A77-16357
Concept of a fusion burner 13 p0061 A77-17014
Advanced fuels for inertial confinement --- in laser fusion 13 p0061 A77-17016
A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices 13 p0061 A77-17017
World survey of major facilities in controlled fusion research --- Book 13 p0067 A77-18264
PLASMA DIAGNOSTICS
Schlieren measurements of a high density z-pinch 13 p0060 A77-16697
PLASMA DYNAMICS
Performance theory of diagonal conducting wall MHD generators 13 p0001 A77-10202
Schlieren measurements of a high density z-pinch 13 p0060 A77-16697
PLASMA ELECTRODES
Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream 13 p0001 A77-10423
Boundary-layer separation from the electrode wall of an MHD generator 13 p0048 A77-13711
A 2-MW electric arc generator with porous cooling of the interelectrode insert 13 p0049 A77-13831
Study of cathode spots in the presence of slag films on the electrodes of an open-cycle MHD generator 13 p0053 A77-15005
PLASMA GENERATORS
A 2-MW electric arc generator with porous cooling of the interelectrode insert 13 p0049 A77-13831
PLASMA HEATING
Muon catalysed fusion for pellet ignition 13 p0012 A77-11468
Supplementary plasma heating studies in the atomic energy commission, France 13 p0064 A77-17819
PLASMA LOSS
Influence of various losses on the characteristics of high-power MHD generators 13 p0046 A77-13258
PLASMA PINCH
Schlieren measurements of a high density z-pinch 13 p0060 A77-16697
PLASMA POWER SOURCES
Limiting capabilities with respect to electric power generation of a pulsed MHD generator operating at a resistive load 13 p0064 A77-17917
PLASMA TEMPERATURE
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator 13 p0054 A77-15666

PLASMA-PARTICLE INTERACTIONS
Muon catalysed fusion for pellet ignition
13 p0012 A77-11468
PLASTICS
Plastics for solar-energy collectors. I - General aspects, hot-water collectors, design variants
13 p0009 A77-11267
Plastics for solar-energy collectors. II - Typical operational data and model parameters, functional diagrams, optimization of layer thicknesses
13 p0009 A77-11269
PLATINUM
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529
PLUMES
Theoretical, numerical, and physical techniques for characterizing power plant plumes
[PB-253099/6] 13 p0101 N77-11599
PLUTONIUM OXIDES
KIPS - Kilowatt Isotope Power System --- for use in satellites
13 p0041 A77-12837
POLAR REGIONS
Concrete placing techniques used during the construction of the kasnoyarsk hydroelectric power plant
[AD-A026967] 13 p0121 N77-14528
POLARIZATION CHARACTERISTICS
Air electrodes for H2-air fuel cells with alkali electrolyte
13 p0065 A77-18196
POLLUTION CONTROL
The fuel approach to control emissions from aircraft
[IAF PAPER 76-111] 13 p0003 A77-10911
Controlled tipping of combustion residues
13 p0008 A77-11175
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
Air cleanup and energy management
13 p0010 A77-11302
Clean air protection and industrial development
13 p0010 A77-11303
The conservation of air purity and its effect on the energy economy
13 p0049 A77-13811
Alternate fuels for road vehicles of the future
13 p0051 A77-14584
The proceedings of the NOx Control Technology Seminar
[PB-253661/3] 13 p0092 N77-10707
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719
Field test sampling/analytical strategies and implementation cost estimates: Coal gasification and flue gas desulfurization
[PB-254166/2] 13 p0101 N77-11581
The air quality and economic implications of supplementary control systems in Illinois --- considering electric power plant fuels
[PB-255699/1] 13 p0101 N77-11588
Investigation and assessment of light-duty-vehicle evaporative emission sources and control
[PB-255813/8] 13 p0102 N77-11603
Proceedings of the Stationary Source Combustion Symposium. Volume 1. Fundamental research
[PB-256320/3] 13 p0116 N77-13569
Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570
Evaluation of pollution control in fossil fuel conversion processes
[PB-255842/7] 13 p0125 N77-14638
Hot fuel gas desulfurization
[PB-257036/4] 13 p0133 N77-15539
Performance of emission control devices on boilers firing municipal solid waste and oil
[PB-257136/2] 13 p0133 N77-15550
POLLUTION MONITORING
Evolution of atmospheric pollution /high acidity and black fumes/ in France during 1975
13 p0002 A77-10670
Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer
13 p0062 A77-17541
Tracking pollutants from a distance
13 p0067 A77-18370
Organization of long range transport of air pollution monitoring in Europe
13 p0071 A77-18754
Advanced coal gasification system for electric power generation --- pollution monitoring
[PB-1514-176] 13 p0088 N77-10653
Methods in environmental sampling for radionuclides
[UCRL-77722] 13 p0091 N77-10697
Compilation of air pollutant emission factors. Supplement
[PB-254274/4] 13 p0093 N77-10731
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380
Pollutant potential of raw and chemically fixed hazardous industrial wastes and flue gas desulfurization sludges
[PB-256691/7] 13 p0133 N77-15540
POLYCRYSTALS
Deposition of polycrystalline silicon solar cells
13 p0076 A77-19082
POLYETHYLENES
Solar water heater using hardened black polythene pipe absorbers
13 p0073 A77-19060
POLYMER CHEMISTRY
Solid Polymer Electrolyte (SPE) fuel cell technology, program review, phase 2
[NASA-CR-150957] 13 p0097 N77-11532
POLYMERIC FILMS
Plastics for solar-energy collectors. II - Typical operational data and model parameters, functional diagrams, optimization of layer thicknesses
13 p0009 A77-11269
POROUS MATERIALS
A comparison of porous silver catalysts in oxygen electrodes of alkaline fuel cells
13 p0067 A77-18350
Desulfurization of flue gases with iron/III/ oxide on porous carrier material - Theoretical and experimental investigation concerning the modelling of semicontinuous solid bed reactors with gas-solid reactions --- German book
13 p0080 A77-19184
POROUS WALLS
A 2-MW electric arc generator with porous cooling of the interelectrode insert
13 p0049 A77-13831
POSITION ERRORS
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
POSTFLIGHT ANALYSIS
Concorde - Endurance flights results
13 p0016 A77-12114
POTASSIUM COMPOUNDS
Evaluation of potassium titanate as a component of alkaline fuel cell matrices
[NASA-TN-D-8341] 13 p0094 N77-11175
POTENTIAL ENERGY
Storage of solar energy in the form of potential hydraulic energy
13 p0075 A77-19078
POWER EFFICIENCY
Optimisation of current source operation in pulse mode --- for electrochemical generators
[IAF PAPER 76-255] 13 p0003 A77-10952
Selection of driving cycles for electric vehicles of the 1990's
13 p0024 A77-12702
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
Dependability of wind energy generators with short-term energy storage
13 p0046 A77-13323
Multi-year time frame optimization of power systems with fossil, nuclear, hydro, pumped storage and peaking units
13 p0096 N77-11525

An estimate of the interaction of a limited array of windmills --- feasibility of windpower group station for proposed site
[DM-16] 13 p0114 N77-13539
POWER PLANTS
Evolution of atmospheric pollution /high acidity and black fumes/ in France during 1975
13 p0002 A77-10670
Economic and engineering implications of the Project Independence 1985 geothermal energy output goal and the associated sensitivity analysis
13 p0029 A77-12745
Direct contact heat exchangers for geothermal power plants
13 p0029 A77-12747
Aerothermic power plant with artificial cyclone
13 p0077 A77-19098
POWER SUPPLIES
Multi-year time frame optimization of power systems with fossil, nuclear, hydro, pumped storage and peaking units
13 p0096 N77-11525
PRECIPITATION (METEOROLOGY)
Organization of long range transport of air pollution monitoring in Europe
13 p0071 A77-18754
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630
PREDICTION ANALYSIS TECHNIQUES
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497
PRESSURE DISTRIBUTION
Pressure ratio optimization criteria in aircraft turbojet-engines design
13 p0062 A77-17258
PRESSURE EFFECTS
The Osmotic power plant
13 p0021 A77-12668
PRESSURE GRADIENTS
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements
13 p0028 A77-12735
PRESSURIZING
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
PRINTED CIRCUITS
Encapsulation of solar cell modules
13 p0076 A77-19092
PRODUCT DEVELOPMENT
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
Heat pipe and space radiator developments
13 p0120 N77-14391
PRODUCTION ENGINEERING
A sulfurization process for the preparation of photovoltaic Cu/x/S and CuInS2 thin films
13 p0076 A77-19087
Meeting electric power needs with photovoltaic power systems
13 p0076 A77-19091
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
Prospects for hydrogen production by water electrolysis to be competitive with conventional methods
[BNL-20877] 13 p0087 N77-10648
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207
Industrial development of silicon solar cells
[NASA-TT-F-17139] 13 p0097 N77-11528
PRODUCTION MANAGEMENT
Evolution of the concept of the automobile from the standpoint of saving energy
13 p0051 A77-14562
Weekly petroleum statistics reports, 1974-1975
[PB-255920/1] 13 p0124 N77-14608
PROJECT MANAGEMENT
Fossil energy research and development in ERDA
13 p0063 A77-17551
The economic viability of pursuing a space power system concept
[AIAA PAPER 77-353] 13 p0066 A77-18258
PROJECT PLANNING
Risk management of liquefied natural gas installations
13 p0002 A77-10451
Off-shore oil scenarios - Method and results
13 p0018 A77-12282
Energy: The policy planning framework in state governments. Volume 1: Summary report
[PB-254466/6] 13 p0089 N77-10665
Energy: The policy planning framework in state governments. Volume 2: Appendices
[PB-254467/4] 13 p0089 N77-10666
Air quality considerations in transportation planning: Findings and recommendations on transportation control planning, phase 2
[PB-256424/3] 13 p0110 N77-12576
PROPANE
Petroleum market shares. Report on sales of propane to ultimate consumers, 1975
[PB-255624/9] 13 p0108 N77-12540
PROPELLANT ADDITIVES
Protocol to characterize gaseous emissions as a function of fuel and additive composition
[PB-253363/6] 13 p0084 N77-10221
PROPELLANT STORAGE
A survey of salt deposits and salt caverns: Their relevance to the strategic petroleum reserve
[PB-255948/2] 13 p0105 N77-12500
PROPELLANT TESTS
Liquid hydrogen as propellant for commercial aircraft
[DGLR PAPER 76-188] 13 p0059 A77-16534
PROPELLER FANS
Energy consumption characteristics of transports using the prop-fan concept
[NASA-CR-137937] 13 p0118 N77-14029
Energy consumption characteristics of transports using the prop-fan concept: Summary report
[NASA-CR-137938] 13 p0118 N77-14030
PROPELLERS
Energy consumption characteristics of transports using the prop-fan concept
[NASA-CR-137937] 13 p0118 N77-14029
Energy consumption characteristics of transports using the prop-fan concept: Summary report
[NASA-CR-137938] 13 p0118 N77-14030
PROPULSION SYSTEM CONFIGURATIONS
Ultralightweight solar array for Naval Sea Control Systems
13 p0040 A77-12828
Pressure ratio optimization criteria in aircraft turbojet-engines design
13 p0062 A77-17258
Variable geometry for high performance aircraft engines
13 p0062 A77-17264
PROPULSION SYSTEM PERFORMANCE
Laser propulsion --- rocket heat engine design
[IAF PAPER 76-166] 13 p0003 A77-10931
Electric vehicle batteries - Opportunities for materials improvement
13 p0049 A77-13736
Fuel consumption of civil jet transport aircraft
13 p0062 A77-17234
Technical highlights in general aviation
[AIAA PAPER 77-312] 13 p0066 A77-18237
PROPULSIVE EFFICIENCY
Pressure ratio optimization criteria in aircraft turbojet-engines design
13 p0062 A77-17258
PROTOTYPES
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533
PUBLIC LAW
Law and solar energy systems - Legal impediments and inducements to solar energy systems
13 p0018 A77-12401
PULSE DURATION MODULATION
Linear model of a dissipative PWM shunt regulator --- Pulse Width Modulation
13 p0080 A77-19172

PULSE GENERATORS
Limiting capabilities with respect to electric power generation of a pulsed MHD generator operating at a resistive load
13 p0064 A77-17917
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293
PULSE TIME MODULATION
Shaping of laser pulses in an amplifying system receiving input signals with a variable spectrum
13 p0053 A77-15237
PULSED LASERS
Shaping of laser pulses in an amplifying system receiving input signals with a variable spectrum
13 p0053 A77-15237
PUMPING
Water pumping - A practical application of solar energy
13 p0079 A77-19117
PYRANOMETERS
Accelerated response of thermopile pyranometers
13 p0019 A77-12405
A method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds --- for solar collector design
13 p0019 A77-12412
PYROHELIOMETERS
Autonomous station for the acquisition and concentration of heliometric data
13 p0072 A77-19046
PYROLYSIS
Energy from solid wastes --- Book
13 p0003 A77-10698
Dutchess County, NY moves towards pyrolysis --- of solid wastes with fuel recovery
13 p0010 A77-11298
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Hydrogen production using solar radiation
13 p0048 A77-13540
Perturbation analysis of second-order effects in kinetics of oil-shale pyrolysis
13 p0070 A77-18585
Basic studies of coal pyrolysis and hydrogasification
[PB-254878/2] 13 p0096 N77-11511
Production of a hydrocarbon-type synthetic fuel from wood
[NRC-15638] 13 p0127 N77-15210
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499

Q

QUALIFICATIONS
Testing and fabrication of solar absorbers for the D5A' satellite
[CNES-NT-37] 13 p0111 N77-13110
QUALITY CONTROL
High temperature gas turbine engine component materials testing program
[PE-1765-7] 13 p0127 N77-15401

R

RADAR IMAGERY
Use of radar in geology
13 p0018 A77-12256
RADIANT COOLING
Flight results of a cryogenic cooler designed for Meteosat
[IAF PAPER 76-210] 13 p0003 A77-10942
RADIANT FLUX DENSITY
Energetic calculation of the concentrating capacity of paraboloidal facets
13 p0051 A77-14579
RADIANT HEATING
Solar assisted heat pumps: A possible wave of the future
[NASA-CR-2771] 13 p0121 N77-14584
RADIATION DETECTORS
Spectral response of a laterally illuminated p-n junction --- as photodetector or photovoltaic energy converter
13 p0062 A77-17478
RADIATION DISTRIBUTION
Isothermal surface in a radiation field --- in solar thermal energy devices
13 p0014 A77-11918
Radiant-vector distribution in the radiant field of a parabolocylindric concentrator
13 p0015 A77-11920
Irradiation field formation on the receiver of 'precise' and 'unprecise' solar concentrators
13 p0057 A77-16209
RADIATION DOSAGE
Occupational radiation exposure at light water cooled power reactors, 1969-1975
[PB-257054/7] 13 p0125 N77-14740
RADIATION EFFECTS
Radiation effects on high efficiency silicon solar cells
13 p0064 A77-18072
RADIATIVE HEAT TRANSFER
Isothermal surface in a radiation field --- in solar thermal energy devices
13 p0014 A77-11918
The problem of use of solar energy specific features of radiative, heat, and mass transfer in solar installations
13 p0057 A77-16204
RADIATIVE TRANSFER
Study of emittance distribution along the walls of a cellular low-loss cell in the case of a base surface with arbitrary emission indicatrix
13 p0069 A77-18495
RADIO FREQUENCY HEATING
Supplementary plasma heating studies in the atomic energy commission, France
13 p0064 A77-17819
RADIOACTIVE ISOTOPES
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678
Isotope heat source for dynamic power systems
13 p0036 A77-12796
RADIOACTIVE MATERIALS
Development of a small radioisotopic heat source
13 p0042 A77-12852
Spherical radioisotope thermoelectric generators - An approach to high specific power devices
13 p0042 A77-12857
RADIOACTIVE WASTES
Methods in environmental sampling for radionuclides
[UCRL-77722] 13 p0091 N77-10697
RADIOISOTOPE BATTERIES
Test and evaluation of the Navy half-watt RTG --- Radioisotope Thermoelectric Generator
13 p0042 A77-12853
The low cost high performance generator /LCHPG/ --- space Radioisotope Thermoelectric Generators
13 p0042 A77-12855
RADIOLYSIS
Radiolytic hydrogen production from a laser fusion system
13 p0035 A77-12795
RAIL TRANSPORTATION
Evolution of thermal traction - From the diesel engine to the gas turbine
13 p0004 A77-10976
Electric arc power collection for high-speed trains
13 p0060 A77-16594
RAMS (PRESSES)
Hydraulic ram effect on composite fuel cell entry walls
[AD-A024832] 13 p0115 N77-13548
RANKINE CYCLE
Solar powered organic Rankine cycle engines - Characteristics and costs
13 p0036 A77-12798
A unique Rankine-cycle heat pump system
13 p0036 A77-12799
Solar-powered Rankine-cycle heat pump system
13 p0036 A77-12800
Alternate fuel capability of Rankine cycle engines
13 p0036 A77-12801
Solar thermal power generation
13 p0077 A77-19095

Organic Rankine Cycle Engine development and solar energy utilization
13 p0077 A77-19096
Comparative evaluation of solar heating alternatives [COO-2703-2] 13 p0129 N77-15498
RAPID TRANSIT SYSTEMS
Transport of the future and the tasks of science
13 p0048 A77-13643
Electric arc power collection for high-speed trains
13 p0060 A77-16594
Aerodynamics as a subway design parameter
13 p0070 A77-18721
Personal rapid transit research conducted at the Aerospace Corporation [PB-256846/7] 13 p0111 N77-12946
RARE EARTH ELEMENTS
Hydrogen atoms: Rare earth ions: Magnetic resonance studies on polycrystalline solids and surface systems relevant to catalysis and other energy-related research
13 p0117 N77-13798
REACTION KINETICS
The influence of the properties of coals on their conversion into clean fuels
13 p0009 A77-11245
A new hydrogen storage electrode
13 p0047 A77-13539
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
Gas release during long-term operation of heat pipes
13 p0050 A77-14328
Perturbation analysis of second-order effects in kinetics of oil-shale pyrolysis
13 p0070 A77-18585
REACTIVITY
Reactivity of oil shale carbonaceous residue with oxygen and carbon dioxide [UCRL-77829] 13 p0123 N77-14596
REACTOR DESIGN
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
Current status of the magnetic fusion program
13 p0035 A77-12792
Heat pipe nuclear reactor for space power
13 p0036 A77-12797
The prospect for fusion --- controlled nuclear fusion
13 p0058 A77-16357
Characteristics of a first generation commercial fusion power plant [GA-A-13661] 13 p0093 N77-10891
REACTOR PHYSICS
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
REACTOR TECHNOLOGY
Fusion power --- nuclear energy technology development
13 p0005 A77-11034
Studies and thoughts on nuclear reactor systems
13 p0055 A77-15800
Concept of a fusion burner
13 p0061 A77-17014
World survey of major facilities in controlled fusion research --- Book
13 p0067 A77-18264
The contribution of nuclear technology toward the solution of energy problems [INIS-MF-1867] 13 p0100 N77-11565
RECEIVERS
Irradiation field formation on the receiver of 'precise' and 'unprecise' solar concentrators
13 p0057 A77-16209
RECLAMATION
Application of LANDSAT-2 data to the implementation and enforcement of the Pennsylvania Surface Mining Conservation and Reclamation Act [E77-10007] 13 p0085 N77-10590
RECTIFIERS
Windmills stage a comeback --- review
13 p0048 A77-13624
RECYCLING
Energy from solid wastes --- Book
13 p0003 A77-10698
The role of recycling in conservation of metals and energy
13 p0061 A77-16825
Energy and environmental impacts of materials alternatives - An assessment of quantitative understanding
13 p0070 A77-18738
Recycling trends in the United States: A review [PB-254222/3] 13 p0085 N77-10391
REDUCED GRAVITY
The International Heat Pipe Experiment --- Black Brant sounding rocket payload zero gravity experiment
13 p0120 N77-14389
REFINING
A laboratory evaluation of precoat filtration parameters for the solvent refined coal process
13 p0059 A77-16474
The production and refining of crude oil into military fuels [AD-A024652] 13 p0095 N77-11207
Trends in refinery capacity and utilization: Petroleum refineries in the United States; foreign refinery exporting centers [PB-256966/3] 13 p0132 N77-15523
REFRACTORY MATERIALS
Development of sodium/sulfur-cells
13 p0026 A77-12716
High-temperature ceramics for automobile gas turbines. II
13 p0063 A77-17591
REFRIGERANTS
Wetting and surface properties of refrigerants to be used in heat pipes --- surface tension and wall contact angles
13 p0119 N77-14386
REFRIGERATORS
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
REGENERATORS
Heat-pipe regenerator for gas turbine engine
13 p0020 A77-12528
Analysis of parameters and characteristics of a bypass turbojet engine operating in a cycle with stepwise heat removal
13 p0063 A77-17765
REGIONAL PLANNING
The 29950 Earth Resource Technology Satellite (ERTS-A) sensor data for mineral resource sector development and regional land use survey, March - August 1976 --- Bolivia [E77-10028] 13 p0096 N77-11491
Bonneville power administration electric energy conservation study [PB-256766/7] 13 p0115 N77-13550
Rapid growth from energy projects: Ideas for state and local action. A program guide [PB-257374/9] 13 p0132 N77-15527
REGULATIONS
Regulatory reform of air transportation [AIAA PAPER 77-276] 13 p0065 A77-18215
REINFORCING FIBERS
Software aspects of super composites --- composition selection to meet user requirements
13 p0053 A77-15301
RELAY SATELLITES
Space-based solar power conversion and delivery systems study. Volume 1: Executive summary [NASA-CR-150146] 13 p0129 N77-15494
RELIABILITY ANALYSIS
R&M - Today's heating and cooling vs. solar energy
13 p0002 A77-10482
RELIABILITY ENGINEERING
Satellite communications for off-shore oil operations using WESTAR
13 p0053 A77-15130
REMOTE SENSORS
Remote sensing of an underground coal-burn cavity with a wide-band induction system
13 p0007 A77-11050
Tracking pollutants from a distance
13 p0067 A77-18370
Utilization of remote sensing techniques to detect land use effects on wildland water quality
13 p0071 A77-18984

Remote sensing of geothermic activities of the volcanoes Aetna, Stromboli and Vesuv by means of infra-red NOAA-VHRR-satellite data --- Italy
13 p0104 N77-12485

REPORTS
Advanced coal gasification system for electric power generation --- pollution monitoring
[PE-1514-176] 13 p0088 N77-10653

RESEARCH AIRCRAFT
Hypersonic technology-approach to an expanded program
13 p0051 A77-14597

RESEARCH AND DEVELOPMENT
Energy: Mathematics and models; Proceedings of the Conference, Alta, Utah, July 7-11, 1975
13 p0008 A77-11233
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
Application of advanced technology to future long-range aircraft
[SAWE PAPER 1126] 13 p0016 A77-12194
An energy center in Sri Lanka --- UN rural energy development program
13 p0021 A77-12669
Benefits of hydrogen production research
13 p0032 A77-12768
Survey of hydrogen energy application projects
13 p0033 A77-12778
Current status of the magnetic fusion program
13 p0035 A77-12792
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
The ERDA Photovoltaic Systems Definition Project
13 p0038 A77-12815
A summary of solar heating and cooling of buildings /SHACOB/ - Phase I demonstration planning studies
13 p0039 A77-12821
ERDA's Bicentennial Thermionic Research and Technology Program
13 p0042 A77-12861
NASA thermionic-conversion program
13 p0043 A77-12863
Operational experience with small wind units
13 p0044 A77-12873
NASA electric propulsion program
[AIAA PAPER 76-1068] 13 p0045 A77-13033
Can Canada harness the wind
13 p0053 A77-15047
Energy research for physicists
13 p0054 A77-15350
Energy research in the UK
13 p0055 A77-15812
Fossil energy research and development in ERDA
13 p0063 A77-17551
Alkali metal space power technology applicable to national energy research and development
[AIAA PAPER 77-289] 13 p0065 A77-18223
Technical highlights in general aviation
[AIAA PAPER 77-312] 13 p0066 A77-18237
Overview of the ERDA fusion power program
13 p0068 A77-18446
Research at the EURATOM-CCR Center --- on solar energy
13 p0080 A77-19126
Research and development for Canadian nuclear power
[AECL-5314] 13 p0097 N77-11533
An analysis of the technology role in US power during the mid-range period
[AD-A024042] 13 p0102 N77-11927
Outlook for research and development in the underground gasification of coal
[PB-256155/3] 13 p0109 N77-12555
Inventory of energy research and development (1973 - 1975), volume 5
[GPO-64-734] 13 p0121 N77-14579
Geothermal R and D project report
[ANCR-1283] 13 p0124 N77-14605

RESEARCH MANAGEMENT
Creating energy choices for the future. Public meeting on A National Plan for Energy Research, Development, and Demonstration
[CONF-751228-P2] 13 p0087 N77-10646
Analysis of fiscal year 1977 DOT program by policy and RD and D management objectives. Program levels for fiscal years 1975, 1976, 1977, volume 1
[PB-255401/2] 13 p0117 N77-13922

RESEARCH PROJECTS
Energy from solid wastes --- Book
13 p0003 A77-10698
Application of solar heat to buildings in Austria
13 p0079 A77-19114
Solar heating projects at the Institute for Environmental Research --- in Austria
13 p0079 A77-19119

RESERVES
Strategic petroleum reserve
[PB-255476/4] 13 p0098 N77-11546

RESERVOIRS
Seasonal storage of thermal energy in water in the underground --- reservoirs
13 p0028 A77-12734
Pressure drawdown and buildup analyses in geothermal reservoirs
13 p0030 A77-12753

RESIDENTIAL AREAS
Detailed geographic analysis of residential energy consumption
13 p0043 A77-12864
National Emissions Data Systems (NEDS) fuel use report, 1973
[PB-253908/8] 13 p0083 N77-10220
Evaluation of the air-to-air heat pump for residential space conditioning
[PB-255652/0] 13 p0108 N77-12545
Definition study for photovoltaic residential prototype system
[NASA-CR-135039] 13 p0113 N77-13532
Intermediate minimum property standards for solar heating and domestic hot water systems
[PB-257086/9] 13 p0132 N77-15525
Integrating community utilities for resource conservation
[PB-256898/8] 13 p0133 N77-15923

RESOURCE ALLOCATION
Energy analysis in modelling
13 p0007 A77-11047
Mandatory Canadian crude oil allocation regulations
[PB-255319/6] 13 p0096 N77-11509
Economics of depletable resources: Market forces and intertemporal bias
[PB-255623/1] 13 p0111 N77-12930
The exploration, development, and production of Naval Petroleum Reserve Number 4
[PB-255947/4] 13 p0124 N77-14610

RESOURCES MANAGEMENT
Oil shale development
13 p0023 A77-12693
In situ recovery of oil and minerals from Piceance Creek Basin oil shale
13 p0023 A77-12694
The role of recycling in conservation of metals and energy
13 p0061 A77-16825
Energy and environmental impacts of materials alternatives - An assessment of quantitative understanding
13 p0070 A77-18738
Helium resources of the United States, 1973
[PB-252473/4] 13 p0085 N77-10623
A basis for analyzing prospective power generation in terms of environmental management and energy use
13 p0096 N77-11526
Strategic petroleum reserve
[PB-255476/4] 13 p0098 N77-11546
An analysis of the technology role in US power during the mid-range period
[AD-A024042] 13 p0102 N77-11927
Crude supply alternatives for the Northern Tier states. Volume 1: Executive summary
[PB-255992/0] 13 p0107 N77-12531
Crude supply alternatives for the Northern Tier states. Volume 2: Technical report
[PB-255993/8] 13 p0107 N77-12532

REUSE
Estimating procedures associated with aircraft modifications
[SAWE PAPER 1101] 13 p0016 A77-12181

REVENUE
Evaluating revenue sources for public transit - A new frontier for environmental planners
13 p0070 A77-18723

REYNOLDS NUMBER
The influence of the Reynolds number on the profiles of velocity and concentration in free jets of different density
13 p0069 A77-18500
RIBBONS
Alternative strategies for implementing silicon-ribbon technology for photovoltaic applications
13 p0039 A77-12819
RISK
Risk management of liquefied natural gas installations
13 p0002 A77-10451
RIVERS
Characterization and evaluation of wastewater sources United States Steel Corporation, Clairton Works, Pittsburgh, Pennsylvania, 28-31 January 1976
[PB-255586/0] 13 p0116 N77-13566
ROCKET ENGINE DESIGN
Laser propulsion --- rocket heat engine design
[IAF PAPER 76-166] 13 p0003 A77-10931
ROCKS
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556
ROOM TEMPERATURE
Contribution of the heat carried by solar radiation to the thermal balance of a room during the cold season and its effect on domestic fuel consumption
13 p0063 A77-17558
ROTATING MIRRORS
Calorimetry of large solar concentrators
13 p0038 A77-12814
ROTOR AERODYNAMICS
Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines
13 p0044 A77-12871
Design consideration for the Darrieus rotor --- wind turbines
13 p0044 A77-12872
Dual optimum aerodynamic design for a conventional windmill
13 p0048 A77-13704
Aerodynamics of the Darrieus rotor
13 p0050 A77-14559
Some dynamic problems of rotating windmill systems
13 p0084 N77-10271
ROTOR BLADES
Dual optimum aerodynamic design for a conventional windmill
13 p0048 A77-13704
Possibilities for utilizing wind energy
13 p0056 A77-15853
ROTOR BLADES (TURBOMACHINERY)
Early operation experience on the ERDA/NASA 100 kW wind turbine --- rotor blade loads
[NASA-TM-X-71601] 13 p0086 N77-10640
RURAL AREAS
An energy center in Sri Lanka --- UN rural energy development program
13 p0021 A77-12669

S

SAFETY FACTORS
Development of a small radioisotopic heat source
13 p0042 A77-12852
SAFETY MANAGEMENT
Risk management of liquefied natural gas installations
13 p0002 A77-10451
Report of the Army Scientific Advisory Panel Ad Hoc Group on fire-safe fuels
[AD-A023763] 13 p0095 N77-11208
Bibliography on Liquefied Natural Gas (LNG) safety
[NASA-TM-X-73408] 13 p0127 N77-15208
SAILS
Comparative wind tunnel investigation of sail profiles for windmills
[VTH-191] 13 p0111 N77-13012
SALTS
Effect of mechanical cooling devices on ambient salt concentration
[PB-256679/2] 13 p0125 N77-14631

SATELLITE CONFIGURATIONS
Space-based solar power conversion and delivery systems study. Volume 3: Economic analysis of space-based solar power systems
[NASA-CR-150148] 13 p0129 N77-15496
SATELLITE CONTROL
UK, T5 ion engine thrust vector control considerations
[AIAA PAPER 76-1064] 13 p0045 A77-13030
SATELLITE LIFETIME
KIPS - Kilowatt Isotope Power System --- for use in satellites
13 p0041 A77-12837
SATELLITE OBSERVATION
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
SATELLITE ORBITS
The ATS-6 power system - Hardware implementation and orbital performance
13 p0040 A77-12831
SATELLITE POWER TRANSMISSION (TO EARTH)
Photovoltaic and thermal energy conversion for solar powered satellites
[IAF PAPER 76-117] 13 p0003 A77-10913
Satellite power systems for large-scale power generation
[IAF PAPER 76-118] 13 p0003 A77-10914
Microwave transmission system for space power
13 p0014 A77-11818
Transportation options for solar power satellites
13 p0040 A77-12829
Satellite solar power stations and energy relay satellites
13 p0052 A77-14901
Solar power satellites - Opportunity and challenge
[AIAA PAPER 77-291] 13 p0065 A77-18224
Preliminary report on the CTS transient event counter performance through the 1976 spring eclipse season
[NASA-TM-X-73487] 13 p0083 N77-10116
Space station systems analysis study. Part 1, volume 1: Executive study
[NASA-CR-151102] 13 p0094 N77-11084
Space station systems analysis study. Part 1, volume 2: Technical report
[NASA-CR-151103] 13 p0094 N77-11085
Space-to-earth power transmission system
[NASA-TM-X-73489] 13 p0105 N77-12517
Satellite power system: Engineering and economic analysis summary
[NASA-TM-X-73344] 13 p0128 N77-15486
Space-based solar power conversion and delivery systems study. Volume 1: Executive summary
[NASA-CR-150146] 13 p0129 N77-15494
Space-based solar power conversion and delivery systems study. Volume 2: Engineering analysis of orbital systems
[NASA-CR-150147] 13 p0129 N77-15495
SATELLITE SOLAR ENERGY CONVERSION
Feasibility of a satellite solar power station /SSPS/
13 p0047 A77-13504
Space solar power - An available energy source
13 p0056 A77-15946
Space-based solar power conversion and delivery systems study. Volume 1: Executive summary
[NASA-CR-150146] 13 p0129 N77-15494
SATELLITE SOLAR POWER STATIONS
Energy - Ecospace --- space law aspects of U.S. and U.S.S.R. solar power proposals
[IAF PAPER ISL-76-59] 13 p0004 A77-10970
Transportation options for solar power satellites
13 p0040 A77-12829
Small space station electrical power system design concepts
13 p0040 A77-12835
Feasibility of a satellite solar power station /SSPS/
13 p0047 A77-13504
Satellite solar power stations and energy relay satellites
13 p0052 A77-14901
Space solar power - An available energy source
13 p0056 A77-15946
Solar power satellites - Opportunity and challenge
[AIAA PAPER 77-291] 13 p0065 A77-18224

Perspectives on Satellite Solar Power
[AIAA PAPER 77-352] 13 p0066 A77-18257
The economic viability of pursuing a space power system concept
[AIAA PAPER 77-353] 13 p0066 A77-18258
The construction of satellite solar power stations from non-terrestrial materials
[AIAA PAPER 77-354] 13 p0066 A77-18259
Space-to-earth power transmission system
[NASA-TM-X-73489] 13 p0105 N77-12517
Satellite power system: Engineering and economic analysis summary
[NASA-TM-X-73344] 13 p0128 N77-15486

SATELLITE TEMPERATURE
Flight results of a cryogenic cooler designed for Meteosat
[IAF PAPER 76-210] 13 p0003 A77-10942
Development of space applications of heat pipes at Aerospatiale
13 p0120 N77-14390

SATELLITE-BORNE PHOTOGRAPHY
An application of ERTS technology to the evaluation of coal strip mining and reclamation in the northern Great Plains
[NASA-CR-149208] 13 p0104 N77-12486

SAUDI ARABIA
Geothermal energy in Saudi Arabia and its use in connection with solar energy
13 p0079 A77-19122

SCANDIUM
Measurements of Sc I gf-values --- absorption spectroscopy using heat pipe oven
13 p0058 A77-16270

SCAVENGING
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630

SCHLIEREN PHOTOGRAPHY
Schlieren measurements of a high density z-pinch
13 p0060 A77-16697

SCHOTTKY DIODES
MIS silicon solar cells
13 p0001 A77-10174
Schottky solar cells on thin epitaxial silicon
13 p0047 A77-13509
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088

SCIENTISTS
An analysis of the technology role in US power during the mid-range period
[AD-A024042] 13 p0102 N77-11927

SCRAP
The role of recycling in conservation of metals and energy
13 p0061 A77-16825

SEA ICE
Tests of oil recovery devices in broken ice fields, phase 2
[AD-A025748] 13 p0110 N77-12572

SEA WATER
Energy recovery from saline water by means of electrochemical cells
13 p0013 A77-11536
Physical and biological aspects of thermal pollution in sea water --- forecasting electric power production in Italy
[ISS-L-75/14] 13 p0109 N77-12560
Effect of mechanical cooling devices on ambient salt concentration
[PB-256679/2] 13 p0125 N77-14631

SEASAT PROGRAM
SEASAT - A candidate ocean industry economic verification experiments
[NASA-CR-149228] 13 p0104 N77-12476

SEEBECK EFFECT
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848

SELENIDES
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848

SEMICONDUCTING FILMS
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
Semiconductor-electrolyte photovoltaic energy converter
[PB-252837/0] 13 p0099 N77-11548

SEMICONDUCTOR DEVICES
Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters
13 p0058 A77-16324
The theory of hydrogen production in a photoelectrochemical cell
13 p0075 A77-19075
A sulfurization process for the preparation of photovoltaic Cu/x/S and CuInS2 thin films
13 p0076 A77-19087
Meeting electric power needs with photovoltaic power systems
13 p0076 A77-19091
Investigation of a TiO2/electrolyte solar cell and the photocatalytic water decomposition
13 p0077 A77-19094

SEMICONDUCTOR JUNCTIONS
Operation of ITO/Si heterojunction solar cells
13 p0014 A77-11762
The lensed high-voltage vertical multijunction solar cell
13 p0069 A77-18489
New analysis of a high-voltage vertical multijunction solar cell
13 p0069 A77-18490
Reply to 'New analysis of a high-voltage vertical multijunction solar cell'
13 p0069 A77-18491
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547

SEPARATORS
New separators for nickel-zinc batteries
[NASA-TM-X-3465] 13 p0121 N77-14585

SERT 2 SPACECRAFT
Status of SERT 2 thrusters and spacecraft 1976
[NASA-TM-X-73501] 13 p0083 N77-10149

SERVICE LIFE
R&M - Today's heating and cooling vs. solar energy
13 p0002 A77-10482
Advances in component technology for nickel-zinc cells
13 p0025 A77-12710
Gas release during long-term operation of heat pipes
13 p0050 A77-14328

SEWAGE TREATMENT
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577
Feasibility study of a nuclear power-sewage treatment system for the conservation and reclamation of water resources
[PB-255630/6] 13 p0126 N77-14960

SHADOWS
Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors
13 p0069 A77-18450
Synergistic effects of shadowing on a solar collector matrix
[SAND-76-0012] 13 p0122 N77-14587

SHALE OIL
A preliminary engineering assessment of jet fuel production from domestic coal and shale derived oils
13 p0023 A77-12690
Hydrocarbon fuels from oil shale
13 p0023 A77-12692
Oil shale development
13 p0023 A77-12693
In situ recovery of oil and minerals from Piceance Creek Basin oil shale
13 p0023 A77-12694
In situ combustion of Michigan oil shale - Current field studies
13 p0024 A77-12695
Retorting of single oil shale blocks with nitrogen and air
13 p0024 A77-12696
Perturbation analysis of second-order effects in kinetics of oil-shale pyrolysis
13 p0070 A77-18585
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207

Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230
Evaluation of a JP-5 type fuel derived from oil shale
[AD-A025417] 13 p0112 N77-13231
Reactivity of oil shale carbonaceous residue with oxygen and carbon dioxide
[UCRL-77829] 13 p0123 N77-14596
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499

SHEAR STRESS
Investigation of performance limits in axial groove heat pipes
[NASA-CR-137912] 13 p0095 N77-11340

SHOCK TESTS
Test and evaluation of the Navy half-watt RTG --- Radioisotope Thermoelectric Generator
13 p0042 A77-12853

SHOCK TUBES
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665

SHOCK TUNNELS
Non-equilibrium MHD power generation using non-seeded argon plasma
13 p0004 A77-11022

SHOCK WAVE INTERACTION
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235

SHORT HAUL AIRCRAFT
The dynamics of STOL /The Daniel and Florence Guggenheim Lecture/ --- utility aircraft for short haul service in remote areas
[ICAS PAPER 76-01] 13 p0081 A77-19247

SHORT TAKEOFF AIRCRAFT
The dynamics of STOL /The Daniel and Florence Guggenheim Lecture/ --- utility aircraft for short haul service in remote areas
[ICAS PAPER 76-01] 13 p0081 A77-19247

SHREDDING
Fine shredding of municipal solid waste
[PB-257105/7] 13 p0133 N77-15919

SIDE-LOOKING RADAR
Use of radar in geology
13 p0018 A77-12256

SIGNAL ANALYSIS
Shaping of laser pulses in an amplifying system receiving input signals with a variable spectrum
13 p0053 A77-15237

SIGNAL PROCESSING
Development of signal processing algorithms for ultrasonic detection of coal seam interfaces
[NASA-CR-150024] 13 p0085 N77-10610

SILICA GEL
Fractionation and structural characterization of coal liquids
13 p0069 A77-18582

SILICON
Alternative strategies for implementing silicon-ribbon technology for photovoltaic applications
13 p0039 A77-12819
Deposition of polycrystalline silicon solar cells
13 p0076 A77-19082
The silicon ribbon solar cell
13 p0076 A77-19083
Industrial development of silicon solar cells
[NASA-TT-F-17139] 13 p0097 N77-11528
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
Analysis of epitaxial drift field N on P silicon solar cells
[NASA-TM-X-73563] 13 p0106 N77-12523
Low reflectivity solar cells
[AD-A025922] 13 p0108 N77-12539
Status of the ERDA/NASA photovoltaic tests and applications project
[NASA-TM-X-73567] 13 p0114 N77-13537
Demonstration of the feasibility of automated silicon solar cell fabrication
[NASA-CR-135095] 13 p0129 N77-15492

SILICON FILMS
On black solar cells or the tetrahedral texturing of a silicon surface
13 p0004 A77-11000
Photovoltaic conversion of solar energy
13 p0058 A77-16368

SILICON JUNCTIONS
MIS silicon solar cells
13 p0001 A77-10174
Reducing grain-boundary effects in polycrystalline silicon solar cells
13 p0014 A77-11761
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916
Schottky solar cells on thin epitaxial silicon
13 p0047 A77-13509
Double-faced silicon solar cell system
13 p0076 A77-19090

SILVER ALLOYS
A comparison of porous silver catalysts in oxygen electrodes of alkaline fuel cells
13 p0067 A77-18350

SIMULATION
Mathematical simulation and empirical determination of the aerochemical and thermal atmospheric pollution resulting from energy conversion processes
[DLR-IB-553-75/1] 13 p0091 N77-10700

SINGLE CRYSTALS
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517

SITES
Siting of wind driven apparatus
13 p0043 A77-12865

SKY RADIATION
Computation of solar radiation design curves
13 p0072 A77-19049

SMOKE
Evolution of atmospheric pollution /high acidity and black fumes/ in France during 1975
13 p0002 A77-10670

SMOKE ABATEMENT
Sulphur pollution and emission charges
13 p0005 A77-11033

SNAP 19
SNAP 19 Viking RTG mission performance
13 p0041 A77-12840

SOCIAL FACTORS
Economic and social impact of solar powered transportation systems
13 p0079 A77-19120

SODIUM
Development of sodium/sulfur-cells
13 p0026 A77-12716
Some studies on sodium/sulfur cells
13 p0055 A77-15813

SOLAR ARRAYS
An integrated photovoltaic/thermal High Intensity Solar Energy System /HISES/ concept for residential applications
13 p0039 A77-12818
SEP solar array technology development
13 p0040 A77-12825
Ultralightweight solar array for Naval Sea Control Systems
13 p0040 A77-12828
The ATS-6 power system - Hardware implementation and orbital performance
13 p0040 A77-12831
Small space station electrical power system design concepts
13 p0040 A77-12835
Comparison of candidate solar array maximum power utilization approaches --- for spacecraft propulsion
13 p0041 A77-12836
Solar photovoltaics - An aerospace technology
[AIAA PAPER 77-293] 13 p0065 A77-18225
Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors
13 p0069 A77-18450
Cylindrical mirror collector field
13 p0074 A77-19071
LSSA (Low-cost Silicon Solar Array) project
[NASA-CR-149091] 13 p0086 N77-10637

Solar power arrays for the concentration of energy
[COO-2699-2] 13 p0087 N77-10651
Solar power array for the concentration of energy. Task 2: Modifications to a specular photometer
[COO-2699-3] 13 p0098 N77-11538
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
Status of the ERDA/NASA photovoltaic tests and applications project
[NASA-TM-X-73567] 13 p0114 N77-13537
Solar cell array design handbook, volume 1
[NASA-CR-149364] 13 p0118 N77-14193
Solar cell array design handbook, volume 2
[NASA-CR-149365] 13 p0118 N77-14194

SOLAR CELLS

MIS silicon solar cells
13 p0001 A77-10174
On black solar cells or the tetrahedral texturing of a silicon surface
13 p0004 A77-11000
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
Reducing grain-boundary effects in polycrystalline silicon solar cells
13 p0014 A77-11761
Operation of ITO/Si heterojunction solar cells
13 p0014 A77-11762
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
The ERDA Photovoltaic Systems Definition Project
13 p0038 A77-12815
Schottky solar cells on thin epitaxial silicon
13 p0047 A77-13509
Utilization of solar power - A new departure
13 p0053 A77-15049
Photovoltaic conversion of solar energy
13 p0058 A77-16368
Radiation effects on high efficiency silicon solar cells
13 p0064 A77-18072
Solar photovoltaics - An aerospace technology
[AIAA PAPER 77-293] 13 p0065 A77-18225
The lensed high-voltage vertical multijunction solar cell
13 p0069 A77-18489
New analysis of a high-voltage vertical multijunction solar cell
13 p0069 A77-18490
Reply to 'New analysis of a high-voltage vertical multijunction solar cell'
13 p0069 A77-18491
Study of emittance distribution along the walls of a cellular low-loss cell in the case of a base surface with arbitrary emission indicatrix
13 p0069 A77-18495
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
Photovoltaic effect applications
13 p0075 A77-19080
An analysis of silicon solar cell parameters for terrestrial applications
13 p0076 A77-19081
Deposition of polycrystalline silicon solar cells
13 p0076 A77-19082
The silicon ribbon solar cell
13 p0076 A77-19083
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088
Photovoltaic systems using sunlight concentration
13 p0076 A77-19089
Double-faced silicon solar cell system
13 p0076 A77-19090
Meeting electric power needs with photovoltaic power systems
13 p0076 A77-19091
Encapsulation of solar cell modules
13 p0076 A77-19092
Alternating photoelectrochemical converters
13 p0077 A77-19093
Investigation of a TiO2/electrolyte solar cell and the photocatalytic water decomposition
13 p0077 A77-19094
Preliminary design data for a solar house in Riyadh, Saudi Arabia
13 p0078 A77-19112
LSSA (Low-cost Silicon Solar Array) project
[NASA-CR-149091] 13 p0086 N77-10637
Theoretical prospects of the CdS-Cu2S solar cell
[PB-252409/8] 13 p0089 N77-10672
Cadmium stannate selective optical films for solar energy applications
[PB-254879/0] 13 p0090 N77-10678
Industrial development of silicon solar cells
[NASA-TT-F-17139] 13 p0097 N77-11528
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
Semiconductor-electrolyte photovoltaic energy converter
[PB-252837/0] 13 p0099 N77-11548
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
Status of silicon solar cell technology
[NASA-TM-X-73531] 13 p0106 N77-12519
The Redox flow system for solar photovoltaic energy storage
[NASA-TM-X-73562] 13 p0106 N77-12522
Analysis of epitaxial drift field N on P silicon solar cells
[NASA-TM-X-73563] 13 p0106 N77-12523
Low reflectivity solar cells
[AD-A025922] 13 p0108 N77-12539
Development of 20 percent efficient solar cell
[PB-255903/7] 13 p0108 N77-12548
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
Results from the IMP-J violet solar cell experiment and violet cell balloon flights
[NASA-TN-D-8393] 13 p0128 N77-15491
Demonstration of the feasibility of automated silicon solar cell fabrication
[NASA-CR-135095] 13 p0129 N77-15492

SOLAR COLLECTORS

Ideal concentrators for finite sources and restricted exit angles --- parabolic solar collector
13 p0003 A77-10835
Solar energy --- conversion technology assessment
13 p0006 A77-11037
Plastics for solar-energy collectors. I - General aspects, hot-water collectors, design variants
13 p0009 A77-11267
Plastics for solar-energy collectors. II - Typical operational data and model parameters, functional diagrams, optimization of layer thicknesses
13 p0009 A77-11269
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
Radiant-vector distribution in the radiant field of a parabolocylindric concentrator
13 p0015 A77-11920
Calculations on an optimized faceted solar concentrator
13 p0015 A77-11921
A cylindrical blackbody solar energy receiver
13 p0018 A77-12404
A method of testing for rating solar collectors based on thermal performance
13 p0019 A77-12408
Optimal control of flow in low temperature solar heat collectors
13 p0019 A77-12409
Performance analysis of a cylindrical parabolic focusing collector and comparison with experimental results
13 p0019 A77-12410
A method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds --- for solar collector design
13 p0019 A77-12412

Solar energy collection by bioconversion
13 p0021 A77-12672
Comparative performance of solar thermal power generation concepts
13 p0036 A77-12803
Economic optimization of the energy transport component of a large distributed solar power plant
13 p0037 A77-12807
Windowed versus windowless solar energy cavity receivers
13 p0037 A77-12808
Transient performance characteristics of a high temperature distributed solar collector field
13 p0037 A77-12810
Collector field optimization for a solar thermal electric power plant
13 p0038 A77-12811
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
Evaluating a solar energy concentrator
13 p0047 A77-13505
Some material considerations involved in the application of solar energy to electric power generation
13 p0049 A77-13739
Practical aspects of solar heating - A review of materials use in solar heating applications
13 p0049 A77-13743
Characteristics of a system for transmitting concentrated solar radiation
13 p0051 A77-14578
Energetic calculation of the concentrating capacity of paraboloidal facets
13 p0051 A77-14579
Characteristic equations of unconcentrated flat solar cell panels
13 p0052 A77-14929
The problem of use of solar energy specific features of radiative, heat, and mass transfer in solar installations
13 p0057 A77-16204
Heat and mass transfer for solar energy utilization
13 p0057 A77-16205
Irradiation field formation on the receiver of 'precise' and 'unprecise' solar concentrators
13 p0057 A77-16209
A Cassegrain system for solar radiation
13 p0063 A77-17561
Application of solar energy in the high-temperature range
13 p0063 A77-17636
The application of aerospace technology to solar thermal electric power generation
[AIAA PAPER 77-294] 13 p0065 A77-18226
Parametric studies of the thermal trap flat plate collector
13 p0068 A77-18443
Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials
13 p0068 A77-18444
Axial conduction in a flat-plate solar collector
13 p0068 A77-18447
Use of Lexan and Kapton honeycombs to increase solar collector efficiency
13 p0068 A77-18448
Arrays of fixed flat-plate solar energy collectors - Performance comparisons for differing individual component orientations
13 p0068 A77-18449
Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors
13 p0069 A77-18450
A solar house with heat pipe collectors
13 p0070 A77-18598
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
Progress in development and application of selective surfaces --- for solar collectors
13 p0072 A77-19052
Thin film solar acceptors
13 p0072 A77-19053
Temperature optimization for power production of infinite heat transfer solar absorbers
13 p0073 A77-19055
Procedure for characterizing flat plate solar collectors
13 p0073 A77-19056
Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity
13 p0073 A77-19057
Termosole flat plate collectors
13 p0073 A77-19058
Performance of an annular cylindrical solar collector
13 p0073 A77-19059
Solergy collector concept --- immobile reflective surface for solar collection using spiral concentrator
13 p0073 A77-19061
Design and fabrication of solar concentrators
13 p0074 A77-19062
Captation and concentration of solar energy
13 p0074 A77-19063
An inflatable solar concentrator for a high temperature storage system
13 p0074 A77-19064
Performance of two fixed-mirror solar concentrators for process heat
13 p0074 A77-19065
Periodically adjustable concentrators adapted to solar cell panels
13 p0074 A77-19068
Stationary solar concentrators for industrial heating and cooling
13 p0074 A77-19069
A new method for collector field optimization --- computerized simulation of solar tower facility
13 p0074 A77-19070
Cylindrical mirror collector field
13 p0074 A77-19071
Design and performance of thermal storage water tank
13 p0075 A77-19079
Solar thermal power generation
13 p0077 A77-19095
Organic Rankine Cycle Engine development and solar energy utilization
13 p0077 A77-19096
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
Application of solar heat to buildings in Austria
13 p0079 A77-19114
Lumiducts for Ecopolis --- urban solar light collection and transmission system
13 p0079 A77-19116
Solar heating projects at the Institute for Environmental Research --- in Austria
13 p0079 A77-19119
Research at the EURATOM-CCR Center --- on solar energy
13 p0080 A77-19126
High-efficiency solar concentrator
13 p0083 N77-10104
A two-dimensional finite difference solution for the transient thermal behavior of tubular solar collector
13 p0083 N77-10105
Solar hot water systems application to the solar building test facility and the Tech House
13 p0084 N77-10342
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire
[PB-254179/5] 13 p0091 N77-10687
Optimized selective coatings for solar collectors
[NASA-TM-X-73498] 13 p0097 N77-11529
Evaluation of flat-plate collector efficiency under controlled conditions in a solar simulator
[NASA-TM-X-73520] 13 p0097 N77-11530
Solar radiation availability to various collector geometries: A preliminary study
[SAND-76-0009] 13 p0097 N77-11537
Solar power array for the concentration of energy. Task 2: Modifications to a specular photometer
[COO-2699-3] 13 p0098 N77-11538

Attic concentrator type solar energy collector
[BNL-50493] 13 p0098 N77-11539
Flat-plate solar collector handbook. A survey of principles, technical data and evaluation results
[UCID-17086] 13 p0105 N77-12506
Outdoor performance results for NBS Round Robin collector no. 1
[NASA-TM-X-73547] 13 p0106 N77-12520
Standardized performance tests of collectors of solar thermal energy - A flat-plate copper collector with parallel mylar striping
[NASA-TM-X-73553] 13 p0114 N77-13535
Standardized performance tests of collectors of solar thermal energy: An evacuated flatplate copper collector with a serpentine flow distribution
[NASA-TM-X-73415] 13 p0114 N77-13536
Synergistic effects of shadowing on a solar collector matrix
[SAND-76-0012] 13 p0122 N77-14587
Performance correlations of five solar collectors tested simultaneously outdoors
[NASA-TM-X-73546] 13 p0128 N77-15487
A performance evaluation of various coatings, substrate materials, and solar collector systems
[NASA-TM-X-73355] 13 p0128 N77-15489

SOLAR ELECTRIC PROPULSION

SEP solar array technology development
13 p0040 A77-12825
Comparison of candidate solar array maximum power utilization approaches --- for spacecraft propulsion
13 p0041 A77-12836
NASA electric propulsion program
[AIAA PAPER 76-1068] 13 p0045 A77-13033

SOLAR ENERGY

Photovoltaic and thermal energy conversion for solar powered satellites
[IAF PAPER 76-117] 13 p0003 A77-10913
Satellite power systems for large-scale power generation
[IAF PAPER 76-118] 13 p0003 A77-10914
Prospects for solar energy utilization in Iran - Photothermal methods
13 p0013 A77-11532
Accelerated response of thermopile pyranometers
13 p0019 A77-12405
Hydrogen from solar energy via water electrolysis
13 p0032 A77-12771
The nuclear spinner for Satcom applications --- comparing nuclear and solar power supplies
13 p0041 A77-12838
Characteristics of a system for transmitting concentrated solar radiation
13 p0051 A77-14578
Theoretical maximum for energy from direct and diffuse sunlight
13 p0064 A77-17845
Hydel and solar power for Pakistan --- hydroelectric power
13 p0079 A77-19121
Geothermal energy in Saudi Arabia and its use in connection with solar energy
13 p0079 A77-19122
Improved use of energy --- through waste and solar energy utilization
13 p0079 A77-19123
Research at the EURATOM-CCR Center --- on solar energy
13 p0080 A77-19126
Direct solar energy conversion for large scale terrestrial use --- using CdS/Cu2S solar cell
[PB-252539/2] 13 p0089 N77-10674
Solar radiation availability to various collector geometries: A preliminary study
[SAND-76-0009] 13 p0097 N77-11537
Measured performance of a 3 ton LiBr absorption water chiller and its effect on cooling system operation
[NASA-TM-X-73496] 13 p0105 N77-12518
Definition study for photovoltaic residential prototype system
[NASA-CR-135039] 13 p0113 N77-13532
Production of chemical energy carriers by non-expandable energy sources --- solar energy electrolysis, photolysis, and thermochemical cycles
[DLR-FB-76-32] 13 p0114 N77-13541
Method for estimating solar heating and cooling system performance
[AD-A026041] 13 p0116 N77-13557
Explaining energy: A manual of non-style for the energy outsider who wants in
[LBL-4458] 13 p0122 N77-14592
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606

SOLAR ENERGY ABSORBERS

Effect of optical properties of a surface exposed to solar radiation on the radiation balance
13 p0052 A77-14928
Study of emittance distribution along the walls of a cellular low-loss cell in the case of a base surface with arbitrary emission indicatrix
13 p0069 A77-18495
Thin film solar acceptors
13 p0072 A77-19053
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
Selection of optimal pan color for solar water heater
13 p0078 A77-19104
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
Two component thermal energy storage material
[PB-252592/1] 13 p0090 N77-10675
Testing and fabrication of solar absorbers for the D5A' satellite
[CNES-NT-37] 13 p0111 N77-13110

SOLAR ENERGY CONVERSION

The options for using the sun
13 p0001 A77-10318
R&M - Today's heating and cooling vs. solar energy
13 p0002 A77-10482
Energy - Ecospace --- space law aspects of U.S. and U.S.S.R. solar power proposals
[IAF PAPER ISL-76-59] 13 p0004 A77-10970
Solar energy --- conversion technology assessment
13 p0006 A77-11037
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108
Energy: A radical redirection
13 p0010 A77-11275
Isothermal surface in a radiation field --- in solar thermal energy devices
13 p0014 A77-11918
Near-uv photon efficiency in a TiO2 electrode - Application to hydrogen production from solar energy
13 p0015 A77-11947
Coming - Solar power plants
13 p0016 A77-12125
The long-range prospects for solar energy
13 p0017 A77-12237
The long-range prospects for solar-derived fuels
13 p0017 A77-12240
Law and solar energy systems - Legal impediments and inducements to solar energy systems
13 p0018 A77-12401
Developments in solar energy utilisation in the United Kingdom
13 p0018 A77-12402
Solar water pump for lift irrigation
13 p0019 A77-12406
Energy conversion via photoelectrolysis
13 p0021 A77-12667
Solar energy collection by bioconversion
13 p0021 A77-12672
Thermochemical energy storage systems
13 p0028 A77-12738
An evaluation of the use of metal hydrides for solar thermal energy storage
13 p0028 A77-12739
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
Solar powered organic Rankine cycle engines - Characteristics and costs
13 p0036 A77-12798
Comparative performance of solar thermal power generation concepts
13 p0036 A77-12803

Solar thermal electric power plants - Their performance characteristics and total social costs
13 p0037 A77-12804
Solar energy prospects for electric power generation in Brazil
13 p0037 A77-12805
Central station solar electric power using liquid metal heat transport
13 p0037 A77-12806
Economic optimization of the energy transport component of a large distributed solar power plant
13 p0037 A77-12807
Windowed versus windowless solar energy cavity receivers
13 p0037 A77-12808
The role of simulation in the development of solar-thermal energy conversion systems
13 p0037 A77-12809
A fixed collector employing reversible vee-trough concentrator and a vacuum tube receiver for high temperature solar energy systems
13 p0038 A77-12813
Calorimetry of large solar concentrators
13 p0038 A77-12814
The ERDA Photovoltaic Systems Definition Project
13 p0038 A77-12815
Performance and cost analysis of photovoltaic power systems for on-site residential applications
13 p0038 A77-12816
New concepts in solar photovoltaic electric power systems design
13 p0038 A77-12817
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822
Experimental evaluation of the University of Florida solar powered ammonia/water absorption air conditioning system
13 p0039 A77-12823
Short and long term comparison of solar absorption air-conditioning system performance using real and synthetic weather data
13 p0039 A77-12824
Life-cycle costs and solar energy
13 p0047 A77-13501
Optimizing solar cooling systems
13 p0047 A77-13502
Atlanta /Towns/ solar experiment - The lessons we learned
13 p0047 A77-13503
Evaluating a solar energy concentrator
13 p0047 A77-13505
The Shenandoah Community Center - A total solar design concept
13 p0047 A77-13506
Hydrogen production using solar radiation
13 p0048 A77-13540
Some material considerations involved in the application of solar energy to electric power generation
13 p0049 A77-13739
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up --- utilizing Stirling engine
13 p0051 A77-14580
Utilization of solar power - A new departure
13 p0053 A77-15049
Cost aspects of solar energy - Selective and critical bibliography
13 p0054 A77-15799
The problem of use of solar energy specific features of radiative, heat, and mass transfer in solar installations
13 p0057 A77-16204
Transient behavior of solid sensible heat thermal storage units for solar energy systems
13 p0057 A77-16208
A central solar energy utilization system
13 p0057 A77-16210
Photovoltaic conversion of solar energy
13 p0058 A77-16368
Application of solar energy in the high-temperature range
13 p0063 A77-17636
The economic viability of pursuing a space power system concept
[AIAA PAPER 77-353] 13 p0066 A77-18258

Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range
13 p0069 A77-18496
The future importance of solar energy for the supply of the German Federal Republic with energy
13 p0070 A77-18597
Chemical evolution of photosynthesis
13 p0071 A77-18898
Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volumes 1 & 2
13 p0072 A77-19043
Survey of quantitative data on the solar energy and its spectra distribution
13 p0072 A77-19044
Autonomous station for the acquisition and concentration of heliometric data
13 p0072 A77-19046
Development of a mobile solar testing and recording /STAR/ system --- trailer for domestic hot water system testing
13 p0072 A77-19047
Computation of solar radiation design curves
13 p0072 A77-19049
Waveguide high pass filter for thermal conversion of solar energy
13 p0073 A77-19054
Captation and concentration of solar energy
13 p0074 A77-19063
Performance of two fixed-mirror solar concentrators for process heat
13 p0074 A77-19065
Solar production of hydrogen as a means of storing solar energy
13 p0075 A77-19072
On the storage of solhydrogen
13 p0075 A77-19073
The theory of hydrogen production in a photoelectrochemical cell
13 p0075 A77-19075
Solar energy utilization - The photochemical approach
13 p0075 A77-19076
The photosynthetic production of hydrogen
13 p0075 A77-19077
Storage of solar energy in the form of potential hydraulic energy
13 p0075 A77-19078
Solar thermal power generation
13 p0077 A77-19095
Organic Rankine Cycle Engine development and solar energy utilization
13 p0077 A77-19096
Aerothermic power plant with artificial cyclone
13 p0077 A77-19098
Energy considerations in HHE power systems --- Heliohydroelectric and Helioelectrolytic systems
13 p0077 A77-19099
Survey of absorption refrigeration systems
13 p0078 A77-19105
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
The two enemies of industrial development of solar energy - Simplicity and economy
13 p0078 A77-19109
Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia
13 p0078 A77-19110
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran --- Heating, Ventilating and Air Conditioning
13 p0078 A77-19111
Preliminary design data for a solar house in Riyadh, Saudi Arabia
13 p0078 A77-19112
Environmentally designed housing incorporating solar energy
13 p0079 A77-19115
Lumiducts for Ecopolis --- urban solar light collection and transmission system
13 p0079 A77-19116
Water pumping - A practical application of solar energy
13 p0079 A77-19117

New frontiers in solar and other energy options
13 p0079 A77-19118
Solar heating projects at the Institute for Environmental Research --- in Austria
13 p0079 A77-19119
Economic and social impact of solar powered transportation systems
13 p0079 A77-19120
Formulation of energy policies - The case of West Africa
13 p0080 A77-19124
The role of solar energy in developing nations - The perspectives in Mali
13 p0080 A77-19125
Solar energy in Switzerland
13 p0080 A77-19127
LSSA (Low-cost Silicon Solar Array) project
[NASA-CR-149091] 13 p0086 N77-10637
Photochemical conversion of solar energy
[PB-255703/1] 13 p0090 N77-10685
Analysis of state solar energy options
[PB-254730/5] 13 p0091 N77-10688
National program for solar heating and cooling (residential and commercial applications)
[ERDA-23A] 13 p0098 N77-11540
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
Semiconductor-electrolyte photovoltaic energy converter
[PB-252837/0] 13 p0099 N77-11548
Status of silicon solar cell technology
[NASA-TM-X-73531] 13 p0106 N77-12519
The feasibility of solar energy usage on Red River Army Depot
[AD-A025119] 13 p0108 N77-12535
Symposium on the Fundamental Optical Properties of Solids Relevant to Solar Energy Conversion
[PB-256615/6] 13 p0108 N77-12538
Development of 20 percent efficient solar cell
[PB-255903/7] 13 p0108 N77-12548
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533
Status of the ERDA/NASA photovoltaic tests and applications project
[NASA-TM-X-73567] 13 p0114 N77-13537
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
The optical properties of chromium oxide films and the high temperature stabilization of silver films for photothermal solar energy conversion
13 p0128 N77-15484
Space-based solar power conversion and delivery systems study. Volume 2: Engineering analysis of orbital systems
[NASA-CR-150147] 13 p0129 N77-15495
Space-based solar power conversion and delivery systems study. Volume 3: Economic analysis of space-based solar power systems
[NASA-CR-150148] 13 p0129 N77-15496

SOLAR FLUX
Calorimetry of large solar concentrators
13 p0038 A77-12814

SOLAR FLUX DENSITY
Survey of quantitative data on the solar energy and its spectra distribution
13 p0072 A77-19044
Procedure for characterizing flat plate solar collectors
13 p0073 A77-19056

SOLAR FURNACES
Design and fabrication of solar concentrators
13 p0074 A77-19062
The structure of building specifications
[PB-257581/9] 13 p0132 N77-15524

SOLAR GENERATORS
Design principles for solar and wind power installations
13 p0015 A77-11922
Optimization criteria for solar and wind power systems
13 p0015 A77-11923
Some features of the operation of a solar installation acting as a low-temperature source of heat for a heat pump
13 p0015 A77-11924
Coming - Solar power plants
13 p0016 A77-12125
Thermal energy storage for solar power plants
13 p0027 A77-12731
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732
Solar thermal electric power plants - Their performance characteristics and total social costs
13 p0037 A77-12804
Economic optimization of the energy transport component of a large distributed solar power plant
13 p0037 A77-12807
Collector field optimization for a solar thermal electric power plant
13 p0038 A77-12811
Problems of energy storage in solar power stations
13 p0063 A77-17555
Economic effectiveness of solar electric power stations
13 p0063 A77-17556
The application of aerospace technology to solar thermal electric power generation
[AIAA PAPER 77-294] 13 p0065 A77-18226
Linear model of a dissipative PWM shunt regulator --- Pulse Width Modulation
13 p0080 A77-19172
Solar power arrays for the concentration of energy
[COO-2699-2] 13 p0087 N77-10651
Costs of alternative sources of electricity
[PB-255765/0] 13 p0107 N77-12528
Solar cell array design handbook, volume 1
[NASA-CR-149364] 13 p0118 N77-14193
Solar cell array design handbook, volume 2
[NASA-CR-149365] 13 p0118 N77-14194
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
Industrial process heat from shallow solar ponds
[UCRL-77801] 13 p0124 N77-14611
Space-based solar power conversion and delivery systems study. Volume 2: Engineering analysis of orbital systems
[NASA-CR-150147] 13 p0129 N77-15495
Space-based solar power conversion and delivery systems study. Volume 3: Economic analysis of space-based solar power systems
[NASA-CR-150148] 13 p0129 N77-15496

SOLAR HEATING
Solar energy --- conversion technology assessment
13 p0006 A77-11037
Plastics for solar-energy collectors. I - General aspects, hot-water collectors, design variants
13 p0009 A77-11267
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568
The solar water heater industry in South Florida - History and projections
13 p0018 A77-12403
A cylindrical blackbody solar energy receiver
13 p0018 A77-12404
Thermal evaluation of a house using a movable-insulation heating and cooling system
13 p0019 A77-12407
Grain drying in stationary bins with solar heated air
13 p0019 A77-12411
A forced circulation system for solar water heating
13 p0019 A77-12413
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732
Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations
13 p0028 A77-12736
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
A unique Rankine-cycle heat pump system
13 p0036 A77-12799
Solar-powered Rankine-cycle heat pump system
13 p0036 A77-12800
Performance and cost analysis of photovoltaic power systems for on-site residential applications
13 p0038 A77-12816
An integrated photovoltaic/thermal High Intensity Solar Energy System /HISES/ concept for residential applications
13 p0039 A77-12818

A summary of solar heating and cooling of buildings /SHACOB/ - Phase I demonstration planning studies
13 p0039 A77-12821
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822
Atlanta /Towns/ solar experiment - The lessons we learned
13 p0047 A77-13503
The Shenandoah Community Center - A total solar design concept
13 p0047 A77-13506
Practical aspects of solar heating - A review of materials use in solar heating applications
13 p0049 A77-13743
Calculation of the radiation entering a 'hot box' type solar set-up
13 p0051 A77-14581
Thermal energy storage for heating and air conditioning
13 p0057 A77-16206
A central solar energy utilization system
13 p0057 A77-16210
Homeowner's guide to solar heating and cooling --- Book
13 p0062 A77-17525
Contribution of the heat carried by solar radiation to the thermal balance of a room during the cold season and its effect on domestic fuel consumption
13 p0063 A77-17558
A solar house with heat pipe collectors
13 p0070 A77-18598
Development of a mobile solar testing and recording /STAR/ system --- trailer for domestic hot water system testing
13 p0072 A77-19047
Solar water heater using hardened black polythene pipe absorbers
13 p0073 A77-19060
Thermo-chemical production of hydrogen
13 p0075 A77-19074
Selection of optimal pan color for solar water heater
13 p0078 A77-19104
The two enemies of industrial development of solar energy - Simplicity and economy
13 p0078 A77-19109
Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia
13 p0078 A77-19110
Heating a building by means of solar and electrical energy
13 p0078 A77-19113
Application of solar heat to buildings in Austria
13 p0079 A77-19114
Environmentally designed housing incorporating solar energy
13 p0079 A77-19115
Solar heating projects at the Institute for Environmental Research --- in Austria
13 p0079 A77-19119
Solar hot water systems application to the solar building test facility and the Tech House
13 p0084 N77-10342
CCMS solar energy pilot study solar heating and cooling systems in buildings
[UMD-4908-5] 13 p0088 N77-10657
A location matrix plan for the residential solar heating and cooling demonstration program. Volume 1: Findings and recommendations
[PB-253784/3] 13 p0089 N77-10673
Hybrid simulation of solar HVAC system for house retro-fit design
[PB-252608/5] 13 p0090 N77-10676
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire
[PB-254179/5] 13 p0091 N77-10687
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689
Commercial building unitary heat pump system with solar heating
[PB-255488/9] 13 p0099 N77-11551
Temperature distribution of a hot water storage tank in a simulated solar heating and cooling system
[NASA-TM-X-73549] 13 p0106 N77-12521
The feasibility of solar energy usage on Red River Army Depot
[AD-A025119] 13 p0108 N77-12535
Method for estimating solar heating and cooling system performance
[AD-A026041] 13 p0116 N77-13557
Solar assisted heat pumps: A possible wave of the future
[NASA-CR-2771] 13 p0121 N77-14584
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606
A design procedure for solar heating systems
13 p0128 N77-15485
A performance evaluation of various coatings, substrate materials, and solar collector systems
[NASA-TM-X-73355] 13 p0128 N77-15489
Comparative evaluation of solar heating alternatives
[COO-2703-2] 13 p0129 N77-15498
The structure of building specifications
[PB-257581/9] 13 p0132 N77-15524
Intermediate minimum property standards for solar heating and domestic hot water systems
[PB-257086/9] 13 p0132 N77-15525

SOLAR INSTRUMENTS
Accelerated response of thermopile pyranometers
13 p0019 A77-12405

SOLAR POSITION
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
Synergistic effects of shadowing on a solar collector matrix
[SAND-76-0012] 13 p0122 N77-14587

SOLAR RADIATION
Energetics of the midlatitude thermosphere
13 p0012 A77-11492
A method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds --- for solar collector design
13 p0019 A77-12412
Survey of quantitative data on the solar energy and its spectra distribution
13 p0072 A77-19044
Computation of solar radiation design curves
13 p0072 A77-19049

SOLAR REFLECTORS
A fixed collector employing reversible vee-trough concentrator and a vacuum tube receiver for high temperature solar energy systems
13 p0038 A77-12813
Standard-size facets for the reflecting surface of a solar concentrator
13 p0063 A77-17557
A Cassegrain system for solar radiation
13 p0063 A77-17561
Solergy collector concept --- immobile reflective surface for solar collection using spiral concentrator
13 p0073 A77-19061
Captation and concentration of solar energy
13 p0074 A77-19063
Double-reflection solar energy concentrators
13 p0074 A77-19067

SOLAR SIMULATION
The role of simulation in the development of solar-thermal energy conversion systems
13 p0037 A77-12809

SOLAR SIMULATORS
Evaluation of flat-plate collector efficiency under controlled conditions in a solar simulator
[NASA-TM-X-73520] 13 p0097 N77-11530
Standardized performance tests of collectors of solar thermal energy: An evacuated flatplate copper collector with a serpentine flow distribution
[NASA-TM-X-73415] 13 p0114 N77-13536

SOLID PHASES
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106

SOLID SOLUTIONS
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
SOLID STATE
Symposium on the Fundamental Optical Properties of Solids Relevant to Solar Energy Conversion
[PB-256615/6] 13 p0108 N77-12538
SOLID WASTES
Energy from solid wastes --- Book
13 p0003 A77-10698
Controlled tipping of combustion residues
13 p0008 A77-11175
Dutchess County, NY moves towards pyrolysis --- of solid wastes with fuel recovery
13 p0010 A77-11298
Fuel gas recovery from controlled landfilling of municipal wastes
13 p0070 A77-18739
Study of the feasibility of federal procurement of fuels produced from solid wastes
[PB-255695/9] 13 p0096 N77-11513
A bioenvironmental study of emissions from refuse derived fuel
[AD-A024661] 13 p0110 N77-12571
Evaluation of pollution control in fossil fuel conversion processes
[PB-255842/7] 13 p0125 N77-14638
Performance of emission control devices on boilers firing municipal solid waste and oil
[PB-257136/2] 13 p0133 N77-15550
Fine shredding of municipal solid waste
[PB-257105/7] 13 p0133 N77-15919
SOLVENT EXTRACTION
Mechanisms of coal particle dissolution
13 p0059 A77-16475
Laboratory analysis of solvent refined coal
[PB-255550/6] 13 p0110 N77-12598
SOLVENTS
Startup solvent selection for the liquefaction of lignite
13 p0059 A77-16472
SPACE ELECTRIC ROCKET TESTS
Status of SERT 2 thrusters and spacecraft 1976
[NASA-TM-X-73501] 13 p0083 N77-10149
SPACE LAW
Legal and economic prerequisites to space industrialization
[IAF PAPER ISL-76-29] 13 p0004 A77-10968
Energy - Ecospace --- space law aspects of U.S. and U.S.S.R. solar power proposals
[IAF PAPER ISL-76-59] 13 p0004 A77-10970
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13 p0053 A77-15050
SPACE MANUFACTURING
Legal and economic prerequisites to space industrialization
[IAF PAPER ISL-76-29] 13 p0004 A77-10968
The construction of satellite solar power stations from non-terrestrial materials
[AIAA PAPER 77-354] 13 p0066 A77-18259
SPACE MISSIONS
Energy storage in orbital and interplanetary missions
[DGLR PAPER 76-189] 13 p0059 A77-16551
SPACE POWER REACTORS
Heat pipe nuclear reactor for space power
13 p0036 A77-12797
SPACE SHUTTLES
Small space station electrical power system design concepts
13 p0040 A77-12835
Satellite power system: Engineering and economic analysis summary
[NASA-TM-X-73344] 13 p0128 N77-15486
SPACE TRANSPORTATION
Transportation options for solar power satellites
13 p0040 A77-12829
NASA Office of Aeronautics and Space Technology Summer Workshop. Volume 4: Power technology panel
[NASA-TM-X-73964] 13 p0117 N77-13913
SPACEBORNE PHOTOGRAPHY
Cross structural plan of the earth's crust and the problem of the manifestation of its plutonic elements on the surface (Tyan-Shan and Turan plate as examples)
[NASA-TT-F-16938] 13 p0117 N77-13590
SPACECRAFT CONSTRUCTION MATERIALS
The construction of satellite solar power stations from non-terrestrial materials
[AIAA PAPER 77-354] 13 p0066 A77-18259
SPACECRAFT DESIGN
SEP solar array technology development
13 p0040 A77-12825
The nuclear spinner for Satcom applications --- comparing nuclear and solar power supplies
13 p0041 A77-12838
SPACECRAFT MOTION
Nuclear-powered Hysat spacecraft: Comparative design study
[ERDA-SNS-3063-8] 13 p0094 N77-11108
SPACECRAFT PERFORMANCE
SEP solar array technology development
13 p0040 A77-12825
Comparison of candidate solar array maximum power utilization approaches --- for spacecraft propulsion
13 p0041 A77-12836
SNAP 19 Viking RTG mission performance
13 p0041 A77-12840
SPACECRAFT POWER SUPPLIES
Uranium zirconium hydride reactor space power systems
[IAF PAPER 76-256] 13 p0004 A77-10953
Isotope heat source for dynamic power systems
13 p0036 A77-12796
The ATS-6 power system - Hardware implementation and orbital performance
13 p0040 A77-12831
Power source requirements of electric propulsion systems used for north-south stationkeeping of communication satellites
13 p0040 A77-12833
KIPS - Kilowatt Isotope Power System --- for use in satellites
13 p0041 A77-12837
The nuclear spinner for Satcom applications --- comparing nuclear and solar power supplies
13 p0041 A77-12838
SNAP 19 Viking RTG mission performance
13 p0041 A77-12840
Spherical radioisotope thermoelectric generators - An approach to high specific power devices
13 p0042 A77-12857
Fuel cells --- electrochemical energy conversion
13 p0055 A77-15804
Radiation effects on high efficiency silicon solar cells
13 p0064 A77-18072
Alkali metal space power technology applicable to national energy research and development
[AIAA PAPER 77-289] 13 p0065 A77-18223
The economic viability of pursuing a space power system concept
[AIAA PAPER 77-353] 13 p0066 A77-18258
Test program for transmitter experiment package and heat pipe system for the communications technology satellite
[NASA-TM-X-3455] 13 p0095 N77-11268
NASA Office of Aeronautics and Space Technology Summer Workshop. Volume 4: Power technology panel
[NASA-TM-X-73964] 13 p0117 N77-13913
SPACECRAFT PROPULSION
Laser propulsion --- rocket heat engine design
[IAF PAPER 76-166] 13 p0003 A77-10931
UK, T5 ion engine thrust vector control considerations
[AIAA PAPER 76-1064] 13 p0045 A77-13030
Energy storage in orbital and interplanetary missions
[DGLR PAPER 76-189] 13 p0059 A77-16551
SPACECRAFT RADIATORS
Status of development and application of gas-stabilized heat-pipe radiators
[DGLR PAPER 76-192] 13 p0060 A77-16557
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[ESA-SP-112-VOL-2] 13 p0119 N77-14378

Extended cryogenic performance of Lobar Wick heat pipe/radiator
13 p0119 N77-14379
Heat pipe and space radiator developments
13 p0120 N77-14391
SPARK IGNITION
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines
13 p0033 A77-12779
SPECIFIC IMPULSE
Laser propulsion --- rocket heat engine design
[IAF PAPER 76-166] 13 p0003 A77-10931
SPECTRAL REFLECTANCE
Progress in development and application of selective surfaces --- for solar collectors
13 p0072 A77-19052
SPECULAR REFLECTION
Low reflectivity solar cells
[AD-A025922] 13 p0108 N77-12539
SPINNERS
The nuclear spinner for Satcom applications --- comparing nuclear and solar power supplies
13 p0041 A77-12838
SPIRALS (CONCENTRATORS)
Solergy collector concept --- immobile reflective surface for solar collection using spiral concentrator
13 p0073 A77-19061
SPRINGS (WATER)
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591
STACKS
Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer
13 p0062 A77-17541
STANNATES
Cadmium stannate selective optical films for solar energy applications
[PB-254879/0] 13 p0090 N77-10678
STARTING
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383
STATIONARY ORBITS
Perspectives on Satellite Solar Power
[AIAA PAPER 77-352] 13 p0066 A77-18257
Captation and concentration of solar energy
13 p0074 A77-19063
STATIONKEEPING
Power source requirements of electric propulsion systems used for north-south stationkeeping of communication satellites
13 p0040 A77-12833
UK, T5 ion engine thrust vector control considerations
[AIAA PAPER 76-1064] 13 p0045 A77-13030
STATISTICAL ANALYSIS
Higher electric power use reduces energy consumption for same gross national product
13 p0011 A77-11334
Concerning world oil resources. II - Statistical logistic models /King Hubbert's models/
13 p0011 A77-11339
STATISTICAL WEATHER FORECASTING
Short and long term comparison of solar absorption air-conditioning system performance using real and synthetic weather data
13 p0039 A77-12824
STEAM
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497
STEAM FLOW
Making electricity from moderate temperature fluids --- geothermal sources
13 p0002 A77-10649
STEAM TURBINES
Steam station repowering - A near-term method of energy conservation
13 p0022 A77-12679
Comparison of geothermal power conversion cycles
13 p0030 A77-12750
Thermionic topping of a steam power plant
13 p0034 A77-12789
Combination power plants for improved utilization of fossil fuels
13 p0045 A77-12939
STEELS
Ship steel weldments for low temperature service
[PB-256997/8] 13 p0103 N77-12203
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[PB-255586/0] 13 p0116 N77-13566
STIRLING CYCLE
The Stirling engine - Engineering considerations in view of future needs
13 p0041 A77-12842
Self-starting, intrinsically controlled Stirling engine
13 p0041 A77-12844
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up --- utilizing Stirling engine
13 p0051 A77-14580
STORAGE BATTERIES
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107
New electrochemical current sources
13 p0020 A77-12650
Small electric vehicle considerations in view of performance and energy usage
13 p0024 A77-12698
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706
Electric vehicle performance with alternate batteries
13 p0025 A77-12707
Advances in component technology for nickel-zinc cells
13 p0025 A77-12710
Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells
13 p0025 A77-12713
Development status of lithium-silicon-iron sulfide load-leveling batteries
13 p0026 A77-12714
Development of sodium/sulfur-cells
13 p0026 A77-12716
Sodium/sulphur battery development in the United Kingdom
13 p0026 A77-12717
Small space station electrical power system design concepts
13 p0040 A77-12835
Electric vehicle batteries - Opportunities for materials improvement
13 p0049 A77-13736
Some studies on sodium/sulfur cells
13 p0055 A77-15813
Electric current from the direct conversion of low molecular weight C,H,O-compounds
13 p0055 A77-15814
Electrically rechargeable REDOX flow cell
[NASA-CASE-LEW-12220-1] 13 p0121 N77-14581
STORAGE TANKS
Design and performance of thermal storage water tank
13 p0075 A77-19079
Temperature distribution of a hot water storage tank in a simulated solar heating and cooling system
[NASA-TM-X-73549] 13 p0106 N77-12521
STRATOSPHERE
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568
STRIP MINING
Water requirements for an integrated SNG plant and mine operation
13 p0060 A77-16651
Application of LANDSAT-2 data to the implementation and enforcement of the Pennsylvania Surface Mining Conservation and Reclamation Act
[E77-10007] 13 p0085 N77-10590
Development of a multi-disciplinary ERTS user program in the state of Ohio
[E77-10045] 13 p0104 N77-12475
An application of ERTS technology to the evaluation of coal strip mining and reclamation in the northern Great Plains
[NASA-CR-149208] 13 p0104 N77-12486

STRUCTURAL ANALYSIS
Heat pipes for fluid-bed gasification of coal - Metallurgical condition of heat pipes after tests in process environment
13 p0031 A77-12764

STRUCTURAL DESIGN
Dual optimum aerodynamic design for a conventional windmill
13 p0048 A77-13704
Captation and concentration of solar energy
13 p0074 A77-19063
Performance of two fixed-mirror solar concentrators for process heat
13 p0074 A77-19065
Design and performance of thermal storage water tank
13 p0075 A77-19079

STRUCTURAL RELIABILITY
Development of a small radioisotopic heat source
13 p0042 A77-12852

STRUCTURAL WEIGHT
Estimating procedures associated with aircraft modifications
[SAWE PAPER 1101] 13 p0016 A77-12181
Ultralightweight solar array for Naval Sea Control Systems
13 p0040 A77-12828
Nuclear-powered Hysat spacecraft: Comparative design study
[ERDA-SNS-3063-8] 13 p0094 N77-11108
Attic concentrator type solar energy collector
[BNL-50493] 13 p0098 N77-11539

SUBSONIC AIRCRAFT
The next-generation subsonic transport
[SAWE PAPER 1127] 13 p0016 A77-12195
Hydrogen-fueled subsonic aircraft: A perspective
13 p0084 N77-10344

SUBSONIC FLOW
Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream
13 p0001 A77-10423
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668

SUBSTRATES
A performance evaluation of various coatings, substrate materials, and solar collector systems
[NASA-TM-X-73355] 13 p0128 N77-15489

SULFATES
Aerosol formation during coal combustion - Condensation of sulfates and chlorides on flyash
13 p0054 A77-15778
General Motors Sulfate Dispersion Experiment - Assessment of the EPA HIWAY model
13 p0071 A77-18882

SULFIDES
Development of compact lithium/iron disulfide electrochemical cells
13 p0026 A77-12715

SULFUR
Development of sodium/sulfur-cells
13 p0026 A77-12716
Sodium/sulphur battery development in the United Kingdom
13 p0026 A77-12717
Some studies on sodium/sulfur cells
13 p0055 A77-15813
Assessing low sulfur coal resources in Montana and Wyoming
13 p0058 A77-16374
Heat pipes for the temperature range from 200 to 600 C --- noting sulfur with iodine additive as working fluid
13 p0119 N77-14381
Availability of potential coal supply through 1985 by quality characteristics
[PB-256680/0] 13 p0121 N77-14573

SULFUR DIOXIDES
Sulphur pollution and emission charges
13 p0005 A77-11033
Is nuclear energy economically viable --- competition with coal
13 p0045 A77-12933
The air quality and economic implications of supplementary control systems in Illinois --- considering electric power plant fuels
[PB-255699/1] 13 p0101 N77-11588

SULFUR OXIDES
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
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[PB-255317/0] 13 p0110 N77-12597
Hot fuel gas desulfurization
[PB-257036/4] 13 p0133 N77-15539

SUNLIGHT
Theoretical maximum for energy from direct and diffuse sunlight
13 p0064 A77-17845
Solar assisted heat pumps: A possible wave of the future
[NASA-CR-2771] 13 p0121 N77-14584

SUPERCHARGERS
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
Effects of a thermal reactor on the energy efficiency of a turbocharged, stratified charge engine
[AD-A026059] 13 p0128 N77-15409

SUPERCONDUCTING MAGNETS
Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
13 p0049 A77-13728
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293

SUPPLYING
The supply of coal in the long run: The case of eastern deep coal
[PB-252642/4] 13 p0086 N77-10626
Electric energy supply alternatives for New York. Phase 2: An appraisal of electrical energy alternatives available to the State of New York
[PB-249881/4] 13 p0101 N77-11575

SURFACE COOLING
Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters
13 p0058 A77-16324

SURFACE GEOMETRY
On black solar cells or the tetrahedral texturing of a silicon surface
13 p0004 A77-11000

SURFACE LAYERS
Effectiveness of heat-emitting coatings with variable degree of blackness
13 p0111 N77-12893

SURFACE PROPERTIES
Effect of optical properties of a surface exposed to solar radiation on the radiation balance
13 p0052 A77-14928
Study of emittance distribution along the walls of a cellular low-loss cell in the case of a base surface with arbitrary emission indicatrix
13 p0069 A77-18495
Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range
13 p0069 A77-18496
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
Progress in development and application of selective surfaces --- for solar collectors
13 p0072 A77-19052
Surface research for development of new electrocatalysts for acid electrolyte fuel cells
[AD-A026053] 13 p0131 N77-15517

SURFACE VEHICLES
Performance of a hydrogen-powered transit vehicle
13 p0033 A77-12781
Transport of the future and the tasks of science
13 p0048 A77-13643

SURVEYS
User's guide to petroleum industry survey data type
[PB-256635/4] 13 p0098 N77-11544

SWITCHING CIRCUITS
Optimization of the geometry of switching buses for thermoelements in thermoelectric generators
13 p0052 A77-14951

SWITZERLAND
Solar energy in Switzerland
13 p0080 A77-19127

SYNCHRONOUS SATELLITES
NASA electric propulsion program
[AIAA PAPER 76-1068] 13 p0045 A77-13033
SYNOPTIC MEASUREMENT
Power resource estimate of ocean surface waves
13 p0071 A77-18790
SYNOPTIC METEOROLOGY
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295
SYNTHANE
Solar SNG - Large-scale production of SNG by anaerobic digestion of specially grown plant matter --- Synthetic Natural Gas
13 p0021 A77-12671
Catalytic coal gasification for SNG production --- Synthetic Natural Gas
13 p0022 A77-12683
Production of methane using offshore wind energy
13 p0026 A77-12722
Water requirements for an integrated SNG plant and mine operation
13 p0060 A77-16651
Hot and dry char let down system for the Synthane demonstration plant, phase 1
[PERC-0058-4] 13 p0130 N77-15505
SYNTHETIC FUELS
The hydrogen economy --- production and applications
13 p0006 A77-11041
Problems involved in improving the industrial fuel and energy balance
13 p0012 A77-11347
Synthetic fuels - Prices, prospects, and prior art
13 p0017 A77-12236
The long-range prospects for solar-derived fuels
13 p0017 A77-12240
Solar SNG - Large-scale production of SNG by anaerobic digestion of specially grown plant matter --- Synthetic Natural Gas
13 p0021 A77-12671
Hydrogen production by the steam-iron process
13 p0023 A77-12688
A preliminary engineering assessment of jet fuel production from domestic coal and shale derived oils
13 p0023 A77-12690
The commercial production of hydrogen by the K-T process
13 p0032 A77-12769
Nuclear power for the production of synthetic fuels and feedstocks
13 p0035 A77-12790
Air, water, nuclear power make gasoline
13 p0045 A77-12935
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534
Preliminary economics and comment: In-situ gasification of coal for power and SNG
[PB-256034/0] 13 p0109 N77-12554
A bioenvironmental study of emissions from refuse derived fuel
[AD-A024661] 13 p0110 N77-12571
Some cost, energy, environmental, and resource implications of synthetic fuels produced from coal for military aircraft
[AD-A026667] 13 p0118 N77-14271
Production of a hydrocarbon-type synthetic fuel from wood
[NRC-15638] 13 p0127 N77-15210
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506
SYSTEM EFFECTIVENESS
Thermal energy storage applied to residential heating systems
13 p0027 A77-12729
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822
Life-cycle costs and solar energy
13 p0047 A77-13501
Atlanta /Towns/ solar experiment - The lessons we learned
13 p0047 A77-13503
Stationary solar concentrators for industrial heating and cooling
13 p0074 A77-19069
A new method for collector field optimization --- computerized simulation of solar tower facility
13 p0074 A77-19070
Energy considerations in HHE power systems --- Heliohydroelectric and Helioelectrolytic systems
13 p0077 A77-19099
A system model for the investigation of alternative energy strategies --- German book
13 p0080 A77-19181
SYSTEMS ANALYSIS
Design principles for solar and wind power installations
13 p0015 A77-11922
The potential for application of energy storage capacity on electric utility systems in the United States. I
13 p0054 A77-15625
Development of a mobile solar testing and recording /STAR/ system --- trailer for domestic hot water system testing
13 p0072 A77-19047
Planning models for the assessment of advanced energy storage systems
13 p0105 N77-12504
SYSTEMS ENGINEERING
Uranium zirconium hydride reactor space power systems
[IAF PAPER 76-256] 13 p0004 A77-10953
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
Energy conservation potential of Modular Integrater Utility Systems /MIUS/
13 p0026 A77-12724
Thermionic topping for central station power plants
13 p0034 A77-12787
Solar-powered Rankine-cycle heat pump system
13 p0036 A77-12800
Small space station electrical power system design concepts
13 p0040 A77-12835
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543
Wind-power generation on a large scale - A design idea
13 p0050 A77-14531
The economic viability of pursuing a space power system concept
[AIAA PAPER 77-353] 13 p0066 A77-18258
Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors
13 p0069 A77-18450
Aerodynamics as a subway design parameter
13 p0070 A77-18721
Selection of optimal pan color for solar water heater
13 p0078 A77-19104
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
Environmentally designed housing incorporating solar energy
13 p0079 A77-19115
Utility distribution systems in Iceland
[AD-A026956] 13 p0126 N77-14957
Integrating community utilities for resource conservation
[PB-256898/8] 13 p0133 N77-15923

T

TABLES (DATA)
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137926] 13 p0126 N77-15007
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008
TANKER SHIPS
Ship steel weldments for low temperature service
[PB-256997/8] 13 p0103 N77-12203

TANKS (CONTAINERS)
A study to obtain verification of Liquid Natural Gas (LNG) tank loading criteria
[AD-A025716] 13 p0120 N77-14492
TECHNOLOGICAL FORECASTING
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
The next-generation subsonic transport
[SAWE PAPER 1127] 13 p0016 A77-12195
The long-range prospects for solar-derived fuels
13 p0017 A77-12240
Off-shore oil scenarios - Method and results
13 p0018 A77-12282
Economic and engineering implications of the Project Independence 1985 geothermal energy output goal and the associated sensitivity analysis
13 p0029 A77-12745
Transport of the future and the tasks of science
13 p0048 A77-13643
Energy and environment post-2000
13 p0050 A77-14560
The pay-off for advanced technology in commercial aircraft design and operation
13 p0071 A77-19012
An analysis of the technology role in US power during the mid-range period
[AD-A024042] 13 p0102 N77-11927
Air transportation beyond the 1980's
13 p0117 N77-13984
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981
Economic analysis of the need for advanced power sources
[HEDL-SA-989] 13 p0131 N77-15509
TECHNOLOGY ASSESSMENT
The options for using the sun
13 p0001 A77-10318
Evolution of thermal traction - From the diesel engine to the gas turbine
13 p0004 A77-10976
The energy problem and the earth's fuel situation
13 p0004 A77-11027
Intermetallic compounds - Background and results of twenty years of research
13 p0014 A77-11600
Coming - Solar power plants
13 p0016 A77-12125
The long-range prospects for solar energy
13 p0017 A77-12237
New electrochemical current sources
13 p0020 A77-12650
Small electric vehicle considerations in view of performance and energy usage
13 p0024 A77-12698
Diversification as an energy conservation strategy
13 p0027 A77-12725
MHD power generation - 1976 Status Report --- coal-fired design
13 p0033 A77-12782
Current status of the magnetic fusion program
13 p0035 A77-12792
SEP solar array technology development
13 p0040 A77-12825
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
The U-240 cyclotron --- review of systems and processes
13 p0046 A77-13151
Hypersonic technology-approach to an expanded program
13 p0051 A77-14597
Heat pipe theory and practice --- Book
13 p0052 A77-14825
Studies and thoughts on nuclear reactor systems
13 p0055 A77-15800
The prospect for fusion --- controlled nuclear fusion
13 p0058 A77-16357
Potentialities and limitations of the utilization of wind machines
13 p0061 A77-16787
LTA - Recent developments --- Lighter Than Air ships
13 p0061 A77-17021
Solar photovoltaics - An aerospace technology
[AIAA PAPER 77-293] 13 p0065 A77-18225
A system model for the investigation of alternative energy strategies --- German book
13 p0080 A77-19181
Underground coal mining: An assessment of technology
[PB-255726/2] 13 p0093 N77-10974
Bosch technical instruction. Gasoline injection D and L-jetronic
[NASA-TT-F-17111] 13 p0095 N77-11399
Mathematics for energy
[PB-252463/5] 13 p0098 N77-11543
The use of an interactive energy model for technology assessment with special reference to underground coal gasification
[PB-255543/1] 13 p0098 N77-11545
Proceedings of the Workshop on Modeling the Interrelationships between the Energy Sector and the General Economy
[PB-255696/7] 13 p0100 N77-11561
Development of 20 percent efficient solar cell
[PB-255903/7] 13 p0108 N77-12548
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications
[PB-255646/2] 13 p0109 N77-12551
Survey of alcohol fuel technology, volume 1
[PB-256007/6] 13 p0112 N77-13232
Survey of alcohol fuel technology, Volume 2
[PB-256008/4] 13 p0112 N77-13233
NASA Office of Aeronautics and Space Technology Summer Workshop. Volume 4: Power technology panel
[NASA-TM-X-73964] 13 p0117 N77-13913
Economic and technical feasibility study of compressed air storage
[COO-2559-1] 13 p0122 N77-14593
Satellite power system: Engineering and economic analysis summary
[NASA-TM-X-73344] 13 p0128 N77-15486
Energy and technology review
[UCID-52000-76-2] 13 p0131 N77-15508
Nuclear unit productivity analysis
[PB-257553/8] 13 p0132 N77-15528
TECHNOLOGY TRANSFER
OTEC - Aerospace and ocean engineering in partnership --- Ocean Thermal Energy Conversion
[AIAA PAPER 77-296] 13 p0066 A77-18227
Gas turbine electric powerplants
[AIAA PAPER 77-346] 13 p0066 A77-18254
TECHNOLOGY UTILIZATION
Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology
13 p0008 A77-11241
Prospects for solar energy utilization in Iran - Photothermal methods
13 p0013 A77-11532
Application of advanced technology to future long-range aircraft
[SAWE PAPER 1126] 13 p0016 A77-12194
Alkali metal space power technology applicable to national energy research and development
[AIAA PAPER 77-289] 13 p0065 A77-18223
The application of aerospace technology to solar thermal electric power generation
[AIAA PAPER 77-294] 13 p0065 A77-18226
Photovoltaic effect applications
13 p0075 A77-19080
Solar energy in Switzerland
13 p0080 A77-19127
Utilization of geothermal energy
[UTIAS-REVIEW-40] 13 p0087 N77-10644
SEASAT - A candidate ocean industry economic verification experiments
[NASA-CR-149228] 13 p0104 N77-12476
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
National benefits associated with commercial application of fuel cell powerplants
[ERDA-76-54] 13 p0123 N77-14597
TEMPERATURE CONTROL
Flight results of a cryogenic cooler designed for Meteosat
[IAF PAPER 76-210] 13 p0003 A77-10942
Optimal control of flow in low temperature solar heat collectors
13 p0019 A77-12409

Status of development and application of gas-stabilized heat-pipe radiators
[DGLR PAPER 76-192] 13 p0060 A77-16557
Temperature optimization for power production of infinite heat transfer solar absorbers
13 p0073 A77-19055
Development of space applications of heat pipes at Aerospatiale
13 p0120 N77-14390
Development of thermal control methods for specialized components and scientific instruments at very low temperatures (follow-on)
[NASA-CR-150152] 13 p0127 N77-15347

TEMPERATURE DISTRIBUTION
Transient performance characteristics of a high temperature distributed solar collector field
13 p0037 A77-12810

TEMPERATURE EFFECTS
A new hydrogen storage electrode
13 p0047 A77-13539
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
Temperature effects of crude oil in the upper intertidal zone
[PB-255956/5] 13 p0110 N77-12581

TEMPERATURE GRADIENTS
Geothermal sources and their utilization
13 p0055 A77-15803

TEMPERATURE MEASUREMENT
Synergistic effects of shadowing on a solar collector matrix
[SAND-76-0012] 13 p0122 N77-14587

TEMPERATURE PROFILES
Results of some geothermal studies in Singhbhum thrust belt, India
13 p0013 A77-11499

TERMINAL FACILITIES
Emergency power plant of rapid availability for the Berlin-Tegel airport
13 p0001 A77-10324

TEST VEHICLES
Baseline test data for the EVA electric vehicle --- low energy consumption automobiles
13 p0025 A77-12704

THERMAL CONDUCTIVITY
Results of some geothermal studies in Singhbhum thrust belt, India
13 p0013 A77-11499
The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction
13 p0042 A77-12850
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326
A central solar energy utilization system
13 p0057 A77-16210
Construction of two-dimensional steady-state solution of equations of a nonequilibrium magnetized plasma
13 p0065 A77-18130

THERMAL CONTROL COATINGS
Testing and fabrication of solar absorbers for the D5A' satellite
[CNES-NT-37] 13 p0111 N77-13110

THERMAL DIFFUSION
Diffuse thermal model of electrode erosion for MHD generators
13 p0049 A77-14319

THERMAL EMISSION
Effectiveness of heat-emitting coatings with variable degree of blackness
13 p0111 N77-12893

THERMAL ENERGY
A method of testing for rating solar collectors based on thermal performance
13 p0019 A77-12408
Thermal energy storage applied to residential heating systems
13 p0027 A77-12729
Storage in oil of off-peak thermal energy from large power stations
13 p0027 A77-12730
Thermal energy storage for solar power plants
13 p0027 A77-12731
Comparative performance of solar thermal power generation concepts
13 p0036 A77-12803
Solar thermal electric power plants - Their performance characteristics and total social costs
13 p0037 A77-12804
The role of simulation in the development of solar-thermal energy conversion systems
13 p0037 A77-12809
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
Development of a small radioisotopic heat source
13 p0042 A77-12852
Thermal explosion of moving reacting fluids of variable viscosity
13 p0052 A77-14980
Thermal energy storage for heating and air conditioning
13 p0057 A77-16206
Application of solar energy in the high-temperature range
13 p0063 A77-17636
Survey of high temperature thermal energy storage
[SAND-75-8063] 13 p0088 N77-10655
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689
Selected aspects of waste heat management: A state-of-the-art study
[PB-255697/5] 13 p0100 N77-11563
Conference proceedings, Energy from the Oceans, Fact or Fantasy
[PB-256093/6] 13 p0108 N77-12547
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552
Dual purpose nuclear power plants for military installations
[AD-A026141] 13 p0132 N77-15521

THERMAL INSULATION
Optimal thermal insulation as an investment-computational problem
13 p0009 A77-11268
Thermal evaluation of a house using a movable-insulation heating and cooling system
13 p0019 A77-12407
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678
Practical aspects of solar heating - A review of materials use in solar heating applications
13 p0049 A77-13743

THERMAL MAPPING
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591

THERMAL POLLUTION
Mathematical simulation and empirical determination of the aerochemical and thermal atmospheric pollution resulting from energy conversion processes
[DLR-IB-553-75/1] 13 p0091 N77-10700
Physical and biological aspects of thermal pollution in sea water --- forecasting electric power production in Italy
[ISS-L-75/14] 13 p0109 N77-12560
Assessment of the impact of proposed thermal effluent guidelines for the steam electric power industry
[PB-255937/5] 13 p0110 N77-12587

THERMAL REACTORS
Uranium zirconium hydride reactor space power systems
[IAF PAPER 76-256] 13 p0004 A77-10953
Effects of a thermal reactor on the energy efficiency of a turbocharged, stratified charge engine
[AD-A026059] 13 p0128 N77-15409

THERMAL RESISTANCE
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321

THERMAL RESOURCES
A cylindrical blackbody solar energy receiver
13 p0018 A77-12404
Optimal control of flow in low temperature solar heat collectors
13 p0019 A77-12409
Performance analysis of a cylindrical parabolic focusing collector and comparison with experimental results
13 p0019 A77-12410
A forced circulation system for solar water heating
13 p0019 A77-12413
Underground storage of off-peak power
13 p0027 A77-12728
Industrial energy conservation through integration of thermal energy storage into process energy dynamics
13 p0028 A77-12733
Seasonal storage of thermal energy in water in the underground --- reservoirs
13 p0028 A77-12734
Geothermal energy in Hawaii - Hydrothermal systems
13 p0029 A77-12741
Pressure drawdown and buildup analyses in geothermal reservoirs
13 p0030 A77-12753
Geothermal powered heat pumps to produce process heat
13 p0030 A77-12754
Direct applications of geothermal energy
13 p0030 A77-12755
Extracting energy from hydraulically-fractured geothermal reservoirs
13 p0030 A77-12757
Geothermal sources and their utilization
13 p0055 A77-15803
Geothermal power - The 'sleeper' in the energy race
13 p0056 A77-15845
A generalized indicator characterizing the hydrodynamics and heating efficiency of subterranean thermal circulation systems
13 p0058 A77-16306
THERMAL STABILITY
Status of development and application of gas-stabilized heat-pipe radiators
[DGLR PAPER 76-192] 13 p0060 A77-16557
THERMIONIC CONVERTERS
Advanced thermionic converter development
13 p0043 A77-12862
NASA thermionic-conversion program
13 p0043 A77-12863
THERMIONIC POWER GENERATION
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
Thermionic topping for central station power plants
13 p0034 A77-12787
Thermionic topping of a steam power plant
13 p0034 A77-12789
Heat pipe nuclear reactor for space power
13 p0036 A77-12797
ERDA's Bicentennial Thermionic Research and Technology Program
13 p0042 A77-12861
NASA thermionic-conversion program
13 p0043 A77-12863
THERMOCHEMICAL PROPERTIES
Experimental demonstration of an iron chloride thermochemical cycle for hydrogen production
13 p0032 A77-12772
Test and evaluation of the Navy half-watt RTG --- Radioisotope Thermoelectric Generator
13 p0042 A77-12853
Hydrogen production using nuclear heat
13 p0057 A77-16211
Hydrogen production from water by means of chemical cycles
13 p0058 A77-16471
Effectiveness of heat-emitting coatings with variable degree of blackness
13 p0111 N77-12893
THERMOCHEMISTRY
Design analyses of a methane-based chemical heat pipe
13 p0028 A77-12737
Thermochemical energy storage systems
13 p0028 A77-12738
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
Thermal alteration of young kerogen in relation to petroleum genesis
13 p0053 A77-15044
Thermo-chemical production of hydrogen
13 p0075 A77-19074
Production of chemical energy carriers by non-expandable energy sources --- solar energy electrolysis, photolysis, and thermochemical cycles
[DLR-FB-76-32] 13 p0114 N77-13541
THERMOCOUPLES
Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters
13 p0058 A77-16324
Branched thermocouple circuits in underground coal gasification experiments
[SAND-75-5910] 13 p0130 N77-15504
THERMODYNAMIC CYCLES
Uranium zirconium hydride reactor space power systems
[IAF PAPER 76-256] 13 p0004 A77-10953
The use of program GEOTHM to design and optimize geothermal power cycles
13 p0031 A77-12758
Experimental demonstration of an iron chloride thermochemical cycle for hydrogen production
13 p0032 A77-12772
Isotope heat source for dynamic power systems
13 p0036 A77-12796
A hydride compressor
13 p0046 A77-13336
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up --- utilizing Stirling engine
13 p0051 A77-14580
Investigation of two-phase liquid-metal magnetohydrodynamic power systems
13 p0057 A77-16212
Analysis of parameters and characteristics of a bypass turbojet engine operating in a cycle with stepwise heat removal
13 p0063 A77-17765
Geothermal energy for electrical and nonelectrical applications
[LA-UR-76-418] 13 p0123 N77-14601
THERMODYNAMIC EFFICIENCY
Making electricity from moderate temperature fluids --- geothermal sources
13 p0002 A77-10649
Total energy systems --- electric power generation with heat recovery
13 p0006 A77-11042
Thermal energy storage applied to residential heating systems
13 p0027 A77-12729
PULSAR, an unconventional topping stage --- MHD generation with metallic armature produced magnetic flux compression
13 p0034 A77-12788
KIPS - Kilowatt Isotope Power System --- for use in satellites
13 p0041 A77-12837
Air transportation and fuel consumption
13 p0051 A77-14563
A generalized indicator characterizing the hydrodynamics and heating efficiency of subterranean thermal circulation systems
13 p0058 A77-16306
Energy and environmental considerations in extending heat pump applications
13 p0062 A77-17058
Pressure ratio optimization criteria in aircraft turbojet-engines design
13 p0062 A77-17258
Thin film solar acceptors
13 p0072 A77-19053

Temperature optimization for power production of infinite heat transfer solar absorbers
13 p0073 A77-19055
Solar thermal power generation
13 p0077 A77-19095
Performance correlations of five solar collectors tested simultaneously outdoors
[NASA-TM-X-73546] 13 p0128 N77-15487
THERMODYNAMIC PROPERTIES
Evolution of thermal traction - From the diesel engine to the gas turbine
13 p0004 A77-10976
Some useful relationships between the physical and thermodynamic properties of metal hydrides
13 p0033 A77-12776
Geothermal energy as a source of electric power: Thermodynamic and economic design criteria --- Book
13 p0060 A77-16623
Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range
13 p0069 A77-18496
Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity
13 p0073 A77-19057
THERMODYNAMICS
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924
THERMOELECTRIC COOLING
Solid state applications of direct energy conversion and heat pumping for a small automotive vehicle
[AD-A026321] 13 p0124 N77-14607
THERMOELECTRIC GENERATORS
SNAP 19 Viking RTG mission performance
13 p0041 A77-12840
Development of a small radioisotopic heat source
13 p0042 A77-12852
Test and evaluation of the Navy half-watt RTG --- Radioisotope Thermoelectric Generator
13 p0042 A77-12853
Spherical radioisotope thermoelectric generators - An approach to high specific power devices
13 p0042 A77-12857
Optimization of the geometry of switching buses for thermoelements in thermoelectric generators
13 p0052 A77-14951
Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters
13 p0058 A77-16324
THERMOELECTRIC MATERIALS
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction
13 p0042 A77-12850
THERMOELECTRIC POWER GENERATION
Power production from high temperature geothermal waters
13 p0030 A77-12751
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction
13 p0042 A77-12850
The low cost high performance generator /LCHPG/ --- space Radioisotope Thermoelectric Generators
13 p0042 A77-12855
Geothermal energy as a source of electric power: Thermodynamic and economic design criteria --- Book
13 p0060 A77-16623
Solid state applications of direct energy conversion and heat pumping for a small automotive vehicle
[AD-A026321] 13 p0124 N77-14607
THERMOHYDRAULICS
Submarine geothermal resources
13 p0010 A77-11322
Geothermal powered heat pumps to produce process heat
13 p0030 A77-12754
Transient behavior of solid sensible heat thermal storage units for solar energy systems
13 p0057 A77-16208
A generalized indicator characterizing the hydrodynamics and heating efficiency of subterranean thermal circulation systems
13 p0058 A77-16306
THERMONUCLEAR EXPLOSIONS
PACER - A practical fusion power concept
13 p0035 A77-12793
THERMONUCLEAR POWER GENERATION
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
A conceptual design study of closed Brayton cycle gas turbines for fusion power generation
13 p0022 A77-12676
World survey of major facilities in controlled fusion research --- Book
13 p0067 A77-18264
Overview of the ERDA fusion power program
13 p0068 A77-18446
THERMOPHYSICAL PROPERTIES
Characteristic equations of unconcentrated flat solar cell panels
13 p0052 A77-14929
THERMOPILES
Accelerated response of thermopile pyranometers
13 p0019 A77-12405
THERMOREGULATION
Optimal control of flow in low temperature solar heat collectors
13 p0019 A77-12409
THERMOSPHERE
Energetics of the midlatitude thermosphere
13 p0012 A77-11492
THIN FILMS
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
Thin film solar acceptors
13 p0072 A77-19053
A sulfurization process for the preparation of photovoltaic Cu/x/S and CuInS2 thin films
13 p0076 A77-19087
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
The optical properties of chromium oxide films and the high temperature stabilization of silver films for photothermal solar energy conversion
13 p0128 N77-15484
THRUST MEASUREMENT
Aerodynamics of the Darrieus rotor
13 p0050 A77-14559
THRUST VECTOR CONTROL
UK, T5 ion engine thrust vector control considerations
[AIAA PAPER 76-1064] 13 p0045 A77-13030
TIDAL WAVES
The atmosphere and the oceans as energy sources
13 p0005 A77-11036
TIME LAG
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
TITANIUM
Evaluation of potassium titanate as a component of alkaline fuel cell matrices
[NASA-TN-D-8341] 13 p0094 N77-11175
TITANIUM ALLOYS
Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage
13 p0033 A77-12777
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543
Titanium-containing Raney nickel catalyst for hydrogen electrodes in alkaline fuel cell systems
13 p0064 A77-18019
TITANIUM COMPOUNDS
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706

TITANIUM OXIDES
Near-uv photon efficiency in a TiO2 electrode - Application to hydrogen production from solar energy
13 p0015 A77-11947
Investigation of a TiO2/electrolyte solar cell and the photocatalytic water decomposition
13 p0077 A77-19094
TOKAMAK FUSION REACTORS
A conceptual design study of closed Brayton cycle gas turbines for fusion power generation
13 p0022 A77-12676
Characteristics of a first generation commercial fusion power plant
[GA-A-13661] 13 p0093 N77-10891
TOWERS
Wind tunnel measurements of the tower shadow on models of the ERDA/NASA 100 KW wind turbine tower
[NASA-TM-X-73548] 13 p0114 N77-13534
TOXICITY
JP-4 and JP-9 fuel toxicity studies using water fish and aufwuchs
[AD-A027594] 13 p0127 N77-15213
TRACKING (POSITION)
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
TRADEOFFS
Trade-off analyses for multi-objective transportation plans
13 p0102 N77-11911
TRANSFER FUNCTIONS
Transfer function analysis of heat pipes
13 p0119 N77-14385
TRANSIENT HEATING
A two-dimensional finite difference solution for the transient thermal behavior of tubular solar collector
13 p0083 N77-10105
TRANSIENT RESPONSE
Transient performance characteristics of a high temperature distributed solar collector field
13 p0037 A77-12810
Preliminary report on the CTS transient event counter performance through the 1976 spring eclipse season
[NASA-TM-X-73487] 13 p0083 N77-10116
TRANSITION METALS
Coal liquefaction with soluble transition-metal complexes
13 p0070 A77-18584
TRANSMISSION CIRCUITS
Microwave transmission system for space power
13 p0014 A77-11818
TRANSMISSION EFFICIENCY
Characteristics of a system for transmitting concentrated solar radiation
13 p0051 A77-14578
Waveguide high pass filter for thermal conversion of solar energy
13 p0073 A77-19054
TRANSMITTER RECEIVERS
Test program for transmitter experiment package and heat pipe system for the communications technology satellite
[NASA-TM-X-3455] 13 p0095 N77-11268
TRANSPORT AIRCRAFT
The next-generation subsonic transport
[SAWE PAPER 1127] 13 p0016 A77-12195
Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575
Fuel consumption of civil jet transport aircraft
13 p0062 A77-17234
LH2 airport requirements study
[NASA-CR-2700] 13 p0083 N77-10032
Hydrogen-fueled subsonic aircraft: A perspective
13 p0084 N77-10344
Energy consumption characteristics of transports using the prop-fan concept
[NASA-CR-137937] 13 p0118 N77-14029
Energy consumption characteristics of transports using the prop-fan concept: Summary report
[NASA-CR-137938] 13 p0118 N77-14030
TRANSPORT PROPERTIES
Organization of long range transport of air pollution monitoring in Europe
13 p0071 A77-18754
Energy and Physics: General Conference of the European Physical Society
[AD-A026962] 13 p0131 N77-15511
TRANSPORT THEORY
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
TRANSPORTATION
Conference report: Energy Conservation in Transportation and Construction
[PB-255857/5] 13 p0100 N77-11562
Analysis of fiscal year 1977 DOT program by policy and RD and D management objectives. Program levels for fiscal years 1975, 1976, 1977, volume 1
[PB-255401/2] 13 p0117 N77-13922
Increased fuel economy in transportation systems by use of energy management - second year's program
[PB-257177/6] 13 p0133 N77-15930
TRANSPORTATION ENERGY
Air transportation energy efficiency - Alternatives and implications
[SAWE PAPER 1124] 13 p0016 A77-12192
An alternative fuel for cars --- hydrogen production and storage
13 p0050 A77-14530
Energy consumption in various modes of transportation
13 p0050 A77-14561
Evolution of the concept of the automobile from the standpoint of saving energy
13 p0051 A77-14562
Air transportation and fuel consumption
13 p0051 A77-14563
Energy recovery in railway and road transportation
13 p0051 A77-14564
Alternate fuels for road vehicles of the future
13 p0051 A77-14584
Transport systems guarantee efficient utilization of energy resources
13 p0053 A77-15048
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
Utility facilities in transportation corridors
[PB-255635/5] 13 p0093 N77-10970
Optimizing the use of materials and energy in transportation construction
[PB-253713/2] 13 p0096 N77-11475
Assessing the relationship between urban form and travel requirements: A literature review and conceptual framework
[PB-254988/9] 13 p0102 N77-11923
Future scenarios for urban transportation
[PB-255349/3] 13 p0102 N77-11930
TRISNET. Directory to transportation research information resources
[PB-255172/9] 13 p0125 N77-14939
Alternative fuels for aviation
[GPO-78-544] 13 p0127 N77-15212
TRENDS
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981
TUBE HEAT EXCHANGERS
Performance of an annular cylindrical solar collector
13 p0073 A77-19059
TUNGSTEN CARBIDES
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815
TURBINE BLADES
Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines
13 p0044 A77-12871
Design consideration for the Darrieus rotor --- wind turbines
13 p0044 A77-12872
TURBINE PUMPS
Underground pumped storage research priorities
[PB-254413/8] 13 p0089 N77-10667
TURBINES
Wind energy conversion
[PB-256198/3] 13 p0115 N77-13552
TURBOCOMPRESSORS
A unique Rankine-cycle heat pump system
13 p0036 A77-12799

Effects of a thermal reactor on the energy efficiency of a turbocharged, stratified charge engine
[AD-A026059] 13 p0128 N77-15409
TURBOFAN ENGINES
Study of small turbofan engines applicable to single-engine light airplanes
[NASA-CR-137944] 13 p0093 N77-11054
TURBOFANS
Noise mechanism separation and design considerations for low tip-speed, axial-flow fans
13 p0046 A77-13339
TURBOGENERATORS
Large-scale electrical power generation and storage
13 p0006 A77-11039
The Osmotic power plant
13 p0021 A77-12668
Solids gasification for gas turbine fuel 100 and 300 Btu gas
13 p0022 A77-12685
Production of methane using offshore wind energy
13 p0026 A77-12722
Energy conservation with advanced power generating systems
13 p0026 A77-12723
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732
KIPS - Kilowatt Isotope Power System --- for use in satellites
13 p0041 A77-12837
Design consideration for the Darrieus rotor --- wind turbines
13 p0044 A77-12872
An experimental 200 kW vertical axis wind turbine for the Magdalen Islands
13 p0044 A77-12874
A combined cycle with a partial-oxidation reactor
13 p0062 A77-17534
TURBOJET ENGINE CONTROL
Equation solution accuracy in calculating jet engine characteristics
13 p0020 A77-12502
Application of simulation studies to the design and improvement of fuel control systems for aviation turbine engines
13 p0054 A77-15798
TURBOJET ENGINES
Pressure ratio optimization criteria in aircraft turbojet-engines design
13 p0062 A77-17258
Analysis of parameters and characteristics of a bypass turbojet engine operating in a cycle with stepwise heat removal
13 p0063 A77-17765
The impact of JP-4/JP-8 conversion on aircraft engine exhaust emissions
[AD-A026546] 13 p0112 N77-13234
TURBULENT BOUNDARY LAYER
Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels
13 p0046 A77-13242
TWO PHASE FLOW
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
Study of the properties of heat pipes with liquid-metal heat-transfer agents in low-temperature regimes
13 p0046 A77-13243
TWO STAGE TURBINES
Design phase utility analysis for gas turbine and combined cycle plants
[PB-256665/1] 13 p0115 N77-13553

U

U.S.S.R. SPACE PROGRAM
Energy - Ecospace --- space law aspects of U.S. and U.S.S.R. solar power proposals
[IAF PAPER ISL-76-59] 13 p0004 A77-10970
ULTRASONIC RADIATION
Development of signal processing algorithms for ultrasonic detection of coal seam interfaces
[NASA-CR-150024] 13 p0085 N77-10610
ULTRAVIOLET RADIATION
Near-uv photon efficiency in a TiO2 electrode - Application to hydrogen production from solar energy
13 p0015 A77-11947
UNDERGROUND STORAGE
Compressed air energy storage - A near term option for utility application
13 p0027 A77-12727
Underground storage of off-peak power
13 p0027 A77-12728
Underground pumped storage research priorities
[PB-254413/8] 13 p0089 N77-10667
A survey of salt deposits and salt caverns: Their relevance to the strategic petroleum reserve
[PB-255948/2] 13 p0105 N77-12500
UNDERGROUND STRUCTURES
Remote sensing of an underground coal-burn cavity with a wide-band induction system
13 p0007 A77-11050
Seasonal storage of thermal energy in water in the underground --- reservoirs
13 p0028 A77-12734
A generalized indicator characterizing the hydrodynamics and heating efficiency of subterranean thermal circulation systems
13 p0058 A77-16306
Aerodynamics as a subway design parameter
13 p0070 A77-18721
UNDERWATER STRUCTURES
Aluminum-based anodes for underwater fuel cells: A phase report
[AD-A026405] 13 p0131 N77-15512
UNITED KINGDOM
Energy and the coal industry
13 p0005 A77-11030
Energy research in the UK
13 p0055 A77-15812
UNITED STATES OF AMERICA
Historical fuels and energy consumption data, 1960 - 1972, United States by states and census districts east of the Mississippi
[PB-255176/0] 13 p0112 N77-13229
Historical fuels and energy consumption data, 1960 - 1972, United States by states and census districts west of the Mississippi
[PB-255177/8] 13 p0112 N77-13230
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594
Trends in refinery capacity and utilization: Petroleum refineries in the United States; foreign refinery exporting centers
[PB-256966/3] 13 p0132 N77-15523
URBAN DEVELOPMENT
Growth effects of major land use projects. Volume 2: Compilation of land use based emission factors
[PB-255302/2] 13 p0092 N77-10709
URBAN PLANNING
Increase in the efficiency of heat and power systems using large artificial accumulators of heat
13 p0064 A77-17939
Lumiducts for Ecopolis --- urban solar light collection and transmission system
13 p0079 A77-19116
Resource recovery technology for urban decision-makers
[PB-252458/5] 13 p0093 N77-10964
URBAN RESEARCH
Detailed geographic analysis of residential energy consumption
13 p0043 A77-12864
Development of a multi-disciplinary ERTS user program in the state of Ohio
[E77-10045] 13 p0104 N77-12475
URBAN TRANSPORTATION
The fuel efficiency potential of a flywheel hybrid vehicle for urban driving
13 p0020 A77-12664
Load leveling with electric vehicles in the urban environment
13 p0024 A77-12701
Selection of driving cycles for electric vehicles of the 1990's
13 p0024 A77-12702
Performance of a hydrogen-powered transit vehicle
13 p0033 A77-12781

Transport of the future and the tasks of science
13 p0048 A77-13643
Energy recovery in railway and road transportation
13 p0051 A77-14564
Transport systems guarantee efficient utilization of energy resources
13 p0053 A77-15048
Aerodynamics as a subway design parameter
13 p0070 A77-18721
Evaluating revenue sources for public transit - A new frontier for environmental planners
13 p0070 A77-18723
Economic and social impact of solar powered transportation systems
13 p0079 A77-19120
Trade-off analyses for multi-objective transportation plans
13 p0102 N77-11911
Assessing the relationship between urban form and travel requirements: A literature review and conceptual framework
[PB-254988/9] 13 p0102 N77-11923
Future scenarios for urban transportation
[PB-255349/3] 13 p0102 N77-11930
Air quality considerations in transportation planning: Findings and recommendations on transportation control planning, phase 2
[PB-256424/3] 13 p0110 N77-12576
Personal rapid transit research conducted at the Aerospace Corporation
[PB-256846/7] 13 p0111 N77-12946

USER MANUALS (COMPUTER PROGRAMS)
Computer program grade 2 for the design and analysis of heat-pipe wicks
[NASA-CR-137954] 13 p0118 N77-14375

USER REQUIREMENTS
Software aspects of super composites --- composition selection to meet user requirements
13 p0053 A77-15301

UTILITIES
Energy conservation potential of Modular Integrater Utility Systems /MIUS/
13 p0026 A77-12724
Utility facilities in transportation corridors
[PB-255635/5] 13 p0093 N77-10970

UTILITY AIRCRAFT
The dynamics of STOL /The Daniel and Florence Guggenheim Lecture/ --- utility aircraft for short haul service in remote areas
[ICAS PAPER 76-01] 13 p0081 A77-19247

V

VACUUM TUBES
A fixed collector employing reversible vee-trough concentrator and a vacuum tube receiver for high temperature solar energy systems
13 p0038 A77-12813

VAPOR PHASES
Investigation of gas-controlled heat pipes with reservoirs of constant and variable volume
13 p0050 A77-14327

VARIABLE GEOMETRY STRUCTURES
Variable geometry for high performance aircraft engines
13 p0062 A77-17264

VEGETATION
Waste heat vs conventional systems for greenhouse environmental control: An economic assessment
[ORNL/TM-5069] 13 p0088 N77-10656

VIBRATION TESTS
Test and evaluation of the Navy half-watt RTG --- Radioisotope Thermoelectric Generator
13 p0042 A77-12853

VIBRATIONAL SPECTRA
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668

VIKING 1 SPACECRAFT
SNAP 19 Viking RTG mission performance
13 p0041 A77-12840

VISCOUS FLUIDS
Thermal explosion of moving reacting fluids of variable viscosity
13 p0052 A77-14980

VOLCANOES
Remote sensing of geothermic activities of the volcanoes Aetna, Stromboli and Vesuv by means of infra-red NOAA-VHRR-satellite data --- Italy
13 p0104 N77-12485

VOLT-AMPERE CHARACTERISTICS
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108
Operation of ITO/Si heterojunction solar cells
13 p0014 A77-11762
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
Performance and cost analysis of photovoltaic power systems for on-site residential applications
13 p0038 A77-12816
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
An analysis of silicon solar cell parameters for terrestrial applications
13 p0076 A77-19081

VOLTAGE REGULATORS
Linear model of a dissipative PWM shunt regulator --- Pulse Width Modulation
13 p0080 A77-19172

VOLTMETERS
On the nature of fluctuations in an open cycle magnetohydrodynamic generator
13 p0117 N77-13841

VORTEX GENERATORS
Vortex kinetic energy concentrator
13 p0044 A77-12870

W

WASTE DISPOSAL
Energy from wastes
13 p0006 A77-11038
Controlled tipping of combustion residues
13 p0008 A77-11175
Dutchess County, NY moves towards pyrolysis --- of solid wastes with fuel recovery
13 p0010 A77-11298
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689
Energy and environment post-2000
13 p0050 A77-14560
Resource recovery technology for urban decision-makers
[PB-252458/5] 13 p0093 N77-10964
Pollutant potential of raw and chemically fixed hazardous industrial wastes and flue gas desulfurization sludges
[PB-256691/7] 13 p0133 N77-15540
Fine shredding of municipal solid waste
[PB-257105/7] 13 p0133 N77-15919

WASTE ENERGY UTILIZATION
Energy from solid wastes --- Book
13 p0003 A77-10698
Energy from wastes
13 p0006 A77-11038
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673
Steam station repowering - A near-term method of energy conservation
13 p0022 A77-12679
Thermionic topping for central station power plants
13 p0034 A77-12787
PULSAR, an unconventional topping stage --- MHD generation with metallic armature produced magnetic flux compression
13 p0034 A77-12788
Thermionic topping of a steam power plant
13 p0034 A77-12789
Energy recovery in railway and road transportation
13 p0051 A77-14564

Improved use of energy --- through waste and solar energy utilization
13 p0079 A77-19123
Gasification of coal and its future aspects regarding the use of heat from high-temperature nuclear reactors
[INIS-MF-1965] 13 p0084 N77-10228
Waste heat vs conventional systems for greenhouse environmental control: An economic assessment
[ORNL/TM-5069] 13 p0088 N77-10656
Selected aspects of waste heat management
[PB-254401/3] 13 p0109 N77-12568
Performance characteristics of a diesel engine using low- and medium-energy gases as a fuel supplement (fumigation)
[NASA-TM-X-58188] 13 p0126 N77-14955

WASTE UTILIZATION
Dutchess County, NY moves towards pyrolysis --- of solid wastes with fuel recovery
13 p0010 A77-11298
The solution of the garbage problem: New proposals for the utilization of refuse - Proposals and suggestions --- materials recycling and energy production facilities
13 p0015 A77-12061
Nuclear power for the production of synthetic fuels and feedstocks
13 p0035 A77-12790
Fuel gas recovery from controlled landfilling of municipal wastes
13 p0070 A77-18739
Recycling trends in the United States: A review
[PB-254222/3] 13 p0085 N77-10391

WASTE WATER
Selected aspects of waste heat management: A state-of-the-art study
[PB-255697/5] 13 p0100 N77-11563

WATER
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666
Hydrogen from solar energy via water electrolysis
13 p0032 A77-12771
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Hydrogen production using solar radiation
13 p0048 A77-13540
Hydrogen production from water by means of chemical cycles
13 p0058 A77-16471

WATER CIRCULATION
Water power in the immediate future
13 p0056 A77-15850

WATER CONSUMPTION
Water requirements for an integrated SNG plant and mine operation
13 p0060 A77-16651

WATER MANAGEMENT
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497

WATER POLLUTION
Physical and biological aspects of thermal pollution in sea water --- forecasting electric power production in Italy
[ISS-L-75/14] 13 p0109 N77-12560
Assessment of the impact of proposed thermal effluent guidelines for the steam electric power industry
[PB-255937/5] 13 p0110 N77-12587
Characterization and evaluation of wastewater sources United States Steel Corporation, Clairton Works, Pittsburgh, Pennsylvania, 28-31 January 1976
[PB-255586/0] 13 p0116 N77-13566
Evaluation of pollution control in fossil fuel conversion processes
[PB-255842/7] 13 p0125 N77-14638
JP-4 and JP-9 fuel toxicity studies using water fish and aufwuchs
[AD-A027594] 13 p0127 N77-15213

WATER QUALITY
Utilization of remote sensing techniques to detect land use effects on wildland water quality
13 p0071 A77-18984

WATER RECLAMATION
Feasibility study of a nuclear power-sewage treatment system for the conservation and reclamation of water resources
[PB-255630/6] 13 p0126 N77-14960

WATER RESOURCES
Solar water pump for lift irrigation
13 p0019 A77-12406
The nature and characteristics of the distribution of helium and argon isotopes in the geothermal waters of the Kuril Islands and Kamchatka
13 p0048 A77-13589
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586
Utility distribution systems in Iceland
[AD-A026956] 13 p0126 N77-14957

WATER TEMPERATURE
Making electricity from moderate temperature fluids --- geothermal sources
13 p0002 A77-10649
The solar water heater industry in South Florida - History and projections
13 p0018 A77-12403
A forced circulation system for solar water heating
13 p0019 A77-12413
Underground storage of off-peak power
13 p0027 A77-12728
Power production from high temperature geothermal waters
13 p0030 A77-12751
The utilization and economics of low temperature geothermal water for space heating
13 p0030 A77-12756
Solar water heater using hardened black polythene pipe absorbers
13 p0073 A77-19060
Design and performance of thermal storage water tank
13 p0075 A77-19079
Selection of optimal pan color for solar water heater
13 p0078 A77-19104
Intermediate minimum property standards for solar heating and domestic hot water systems
[PB-257086/9] 13 p0132 N77-15525

WATER TREATMENT
Selected aspects of waste heat management: A state-of-the-art study
[PB-255697/5] 13 p0100 N77-11563
Selected aspects of waste heat management
[PB-254401/3] 13 p0109 N77-12568

WATER VAPOR
Electric energy from atmospheric water vapor
13 p0077 A77-19097

WATERWAVE ENERGY
Power resource estimate of ocean surface waves
13 p0071 A77-18790

WATERWAVE ENERGY CONVERSION
The atmosphere and the oceans as energy sources
13 p0005 A77-11036

WAVEGUIDE FILTERS
Waveguide high pass filter for thermal conversion of solar energy
13 p0073 A77-19054

WEIGHT REDUCTION
Estimating procedures associated with aircraft modifications
[SAWE PAPER 1101] 13 p0016 A77-12181
Theoretical aspects of optimization of aviation gas turbine engine design variables
13 p0063 A77-17762

WELD STRENGTH
Ship steel weldments for low temperature service
[PB-256997/8] 13 p0103 N77-12203

WELLS
Pressure drawdown and buildup analyses in geothermal reservoirs
13 p0030 A77-12753

WESTAR SATELLITES
Satellite communications for off-shore oil operations using WESTAR
13 p0053 A77-15130

WETTING
Wetting and surface properties of refrigerants to be used in heat pipes --- surface tension and wall contact angles
13 p0119 N77-14386

WICKS
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326
Computer program grade 2 for the design and analysis of heat-pipe wicks
[NASA-CR-137954] 13 p0118 N77-14375
Extended cryogenic performance of Lobar Wick heat pipe/radiator
13 p0119 N77-14379
WILDERNESS
Utilization of remote sensing techniques to detect land use effects on wildland water quality
13 p0071 A77-18984
WIND EFFECTS
The wind and its effect on the heating requirements
13 p0009 A77-11266
WIND PROFILES
Siting of wind driven apparatus
13 p0043 A77-12865
Wind tunnel measurements of the tower shadow on models of the ERDA/NASA 100 KW wind turbine tower
[NASA-TM-X-73548] 13 p0114 N77-13534
WIND TUNNEL TESTS
Wind tunnel investigation of devices to reduce bus aerodynamic drag
[AIAA PAPER 77-307] 13 p0066 A77-18232
Comparative wind tunnel investigation of sail profiles for windmills
[VTH-191] 13 p0111 N77-13012
Wind tunnel measurements of the tower shadow on models of the ERDA/NASA 100 KW wind turbine tower
[NASA-TM-X-73548] 13 p0114 N77-13534
WIND VELOCITY
Estimating wind power feasibility
13 p0010 A77-11315
A new generation scheme for large wind energy conversion systems
13 p0043 A77-12868
Wind driven field modulated generator systems
13 p0044 A77-12869
New England wind power...coastal or mountain
13 p0058 A77-16250
WINDMILLS (WINDPOWERED MACHINES)
Windmills stage a comeback --- review
13 p0048 A77-13624
Dual optimum aerodynamic design for a conventional windmill
13 p0048 A77-13704
Wind-power generation on a large scale - A design idea
13 p0050 A77-14531
Aerodynamics of the Darrieus rotor
13 p0050 A77-14559
Possibilities for utilizing wind energy
13 p0056 A77-15853
Windmills change direction --- British system utilizing offshore windmills and depleted North Sea fields
13 p0060 A77-16620
Some dynamic problems of rotating windmill systems
13 p0084 N77-10271
Comparative wind tunnel investigation of sail profiles for windmills
[VTH-191] 13 p0111 N77-13012
An estimate of the interaction of a limited array of windmills --- feasibility of windpower group station for proposed site
[DM-16] 13 p0114 N77-13539
WINDOWS (APERTURES)
Windowed versus windowless solar energy cavity receivers
13 p0037 A77-12808
WINDPOWER UTILIZATION
The atmosphere and the oceans as energy sources
13 p0005 A77-11036
The overcoming of energy deficiencies with the aid of wind power
13 p0008 A77-11174
Energy: A radical redirection
13 p0010 A77-11275
Estimating wind power feasibility
13 p0010 A77-11315
Production of methane using offshore wind energy
13 p0026 A77-12722
Siting of wind driven apparatus
13 p0043 A77-12865
A new generation scheme for large wind energy conversion systems
13 p0043 A77-12868
Operational experience with small wind units
13 p0044 A77-12873
An experimental 200 kW vertical axis wind turbine for the Magdalen Islands
13 p0044 A77-12874
Possibilities for utilizing wind energy
13 p0056 A77-15853
Potentialities and limitations of the utilization of wind machines
13 p0061 A77-16787
Wind power prediction models
[NASA-CR-149235] 13 p0105 N77-12509
Wind energy conversion
[PB-256198/3] 13 p0115 N77-13552
WINDPOWERED GENERATORS
The overcoming of energy deficiencies with the aid of wind power
13 p0008 A77-11174
Design principles for solar and wind power installations
13 p0015 A77-11922
Optimization criteria for solar and wind power systems
13 p0015 A77-11923
Siting of wind driven apparatus
13 p0043 A77-12865
The consumer's cost of electricity from windmills
13 p0043 A77-12866
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
A new generation scheme for large wind energy conversion systems
13 p0043 A77-12868
Wind driven field modulated generator systems
13 p0044 A77-12869
Vortex kinetic energy concentrator
13 p0044 A77-12870
Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines
13 p0044 A77-12871
Design consideration for the Darrieus rotor --- wind turbines
13 p0044 A77-12872
Operational experience with small wind units
13 p0044 A77-12873
An experimental 200 kW vertical axis wind turbine for the Magdalen Islands
13 p0044 A77-12874
Dependability of wind energy generators with short-term energy storage
13 p0046 A77-13323
Windmills stage a comeback --- review
13 p0048 A77-13624
Wind-power generation on a large scale - A design idea
13 p0050 A77-14531
Can Canada harness the wind
13 p0053 A77-15047
New England wind power...coastal or mountain
13 p0058 A77-16250
Windmills change direction --- British system utilizing offshore windmills and depleted North Sea fields
13 p0060 A77-16620
Potentialities and limitations of the utilization of wind machines
13 p0061 A77-16787
Early operation experience on the ERDA/NASA 100 kW wind turbine --- rotor blade loads
[NASA-TM-X-71601] 13 p0086 N77-10640
Costs of alternative sources of electricity
[PB-255765/0] 13 p0107 N77-12528
An estimate of the interaction of a limited array of windmills --- feasibility of windpower group station for proposed site
[DM-16] 13 p0114 N77-13539
WINDPOWERED PUMPS
Potentialities and limitations of the utilization of wind machines
13 p0061 A77-16787

WING TIPS
Vortex kinetic energy concentrator
13 p0044 A77-12870
WOOD
Production of a hydrocarbon-type synthetic fuel from wood
[NRC-15638] 13 p0127 N77-15210
WORKING FLUIDS
Economic optimization of binary fluid cycle power plants for geothermal systems
13 p0029 A77-12744
Geothermal powered heat pumps to produce process heat
13 p0030 A77-12754
Liquid-metal magnetohydrodynamic system evaluation --- coal-fired designs
13 p0034 A77-12784
Organic Rankine Cycle Engine development and solar energy utilization
13 p0077 A77-19096
Closed Brayton cycle using hydrogen as a work fluid
[BNL-20899] 13 p0085 N77-10542
Heat pipes for the temperature range from 200 to 600 C --- noting sulfur with iodine additive as working fluid
13 p0119 N77-14381
WYOMING
Assessing low sulfur coal resources in Montana and Wyoming
13 p0058 A77-16374
Draft environmental assessment of application by ERDA for a special land use permit for use of public lands in Wyoming for in-situ coal gasification experiments
[UCID-17011] 13 p0100 N77-11572

X

X-15 AIRCRAFT
Hypersonic technology-approach to an expanded program
13 p0051 A77-14597

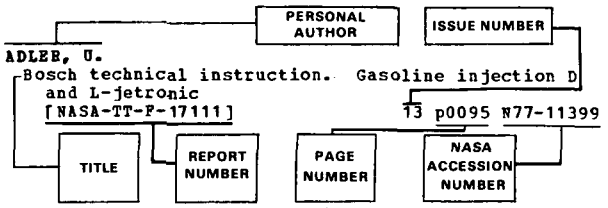
Y

YELLOWSTONE NATIONAL PARK (ID-MT-WY)
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121

Z

ZIRCONIUM HYDRIDES
Uranium zirconium hydride reactor space power systems
[IAF PAPER 76-256] 13 p0004 A77-10953

Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The issue, page and accession numbers are located beneath and to the right of the title, e.g., 13 p0095 N77-11399. Under any one author's name the accession numbers are arranged in sequence with the *IAA* accession numbers appearing first.

A

AAHOT, H. W. C.
Utility distribution systems in Iceland
[AD-A026956] 13 p0126 N77-14957

ABDALLAH, Y.
Selection of optimal pan color for solar water heater
13 p0078 A77-19104

ABDEL-AAL, H. K.
On the storage of solhydrogen
13 p0075 A77-19073

ABDEL-HAMEED, M. F.
New frontiers in solar and other energy options
13 p0079 A77-19118

ABDEL-MONEM, M. S.
A new method for collector field optimization
13 p0074 A77-19070

ABDUL-AZEEM, E. M.
Thermo-chemical production of hydrogen
13 p0075 A77-19074

ABDUL-SALAM, E.
Thermo-chemical production of hydrogen
13 p0075 A77-19074

ABDUL-SALAM, E. M.
Preliminary design data for a solar house in Riyadh, Saudi Arabia
13 p0078 A77-19112

ABENS, S. G.
Fuel cell stacks
[AD-A024216] 13 p0090 N77-10684

ACHARD, J. C.
A new hydrogen storage electrode
13 p0047 A77-13539

ACHENBACH, J. D.
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556

ADAMS, A. A.
Research on electrochemical energy conversion systems
[AD-A023689] 13 p0090 N77-10681
An improved electrolyte for direct oxidation fuel cells
[AD-A026164] 13 p0131 N77-15518

ADAMS, J. A., JR.
Atmospheric carbon dioxide variations at the South Pole
13 p0067 A77-18439

ADLER, D.
Operation of ITO/Si heterojunction solar cells
13 p0014 A77-11762

ADLER, U.
Bosch technical instruction. Gasoline injection D and L-jetronic
[NASA-TT-F-17111] 13 p0095 N77-11399

AFFENS, W. A.
Ignition of flammable gases in crude-oil tankers as a result of metal fracture
[AD-A027411] 13 p0127 N77-15121

AFGAN, N. H.
Future energy production systems: Heat and mass transfer processes. Volume 1
13 p0056 A77-16201

AHLGREN, W. L.
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604

AHMED, S. B.
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594

AIACHE, L.
Alternating photoelectrochemical converters
13 p0077 A77-19093

AIYAMA, Y.
Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
13 p0049 A77-13728

AKHMEDZIANOV, A. M.
Equation solution accuracy in calculating jet engine characteristics
13 p0020 A77-12502

AKHMIN, Y. V.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4P)] 13 p0112 N77-13235

AKSELROD, S. KH.
Equation solution accuracy in calculating jet engine characteristics
13 p0020 A77-12502

AKYILMAZ, M. O.
Trade-off analyses for multi-objective transportation plans
13 p0102 N77-11911

ALAVIDZE, G. R.
Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels
13 p0046 A77-13242

ALAVUTDINOV, D. M.
A Cassegrain system for solar radiation
13 p0063 A77-17561

ALBERTSON, V. D.
Solar power arrays for the concentration of energy
[COO-2699-2] 13 p0087 N77-10651

ALEREZA, T.
Detailed geographic analysis of residential energy consumption
13 p0043 A77-12864

ALIMOV, A. K.
A Cassegrain system for solar radiation
13 p0063 A77-17561

ALLEN, C. A.
Fluidized bed heat exchangers for geothermal applications
13 p0029 A77-12748

ALLEN, J.
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812

ALLEN, R. W.
Short and long term comparison of solar absorption air-conditioning system performance using real and synthetic weather data
13 p0039 A77-12824

ALLER, P.
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678

ALLISON, H. J.
An energy center in Sri Lanka
13 p0021 A77-12669

ALMS, F. U.
Controlled tipping of combustion residues
13 p0008 A77-11175

ALT, C. B.
National petroleum product supply and demand, 1976 - 1978
[PB-254969/9] 13 p0084 N77-10224

AMEND, W. E.
Investigation of two-phase liquid-metal magnetohydrodynamic power systems
13 p0057 A77-16212

AMODE, J. O.
Analysis of a heat pipe exchanger
13 p0112 N77-13355

AMODIO, U.
Evolution of thermal traction - From the diesel engine to the gas turbine
13 p0004 A77-10976

ANAND, D. K.
Short and long term comparison of solar absorption air-conditioning system performance using real and synthetic weather data
13 p0039 A77-12824

ANANTH, K. P.
Pine shredding of municipal solid waste
[PB-257105/7] 13 p0133 N77-15919

ANDERSON, D. N.
Emissions and performance of catalysts for gas turbine catalytic combustors
[NASA-TM-X-73543] 13 p0104 N77-12406

ANDERSON, J. A.
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California
[PB-254449/2] 13 p0092 N77-10720

ANDERSON, K. E.
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107

ANDERSON, K. P.
The long-run marginal costs of energy
[PB-252504/6] 13 p0085 N77-10625
A simulation analysis of US energy demand, supply, and prices
[PB-254314/8] 13 p0090 N77-10680

ANDERSON, L. B.
Semiconductor-electrolyte photovoltaic energy converter
[PB-252837/0] 13 p0099 N77-11548

ANDERSON, W. A.
Schottky solar cells on thin epitaxial silicon
13 p0047 A77-13509

ANDERSON, W. W.
Semiconductor-electrolyte photovoltaic energy converter
[PB-252837/0] 13 p0099 N77-11548

ANSPAUGH, L. R.
Overview of the Imperial Valley environmental project
[UCID-17067] 13 p0132 N77-15533

ANWAR, M. M.
Double-faced silicon solar cell system
13 p0076 A77-19090

APARISI, R. R.
Problems of energy storage in solar power stations
13 p0063 A77-17555

APPELL, H. R.
COSTEAM: Low-rank coal liquefaction - An updated analysis
13 p0045 A77-12934

ARANA, V.
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497

ARANOVICH, J.
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547

ARKANIIA, Z. V.
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924

ARMBRUST, S.
Possibilities for utilizing wind energy
13 p0056 A77-15853

ARNORSSON, S.
The utility of waters from the high-temperature areas in Iceland for space heating as determined by their chemical composition
13 p0012 A77-11496

ARTEMOV, V. I.
Construction of two-dimensional steady-state solution of equations of a nonequilibrium magnetized plasma
13 p0065 A77-18130

ASINOVSKII, E. I.
Limiting capabilities with respect to electric power generation of a pulsed MHD generator operating at a resistive load
13 p0064 A77-17917

ATALLAH, S.
Solar thermal power generation
13 p0077 A77-19095

AUER, P. L.
Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/
13 p0013 A77-11524

AUGENSTEIN, D. C.
Fuel gas recovery from controlled landfilling of municipal wastes
13 p0070 A77-18739

AVERETT, D. E.
Pollutant potential of raw and chemically fixed hazardous industrial wastes and flue gas desulfurization sludges
[PB-256691/7] 13 p0133 N77-15540

AVERY, J.
Low reflectivity solar cells
[AD-A025922] 13 p0108 N77-12539

AVERY, W. H.
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships, detailed report
[PB-257444/0] 13 p0116 N77-13554

AVEZOV, R. R.
Some features of the operation of a solar installation acting as a low-temperature source of heat for a heat pump
13 p0015 A77-11924
Calculation of the radiation entering a 'hot box' type solar set-up
13 p0051 A77-14581

AYER, F. A.
Second Environmental Aspects of Fuel Conversion Technology Symposium
[PB-257182/6] 13 p0125 N77-14645

AYYASWAMY, P. S.
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732

B

BABAEV, A. B.
Contribution of the heat carried by solar radiation to the thermal balance of a room during the cold season and its effect on domestic fuel consumption
13 p0063 A77-17558

BABEL, H. W.
Some material considerations involved in the application of solar energy to electric power generation
13 p0049 A77-13739

BACKUS, C. E.
On black solar cells or the tetrahedral texturing of a silicon surface
13 p0004 A77-11000
Photovoltaic systems using sunlight concentration
13 p0076 A77-19089

BAGOTSKII, V. S.
New electrochemical current sources
13 p0020 A77-12650

BAHARI-KASHANI, M.
Superflywheel energy storage and nonsynchronous AC/DC/AC electric transmission supplements power system operation
13 p0002 A77-10638

BAIBATYROV, E. N.
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815
BAILEY, J. A.
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689
BAILEY, R. L.
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
BAINBRIDGE, G. R.
The energy problem and the earth's fuel situation
13 p0004 A77-11027
BAIRD, R.
Radiolytic hydrogen production from a laser fusion system
13 p0035 A77-12795
BAIRIEV, A. CH.
Calculations on an optimized faceted solar concentrator
13 p0015 A77-11921
BAKER, B. S.
Fuel cell stacks
[AD-A024216] 13 p0090 N77-10684
BAKER, C. C.
Characteristics of a first generation commercial fusion power plant
[GA-A-13661] 13 p0093 N77-10891
BALASUBRAMANIAN, N.
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665
BALDRIDGE, P. E.
Development of a multi-disciplinary ERTS user program in the state of Ohio
[E77-10045] 13 p0104 N77-12475
BALDWIN, R. M.
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
BALTISBERGER, R. J.
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243
BANNA, S. M.
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
BANNEROT, R. B.
Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials
13 p0068 A77-18444
BARANOV, V. K.
Characteristics of a system for transmitting concentrated solar radiation
13 p0051 A77-14578
BARAONA, C. R.
Analysis of epitaxial drift field N on P silicon solar cells
[NASA-TM-X-73563] 13 p0106 N77-12523
BARATZ, B.
Survey of alcohol fuel technology, volume 1
[PB-256007/6] 13 p0112 N77-13232
BARBER, R. E.
Solar powered organic Rankine cycle engines - Characteristics and costs
13 p0036 A77-12798
BARBER, S. C.
Availability of potential coal supply through 1985 by quality characteristics
[PB-256680/0] 13 p0121 N77-14573
BARNES, J. A.
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements
13 p0028 A77-12735
BARNETT, J. P.
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire
[PB-254179/5] 13 p0091 N77-10687
BARON, R. E.
Synthetic fuels - Prices, prospects, and prior art
13 p0017 A77-12236
BARON, S.
Air, water, nuclear power make gasoline
13 p0045 A77-12935
BARR, I. R.
Production of methane using offshore wind energy
13 p0026 A77-12722
BARRA, O.
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
BARRIE, L. A.
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295
BARSUKOV, V. V.
Investigation of gas-controlled heat pipes with reservoirs of constant and variable volume
13 p0050 A77-14327
BARTEL, J. J.
Survey of high temperature thermal energy storage
[SAND-75-8063] 13 p0088 N77-10655
BARTICK, H.
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207
BARTLETT, J. C.
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822
BARTOS, M. J., JR.
Pollutant potential of raw and chemically fixed hazardous industrial wastes and flue gas desulfurization sludges
[PB-256691/7] 13 p0133 N77-15540
BASFORD, R. C.
Solar hot water systems application to the solar building test facility and the Tech House
13 p0084 N77-10342
BASIULIS, A.
VBP heat pipes for energy storage
13 p0032 A77-12767
BASS, R. L.
A study to obtain verification of Liquid Natural Gas (LNG) tank loading criteria
[AD-A025716] 13 p0120 N77-14492
BAUER, R.
Development of sodium/sulfur-cells
13 p0026 A77-12716
Some studies on sodium/sulfur cells
13 p0055 A77-15813
BAUKAL, W.
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817
BAUM, I. V.
Calculations on an optimized faceted solar concentrator
13 p0015 A77-11921
Irradiation field formation on the receiver of 'precise' and 'unprecise' solar concentrators
13 p0057 A77-16209
BAUM, V. A.
The problem of use of solar energy specific features of radiative, heat, and mass transfer in solar installations
13 p0057 A77-16204
BAZANT, Z. P.
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556
BAZQUES, E. O.
Short and long term comparison of solar absorption air-conditioning system performance using real and synthetic weather data
13 p0039 A77-12824
BEACHLEY, N. H.
The fuel efficiency potential of a flywheel hybrid vehicle for urban driving
13 p0020 A77-12664
Increased fuel economy in transportation systems by use of energy management: Second year's program. Executive summary
[PB-256117/3] 13 p0108 N77-12536
Increased fuel economy in transportation systems by use of energy management - second year's program
[PB-257177/6] 13 p0133 N77-15930

BEADLE, P. C.
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568
BEAN, J. W.
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire
[PB-254179/5] 13 p0091 N77-10687
BEAUFRERE, A.
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201
BEAUFRERE, A. H.
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543
BEBBINGTON, W. P.
The reprocessing of nuclear fuels
13 p0055 A77-15807
BECHTOFT NIELSEN, P.
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106
BECKER, L.
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497
BECKER, M.
Electric energy supply alternatives for New York. Phase 2: An appraisal of electrical energy alternatives available to the State of New York
[PB-249881/4] 13 p0101 N77-11575
BEHRIN, E.
California energy outlook
[UCRL-5196-REV-1] 13 p0106 N77-12525
BEKMUKHAMBETOV, E. S.
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
BELOUET, C.
Deposition of polycrystalline silicon solar cells
13 p0076 A77-19082
BELYKH, A. D.
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665
BEN-BASSAT, M.
Development of signal processing algorithms for ultrasonic detection of coal seam interfaces
[NASA-CR-150024] 13 p0085 N77-10610
BENENSON, P.
A linear economic model of fuel and energy use in the United States. Volume 1: Model Description and results
[PB-252485/8] 13 p0088 N77-10662
A linear economic model of fuel and energy in the United States. Volume 2: Submodels and data
[PB-252486/6] 13 p0089 N77-10663
BENESH, F. H.
Growth effects of major land use projects. Volume 2: Compilation of land use based emission factors
[PB-255302/2] 13 p0092 N77-10709
BENNETT, E.
Air quality considerations in transportation planning: Findings and recommendations on transportation control planning, phase 2
[PB-256424/3] 13 p0110 N77-12576
BENNETT, L. H.
The electron factor in catalysis on metals electrocatalysis on non-metallic surfaces
[PB-256264/3] 13 p0103 N77-12166
BENSON, F. A.
Electric arc power collection for high-speed trains
13 p0060 A77-16594
BEREZHINSKII, A. I.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235
BERMAN, S. M.
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948
BERNSTEIN, H.
Detailed geographic analysis of residential energy consumption
13 p0043 A77-12864
Personal rapid transit research conducted at the Aerospace Corporation
[PB-256846/7] 13 p0111 N77-12946
BERTSCHINGER, G.
Schlieren measurements of a high density z-pinch
13 p0060 A77-16697
BERZHATYI, V. I.
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
BESSEY, M.
Air quality considerations in transportation planning: Findings and recommendations on transportation control planning, phase 2
[PB-256424/3] 13 p0110 N77-12576
BETZER, P. R.
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890
BHATNAGAR, P. K.
Spectral response of a laterally illuminated p-n junction
13 p0062 A77-17478
BIANCARDI, F. R.
A unique Rankine-cycle heat pump system
13 p0036 A77-12799
BIEDERMAN, N.
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
BILLINGS, R. E.
Survey of hydrogen energy application projects
13 p0033 A77-12778
BITER, W. J.
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
BITIURIN, V. A.
Influence of various losses on the characteristics of high-power MHD generators
13 p0046 A77-13258
BJORNSTAD, D. J.
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
BLACK, D. L.
Transient performance characteristics of a high temperature distributed solar collector field
13 p0037 A77-12810
BLAIR, I. M.
Aspects of energy conversion; Proceedings of the Summer School, Lincoln College, Oxford, England, July 14-25, 1975
13 p0004 A77-11026
BLANCHARD, C.
Procedure for characterizing flat plate solar collectors
13 p0073 A77-19056
BLAND, J. S.
Occupational radiation exposure at light water cooled power reactors, 1969-1975
[PB-257054/7] 13 p0125 N77-14740
BLANK, Z.
An evaluation of the use of metal hydrides for solar thermal energy storage
13 p0028 A77-12739
BLAZOWSKI, W. S.
The impact of JP-4/JP-8 conversion on aircraft engine exhaust emissions
[AD-A026546] 13 p0112 N77-13234
BLEVINS, R. W.
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships, detailed report
[PB-257444/0] 13 p0116 N77-13554
BLISS, R.
Direct contact heat exchangers for geothermal power plants
13 p0029 A77-12747

BLOOMSTER, C. H.
The potential national benefits of geothermal electrical energy production from hydrothermal resources in the West
13 p0031 A77-12760
Economics of geothermal electricity generation from hydrothermal resources
[BNWL-1989] 13 p0123 N77-14602

BLOSSER, E. R.
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715

BOCKRIS, J. O'M.
The theory of hydrogen production in a photoelectrochemical cell
13 p0075 A77-19075
The photosynthetic production of hydrogen
13 p0075 A77-19077

BODNER, R. M.
Dutchess County, NY moves towards pyrolysis
13 p0010 A77-11298

BOEHM, H.
Fuel cell assemblies with an acidic electrolyte
13 p0055 A77-15816

BOEHM, R.
Direct contact heat exchangers for geothermal power plants
13 p0029 A77-12747

BOEHM, R. F.
Arrays of fixed flat-plate solar energy collectors - Performance comparisons for differing individual component orientations
13 p0068 A77-18449

BOER, K. W.
Direct solar energy conversion for large scale terrestrial use
[PB-252539/2] 13 p0089 N77-10674

BOERNER, H.
The assurance of the heat supply with respect to the primary energy use in the case of heating and air conditioning installations
13 p0009 A77-11270

BOES, E. C.
Solar radiation availability to various collector geometries: A preliminary study
[SAND-76-0009] 13 p0097 N77-11537

BOGART, S. L.
Current status of the magnetic fusion program
13 p0035 A77-12792

BOHACHEVSKY, I. O.
Heat transfer problems associated with laser fusion
13 p0068 A77-18441

BOIARCHENKO, V. I.
Thermal explosion of moving reacting fluids of variable viscosity
13 p0052 A77-14980

BOKOVETS, A. P.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235

BOLTS, J. M.
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666

BONNEMAY, M.
A new hydrogen storage electrode
13 p0047 A77-13539

BOOTH, L. A.
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
Heat transfer problems associated with laser fusion
13 p0068 A77-18441

BORIO, R. W.
Laboratory analysis of solvent refined coal
[PB-255550/6] 13 p0110 N77-12598

BORTNIKOV, IU. S.
Optimisation of current source operation in pulse mode
[IAF PAPER 76-255] 13 p0003 A77-10952

BORTZ, B. J.
Resource recovery technology for urban decision-makers
[PB-252458/5] 13 p0093 N77-10964

BORZONI, J. T.
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638

BOSTANDZHIAN, S. A.
Thermal explosion of moving reacting fluids of variable viscosity
13 p0052 A77-14980

BOTTS, W. V.
Low-Btu gasification of coal by Atomics International's molten salt process
13 p0023 A77-12687

BOUGHTON, E. M.
In situ recovery of oil and minerals from Piceance Creek Basin oil shale
13 p0023 A77-12694

BOWDEN, J. R.
Prospects for coal as a direct fuel and its potential through application of liquefaction and gasification technology
13 p0008 A77-11241

BOWEN, J. S.
Proceedings of the Stationary Source Combustion Symposium. Volume 1. Fundamental research
[PB-256320/3] 13 p0116 N77-13569
Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570

BOWEN, R.
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207

BOYD, D. A.
A cylindrical blackbody solar energy receiver
13 p0018 A77-12404

BOYD, R. M.
Environmental impact studies related to underground coal gasification
[TID-27003] 13 p0100 N77-11573

BOZEK, J.
Baseline test data for the EVA electric vehicle
13 p0025 A77-12704

BRADLEY, G. W.
Utility facilities in transportation corridors
[PB-255635/5] 13 p0093 N77-10970

BRADLEY, T. G.
Development of compact lithium/iron disulfide electrochemical cells
13 p0026 A77-12715

BRAGG, C.
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719

BRAMLETTE, T. T.
Survey of high temperature thermal energy storage
[SAND-75-8063] 13 p0088 N77-10655

BRANCH, M. C.
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717

BRANDHORST, H. W., JR.
Status of silicon solar cell technology
[NASA-TM-X-73531] 13 p0106 N77-12519
Analysis of epitaxial drift field N on P silicon solar cells
[NASA-TM-X-73563] 13 p0106 N77-12523
Status of the ERDA/NASA photovoltaic tests and applications project
[NASA-TM-X-73567] 13 p0114 N77-13537

BRAUN, C.
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201

BRAUN, P.
Application of solar heat to buildings in Austria
13 p0079 A77-19114

BRAUN, R. L.
Reactivity of oil shale carbonaceous residue with oxygen and carbon dioxide
[UCRL-77829] 13 p0123 N77-14596

BRAUNLICH, G.
Solar heating projects at the Institute for Environmental Research
13 p0079 A77-19119

BRECHER, L. E.
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791

BREWER, G. D.
LH2 airport requirements study
[NASA-CR-2700] 13 p0083 N77-10032
BRIERE, T. R.
Advanced thermionic converter development
13 p0043 A77-12862
BRINKWORTH, B. J.
Solar energy
13 p0006 A77-11037
Accelerated response of thermopile pyranometers
13 p0019 A77-12405
BRISSOT, J. J.
Deposition of polycrystalline silicon solar cells
13 p0076 A77-19082
BRITT, E. J.
Thermionic topping for central station power plants
13 p0034 A77-12787
BRITTAIN, W. H.
SNAP 19 Viking RTG mission performance
13 p0041 A77-12840
BROCKMANN, C. E.
The 29950 Earth Resource Technology Satellite (ERTS-A) sensor data for mineral resource sector development and regional land use survey, March - August 1976
[E77-10028] 13 p0096 N77-11491
BRODA, E.
Solar energy utilization - The photochemical approach
13 p0075 A77-19076
BRODY, T. P.
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
BRONOEL, G.
A new hydrogen storage electrode
13 p0047 A77-13539
BROOMAN, E. W.
Electric vehicle batteries - Opportunities for materials improvement
13 p0049 A77-13736
BROWNS, H. C.
KIPS - Kilowatt Isotope Power System
13 p0041 A77-12837
BROWN, D. G.
The pay-off for advanced technology in commercial aircraft design and operation
13 p0071 A77-19012
BROWN, N. J.
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
BROWN, W. S.
Direct applications of geothermal energy
13 p0030 A77-12755
BRUENING, G.
Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575
BRUHLEVE, T. D.
Survey of high temperature thermal energy storage
[SAND-75-8063] 13 p0088 N77-10655
BRUNING, S. P.
The Shenandoah Community Center - A total solar design concept
13 p0047 A77-13506
BRUNSVOLD, A. R.
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
BRUZZONE, H. A.
A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices
13 p0061 A77-17017
BUBE, R. H.
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
BUCH, A.
Geothermal sources and their utilization
13 p0055 A77-15803
BUCH, F.
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
BUNKER, W. W.
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
BURCH, D. F.
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
BURENKOV, D. K.
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666
BURRAFATO, G.
Thin film solar acceptors
13 p0072 A77-19053
BURTON, L. C.
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
Cadmium stannate selective optical films for solar energy applications
[PB-254879/0] 13 p0090 N77-10678
BURTZ, R. D.
Alternate fuel capability of Rankine cycle engines
13 p0036 A77-12801
BUSCHING, H. W.
Conference report: Energy Conservation in Transportation and Construction
[PB-255857/5] 13 p0100 N77-11562
BUSH, J. B., JR.
Compressed air energy storage - A near term option for utility application
13 p0027 A77-12727
BUSH, T. W.
Basic studies of coal pyrolysis and hydrogasification
[PB-254878/2] 13 p0096 N77-11511
BUTZE, H. F.
Effect of ceramic coating of JT8D combustor liner on maximum liner temperatures and other combustor performance parameters
[NASA-TM-X-73581] 13 p0126 N77-15037
BYRD, J., JR.
The use of an interactive energy model for technology assessment with special reference to underground coal gasification
[PB-255543/1] 13 p0098 N77-11545
BYSTROV, P. I.
Study of the properties of heat pipes with liquid-metal heat-transfer agents in low-temperature regimes
13 p0046 A77-13243

C

CAESAR, P.
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948
CAHN, R. P.
Storage in oil of off-peak thermal energy from large power stations
13 p0027 A77-12730
CAIOLA, M. J.
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822
CALIFANO, F. P.
Photovoltaic effect applications
13 p0075 A77-19080
CALVIN, M.
Photosynthesis as a resource for energy and materials
13 p0017 A77-12233
CANNAVIELLO, M.
Wetting and surface properties of refrigerants to be used in heat pipes
13 p0119 N77-14386
CAPUTO, R. S.
Solar thermal electric power plants - Their performance characteristics and total social costs
13 p0037 A77-12804
CARD, W. H.
Commercial building unitary heat pump system with solar heating
[PB-255488/9] 13 p0099 N77-11551
CARMICHAEL, D. C.
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
CARNEY, J. K.
New analysis of a high-voltage vertical multijunction solar cell
13 p0069 A77-18490

CARPENTER, R. T.
The low cost high performance generator /LCHPG/
13 p0042 A77-12855
CARR, R. B.
Energy and technology review
[UCID-52000-76-2] 13 p0131 N77-15508
CARROLL, S. L.
Methanol from coal fuel and other applications
[ORAU-126] 13 p0094 N77-11200
CARTER, L. F.
Societal implications of energy scarcity. Social and technological priorities in steady state and constricting systems
[PB-253097/0] 13 p0099 N77-11556
CARTY, R. H.
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
CAVARD, D.
Cost aspects of solar energy - Selective and critical bibliography
13 p0054 A77-15799
CENKNER, A. A., JR.
Extended cryogenic performance of Lobar Wick heat pipe/radiator
13 p0119 N77-14379
CERINI, D. J.
Onboard hydrogen generation for automobiles
13 p0020 A77-12663
Hydrogen-rich gas generator
[NASA-CASE-NPO-13560-1] 13 p0086 N77-10636
CERVI, M. C.
Aluminum-based anodes for underwater fuel cells: A phase report
[AD-A026405] 13 p0131 N77-15512
CHAIT, I. L.
Energy conservation with advanced power generating systems
13 p0026 A77-12723
CHAKEDIS, D. V.
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
CHAMBERLAIN, R. M.
Advanced coal gasification system for electric power generation
[PE-1514-176] 13 p0088 N77-10653
CHANG, G. C.
Compressed air energy storage - A near term option for utility application
13 p0027 A77-12727
CHANNON, S.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
CHAPMAN, D.
User's guide to petroleum industry survey data type
[PB-256635/4] 13 p0098 N77-11544
CHAPMAN, P. F.
Principles of energy analysis
13 p0007 A77-11045
Methods of energy analysis
13 p0007 A77-11046
CHARKEY, A.
Advances in component technology for nickel-zinc cells
13 p0025 A77-12710
CHATTERJEE, J. S.
An alternative fuel for cars
13 p0050 A77-14530
CHEEMA, L. S.
Temperature optimization for power production of infinite heat transfer solar absorbers
13 p0073 A77-19055
CHEREMISINOFF, P. N.
Energy from solid wastes
13 p0003 A77-10698
CHERISH, P.
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689
CHERKAS, V. D.
Study of the ionization of the additive in MHD installations
13 p0002 A77-10424
CHI, S. W.
Heat pipe theory and practice
13 p0052 A77-14825
CHICKERING, J. B.
A basis for analyzing prospective power generation in terms of environmental management and energy use
13 p0096 N77-11526
CHOCK, D. P.
General Motors Sulfate Dispersion Experiment - Assessment of the EPA HIWAY model
13 p0071 A77-18882
CHOKIN, SH. CH.
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance
13 p0020 A77-12657
CHOULET, R.
Evolution of the concept of the automobile from the standpoint of saving energy
13 p0051 A77-14562
CHOWANIEC, C. R.
New concepts in solar photovoltaic electric power systems design
13 p0038 A77-12817
CHRISTMAN, R. C.
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597
CHROBOT, M.
Application of simulation studies to the design and improvement of fuel control systems for aviation turbine engines
13 p0054 A77-15798
CHU, T. L.
Reducing grain-boundary effects in polycrystalline silicon solar cells
13 p0014 A77-11761
CHUKHANOV, Z. F.
Scientific-technological problems of the development of a fuel-energy complex in the USSR
13 p0051 A77-14703
CLAMPITT, B. H.
Energy recovery from saline water by means of electrochemical cells
13 p0013 A77-11536
CLARK, A. P.
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
Industrial process heat from shallow solar ponds
[UCRL-77801] 13 p0124 N77-14611
CLARK, J. W.
Assessing the relationship between urban form and travel requirements: A literature review and conceptual framework
[PB-254988/9] 13 p0102 N77-11923
CLARKE, P. J.
Investigation and assessment of light-duty-vehicle evaporative emission sources and control
[PB-255813/8] 13 p0102 N77-11603
CLAYTON, R. M.
Reduction of gaseous pollutant emissions from gas turbine combustors using hydrogen-enriched jet fuel
[NASA-CR-149146] 13 p0094 N77-11198
CLEMOT, M.
Water pumping - A practical application of solar energy
13 p0079 A77-19117
CLIFFORD, J. E.
Electric vehicle batteries - Opportunities for materials improvement
13 p0049 A77-13736
CLIQUE, M.
Linear model of a dissipative PWM shunt regulator
13 p0080 A77-19172
CNARE, E. C.
PULSAR, an unconventional topping stage
13 p0034 A77-12788
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293
COBBLE, M. H.
Parametric studies of the thermal trap flat plate collector
13 p0068 A77-18443

CODER, D. W.
Hydrodynamic equilibrium conditions for AG(EH) main strut-pod foil system using flap incidence control
[AD-A027521] 13 p0127 N77-15220
COFFARI, E.
Termosole flat plate collectors
13 p0073 A77-19058
COHEN, A. D.
A summary of solar heating and cooling of buildings /SHACOB/ - Phase I demonstration planning studies
13 p0039 A77-12821
COLE, K.
User's guide to petroleum industry survey data type
[PB-256635/4] 13 p0098 N77-11544
COLE, R. L.
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
COLEMAN, D. D.
Isotopic characterization of Illinois natural gas
13 p0113 N77-13484
COLLINS, T. A.
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230
COLOMES, J.
Autonomous station for the acquisition and concentration of heliometric data
13 p0072 A77-19046
Procedure for characterizing flat plate solar collectors
13 p0073 A77-19056
COLTHARP, G. B.
Utilization of remote sensing techniques to detect land use effects on wildland water quality
13 p0071 A77-18984
CONGER, W. L.
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
CONN, W. D.
Evaluating revenue sources for public transit - A new frontier for environmental planners
13 p0070 A77-18723
CONSOLI, T.
Supplementary plasma heating studies in the atomic energy commission, France
13 p0064 A77-17819
CONSTANT, E.
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
CONTI, M.
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
COOKSON, C.
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533
COONEY, C. L.
Fuel gas recovery from controlled landfilling of municipal wastes
13 p0070 A77-18739
COOPER, R.
JP-4 and JP-9 fuel toxicity studies using water fish and aufwuchs
[AD-A027594] 13 p0127 N77-15213
COOPER, R. L.
California energy outlook
[UCRL-5196-REV-1] 13 p0106 N77-12525
COPE, J.
Modeling residential energy use
13 p0027 A77-12726
COPLEN, T. B.
Cooperative geochemical resource assessment of the Mesa Geothermal system
[PB-257225/3] 13 p0132 N77-15520
CORTES, H.
Double-reflection solar energy concentrators
13 p0074 A77-19067
COSTOGUE, E. N.
Comparison of candidate solar array maximum power utilization approaches
13 p0041 A77-12836
COTTINGHAM, J. G.
Attic concentrator type solar energy collector
[BNL-50493] 13 p0098 N77-11539
COUTINHO, J. DE C.
Risk management of liquefied natural gas installations
13 p0002 A77-10451
COVAULT, D. O.
Conference report: Energy Conservation in Transportation and Construction
[PB-255857/5] 13 p0100 N77-11562
COVENEY, D. B.
Energy equivalents for current and prospective automotive fuels in Canada
[AD-A026195] 13 p0124 N77-14609
COWAN, M.
PULSAR, an unconventional topping stage
13 p0034 A77-12788
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293
COWLES, J. O.
In situ recovery of oil and minerals from Piceance Creek Basin oil shale
13 p0023 A77-12694
COX, K. E.
Hydrogen from solar energy via water electrolysis
13 p0032 A77-12771
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
COX, P. A.
A study to obtain verification of Liquid Natural Gas (LNG) tank loading criteria
[AD-A025716] 13 p0120 N77-14492
CRAFOORD, C.
An estimate of the interaction of a limited array of windmills
[DM-16] 13 p0114 N77-13539
CRAIG, H.
Production of atmospheric nitrous oxide by combustion
13 p0061 A77-16922
CRAWFORD, L. W.
Investigation of direct coal-fired MHD power generation
13 p0034 A77-12783
CRECRAFT, H.
Ultralightweight solar array for Naval Sea Control Systems
13 p0040 A77-12828
CREMER, H.
Hydrogen production using nuclear heat
13 p0057 A77-16211
CRESWICK, F. A.
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715
CRIM, W. H.
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
CRIQUI, P.
Cost aspects of solar energy - Selective and critical bibliography
13 p0054 A77-15799
CROUCH, W. B.
Solids gasification for gas turbine fuel 100 and 300 Btu gas
13 p0022 A77-12685
CROWDER, G. W.
The feasibility of solar energy usage on Red River Army Depot
[AD-A025119] 13 p0108 N77-12535
CRUMP, L. H.
Historical fuels and energy consumption data, 1960 - 1972, United States by states and census districts east of the Mississippi
[PB-255176/0] 13 p0112 N77-13229

Historical fuels and energy consumption data, 1960 - 1972, United States by states and census districts west of the Mississippi
[PB-255177/8] 13 p0112 N77-13230
CURRAN, H. M.
Comparative evaluation of solar heating alternatives
[COO-2703-2] 13 p0129 N77-15498
CURTIS, H. B.
Optimized selective coatings for solar collectors
[NASA-TM-X-73498] 13 p0097 N77-11529
CUTTICA, J. J.
ERDA's Bicentennial Thermionic Research and Technology Program
13 p0042 A77-12861
CUTTING, J.
Investigation of two-phase liquid-metal magnetohydrodynamic power systems
13 p0057 A77-16212

D

DAEUBLER, K.-D.
Optimal thermal insulation as an investment-computational problem
13 p0009 A77-11268
DALIBOT, B.
Encapsulation of solar cell modules
13 p0076 A77-19092
DANA, M. T.
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630
DART, E. H.
The economic generation of electricity from moderate temperature geothermal resources
13 p0030 A77-12749
DAVID, J. P.
Alternating photoelectrochemical converters
13 p0077 A77-19093
DAVIDSON, M.
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948
DAVIDUK, N.
Design of a 100 BPD pilot plant to convert methanol to gasoline using the Mobil process
13 p0023 A77-12691
DAVIS, A.
The influence of the properties of coals on their conversion into clean fuels
13 p0009 A77-11245
DAVIS, E. E.
Transportation options for solar power satellites
13 p0040 A77-12829
DAVIS, J. P.
A study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255658/7] 13 p0115 N77-13542
A study of implant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255659/5] 13 p0115 N77-13543
DAVIS, R. M.
Energy: The policy planning framework in state governments. Volume 1: Summary report
[PB-254466/6] 13 p0089 N77-10665
Energy: The policy planning framework in state governments. Volume 2: Appendices
[PB-254467/4] 13 p0089 N77-10666
DAVITIAN, H. E.
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594
DAWSON, J. K.
The hydrogen economy
13 p0006 A77-11041
DAYEN, N. J.
Occupational radiation exposure at light water cooled power reactors, 1969-1975
[PB-257054/7] 13 p0125 N77-14740
DE ARAUJO, S. R.
Performance of an annular cylindrical solar collector
13 p0073 A77-19059
DE GOEYSE, A.
A combined cycle with a partial-oxidation reactor
13 p0062 A77-17534
DEAN, R. L.
Conference report: Energy Conservation in Transportation and Construction
[PB-255857/5] 13 p0100 N77-11562
DECHAMBENOY, C.
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591
DEHAVEN, J. C.
The long-run marginal costs of energy
[PB-252504/6] 13 p0085 N77-10625
DELPOSSE, R. J.
Evaluation of a JP-5 type fuel derived from oil shale
[AD-A025417] 13 p0112 N77-13231
DELL, R. M.
Sodium/sulphur battery development in the United Kingdom
13 p0026 A77-12717
DENEO, E. A.
Assessment of cadmium sulfide photovoltaic arrays for large scale electric utility applications
[PB-255646/2] 13 p0109 N77-12551
DEMPSEY, R. M.
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380
DENUYNCK, M.
Compilation of an inventory for particulate emissions in Belgium
13 p0009 A77-11271
DENT, A. L.
Catalytic synthesis of gaseous hydrocarbons
[PB-1814-2] 13 p0130 N77-15503
DENTON, J. C.
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665
Future energy production systems: Heat and mass transfer processes. Volume 1
13 p0056 A77-16201
Perspectives for world energy production
13 p0056 A77-16202
Heat and mass transfer for solar energy utilization
13 p0057 A77-16205
Thermal energy storage for heating and air conditioning
13 p0057 A77-16206
DEPAUW, J. F.
Test program for transmitter experiment package and heat pipe system for the communications technology satellite
[NASA-TM-X-3455] 13 p0095 N77-11268
DERRICKSON, R. A., JR.
New England wind power...coastal or mountain
13 p0058 A77-16250
DESPLAT, J.-L.
Near-uv photon efficiency in a TiO2 electrode - Application to hydrogen production from solar energy
13 p0015 A77-11947
DETRIE, J. P.
Evolution of atmospheric pollution /high acidity and black fumes/ in France during 1975
13 p0002 A77-10670
DEYO, J. N.
Status of the ERDA/NASA photovoltaic tests and applications project
[NASA-TM-X-73567] 13 p0114 N77-13537
DI STEFANO, L.
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
DICKINSON, R. M.
Microwave transmission system for space power
13 p0014 A77-11818
DICKINSON, W. C.
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
DICKS, J. B.
Investigation of direct coal-fired MHD power generation
13 p0034 A77-12783

DICKSON, E. M.
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534
DIETZMANN, H. E.
Protocol to characterize gaseous emissions as a function of fuel and additive composition
[PB-253363/6] 13 p0084 N77-10221
DILLON, R. R.
Startup solvent selection for the liquefaction of lignite
13 p0059 A77-16472
DMITRIN, V. I.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235
DOBROZEMSKY, R.
Application of solar heat to buildings in Austria
13 p0079 A77-19114
DOLAN, F. J.
A performance evaluation of various coatings, substrate materials, and solar collector systems
[NASA-TM-X-73355] 13 p0128 N77-15489
DOLGININ, E. A.
Concrete placing techniques used during the construction of the kasnoyarsk hydroelectric power plant
[AD-A026967] 13 p0121 N77-14528
DONOVAN, L. E.
Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations
13 p0028 A77-12736
DOOLEY, J. L.
Underground storage of off-peak power
13 p0027 A77-12728
DORMAN, J.
High-efficiency solar concentrator
13 p0083 N77-10104
DOYLE, L. J.
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890
DREWES, D. R.
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630
DRUCKER, E. E.
Commercial building unitary heat pump system with solar heating
[PB-255488/9] 13 p0099 N77-11551
DUCHET, C.-G.
Environmental aspects of energy conversion and use
13 p0006 A77-11044
DUDA, J. L.
Economic and social impact of solar powered transportation systems
13 p0079 A77-19120
DUDKO, IU. A.
Standard-size facets for the reflecting surface of a solar concentrator
13 p0063 A77-17557
DUFFY, T. E.
Alternate fuel capability of Rankine cycle engines
13 p0036 A77-12801
DUGA, J. J.
Energy: The policy planning framework in state governments. Volume 1: Summary report
[PB-254466/6] 13 p0089 N77-10665
Energy: The policy planning framework in state governments. Volume 2: Appendices
[PB-254467/4] 13 p0089 N77-10666
DUGGER, G. L.
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships, detailed report
[PB-257444/0] 13 p0116 N77-13554
DUGUNDJI, J.
Some dynamic problems of rotating windmill systems
13 p0084 N77-10271
Wind energy conversion
[PB-256198/3] 13 p0115 N77-13552
DULA, A. M.
Legal and economic prerequisites to space industrialization
[IAF PAPER ISL-76-29] 13 p0004 A77-10968
DUNCAN, R. T.
Atlanta /Towns/ solar experiment - The lessons we learned
13 p0047 A77-13503
DUNDURS, J.
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556
DUNLAY, J.
A study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255658/7] 13 p0115 N77-13542
A study of implant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255659/5] 13 p0115 N77-13543
DUNN, P. D.
Energy and the developing countries
13 p0006 A77-11043
DUNNING, J. S.
Development of compact lithium/iron disulfide electrochemical cells
13 p0026 A77-12715
DURAND, H.
Periodically adjustable concentrators adapted to solar cell panels
13 p0074 A77-19068
DUVA, A. N., JR.
Hydraulic ram effect on composite fuel cell entry walls
[AD-A024832] 13 p0115 N77-13548
DZHAIMURZIN, A. A.
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361

E

EASTON, C. R.
Collector field optimization for a solar thermal electric power plant
13 p0038 A77-12811
ECKERT, J. A.
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108
ECKERT, E. R. G.
Heat transfer - A review of 1975 literature
13 p0002 A77-10615
EDENBURN, M. W.
Performance analysis of a cylindrical parabolic focusing collector and comparison with experimental results
13 p0019 A77-12410
EDWARDS, D. K.
Flight data analysis and further development of variable-conductance heat pipes
[NASA-CR-137953] 13 p0118 N77-14374
Computer program grade 2 for the design and analysis of heat-pipe wicks
[NASA-CR-137954] 13 p0118 N77-14375
EDWARDS, R.
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207
EGGERS-LURA, A.
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106
EGGERS, P. E.
Test and evaluation of the Navy half-watt RTG
13 p0042 A77-12853
Spherical radioisotope thermoelectric generators - An approach to high specific power devices
13 p0042 A77-12857
EHRENREICH, H.
Symposium on the Fundamental Optical Properties of Solids Relevant to Solar Energy Conversion
[PB-256615/6] 13 p0108 N77-12538
EJEBE, G. C.
Assessment of power system security under load uncertainty
13 p0112 N77-13324

EKCHIAN, A.
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
EKDAHL, C. A., JR.
Atmospheric carbon dioxide variations at the South Pole
13 p0067 A77-18439
EL-DIFRAWI, A. A.
New frontiers in solar and other energy options
13 p0079 A77-19118
ELLIOTT, D. G.
Comparison of geothermal power conversion cycles
13 p0030 A77-12750
ELLIS, A. B.
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666
ELLIS, J. F.
Transient performance characteristics of a high temperature distributed solar collector field
13 p0037 A77-12810
ELMS, R. V., JR.
SEP solar array technology development
13 p0040 A77-12825
ENGEL, R. L.
The potential national benefits of geothermal electrical energy production from hydrothermal resources in the West
13 p0031 A77-12760
EWINGER, J. E.
Heat pipe materials compatibility
[NASA-CR-135069] 13 p0103 N77-12182
Flight data analysis and further development of variable-conductance heat pipes
[NASA-CR-137953] 13 p0118 N77-14374
Computer program grade 2 for the design and analysis of heat-pipe wicks
[NASA-CR-137954] 13 p0118 N77-14375
EPPERLY, W. R.
Catalytic coal gasification for SNG production
13 p0022 A77-12683
ERICSON, R. B.
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
ERMOLAEVA, G. K.
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668
ESTES, J.
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497
EVANS, D. L.
Photovoltaic systems using sunlight concentration
13 p0076 A77-19089
EZZARD, H. S., JR.
A study of the failure of joints in composite material fuel cells due to hydraulic ram loading
[AD-A027258] 13 p0117 N77-14016

F

FABRE, E.
MIS silicon solar cells
13 p0001 A77-10174
FABRIS, G.
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
Investigation of two-phase liquid-metal magnetohydrodynamic power systems
13 p0057 A77-16212
FADDOUL, J. R.
Cost/benefit assessment of the application of composite materials to subsonic commercial transport engines
[NASA-TM-X-73557] 13 p0111 N77-13064
FAHRENBRUCH, A.
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
FAIN, S.
A study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255658/7] 13 p0115 N77-13542
A study of implant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255659/5] 13 p0115 N77-13543
FANCELLI, R.
Locating interesting geothermal areas in the Tuscany region /Italy/ by geochemical and isotopic methods
13 p0013 A77-11498
FANUCCI, J. B.
Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines
13 p0044 A77-12871
FARBER, E. A.
Experimental evaluation of the University of Florida solar powered ammonia/water absorption air conditioning system
13 p0039 A77-12823
FARBMAN, G. H.
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791
FARCASIU, M.
Fractionation and structural characterization of coal liquids
13 p0069 A77-18582
FAUEL, P. L.
Comparative wind tunnel investigation of sail profiles for windmills
[VTH-191] 13 p0111 N77-13012
FAZZOLARE, R.
Feasibility study of a nuclear power-sewage treatment system for the conservation and reclamation of water resources
[PB-255630/6] 13 p0126 N77-14960
FEDERMANN, E. P.
New concepts in solar photovoltaic electric power systems design
13 p0038 A77-12817
FEDOR, O. H.
Risk management of liquefied natural gas installations
13 p0002 A77-10451
FEDOROV, I. I.
Heat-pipe regenerator for gas turbine engine
13 p0020 A77-12528
FEIRTAG, M.
The prospect for fusion
13 p0058 A77-16357
FELDKIRCHNER, H. L.
Hydrocarbon fuels from oil shale
13 p0023 A77-12692
FELDMAN, K. T.
Heat pipe heat exchanger design considerations
13 p0031 A77-12765
Investigation of performance limits in axial groove heat pipes
[NASA-CR-137912] 13 p0095 N77-11340
FELIX, F.
Higher electric power use reduces energy consumption for same gross national product
13 p0011 A77-11334
FENVES, S. J.
The structure of building specifications
[PB-257581/9] 13 p0132 N77-15524
FERBER, R. R.
New concepts in solar photovoltaic electric power systems design
13 p0038 A77-12817
FERDMAN, S.
Space solar power - An available energy source
13 p0056 A77-15946
FERRER, J.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
FETTERMAN, G. P., JR.
Selection of driving cycles for electric vehicles of the 1990's
13 p0024 A77-12702
FIATTE, F.
Water pumping - A practical application of solar energy
13 p0079 A77-19117
FILATOV, A. I.
Economic effectiveness of solar electric power stations
13 p0063 A77-17556

FINCH, E. R., JR.
Energy - Ecospace
[IAF PAPER ISL-76-59] 13 p0004 A77-10970
FINCH, F. T.
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
FINKE, R. C.
NASA electric propulsion program
[AIAA PAPER 76-1068] 13 p0045 A77-13033
FINKEN, K. H.
Schlieren measurements of a high density z-pinch
13 p0060 A77-16697
FINUCANE, D.
Perturbation analysis of second-order effects in kinetics of oil-shale pyrolysis
13 p0070 A77-18585
FISCHER, D. D.
Environmental impact studies related to underground coal gasification
[TID-27003] 13 p0100 N77-11573
FISCHER, H.
Manufacturing and evaluation of phthalocyanines as catalysts for fuel cells
[BMFT-FB-T-76-25] 13 p0114 N77-13540
FISCHER, W.
Development of sodium/sulfur-cells
13 p0026 A77-12716
Some studies on sodium/sulfur cells
13 p0055 A77-15813
FISH, L. W.
Resource utilization efficiency improvement of geothermal binary cycles, phase 1
[ORO-4944-3] 13 p0123 N77-14600
FITZPATRICK, G. O.
Thermionic topping for central station power plants
13 p0034 A77-12787
FLECHON, J.
Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity
13 p0073 A77-19057
FLEISCHMAN, G. L.
Heat pipe materials compatibility
[NASA-CR-135069] 13 p0103 N77-12182
FLEMING, W. S.
Commercial building unitary heat pump system with solar heating
[PB-255488/9] 13 p0099 N77-11551
FOLEY, R. T.
Research on electrochemical energy conversion systems
[AD-A023689] 13 p0090 N77-10681
FORESTIERI, A. F.
Status of the ERDA/NASA photovoltaic tests and applications project
[NASA-TM-X-73567] 13 p0114 N77-13537
FORRESTER, R. C., III
Recovery of inaccessible coal reserves by in situ gasification
13 p0022 A77-12686
FORTAK, H.
Mathematical simulation and empirical determination of the aerochemical and thermal atmospheric pollution resulting from energy conversion processes
[DLR-IB-553-75/1] 13 p0091 N77-10700
FORTIN, M.
An experimental 200 kW vertical axis wind turbine for the Magdalen Islands
13 p0044 A77-12874
FOSSARD, A. J.
Linear model of a dissipative PWM shunt regulator
13 p0080 A77-19172
FOSTER, J. F.
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715
FOSTER, W. M.
Homeowner's guide to solar heating and cooling
13 p0062 A77-17525
FRANCIA, J.
Clean air protection and industrial development
13 p0010 A77-11303
FRANCIS, E. J.
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships, detailed report
[PB-257444/0] 13 p0116 N77-13554
FRANCIS, R. W.
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706
FRANK, A. A.
The fuel efficiency potential of a flywheel hybrid vehicle for urban driving
13 p0020 A77-12664
Increased fuel economy in transportation systems by use of energy management: Second year's program. Executive summary
[PB-256117/3] 13 p0108 N77-12536
Increased fuel economy in transportation systems by use of energy management - second year's program
[PB-257177/6] 13 p0133 N77-15930
FRANK, R. I.
New analysis of a high-voltage vertical multijunction solar cell
13 p0069 A77-18490
FRANK, T. G.
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
Heat transfer problems associated with laser fusion
13 p0068 A77-18441
FRANKLIN, A. D.
The electron factor in catalysis on metals electrocatalysis on non-metallic surfaces
[PB-256264/3] 13 p0103 N77-12166
FRASER, M. D.
Solar SNG - Large-scale production of SNG by anaerobic digestion of specially grown plant matter
13 p0021 A77-12671
FREDERICK, N. V.
Magnetic suspension densimeter for measurements on fluids of cryogenic interest
13 p0007 A77-11093
FREIWALD, D. A.
Prospects of generating power with laser-driven fusion
13 p0002 A77-10634
FRESTREPO, F.
On black solar cells or the tetrahedral texturing of a silicon surface
13 p0004 A77-11000
FREY, K.
Solar heating projects at the Institute for Environmental Research
13 p0079 A77-19119
FRIEDMAN, J. D.
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
FRIEDMAN, N.
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981
FRIEND, M. J.
Energy equivalents for current and prospective automotive fuels in Canada
[AD-A026195] 13 p0124 N77-14609
FROHNERT, H.
Energy in the household - Comparison of heating costs and prognosis concerning the consumption of energy until 1985
13 p0015 A77-12059
FROHNHOLZER, J.
Water power in the immediate future
13 p0056 A77-15850
FU, Y. C.
Catalytic coal liquefaction using synthesis gas
13 p0059 A77-16473
FUJITA, T.
Benefits of hydrogen production research
13 p0032 A77-12768
FULOP, J.
The shaping of our needs in mineral raw materials and sources for meeting those needs
13 p0017 A77-12246

FUNK, J. E.
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541

G

GADDY, E. M.
Results from the IMP-J violet solar cell experiment and violet cell balloon flights
[NASA-TN-D-8393] 13 p0128 N77-15491
GADDY, J. L.
Solar energy collection by bioconversion
13 p0021 A77-12672
GAEDKE, M.
High-speed flywheels as possible energy storage devices in the future
13 p0056 A77-15856
GAHIMER, J.
Experimental demonstration of an iron chloride thermochemical cycle for hydrogen production
13 p0032 A77-12772
GAHN, R. F.
The Redox flow system for solar photovoltaic energy storage
[NASA-TM-X-73562] 13 p0106 N77-12522
GAINES, G. B.
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
GAINES, L. M.
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706
GAJEWSKI, R.
A cylindrical blackbody solar energy receiver
13 p0018 A77-12404
GALESKI, J. B.
Performance of emission control devices on boilers firing municipal solid waste and oil
[PB-257136/2] 13 p0133 N77-15550
GALLAGHER, J. P.
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230
GALLET, P.
Effect of optical properties of a surface exposed to solar radiation on the radiation balance
13 p0052 A77-14928
Study of emittance distribution along the walls of a cellular low-loss cell in the case of a base surface with arbitrary emission indicatrix
13 p0069 A77-18495
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
GALOWIN, L. S.
A central solar energy utilization system
13 p0057 A77-16210
GARDNER, L.
Production of a hydrocarbon-type synthetic fuel from wood
[NRC-15638] 13 p0127 N77-15210
GARNER, P. J.
Energy and the oil industry
13 p0005 A77-11031
GARSON, D.
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719
GARY, J. H.
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
GAULT, J.
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
GAUT, N. E.
Electric energy from atmospheric water vapor
13 p0077 A77-19097
GAVRILOVA, I. P.
Effectiveness of heat-emitting coatings with variable degree of blackness
13 p0111 N77-12893
GAWTHROP, W. E.
Test and evaluation of the Navy half-watt RTG
13 p0042 A77-12853
GAY, E. C.
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107
Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells
13 p0025 A77-12713
GEHRKE, G.
A solar house with heat pipe collectors
13 p0070 A77-18598
GENSLER, W. G.
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
GEORGE, J. H.
Perturbation analysis of second-order effects in kinetics of oil-shale pyrolysis
13 p0070 A77-18585
GEORGE, M. S.
The Shenandoah Community Center - A total solar design concept
13 p0047 A77-13506
GERSHUNI, A. N.
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321
GERVAIS, R. L.
Some material considerations involved in the application of solar energy to electric power generation
13 p0049 A77-13739
GIAQUINTA, G.
Thin film solar acceptors
13 p0072 A77-19053
GIBERT, J. P.
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591
GIBRAT, R.
Energy and environment post-2000
13 p0050 A77-14560
Environment and energy production after the year 2000
13 p0056 A77-16203
GIDASPOW, D.
Hydrogen separation and compression through hydride formation and dissociation by low-level heat
13 p0032 A77-12770
GIEDT, W. H.
Investigation of heat exchanger flow arrangement on performance and cost in a geothermal binary cycle
13 p0029 A77-12746
GIL, V. V.
Gas release during long-term operation of heat pipes
13 p0050 A77-14328
GILLI, P.
Application of solar heat to buildings in Austria
13 p0079 A77-19114
GISSLER, W.
Investigation of a TiO2/electrolyte solar cell and the photocatalytic water decomposition
13 p0077 A77-19094
GIVEN, P. H.
The influence of the properties of coals on their conversion into clean fuels
13 p0009 A77-11245
Problems and solutions in the use of coal analyses
[FE-0390-1] 13 p0097 N77-11535
GLANDT, E. D.
Hydrogen production from water by means of chemical cycles
13 p0058 A77-16471
GLASER, P. E.
Feasibility of a satellite solar power station /SSPS/
13 p0047 A77-13504
Perspectives on Satellite Solar Power
[AIAA PAPER 77-352] 13 p0066 A77-18257
Solar thermal power generation
13 p0077 A77-19095

GLASGOW, J. C.
Early operation experience on the ERDA/NASA 100 kW wind turbine
[NASA-TM-X-71601] 13 p0086 N77-10640
GLASS, I. I.
Utilization of geothermal energy
[UTIAS-REVIEW-40] 13 p0087 N77-10644
GLASSEY, C. R.
A linear economic model of fuel and energy use in the United States. Volume 1: Model Description and results
[PB-252485/8] 13 p0088 N77-10662
A linear economic model of fuel and energy in the United States. Volume 2: Submodels and data
[PB-252486/6] 13 p0089 N77-10663
GLENN, D. R.
Thermal energy storage applied to residential heating systems
13 p0027 A77-12729
Industrial energy conservation through integration of thermal energy storage into process energy dynamics
13 p0028 A77-12733
GLOVER, D. W.
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630
GNUGESSER, E.
Application of solar energy in the high-temperature range
13 p0063 A77-17636
GOBLE, R. L.
Solar hot water systems application to the solar building test facility and the Tech House
13 p0084 N77-10342
GODET, M.
Off-shore oil scenarios - Method and results
13 p0018 A77-12282
GOFF, J. F.
The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction
13 p0042 A77-12850
GOLD, H. S.
Automotive gas turbine fuel control
[NASA-CASE-LEW-12785-1] 13 p0113 N77-13426
GOLDEN, J. E.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
GOLDEN, J. O.
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
GOLDSMITH, J. V.
Solar photovoltaics - An aerospace technology
[AIAA PAPER 77-293] 13 p0065 A77-18225
GOLDSTEIN, D. J.
Water requirements for an integrated SNG plant and mine operation
13 p0060 A77-16651
GOLDSTEIN, H. L.
Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions
13 p0008 A77-11162
GOLDSTEIN, R. J.
Heat transfer - A review of 1975 literature
13 p0002 A77-10615
GOLOVIN, A. M.
Evaporation of solution droplets in a high-temperature medium
13 p0046 A77-13254
GOLOVNER, T. M.
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916
GOLUBEV, V. S.
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665
GOODACRE, J. B.
Heat pipe and space radiator developments
13 p0120 N77-14391
GOODENOUGH, J. B.
The options for using the sun
13 p0001 A77-10318
GOODMAN, J. B.
Availability of potential coal supply through 1985 by quality characteristics
[PB-256680/0] 13 p0121 N77-14573
GORADIA, C.
An integrated photovoltaic/thermal High Intensity Solar Energy System /HISES/ concept for residential applications
13 p0039 A77-12818
GORDON, C. R.
An energy center in Sri Lanka
13 p0021 A77-12669
GORDON, R. L.
The economics of coal supply - The state of the art
13 p0013 A77-11523
GOSSETT, J. M.
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577
GOUNI, L.
The mysteries of nuclear programs
13 p0011 A77-11337
GOURGI, I.
Selection of optimal pan color for solar water heater
13 p0078 A77-19104
GOVEK, M.
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243
GRAHAM, H. R.
MHD power generation - 1976 Status Report
13 p0033 A77-12782
GRAHAM, R. W.
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673
GRAVEL, M.
Energy: A radical redirection
13 p0010 A77-11275
GRAVES, D. H.
Utilization of remote sensing techniques to detect land use effects on wildland water quality
13 p0071 A77-18984
GRAY, J. A.
Energy and the gas industry
13 p0005 A77-11032
GRAY, L. N.
Societal implications of energy scarcity. Social and technological priorities in steady state and constricting systems
[PB-253097/0] 13 p0099 N77-11556
GREEN, L., JR.
Energy storage via calcium hydride production
13 p0032 A77-12774
GREEN, M. A.
The use of program GEOTHM to design and optimize geothermal power cycles
13 p0031 A77-12758
GREEN, R. M.
Survey of high temperature thermal energy storage
[SAND-75-8063] 13 p0088 N77-10655
GREEN, S., JR.
Mechanisms of coal particle dissolution
13 p0059 A77-16475
GREENEICH, E. W.
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
GREENSTEIN, T.
Societal implications of energy scarcity. Social and technological priorities in steady state and constricting systems
[PB-253097/0] 13 p0099 N77-11556
GRENON, M.
A word on worldwide petroleum resources
13 p0011 A77-11336
Concerning world oil resources. II - Statistical logistic models /King Hubbert's models/
13 p0011 A77-11339
World oil resources. III - The geological analogy method
13 p0012 A77-11341
World petroleum resources. IV - Probabilistic methods
13 p0012 A77-11342
The world's oil resources. V - Recovery rates
13 p0012 A77-11343

Studies and thoughts on nuclear reactor systems
13 p0055 A77-15800
GRESKO, T. M.
Thermal energy storage applied to residential heating systems
13 p0027 A77-12729
GRETZ, J.
Research at the EURATOM-CCR Center
13 p0080 A77-19126
GREY, J.
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13 p0045 A77-12928
GRIFFITH, J. L.
Making electricity from moderate temperature fluids
13 p0002 A77-10649
Direct applications of geothermal energy
13 p0030 A77-12755
GRIFFITHS, G. D.
Heat pipe and space radiator developments
13 p0120 N77-14391
GRIMMER, D. P.
Practical aspects of solar heating - A review of materials use in solar heating applications
13 p0049 A77-13743
GRIMMETT, E. S.
Fluidized bed heat exchangers for geothermal applications
13 p0029 A77-12748
GRISLIS, B. IA.
Increase in the efficiency of heat and power systems using large artificial accumulators of heat
13 p0064 A77-17939
GROSHKOVA, G. N.
Effectiveness of heat-emitting coatings with variable degree of blackness
13 p0111 N77-12893
GRUEN, D. M.
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
GUAZZONI, G.
Composite material structures for thermophotovoltaic conversion radiator
[AD-A026859] 13 p0132 N77-15519
GUCERI, S. I.
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689
GUENTHER, P. R.
Atmospheric carbon dioxide variations at the South Pole
13 p0067 A77-18439
GUIN, J.
Mechanisms of coal particle dissolution
13 p0059 A77-16475
GUIZZI, G. L.
Potentialities and limitations of the utilization of wind machines
13 p0061 A77-16787
GUMEROV, KH. S.
Equation solution accuracy in calculating jet engine characteristics
13 p0020 A77-12502
GURASHVILI, V. A.
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665
GUTSALO, L. K.
The nature and characteristics of the distribution of helium and argon isotopes in the geothermal waters of the Kuril Islands and Kamchatka
13 p0048 A77-13589
GWINNER, D.
Alternate fuels for road vehicles of the future
13 p0051 A77-14584

H

HAACKE, G.
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
Cadmium stannate selective optical films for solar energy applications
[PB-254879/0] 13 p0090 N77-10678
HAAR, W.
Development of sodium/sulfur-cells
13 p0026 A77-12716
Some studies on sodium/sulfur cells
13 p0055 A77-15813
HACKAM, R.
Electric arc power collection for high-speed trains
13 p0060 A77-16594
HAGER, A.
Application of simulation studies to the design and improvement of fuel control systems for aviation turbine engines
13 p0054 A77-15798
HAHN, O. J.
Hot fuel gas desulfurization
[PB-257036/4] 13 p0133 N77-15539
HAHN, R. E.
The optical properties of chromium oxide films and the high temperature stabilization of silver films for photothermal solar energy conversion
13 p0128 N77-15484
HALE, F. J.
Best-range flight conditions for cruise-climb flight of a jet aircraft
13 p0085 N77-10379
HALES, J. M.
Precipitation scavenging of fossil-fuel effluents
[PB-256649/5] 13 p0124 N77-14630
HALL, J. W.
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
HALL, R. E.
Proceedings of the Stationary Source Combustion Symposium. Volume 1. Fundamental research
[PB-256320/3] 13 p0116 N77-13569
Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570
HALLET, R. W., JR.
The application of aerospace technology to solar thermal electric power generation
[AIAA PAPER 77-294] 13 p0065 A77-18226
HAMANN, C. H.
Electric current from the direct conversion of low molecular weight C,H,O-compounds
13 p0055 A77-15814
HAMERSMA, J. W.
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
Field test sampling/analytical strategies and implementation cost estimates: Coal gasification and flue gas desulfurization
[PB-254166/2] 13 p0101 N77-11581
HAMID, Y. H.
Solar water heater using hardened black polythene pipe absorbers
13 p0073 A77-19060
HAMILTON, R. C.
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran
13 p0078 A77-19111
HAMMEL, T. E.
The low cost high performance generator /LCHPG/
13 p0042 A77-12855
HAMMETTER, M. C.
Utilization of remote sensing techniques to detect land use effects on wildland water quality
13 p0071 A77-18984
HAMMOND, O. H.
Synthetic fuels - Prices, prospects, and prior art
13 p0017 A77-12236
HAMMOND, R. P.
PACER - A practical fusion power concept
13 p0035 A77-12793
HAMPL, E. F., JR.
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
HANDWERK, J. G.
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242

HANSON, R. J.
An investigation of condensation heat transfer in a closed tube containing a soluble noncondensable gas
[NASA-CR-149095] 13 p0085 N77-10465
HANTMAN, R. G.
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
HARDEE, C. R.
Characteristics of a first generation commercial fusion power plant
[GA-A-13661] 13 p0093 N77-10891
HARDIE, R. W.
Economic analysis of the need for advanced power sources
[HEDL-SA-989] 13 p0131 N77-15509
HARDIN, T. C.
Methanol from coal fuel and other applications
[ORAU-126] 13 p0094 N77-11200
HARHAY, W. C.
Baseline test data for the EVA electric vehicle
13 p0025 A77-12704
HARRIS, H. G.
Perturbation analysis of second-order effects in kinetics of oil-shale pyrolysis
13 p0070 A77-18585
HARRIS, L. P.
A summary of the ECAS MHD power plant results
[NASA-TM-X-73491] 13 p0086 N77-10642
HARRISON, J. S.
Energy and the coal industry
13 p0005 A77-11030
HARRISON, W. B.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
HARVEY, C.
Air quality considerations in transportation planning: Findings and recommendations on transportation control planning, phase 2
[PB-256424/3] 13 p0110 N77-12576
HARWELL, W.
The International Heat Pipe Experiment
13 p0120 N77-14389
HASEGAWA, A.
Concept of a fusion burner
13 p0061 A77-17014
HASELL, P. G., JR.
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121
HATAMI, R.
Improved use of energy
13 p0079 A77-19123
HATORI, T.
Concept of a fusion burner
13 p0061 A77-17014
HAUSENBAUER, T. C.
The fuel efficiency potential of a flywheel hybrid vehicle for urban driving
13 p0020 A77-12664
HAYNES, W. M.
Magnetic suspension densimeter for measurements on fluids of cryogenic interest
13 p0007 A77-11093
HAZELRIGG, G. A., JR.
The economic viability of pursuing a space power system concept
[AIAA PAPER 77-353] 13 p0066 A77-18258
Space-based solar power conversion and delivery systems study. Volume 1: Executive summary
[NASA-CR-150146] 13 p0129 N77-15494
Space-based solar power conversion and delivery systems study. Volume 3: Economic analysis of space-based solar power systems
[NASA-CR-150148] 13 p0129 N77-15496
HEALY, J. B., JR.
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577
HEAPS, J. D.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
HEARTH, D. P.
Hypersonic technology-approach to an expanded program
13 p0051 A77-14597
HEGAZI, A. I.
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
HEGELS, S.
Hydrogen production using nuclear heat
13 p0057 A77-16211
HEIN, L. A.
Mechanical thermal motor
[NASA-CASE-MFS-23062-1] 13 p0104 N77-12402
HELLER, L.
The significance of coal in the future energy picture
13 p0018 A77-12247
HENCH, T.
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110
HENDRICKSON, G.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
HENDRICKSON, R. L.
Gas turbine electric powerplants
[AIAA PAPER 77-346] 13 p0066 A77-18254
HENRIKSEN, D. L.
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines
13 p0033 A77-12779
HENTSCHEL, P.-J.
The conservation of air purity and its effect on the energy economy
13 p0049 A77-13811
HERRDY, L. A.
Development status of lithium-silicon-iron sulfide load-leveling batteries
13 p0026 A77-12714
HERVERT, G. L.
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529
HEYMAN, G. A.
Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer
13 p0062 A77-17541
HEYWOOD, J. B.
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
HILDEBRANDT, A. F.
A new method for collector field optimization
13 p0074 A77-19070
HILENBRAND, S. J.
Waste heat vs conventional systems for greenhouse environmental control: An economic assessment
[ORNL/TM-5069] 13 p0088 N77-10656
HILL, J. E.
A method of testing for rating solar collectors based on thermal performance
13 p0019 A77-12408
HILY, C.
Periodically adjustable concentrators adapted to solar cell panels
13 p0074 A77-19068
HIMMELBLAU, A.
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506
HIRES, S. D.
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
HIRSCHFELD, F.
Geothermal power - The 'sleeper' in the energy race
13 p0056 A77-15845
HIRSCHRON, R.
Study of unconventional aircraft engines designed for low energy consumption
[NASA-CR-135136] 13 p0127 N77-15043
HIRST, E.
Modeling residential energy use
13 p0027 A77-12726

HISCOCKS, B. D.
The dynamics of STOL /The Daniel and Florence Guggenheim Lecture/
[ICAS PAPER 76-01] 13 p0081 A77-19247
HISSONG, D. W.
Reductant gases for flue gas desulfurization systems
[PB-254168/8] 13 p0092 N77-10722
Fuel contaminants. Volume 1: Chemistry
[PB-256020/9] 13 p0103 N77-12231
HITTLE, D. C.
Method for estimating solar heating and cooling system performance
[AD-A026041] 13 p0116 N77-13557
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606
HIZA, M. J.
Magnetic suspension densimeter for measurements on fluids of cryogenic interest
13 p0007 A77-11093
HO, R.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
HODGSON, J. W.
Methanol from coal fuel and other applications
[ORAU-126] 13 p0094 N77-11200
HOEHNE, K.
Air electrodes for H2-air fuel cells with alkali electrolyte
13 p0065 A77-18196
HOFFSTEDT, D. J.
Advanced helicopter structural design investigation. Volume 1: Investigation of advanced structural component design concepts
[AD-A024662] 13 p0102 N77-12052
HOKANSON, J. C.
A study to obtain verification of Liquid Natural Gas (LNG) tank loading criteria
[AD-A025716] 13 p0120 N77-14492
HOLLAND, T. H.
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
HOLMAN, R. R.
Liquid-metal magnetohydrodynamic system evaluation
13 p0034 A77-12784
HOLSHOUSER, D. F.
Method for estimating solar heating and cooling system performance
[AD-A026041] 13 p0116 N77-13557
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606
HOLY, N.
Coal liquefaction with soluble transition-metal complexes
13 p0070 A77-18584
HONDA, T.
Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
13 p0049 A77-13728
HOPKINS, J. P.
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137926] 13 p0126 N77-15007
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008
HOPKINS, T. L.
Black magnetic spherule fallout in the eastern Gulf of Mexico
13 p0052 A77-14890
HORNADY, R. S.
Schlieren measurements of a high density z-pinch
13 p0060 A77-16697
HORNBUCKLE, F. L.
The ATS-6 power system - Hardware implementation and orbital performance
13 p0040 A77-12831
HORNING, W.
Laser propulsion
[IAF PAPER 76-166] 13 p0003 A77-10931
HORROX, A. J. W.
Metalhydrides
[OUEL-1146/76] 13 p0094 N77-11158
HOTCHAND, K. T.
The structure of building specifications
[PB-257581/9] 13 p0132 N77-15524
HOURMOUZIADIS, J.
Variable geometry for high performance aircraft engines
13 p0062 A77-17264
HOUSEMAN, J.
Onboard hydrogen generation for automobiles
13 p0020 A77-12663
Hydrogen-rich gas generator
[NASA-CASE-NPO-13560-1] 13 p0086 N77-10636
HOWARD, E. B.
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
HOWARD, J. B.
Basic studies of coal pyrolysis and hydrogasification
[PB-254878/2] 13 p0096 N77-11511
HSIA, Y.-P.
Evaluation of coal liquefaction efficiency based on various ranks
13 p0009 A77-11244
HSU, M. S. S.
Electrochemical power and hydrogen generation from high temperature electrolytic cells
13 p0025 A77-12709
HSU, Y.-Y.
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673
HU, C.
New analysis of a high-voltage vertical multijunction solar cell
13 p0069 A77-18490
HUANG, E. T. S.
Retorting of single oil shale blocks with nitrogen and air
13 p0024 A77-12696
HUBBARD, H. W.
PACER - A practical fusion power concept
13 p0035 A77-12793
HUDSON, W. R.
NASA electric propulsion program
[AIAA PAPER 76-1068] 13 p0045 A77-13033
HUEBNER, R.
Combination power plants for improved utilization of fossil fuels
13 p0045 A77-12939
MHD - Energy transformation by burning coal
13 p0045 A77-12940
HUENING, R.
Fuel cells
13 p0055 A77-15804
HUFFMAN, F. N.
Advanced thermionic converter development
13 p0043 A77-12862
HUGHES, E. E.
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534
HUGHES, T. D. R.
Accelerated response of thermopile pyranometers
13 p0019 A77-12405
HULL, J. F.
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
HULSTROM, R. L.
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533
HUMES, T.
Wind energy conversion
[PB-256198/3] 13 p0115 N77-13552
HUMPHREY, J. H.
In situ combustion of Michigan oil shale - Current field studies
13 p0024 A77-12695
HUNTER, H. E.
Effect of mechanical cooling devices on ambient salt concentration
[PB-256679/2] 13 p0125 N77-14631

HUNZINGER, J. J.
Periodically adjustable concentrators adapted to solar cell panels
13 p0074 A77-19068
HUQ, R.
Vortex kinetic energy concentrator
13 p0044 A77-12870
HURN, R. W.
The fuel approach to control emissions from aircraft
[IAF PAPER 76-111] 13 p0003 A77-10911
HYDE, R. W.
Comparative economics for the Arthur D. Little extractive coking process
13 p0022 A77-12684

I

IAKUSHEV, A. A.
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665
IANTUONO, A.
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
IBRAGIMOV, D. IU.
Economic effectiveness of solar electric power stations
13 p0063 A77-17556
ICHIKAWA, S.
Organic Rankine Cycle Engine development and solar energy utilization
13 p0077 A77-19096
IGENBERGS, E.
Energy storage in orbital and interplanetary missions
[DGLR PAPER 76-189] 13 p0059 A77-16551
IGOU, R. D.
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
IKEDA, S.
Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
13 p0049 A77-13728
IKUTA, T.
Concept of a fusion burner
13 p0061 A77-17014
ILLIG, E. G.
Catalytic coal liquefaction using synthesis gas
13 p0059 A77-16473
ILYIN, Y. A.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
IMANURA, M. S.
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533
IMANUTDINOV, F. M.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4P)] 13 p0112 N77-13235
INGLEY, H. A.
Experimental evaluation of the University of Florida solar powered ammonia/water absorption air conditioning system
13 p0039 A77-12823
IQBAL, K. Z.
Resource utilization efficiency improvement of geothermal binary cycles, phase 1
[ORO-4944-3] 13 p0123 N77-14600
IRBY, J. E.
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822
IRICK, P. E.
TRISNET. Directory to transportation research information resources
[PB-255172/9] 13 p0125 N77-14939
IRWIN, S. E.
Performance and cost analysis of photovoltaic power systems for on-site residential applications
13 p0038 A77-12816
ISHIWATARI, M.
Thermal alteration of young kerogen in relation to petroleum genesis
13 p0053 A77-15044
ISHIWATARI, R.
Thermal alteration of young kerogen in relation to petroleum genesis
13 p0053 A77-15044
ISLER, R. J.
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543
ITOH, K.
Concept of a fusion burner
13 p0061 A77-17014
ITON, L. E.
Hydrogen atoms: Rare earth ions: Magnetic resonance studies on polycrystalline solids and surface systems relevant to catalysis and other energy-related research
13 p0117 N77-13798
IURA, T.
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495
IVANOV, P. P.
Influence of various losses on the characteristics of high-power MHD generators
13 p0046 A77-13258
IVANOVSKY, M. I.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
IVANOVSKY, M. N.
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383

J

JACKSON, J. W.
A bioenvironmental study of emissions from refuse derived fuel
[AD-A024661] 13 p0110 N77-12571
JACKSON, W. D.
MHD power generation - 1976 Status Report
13 p0033 A77-12782
JACOBS, C.
Benefits of hydrogen production research
13 p0032 A77-12768
JACOBS, H.
Direct contact heat exchangers for geothermal power plants
13 p0029 A77-12747
JAKOBSSON, S.
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
JANKE, S. H.
Arrays of fixed flat-plate solar energy collectors - Performance comparisons for differing individual component orientations
13 p0068 A77-18449
JARVINEN, P. O.
Windowed versus windowless solar energy cavity receivers
13 p0037 A77-12808
JAUMOTTE, A.
A combined cycle with a partial-oxidation reactor
13 p0062 A77-17534
JAYADEV, T. S.
A new generation scheme for large wind energy conversion systems
13 p0043 A77-12868
Windmills stage a comeback
13 p0048 A77-13624
JEFFS, E.
Nova Scotia seeks to cut oil bill for power generation
13 p0063 A77-17588
JENKINS, D.
JP-4 and JP-9 fuel toxicity studies using water fish and aufwuchs
[AD-A027594] 13 p0127 N77-15213

JENSEN, R. N.
Solar hot water systems application to the solar building test facility and the Tech House
13 p0084 N77-10342
JENSEN, W. P.
Geothermal powered heat pumps to produce process heat
13 p0030 A77-12754
JERABEK, E. C.
Load leveling with electric vehicles in the urban environment
13 p0024 A77-12701
JIRIK, C. J.
A survey of salt deposits and salt caverns: Their relevance to the strategic petroleum reserve
[PB-255948/2] 13 p0105 N77-12500
JOEBSTL, J. A.
Surface research for development of new electrocatalysts for acid electrolyte fuel cells
[AD-A026053] 13 p0131 N77-15517
JOHNSON, C. C.
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
JOHNSON, J. R.
Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage
13 p0033 A77-12777
JOHNSON, S. M.
Evaluation of flat-plate collector efficiency under controlled conditions in a solar simulator
[NASA-TM-X-73520] 13 p0097 N77-11530
Standardized performance tests of collectors of solar thermal energy - A flat-plate copper collector with parallel mylar striping
[NASA-TM-X-73553] 13 p0114 N77-13535
Standardized performance tests of collectors of solar thermal energy: An evacuated flatplate copper collector with a serpentine flow distribution
[NASA-TM-X-73415] 13 p0114 N77-13536
JOHNSTON, F. J. H.
The future of air transportation - Economic association considerations
[AIAA PAPER 77-286] 13 p0065 A77-18222
JOHNSTON, R. P.
Study of unconventional aircraft engines designed for low energy consumption
[NASA-CR-135136] 13 p0127 N77-15043
JONES, B. D.
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13 p0004 A77-11026
JONES, G. J.
Development of a small radioisotopic heat source
13 p0042 A77-12852
JONES, G. M.
Small space station electrical power system design concepts
13 p0040 A77-12835
JONES, I. W.
Sodium/sulphur battery development in the United Kingdom
13 p0026 A77-12717
JONES, R. A.
Auxiliary power system for activity cooled aircraft
[NASA-CASE-LAR-11626-1] 13 p0103 N77-12332
JONES, R. G.
Analysis of state solar energy options
[PB-254730/5] 13 p0091 N77-10688
JONES, R. W.
Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia
13 p0078 A77-19110
JORDAN, D.
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
JOST, A.
Emergency power plant of rapid availability for the Berlin-Tegel airport
13 p0001 A77-10324

K

KADLEC, P. A.
Design phase utility analysis for gas turbine and combined cycle plants
[PB-256665/1] 13 p0115 N77-13553
KAHN, E.
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948
KAISER, S. W.
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666
KAKAC, S.
Solar production of hydrogen as a means of storing solar energy
13 p0075 A77-19072
KAKHRAMANOV, K. S.
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
KALFADELIS, C. D.
A preliminary engineering assessment of jet fuel production from domestic coal and shale derived oils
13 p0023 A77-12690
KAMINS, R. M.
Geothermal energy in Hawaii - Hydrothermal systems
13 p0029 A77-12741
KAMINSKI, H.
Remote sensing of geothermic activities of the volcanoes Aetna, Stromboli and Vesuv by means of infra-red NOAA-VHRR-satellite data
13 p0104 N77-12485
KAMMHOLZ, G.
Energy in the household - Comparison of heating costs and prognosis concerning the consumption of energy until 1985
13 p0015 A77-12059
KAPLAN, I. R.
Thermal alteration of young kerogen in relation to petroleum genesis
13 p0053 A77-15044
KAPLAN, S. M.
High temperature gas turbine engine
[PE-1765-8] 13 p0120 N77-14488
High temperature gas turbine engine component materials testing program
[PE-1765-7] 13 p0127 N77-15401
KARABUT, A. B.
A 2-MW electric arc generator with porous cooling of the interelectrode insert
13 p0049 A77-13831
KARIM, G. A.
Hydrogen as a fuel in compression ignition engines
13 p0071 A77-18932
KARLIN, J. J.
The nuclear spinner for Satcom applications
13 p0041 A77-12838
KARNAUKHOV, A. S.
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
KARR, C. H.
R&M - Today's heating and cooling vs. solar energy
13 p0002 A77-10482
KATZ, S.
A laboratory evaluation of precoat filtration parameters for the solvent refined coal process
13 p0059 A77-16474
KAUFFMAN, K. W.
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732
Thermal energy storage for heating and air conditioning
13 p0057 A77-16206
KAUN, T. D.
Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells
13 p0025 A77-12713
KAWAMURA, Y.
Non-equilibrium MHD power generation using non-seeded argon plasma
13 p0004 A77-11022

KAYTEN, G. G.
Air transportation beyond the 1980's
13 p0117 N77-13984
KEAIRNS, D. L.
Advanced coal gasification system for electric power generation
[FE-1514-176] 13 p0088 N77-10653
KEDDY, E. S.
Heat pipes for fluid-bed gasification of coal - Metallurgical condition of heat pipes after tests in process environment
13 p0031 A77-12764
KEELING, C. D.
Atmospheric carbon dioxide variations at the South Pole
13 p0067 A77-18439
KEER, L. M.
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556
KELLER, J. G.
Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations
13 p0028 A77-12736
KELLOGG, H. H.
The role of recycling in conservation of metals and energy
13 p0061 A77-16825
KELLY, D.
Direct contact heat exchangers for geothermal power plants
13 p0029 A77-12747
KELLY, H. J.
A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices
13 p0061 A77-17017
KELLY, R. D.
Our amazing air transportation system /AIAA-SAE William Littlewood Memorial Lecture/
[AIAA PAPER 77-356] 13 p0067 A77-18260
KENTFIELD, J. A. C.
The pressure divider - A device for reducing gas-pipe-line pumping-energy requirements
13 p0028 A77-12735
KERN, P. J.
Effects of a thermal reactor on the energy efficiency of a turbocharged, stratified charge engine
[AD-A026059] 13 p0128 N77-15409
KERSLAKE, W. R.
Status of SERT 2 thrusters and spacecraft 1976
[NASA-TM-X-73501] 13 p0083 N77-10149
KETTANI, M. A.
Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volumes 1 & 2
13 p0072 A77-19043
Storage of solar energy in the form of potential hydraulic energy
13 p0075 A77-19078
KHALIL, K. H.
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
KHAN, M. I.
Hydel and solar power for Pakistan
13 p0079 A77-19121
KHAZZOOM, J. D.
Proceedings of the Workshop on Modeling the Interrelationships between the Energy Sector and the General Economy
[PB-255696/7] 13 p0100 N77-11561
KHODZHAEV, A. SH.
Radiant-vector distribution in the radiant field of a parabolocylindric concentrator
13 p0015 A77-11920
Energetic calculation of the concentrating capacity of paraboloidal facets
13 p0051 A77-14579
KIRICHENKO, B. A.
Optimization of the geometry of switching buses for thermoelements in thermoelectric generators
13 p0052 A77-14951
KIRILLOV, V. V.
Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream
13 p0001 A77-10423
Study of cathode spots in the presence of slag films on the electrodes of an open-cycle MHD generator
13 p0053 A77-15005
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666
KIRPICH, A.
Performance and cost analysis of photovoltaic power systems for on-site residential applications
13 p0038 A77-12816
KISTLER, C. W.
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
KITTL, E.
Composite material structures for thermophotovoltaic conversion radiator
[AD-A026859] 13 p0132 N77-15519
KIVIAT, F. E.
Energy recovery from saline water by means of electrochemical cells
13 p0013 A77-11536
KLABUNDE, K. J.
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243
KLAPAS, D.
Electric arc power collection for high-speed trains
13 p0060 A77-16594
KLAPATCH, R. D.
Solids gasification for gas turbine fuel 100 and 300 Btu gas
13 p0022 A77-12685
KLEIN, B. W.
Proceedings of the Mineral Economics Symposium: Winning the high stakes at the critical commodity game
[PB-255607/4] 13 p0105 N77-12502
KLEIN, M.
An analysis of electric vehicle mission, design, energy impact and cost
13 p0024 A77-12700
KLEIN, S.
JP-4 and JP-9 fuel toxicity studies using water fish and aufwuchs
[AD-A027594] 13 p0127 N77-15213
KLEIN, S. A.
A design procedure for solar heating systems
13 p0128 N77-15485
KLEINSCHMAGER, H.
Development of sodium/sulfur-cells
13 p0026 A77-12716
Some studies on sodium/sulfur cells
13 p0055 A77-15813
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817
KLEINWAECHTER, H.
Captation and concentration of solar energy
13 p0074 A77-19063
KLINE, R. L.
Space solar power - An available energy source
13 p0056 A77-15946
KLINECT, V. W.
Preliminary report on the CTS transient event counter performance through the 1976 spring eclipse season
[NASA-TM-X-73487] 13 p0083 N77-10116
KLIUCHEVSKII, IU. E.
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up
13 p0051 A77-14580
KLOSTER, M.
Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575

KLUPPEL, R. P.
Performance of an annular cylindrical solar collector
13 p0073 A77-19059
KNAGG, J. A.
Estimating procedures associated with aircraft modifications
[SAWE PAPER 1101] 13 p0016 A77-12181
KNOCHE, K. F.
Hydrogen production using nuclear heat
13 p0057 A77-16211
KNUTSEN, C. A.
Economics of geothermal electricity generation from hydrothermal resources
[BNWL-1989] 13 p0123 N77-14602
KNY, K.
The conservation of air purity and its effect on the energy economy
13 p0049 A77-13811
KOCH, H.
Status of development and application of gas-stabilized heat-pipe radiators
[DGLR PAPER 76-192] 13 p0060 A77-16557
KODAMA, Y.
Concept of a fusion burner
13 p0061 A77-17014
KOEHLER, M.
High-temperature ceramics for automobile gas turbines. II
13 p0063 A77-17591
KOENING, D. R.
Heat pipe nuclear reactor for space power
13 p0036 A77-12797
KOHL, A. L.
Low-Btu gasification of coal by Atomics International's molten salt process
13 p0023 A77-12687
KOHL, J.
Conference proceedings, Energy from the Oceans, Fact or Fantasy
[PB-256093/6] 13 p0108 N77-12547
KOKLIUEV, G. A.
Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters
13 p0058 A77-16324
KOLGOTIN, F. P.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
KOLOMOETS, N. V.
Optimization of the geometry of switching buses for thermoelements in thermoelectric generators
13 p0052 A77-14951
KOLTUN, M. M.
Effectiveness of heat-emitting coatings with variable degree of blackness
13 p0111 N77-12893
KONONENKO, G. N.
A generalized indicator characterizing the hydrodynamics and heating efficiency of subterranean thermal circulation systems
13 p0058 A77-16306
KONOPKA, A.
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
KORANYI, G.
Air cleanup and energy management
13 p0010 A77-11302
KORIAGINA, G. M.
Influence of various losses on the characteristics of high-power MHD generators
13 p0046 A77-13258
KORNEEV, V. I.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
KORNRUMPF, W. P.
Definition study for photovoltaic residential prototype system
[NASA-CR-135039] 13 p0113 N77-13532
KOROPEY, O. B.
Effects of a thermal reactor on the energy efficiency of a turbocharged, stratified charge engine
[AD-A026059] 13 p0128 N77-15409
KORSHUNOV, V. N.
A 2-MW electric arc generator with porous cooling of the interelectrode insert
13 p0049 A77-13831
KOSKINAS, G. J.
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499
KOSKY, P. G.
Design analyses of a methane-based chemical heat pipe
13 p0028 A77-12737
KOSTORNOV, A. G.
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326
KOUTSANDREAS, J. D.
Tracking pollutants from a distance
13 p0067 A77-18370
KOVARIK, M.
Optimal control of flow in low temperature solar heat collectors
13 p0019 A77-12409
KOVBASIUK, V. I.
Influence of various losses on the characteristics of high-power MHD generators
13 p0046 A77-13258
KOVITZ, A. A.
Interfacial effects in the recovery of residual oil by displacement: Studies at Northwestern University
[COO-0019-5] 13 p0122 N77-14595
KRAMMER, H.
Layout and flight performance of a hypersonic transport /HST/
[DGLR PAPER 76-198] 13 p0060 A77-16575
KRAN, A.
Alternative strategies for implementing silicon-ribbon technology for photovoltaic applications
13 p0039 A77-12819
KRASNOVSKII, A. A.
Chemical evolution of photosynthesis
13 p0071 A77-18898
KRAUSE, P. R.
Prerequisites for military/civilian geopressured geothermal resource development
13 p0031 A77-12761
KRAUSE, H.
Electric power supply in the case of airports. I
13 p0061 A77-16742
KREIDER, J. F.
Performance of two fixed-mirror solar concentrators for process heat
13 p0074 A77-19065
KREININ, L. B.
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916
KREITH, F.
An engineering feasibility study of using low temperature geothermal sources in Colorado
13 p0031 A77-12762
KREMHELLER, A.
Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia
13 p0078 A77-19110
KRENZ, J. H.
Energy: Conversion and utilization
13 p0052 A77-14957
KRISHNA, M.
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689
KRISHNASWAMY, P. R.
Transfer function analysis of heat pipes
13 p0119 N77-14385

KROMS, A.
Underground fuel gasification
[UCRL-TRANS-10998] 13 p0088 N77-10659
KRONG, U.
Manufacturing and evaluation of phthalocyanines as catalysts for fuel cells
[BMFT-FB-T-76-25] 13 p0114 N77-13540
KRUEGER, E. C.
KIPS - Kilowatt Isotope Power System
13 p0041 A77-12837
KRUZHILIN, IU. I.
Shaping of laser pulses in an amplifying system receiving input signals with a variable spectrum
13 p0053 A77-15237
KUHN, W.
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817
KUKLINSKII, M. I.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235
KULIEV, A. Z.
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
KUNCHAL, K.
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207
KUNZE, J. F.
Making electricity from moderate temperature fluids
13 p0002 A77-10649
Space heating systems new and conventional in the Northwest with emphasis on alternate energy adaptations
13 p0028 A77-12736
The economic generation of electricity from moderate temperature geothermal resources
13 p0030 A77-12749
KUO, S. C.
A conceptual design study of closed Brayton cycle gas turbines for fusion power generation
13 p0022 A77-12676
KUROCHKIN, IU. V.
A 2-MW electric arc generator with porous cooling of the interelectrode insert
13 p0049 A77-13831
KURTZ, D. W.
Aerodynamics as a subway design parameter
13 p0070 A77-18721
KUSAKA, Y.
Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
13 p0049 A77-13728
KUSSMANN, A.
Possibilities for utilizing wind energy
13 p0056 A77-15853
KUSUDA, T.
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire
[PB-254179/5] 13 p0091 N77-10687
KUZNETSOV, I. M.
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361

L

LACONTI, A. B.
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380
LAGRAFF, J. E.
Commercial building unitary heat pump system with solar heating
[PB-255488/9] 13 p0099 N77-11551
LAGUES, M.
A hydride compressor
13 p0046 A77-13336
LAIGROZ, J.
Characteristic aspects of the evolution of the French electric balance in 1975
13 p0012 A77-11340
LAINE, E. F.
Monitoring fluid flow by using high-frequency electromagnetic probing
[UCRL-51979] 13 p0120 N77-14393
LAKI, G.
Experience in putting the Kiskore hydroelectric power plant on line
13 p0010 A77-11301
LALEVIC, B.
Schottky solar cells on thin epitaxial silicon
13 p0047 A77-13509
LANCASTER, B. W.
Advanced coal gasification system for electric power generation
[FE-1514-176] 13 p0088 N77-10653
LANDES, H.
Definition study for photovoltaic residential prototype system
[NASA-CR-135039] 13 p0113 N77-13532
LANE, H.
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533
LANE, S. D.
Test and evaluation of the Navy half-watt RTG
13 p0042 A77-12853
LANGE, E. A.
Ignition of flammable gases in crude-oil tankers as a result of metal fracture
[AD-A027411] 13 p0127 N77-15121
LANGPAPE, R.
Development of sodium/sulfur-cells
13 p0026 A77-12716
LANSING, F. L.
High-efficiency solar concentrator
13 p0083 N77-10104
A two-dimensional finite difference solution for the transient thermal behavior of tubular solar collector
13 p0083 N77-10105
LAPIDES, M. E.
Nuclear unit productivity analysis
[PB-257553/8] 13 p0132 N77-15528
LARRABEE, E.
Wind energy conversion
[PB-256198/3] 13 p0115 N77-13552
LARSEN, R.
Development of a mobile solar testing and recording /STAR/ system
13 p0072 A77-19047
LASER, D. L.
Monitoring fluid flow by using high-frequency electromagnetic probing
[UCRL-51979] 13 p0120 N77-14393
LASZLO, J.
Application of the Stretford process for H2S abatement at the Geysers geothermal power plant
13 p0029 A77-12743
LAVIGNA, T. A.
The ATS-6 power system - Hardware implementation and orbital performance
13 p0040 A77-12831
LAWAND, T. A.
Environmentally designed housing incorporating solar energy
13 p0079 A77-19115
LAWRENCE, J.
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
LAWRENCE, R. W.
An improved electrolyte for direct oxidation fuel cells
[AD-A026164] 13 p0131 N77-15518
LAWSON, K. S.
The pay-off for advanced technology in commercial aircraft design and operation
13 p0071 A77-19012
LE VERT, P.
Energy consumption in various modes of transportation
13 p0050 A77-14561
LEAHY, M. P.
Future scenarios for urban transportation
[PB-255349/3] 13 p0102 N77-11930
LEBOUC, P.
Concorde - Endurance flights results
13 p0016 A77-12114

LEBOUEG, R.
Procedure for characterizing flat plate solar collectors
13 p0073 A77-19056
LEE, D. O.
Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors
13 p0069 A77-18450
Synergistic effects of shadowing on a solar collector matrix
[SAND-76-0012] 13 p0122 N77-14587
LEFROIS, R. T.
Thermal energy storage for solar power plants
13 p0027 A77-12731
LEHMAN, S. J.
Steam station repowering - A near-term method of energy conservation
13 p0022 A77-12679
LEISHER, W. B.
PULSAR, an unconventional topping stage
13 p0034 A77-12788
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293
LEMMON, A. W.
Reductant gases for flue gas desulfurization systems
[PB-254168/8] 13 p0092 N77-10722
LENGQUIST, R.
Geothermal power - The 'sleeper' in the energy race
13 p0056 A77-15845
LENZE, B.
The influence of the Reynolds number on the profiles of velocity and concentration in free jets of different density
13 p0069 A77-18500
LEONARD, H. F.
The commercial production of hydrogen by the K-T process
13 p0032 A77-12769
LEONARD, J. T.
Electrostatic properties of JP-5 jet fuel from alternate sources
[AD-A025684] 13 p0103 N77-12232
LESKOVJAN, L. L.
Nuclear power - Compared to what
13 p0017 A77-12234
LESSARD, R. D.
Steam station repowering - A near-term method of energy conservation
13 p0022 A77-12679
LESSE, P. F.
Optimal control of flow in low temperature solar heat collectors
13 p0019 A77-12409
LEVELL, R. H.
Preliminary report on the CTS transient event counter performance through the 1976 spring eclipse season
[NASA-TM-X-73487] 13 p0083 N77-10116
LEVI, J.
The Osmotic power plant
13 p0021 A77-12668
LEVITZ, N.
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
LEVY, M. J.
Energy and environmental considerations in extending heat pump applications
13 p0062 A77-17058
LEVY, R.
Wind power prediction models
[NASA-CR-149235] 13 p0105 N77-12509
LEYERLE, R. W.
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529
LIAO, C. K.
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings
[PB-254665/3] 13 p0091 N77-10689
LIBOWITZ, G. G.
An evaluation of the use of metal hydrides for solar thermal energy storage
13 p0028 A77-12739
LICHTIN, N. N.
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108
Photochemical conversion of solar energy
[PB-255703/1] 13 p0090 N77-10685
LIEB, D.
Advanced thermionic converter development
13 p0043 A77-12862
LIEBERMAN, A. R.
The low cost high performance generator /LCHPG/
13 p0042 A77-12855
LIEBERT, C. H.
Effect of ceramic coating of JT8D combustor liner on maximum liner temperatures and other combustor performance parameters
[NASA-TM-X-73581] 13 p0126 N77-15037
LIGON, C.
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
LILES, A. W.
Selection of driving cycles for electric vehicles of the 1990's
13 p0024 A77-12702
LIN, W.
Modeling residential energy use
13 p0027 A77-12726
LINDENA, S.
Comparison of candidate solar array maximum power utilization approaches
13 p0041 A77-12836
LINDMAYER, J.
Development of 20 percent efficient solar cell
[PB-255903/7] 13 p0108 N77-12548
LINGARD, M. P. A.
Electricity and heat production - Energy efficiency versus cost efficiency
13 p0011 A77-11338
LINN, R. J.
Future aircraft requirements: A notebook of airline thoughts
13 p0117 N77-13976
LINSCOTT, B. S.
Early operation experience on the ERDA/NASA 100 kW wind turbine
[NASA-TM-X-71601] 13 p0086 N77-10640
LIOR, N.
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732
LIPPERT, T. E.
Liquid-metal magnetohydrodynamic system evaluation
13 p0034 A77-12784
LIPPS, F. W.
A new method for collector field optimization
13 p0074 A77-19070
LIPSCHUTZ, R. C.
A method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds
13 p0019 A77-12412
LISSAMAN, P. B. S.
Aerodynamics of the Darrieus rotor
13 p0050 A77-14559
LIU, M. K.
Theoretical, numerical, and physical techniques for characterizing power plant plumes
[PB-253099/6] 13 p0101 N77-11599
LIU, S. T.
Analysis of solar energy system for the GSA demonstration office building at Manchester, New Hampshire
[PB-254179/5] 13 p0091 N77-10687
LIU, Y.
Hydrogen separation and compression through hydride formation and dissociation by low-level heat
13 p0032 A77-12770
LOBO, P. C.
Performance of an annular cylindrical solar collector
13 p0073 A77-19059
LOCHOW, R.
Conference report: Energy Conservation in Transportation and Construction
[PB-255857/5] 13 p0100 N77-11562

LOCKEN, J.
User's guide to petroleum industry survey data type [PB-256635/4] 13 p0098 N77-11544
LOEB, S.
The Osmotic power plant 13 p0021 A77-12668
LOEBL, A. S.
Transportation energy conservation data book [ORNL-5198] 13 p0086 N77-10643
LOFERSKI, J. J.
A sulfurization process for the preparation of photovoltaic Cu/x/S and CuInS2 thin films 13 p0076 A77-19087
LOFTHOUSE, J. H.
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines 13 p0033 A77-12779
LOITER, E. E.
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance 13 p0020 A77-12657
LOKAI, N. V.
Heat-pipe regenerator for gas turbine engine 13 p0020 A77-12528
LOKMANHEKIM, M.
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran 13 p0078 A77-19111
LONGHOUSE, R. E.
Noise mechanism separation and design considerations for low tip-speed, axial-flow fans 13 p0046 A77-13339
LORGEOU, M.
Autonomous station for the acquisition and concentration of heliometric data 13 p0072 A77-19046
LORSCH, H. G.
Thermal energy storage considerations for solar-thermal power generation 13 p0027 A77-12732
Thermal energy storage for heating and air conditioning 13 p0057 A77-16206
LOTH, J. L.
Vortex kinetic energy concentrator 13 p0044 A77-12870
LOW, J. Y. F.
Catalytic hydrogenation of solvent-refined lignite to liquid fuels 13 p0008 A77-11243
LOWE, P. A.
Thermochemical energy storage systems 13 p0028 A77-12738
LOWI, A.
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system 13 p0020 A77-12665
LOWNEY, J. R.
The integral formulation of the thermoelectric figure-of-merit - Effects of lattice thermal conduction 13 p0042 A77-12850
LU, D. C.
Heat pipe heat exchanger design considerations 13 p0031 A77-12765
LUEDKE, E. E.
Heat pipe materials compatibility [NASA-CR-135069] 13 p0103 N77-12182
Flight data analysis and further development of variable-conductance heat pipes [NASA-CR-137953] 13 p0118 N77-14374
LUEHRMANN, W.
Energy in the household - Comparison of heating costs and prognosis concerning the consumption of energy until 1985 13 p0015 A77-12059
LUFT, W.
Ultralightweight solar array for Naval Sea Control Systems 13 p0040 A77-12828
Radiation effects on high efficiency silicon solar cells 13 p0064 A77-18072
LUKENS, L. L.
Parametric studies of the thermal trap flat plate collector 13 p0068 A77-18443
LUND, J. W.
The utilization and economics of low temperature geothermal water for space heating 13 p0030 A77-12756
LUNDHOLM, J. G.
NASA thermionic-conversion program 13 p0043 A77-12863
LUNDIN, C. E.
Some useful relationships between the physical and thermodynamic properties of metal hydrides 13 p0033 A77-12776
LYNCH, F. E.
Some useful relationships between the physical and thermodynamic properties of metal hydrides 13 p0033 A77-12776
LYTLE, R. J.
Monitoring fluid flow by using high-frequency electromagnetic probing [UCRL-51979] 13 p0120 N77-14393

M

MA, F. S. T.
Planning models for the assessment of advanced energy storage systems 13 p0105 N77-12504
MACDONALD, H. C.
Use of radar in geology 13 p0018 A77-12256
MACEDO, I. C.
Grain drying in stationary bins with solar heated air 13 p0019 A77-12411
MACIOLEK, R. B.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project [NASA-CR-149242] 13 p0105 N77-12513
MACPHERSON, H. G.
IEA energy simulation model: A framework for long-range US energy analysis [ORAU-125] 13 p0122 N77-14594
MADEWELL, D. G.
Transportation energy conservation data book [ORNL-5198] 13 p0086 N77-10643
MAEVSKII, V. A.
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies 13 p0018 A77-12361
MAGEE, C. B.
Some useful relationships between the physical and thermodynamic properties of metal hydrides 13 p0033 A77-12776
MAGEE, E. M.
Evaluation of pollution control in fossil fuel conversion processes [PB-255842/7] 13 p0125 N77-14638
MAGLICH, B. C.
The migma high energy advanced fuel direct conversion fusion power plant 13 p0035 A77-12794
MAGNOLI, D.
Solar energy prospects for electric power generation in Brazil 13 p0037 A77-12805
MAHAJAN, O. P.
Differential scanning calorimetry studies on coal. II - Hydrogenation of coals 13 p0070 A77-18583
MAHLOCH, J. L.
Pollutant potential of raw and chemically fixed hazardous industrial wastes and flue gas desulfurization sludges [PB-256691/7] 13 p0133 N77-15540
MAIANI, L.
Physical and biological aspects of thermal pollution in sea water [ISS-L-75/14] 13 p0109 N77-12560
MAIER, H.-H.
A system model for the investigation of alternative energy strategies 13 p0080 A77-19181
MAKAROV, V. I.
Cross structural plan of the earth's crust and the problem of the manifestation of its plutonic elements on the surface (Tyan-Shan and Turan plate as examples) [NASA-TT-F-16938] 13 p0117 N77-13590

MAKHIJANI, A.
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948
MALLON, R. G.
Reactivity of oil shale carbonaceous residue with oxygen and carbon dioxide
[UCRL-77829] 13 p0123 N77-14596
MALONE, D. W.
Energy: The policy planning framework in state governments. Volume 1: Summary report
[PB-254466/6] 13 p0089 N77-10665
Energy: The policy planning framework in state governments. Volume 2: Appendices
[PB-254467/4] 13 p0089 N77-10666
MALTESE, J.
Availability of potential coal supply through 1985 by quality characteristics
[PB-256680/0] 13 p0121 N77-14573
MALTHOUSE, N. S.
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
MANCINI, N. A.
Thin film solar acceptors
13 p0072 A77-19053
MANIAKHIN, S. M.
Optimisation of current source operation in pulse mode
[IAF PAPER 76-255] 13 p0003 A77-10952
MANN, J. R.
Underground gasification of coal: A National Coal Board reappraisal. 1976
13 p0044 A77-12926
MANNE, A. S.
Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/
13 p0013 A77-11524
MANNING, G. B.
ERDA's gas turbine development program for the next decade
13 p0011 A77-11324
MANSOORI, G. A.
Prospects for solar energy utilization in Iran - Photothermal methods
13 p0013 A77-11532
MANVI, R.
Benefits of hydrogen production research
13 p0032 A77-12768
MARCHETTI, C.
Primary energy sources for hydrogen production
13 p0011 A77-11335
MARGARITIS, P. J.
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689
MARIANOWSKI, L. R.
Production of methane using offshore wind energy
13 p0026 A77-12722
MARKINA, A. P.
Study of cathode spots in the presence of slag films on the electrodes of an open-cycle MHD generator
13 p0053 A77-15005
MARSH, D. P.
The next-generation subsonic transport
[SAWE PAPER 1127] 13 p0016 A77-12195
MARSH, S. L.
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California
[PB-254449/2] 13 p0092 N77-10720
MARSHALL, K. N.
Use of Lexan and Kapton honeycombs to increase solar collector efficiency
13 p0068 A77-18448
MARSHALL, W.
Energy research in the UK
13 p0055 A77-15812
MARSIK, F. V.
Trends in refinery capacity and utilization: Petroleum refineries in the United States; foreign refinery exporting centers
[PB-256966/3] 13 p0132 N77-15523
MARTIN, G.
Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity
13 p0073 A77-19057
MARTINEZ-SANCHEZ, M.
Wind energy conversion
[PB-256198/3] 13 p0115 N77-13552
MARTINEZ, I.
Development of space applications of heat pipes at Aerospatiale
13 p0120 N77-14390
MARTINI, W. R.
Self-starting, intrinsically controlled Stirling engine
13 p0041 A77-12844
MARTINO, F. J.
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107
Review of electrode designs and fabrication techniques for lithium-aluminum/iron sulfide cells
13 p0025 A77-12713
MARTINS, O. R.
Design phase utility analysis for gas turbine and combined cycle plants
[PB-256665/1] 13 p0115 N77-13553
MASLOV, V. G.
Theoretical aspects of optimization of aviation gas turbine engine design variables
13 p0063 A77-17762
MASUDA, T.
Experiment on MHD generator with a large-scale superconducting magnet /ETL Mark V/
13 p0049 A77-13728
MATHE, P.
Schottky solar cells on thin epitaxial silicon
13 p0047 A77-13509
MATHIEU, J. P.
Development of space applications of heat pipes at Aerospatiale
13 p0120 N77-14390
MATHUR, R. M.
Transport systems guarantee efficient utilization of energy resources
13 p0053 A77-15048
MATTERSDORFF, E.
The wind and its effect on the heating requirements
13 p0009 A77-11266
MATTHEWS, R. D.
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
MATTINGLY, S. R.
Stratospheric heating due to absorption of solar radiation by NO2
13 p0013 A77-11568
MAYER, H. J.
LTA - Recent developments
13 p0061 A77-17021
MAZARAKIS, M.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
MAZIUK, J.
Design of a 100 BPD pilot plant to convert methanol to gasoline using the Mobil process
13 p0023 A77-12691
MAZULEVSKII, E. A.
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815
MAZUMDER, M.
Experimental demonstration of an iron chloride thermochemical cycle for hydrogen production
13 p0032 A77-12772
MCALEVY, R. F., III
The performance of hydrogen-injected reciprocating engines
13 p0033 A77-12780
MCBETH, R. L.
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
MCCALLUM, B.
Can Canada harness the wind
13 p0053 A77-15047
MCCANN, J. F.
The photosynthetic production of hydrogen
13 p0075 A77-19077
MCCARTHY, P.
Detailed geographic analysis of residential energy consumption
13 p0043 A77-12864

MCCARTHY, R. L.
Industrial energy conservation through integration of thermal energy storage into process energy dynamics
13 p0028 A77-12733
MCCARTY, P. L.
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577
MCCLANAHAN, S.
Coal liquefaction with soluble transition-metal complexes
13 p0070 A77-18584
MCCONNELL, R. D.
An experimental 200 kW vertical axis wind turbine for the Magdalen Islands
13 p0044 A77-12874
MCCOY, L. R.
Development status of lithium-silicon-iron sulfide load-leveling batteries
13 p0026 A77-12714
MCCULLOCH, C. M.
Applying computer-drawn maps of geologic data to analysis of mining problems
[PB-255497/0] 13 p0096 N77-11518
MCCULLOCH, D. E.
Small electric vehicle considerations in view of performance and energy usage
13 p0024 A77-12698
MCDONALD, G.
Optimized selective coatings for solar collectors
[NASA-TM-X-73498] 13 p0097 N77-11529
MCFARLAND, R. D.
Extracting energy from hydraulically-fractured geothermal reservoirs
13 p0030 A77-12757
MCGINNESS, H.
Wind power prediction models
[NASA-CR-149235] 13 p0105 N77-12509
MCHENRY, H. I.
Ship steel weldments for low temperature service
[PB-256997/8] 13 p0103 N77-12203
MCINTOSH, R.
The International Heat Pipe Experiment
13 p0120 N77-14389
MCKENNA, E. F.
KIPS - Kilowatt Isotope Power System
13 p0041 A77-12837
MCKITTRICK, S.
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719
MCKOWN, G. L.
Prerequisites for military/civilian geopressured geothermal resource development
13 p0031 A77-12761
MCNALLY, J. R., JR.
Advanced fuels for inertial confinement
13 p0061 A77-17016
MCVEIGH, J. C.
Developments in solar energy utilisation in the United Kingdom
13 p0018 A77-12402
MEAD, W.
Draft environmental assessment of application by ERDA for a special land use permit for use of public lands in Wyoming for in situ coal gasification experiments
[UCID-17011] 13 p0100 N77-11572
MEADER, M. D.
A unique Rankine-cycle heat pump system
13 p0036 A77-12799
MEBUSS, H. G.
A methodical approach concerning energy supply problems
13 p0016 A77-12062
MEHALICK, E. M.
Two component thermal energy storage material
[PB-252592/1] 13 p0090 N77-10675
MEI, J. S.
Heat pipes for fluid-bed gasification of coal - Metallurgical condition of heat pipes after tests in process environment
13 p0031 A77-12764
MEINEL, A. B.
Progress in development and application of selective surfaces
13 p0072 A77-19052
MELFI, S. H.
Tracking pollutants from a distance
13 p0067 A77-18370
MELISS, M.
The future importance of solar energy for the supply of the German Federal Republic with energy
13 p0070 A77-18597
MENASIAN, S.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
MENDELSOHN, M.
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
MENENGER, L.
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591
MENSFORTH, T.
Wind-power generation on a large scale - A design idea
13 p0050 A77-14531
MERCER, L. M.
Small space station electrical power system design concepts
13 p0040 A77-12835
MERCK, W. F. M.
Boundary-layer separation from the electrode wall of an MHD generator
13 p0048 A77-13711
MERRILL, G. L.
Study of small turbofan engines applicable to single-engine light airplanes
[NASA-CR-137944] 13 p0093 N77-11054
MERRILL, O. S.
Uranium zirconium hydride reactor space power systems
[IAF PAPER 76-256] 13 p0004 A77-10953
ERDA's Bicentennial Thermionic Research and Technology Program
13 p0042 A77-12861
MEYERS, R. A.
Low-sulfur coal obtained by chemical desulfurization followed by liquefaction
13 p0008 A77-11242
MEZEY, E. J.
Fuel contaminants. Volume 1: Chemistry
[PB-256020/9] 13 p0103 N77-12231
MICHAEL, H.
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
MICHEL, J.
Periodically adjustable concentrators adapted to solar cell panels
13 p0074 A77-19068
MIGLIORE, P. G.
Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines
13 p0044 A77-12871
MIKOLOWSKY, W. T.
The potential of liquid hydrogen as a military aircraft fuel
[AD-A026666] 13 p0118 N77-14272
MILANESE, M. M.
A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices
13 p0061 A77-17017
MILAU, J.
Closed Brayton cycle using hydrogen as a work fluid
[BNL-20899] 13 p0085 N77-10542
MILLER, B. P.
SEASAT - A candidate ocean industry economic verification experiments
[NASA-CR-149228] 13 p0104 N77-12476
MILLER, D. E.
Outdoor performance results for NBS Round Robin collector no. 1
[NASA-TM-X-73547] 13 p0106 N77-12520
Performance correlations of five solar collectors tested simultaneously outdoors
[NASA-TM-X-73546] 13 p0128 N77-15487
MILLER, L. G.
Making electricity from moderate temperature fluids
13 p0002 A77-10649

MILLER, M.
Detailed geographic analysis of residential energy consumption
13 p0043 A77-12864
Comparative evaluation of solar heating alternatives [COO-2703-2] 13 p0129 N77-15498
MILLER, R. A.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
MILLER, R. H.
Wind energy conversion [PB-256198/3] 13 p0115 N77-13552
MILORA, S. L.
Geothermal energy as a source of electric power: Thermodynamic and economic design criteria
13 p0060 A77-16623
Geothermal energy for electrical and nonelectrical applications [LA-UR-76-418] 13 p0123 N77-14601
MILTNER, E.
An analysis of the technology role in US power during the mid-range period [AD-A024042] 13 p0102 N77-11927
MINKOVICH, E. M.
Gas release during long-term operation of heat pipes
13 p0050 A77-14328
MIRZA, R. H.
Computation of solar radiation design curves
13 p0072 A77-19049
MISKOLCZY, G.
Thermionic topping of a steam power plant
13 p0034 A77-12789
MITCHELL, W. C.
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
MIXON, W. R.
Energy conservation potential of Modular Integrater Utility Systems /MIUS/
13 p0026 A77-12724
MIYATA, M.
Non-equilibrium MHD power generation using non-seeded argon plasma
13 p0004 A77-11022
MIZRAH, T.
Operation of ITO/Si heterojunction solar cells
13 p0014 A77-11762
MLAVSKY, A. I.
The silicon ribbon solar cell
13 p0076 A77-19083
MOLL, K. D.
Research to anticipate environmental impacts of changing resource usage [PB-256293/2] 13 p0101 N77-11602
MOLLY, J. P.
Possibilities for utilizing wind energy
13 p0056 A77-15853
MONFORD, L. G.
Performance characteristics of a diesel engine using low- and medium-energy gases as a fuel supplement (fumigation) [NASA-TM-X-58188] 13 p0126 N77-14955
MOORE, B. J.
Helium resources of the United States, 1973 [PB-252473/4] 13 p0085 N77-10623
MOORE, D. F.
Remote sensing of an underground coal-burn cavity with a wide-band induction system
13 p0007 A77-11050
MOORE, S. W.
Practical aspects of solar heating - A review of materials use in solar heating applications
13 p0049 A77-13743
MORAN, J.
Tracking pollutants from a distance
13 p0067 A77-18370
MOREHOUSE, J. H.
Diversification as an energy conservation strategy
13 p0027 A77-12725
MOROZ, A. L.
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326
MOROZOV, V. K.
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
MORRESI, A. C.
Energy from solid wastes
13 p0003 A77-10698
MORRIS, D. N.
Possible effects of nuclear initiative on supply and use of electricity in California [AD-A026582] 13 p0131 N77-15510
MORRIS, J. F.
NASA thermionic-conversion program
13 p0043 A77-12863
MORRISON, C. A.
Experimental evaluation of the University of Florida solar powered ammonia/water absorption air conditioning system
13 p0039 A77-12823
MORSE, F. H.
CCMS solar energy pilot study solar heating and cooling systems in buildings [UMD-4908-5] 13 p0088 N77-10657
MOSCHETTI, B.
Development of space applications of heat pipes at Aerospatiale
13 p0120 N77-14390
MOSIN, I. I.
Heat-pipe regenerator for gas turbine engine
13 p0020 A77-12528
MUELLER, R. E.
Solar energy in Switzerland
13 p0080 A77-19127
MUKHERJEE, M. K.
Software aspects of super composites
13 p0053 A77-15301
MUKHERJEE, S. K.
Application of solar energy in the high-temperature range
13 p0063 A77-17636
MUKHOPADHYAY, A. K.
Economic and engineering implications of the Project Independence 1985 geothermal energy output goal and the associated sensitivity analysis
13 p0029 A77-12745
MULLIGAN, J. C.
Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of buildings [PB-254665/3] 13 p0091 N77-10689
MUND, K.
Titanium-containing Raney nickel catalyst for hydrogen electrodes in alkaline fuel cell systems
13 p0064 A77-18019
A comparison of porous silver catalysts in oxygen electrodes of alkaline fuel cells
13 p0067 A77-18350
MUNN, R. E.
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295
MUNOZ-CANDELARIO, R.
Methanol from coal fuel and other applications [ORAU-126] 13 p0094 N77-11200
MURA, T.
Heat extraction from hot dry rock masses [PB-256775/8] 13 p0116 N77-13556
MURPHY, H. D.
Extracting energy from hydraulically-fractured geothermal reservoirs
13 p0030 A77-12757
MURPHY, L. M.
Coming - Solar power plants
13 p0016 A77-12125
MURPHY, T. D.
Occupational radiation exposure at light water cooled power reactors, 1969-1975 [PB-257054/7] 13 p0125 N77-14740
MURTHY, K. S.
Reductant gases for flue gas desulfurization systems [PB-254168/8] 13 p0092 N77-10722
MUSGROVE, P.
Windmills change direction
13 p0060 A77-16620

MOSSER, W. M.
In situ combustion of Michigan oil shale - Current field studies
13 p0024 A77-12695

MYERS, A. L.
Hydrogen production from water by means of chemical cycles
13 p0058 A77-16471

MYERS, W. M.
Mechanical thermal motor
[NASA-CASE-MFS-23062-1] 13 p0104 N77-12402

N

NABATOV, G. V.
Study of the ionization of the additive in MHD installations
13 p0002 A77-10424

NADKARNI, R. M.
Comparative economics for the Arthur D. Little extractive coking process
13 p0022 A77-12684

NAKAJIMA, Y.
Design and performance of thermal storage water tank
13 p0075 A77-19079

NALESNIK, T.
Coal liquefaction with soluble transition-metal complexes
13 p0070 A77-18584

NAMKOONG, D.
Measured performance of a 3 ton LiBr absorption water chiller and its effect on cooling system operation
[NASA-TM-X-73496] 13 p0105 N77-12518
Temperature distribution of a hot water storage tank in a simulated solar heating and cooling system
[NASA-TM-X-73549] 13 p0106 N77-12521

NANNEN, L. W.
An engineering feasibility study of using low temperature geothermal sources in Colorado
13 p0031 A77-12762

NASH, J. M.
Long term performance prediction of residential solar energy heating systems
13 p0039 A77-12822

NAZARE, E.
Aerothermic power plant with artificial cyclone
13 p0077 A77-19098

NAZLI, M.
Combined solar and petroleum energy HVAC system for a commercial building in Dhahran
13 p0078 A77-19111

NAZMY, M. Y.
On the storage of solhydrogen
13 p0075 A77-19073

NEAMATALLA, M.
Resource recovery technology for urban decision-makers
[PB-252458/5] 13 p0093 N77-10964

NEIL, G.
The photosynthetic production of hydrogen
13 p0075 A77-19077

NEILL, D. T.
Geothermal powered heat pumps to produce process heat
13 p0030 A77-12754

NEITZEL, R. E.
Study of unconventional aircraft engines designed for low energy consumption
[NASA-CR-135136] 13 p0127 N77-15043

NELSON, B. E.
Extended cryogenic performance of Lobar Wick heat pipe/radiator
13 p0119 N77-14379

NELSON, J. R.
Differential scanning calorimetry studies on coal. II - Hydrogenation of coals
13 p0070 A77-18583

NELSON, L. D.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513

NELSON, T. J.
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230

NEMAT-NASSER, S.
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556

NEMETS, O. F.
The U-240 cyclotron
13 p0046 A77-13151

NERING, J.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794

NEWKIRK, H. W.
Flat-plate solar collector handbook. A survey of principles, technical data and evaluation results
[UCID-17086] 13 p0105 N77-12506

NEWMAN, G. H.
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706

NEWTON, A. B.
Optimizing solar cooling systems
13 p0047 A77-13502

NEWTON, G. E. H.
Energy use in industry
13 p0005 A77-11029

NICHOLAS, D. J. D.
The photosynthetic production of hydrogen
13 p0075 A77-19077

NICHOLSON, E. W.
Storage in oil of off-peak thermal energy from large power stations
13 p0027 A77-12730

NIDA, A. V.
Dual purpose nuclear power plants for military installations
[AD-A026141] 13 p0132 N77-15521

NIGGEMANN, R. E.
KIPS - Kilowatt Isotope Power System
13 p0041 A77-12837

NILES, P. W. B.
Thermal evaluation of a house using a movable-insulation heating and cooling system
13 p0019 A77-12407

NIMMO, B.
Development of a mobile solar testing and recording /STAR/ system
13 p0072 A77-19047

NITSCH, J.
The storage of energy in future energy supply systems
[DGLR PAPER 76-182] 13 p0059 A77-16533
Production of chemical energy carriers by non-expandable energy sources
[DLR-FB-76-32] 13 p0114 N77-13541

NITSKEVICH, E. A.
Problems involved in improving the industrial fuel and energy balance
13 p0012 A77-11347

NIXON, J. M.
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740

NOE, J. C.
Solar-powered Rankine-cycle heat pump system
13 p0036 A77-12800

NOGGLE, L. W.
The potential of liquid hydrogen as a military aircraft fuel
[AD-A026666] 13 p0118 N77-14272

NOLAN, M. E.
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380

NORCO, J. E.
The air quality and economic implications of supplementary control systems in Illinois
[PB-255699/1] 13 p0101 N77-11588

NORTON, J.
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506

NOWACK, C. J.
Evaluation of a JP-5 type fuel derived from oil shale
[AD-A025417] 13 p0112 N77-13231

NOZAKI, K.
Concept of a fusion burner
13 p0061 A77-17014

NOZIK, A. J.
Energy conversion via photoelectrolysis
13 p0021 A77-12667
NUTI, S.
Locating interesting geothermal areas in the Tuscany region /Italy/ by geochemical and isotopic methods
13 p0013 A77-11498
NYDICK, S. E.
A study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255658/7] 13 p0115 N77-13542
A study of implant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255659/5] 13 p0115 N77-13543

O

ODONNELL, P.
The Redox flow system for solar photovoltaic energy storage
[NASA-TM-X-73562] 13 p0106 N77-12522
OESTERWIND, D.
The future importance of solar energy for the supply of the German Federal Republic with energy
13 p0070 A77-18597
OGANOV, E. P.
Effect of heat transfer from lateral surfaces of semiconductor thermoelements on the power output of thermoelectric converters
13 p0058 A77-16324
OGILVIE, D. G.
Summary of EPA energy policy analysis
[PB-253361/0] 13 p0089 N77-10669
OGLE, M. C.
Transportation energy conservation data book
[ORNL-5198] 13 p0086 N77-10643
OHTA, T.
Hydrogen production using solar radiation
13 p0048 A77-13540
OLDS, F. C.
The availability of fuels for power plants
13 p0010 A77-11316
OLEARY, B.
The construction of satellite solar power stations from non-terrestrial materials
[AIAA PAPER 77-354] 13 p0066 A77-18259
OLEARY, J.
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732
OLLENDORF, S.
The International Heat Pipe Experiment
13 p0120 N77-14389
OLSON, C. L.
Personal rapid transit research conducted at the Aerospace Corporation
[PB-256846/7] 13 p0111 N77-12946
OLSZEWSKI, M.
Waste heat vs conventional systems for greenhouse environmental control: An economic assessment
[ORNL/TM-5069] 13 p0088 N77-10656
OMBERG, R. P.
Economic analysis of the need for advanced power sources
[HEDL-SA-989] 13 p0131 N77-15509
OPILA, R. J.
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499
ORDIN, P. M.
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[NASA-TM-X-73408] 13 p0127 N77-15208
ORUNOV, B. B.
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up
13 p0051 A77-14580
OSHEYER, W. E.
The low cost high performance generator /LCHPG/
13 p0042 A77-12855
OSTASHEV, V. E.
Limiting capabilities with respect to electric power generation of a pulsed MHD generator operating at a resistive load
13 p0064 A77-17917
OTKUN, G.
Geothermal energy in Saudi Arabia and its use in connection with solar energy
13 p0079 A77-19122
OTTAR, B.
Organization of long range transport of air pollution monitoring in Europe
13 p0071 A77-18754
OTTESEN, D. K.
Survey of high temperature thermal energy storage
[SAND-75-8063] 13 p0088 N77-10655
OUELLETTE, R.
Survey of alcohol fuel technology, volume 1
[PB-256007/6] 13 p0112 N77-13232
OVERHOLT, W.
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981
OXBURGH, E. R.
Geothermal energy
13 p0005 A77-11035

P

PAFFRATH, D.
Mathematical simulation and empirical determination of the aerochemical and thermal atmospheric pollution resulting from energy conversion processes
[DLR-IB-553-75/1] 13 p0091 N77-10700
PALANKER, V. SH.
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815
PALZ, W.
Utilization of solar power - A new departure
13 p0053 A77-15049
PAN, Y. C.
Carbon oxidation catalyst mechanism study for fuel cells
[PB-256420/1] 13 p0115 N77-13551
PANGBORN, J.
Experimental demonstration of an iron chloride thermochemical cycle for hydrogen production
13 p0032 A77-12772
PANICHI, C.
Isotopic composition of steam samples from Lanzarote, Canary Islands
13 p0013 A77-11497
PANICKER, N. N.
Power resource estimate of ocean surface waves
13 p0071 A77-18790
PANOVKO, M. IA.
Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream
13 p0001 A77-10423
PANZHAUSER, E.
Application of solar heat to buildings in Austria
13 p0079 A77-19114
PAORICI, C.
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
PAPAMARCOS, J.
Combined cycles and refined coal
13 p0058 A77-16249
PAPINI, P.
Effect of optical properties of a surface exposed to solar radiation on the radiation balance
13 p0052 A77-14928
Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range
13 p0069 A77-18496
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
PARK, J.
Operational experience with small wind units
13 p0044 A77-12873
PARK, W.
Survey of alcohol fuel technology, volume 1
[PB-256007/6] 13 p0112 N77-13232
Survey of alcohol fuel technology, Volume 2
[PB-256008/4] 13 p0112 N77-13233

PARKER, G. H.
Nuclear driven water decomposition plant for hydrogen production
13 p0035 A77-12791
PARKER, G. J.
A forced circulation system for solar water heating
13 p0019 A77-12413
PARKINSON, W. H.
Measurements of Sc I gf-values
13 p0058 A77-16270
PARSONS, R. E.
LLL-Sohio solar process heat project. Report no. 3: LLL solar energy group
[UCID-16630-3] 13 p0123 N77-14604
PARSONS, W. N.
Risk management of liquefied natural gas installations
13 p0002 A77-10451
PASCAL, E. P.
TRISNET. Directory to transportation research information resources
[PB-255172/9] 13 p0125 N77-14939
PASCIAK, W. J.
Occupational radiation exposure at light water cooled power reactors, 1969-1975
[PB-257054/7] 13 p0125 N77-14740
PASHKIN, S. V.
Shock tube for investigations of high-temperature MHD generators
13 p0054 A77-15665
PASQUETTI, R.
Effect of optical properties of a surface exposed to solar radiation on the radiation balance
13 p0052 A77-14928
Study and materialization of a selective surface designed for direct thermal conversion of solar energy - Application to medium temperature range
13 p0069 A77-18496
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
PATANKAR, S. V.
Heat transfer - A review of 1975 literature
13 p0002 A77-10615
PATIN, P.
Energy recovery in railway and road transportation
13 p0051 A77-14564
PAUL, S.
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591
PEDERSEN, H. J.
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230
PEDROSO, E. I.
The Stirling engine - Engineering considerations in view of future needs
13 p0041 A77-12842
PEER, E. L.
Trends in refinery capacity and utilization: Petroleum refineries in the United States; foreign refinery exporting centers
[PB-256966/3] 13 p0132 N77-15523
PELSTER, J. H.
Analysis of state solar energy options
[PB-254730/5] 13 p0091 N77-10688
PENDERGRASS, J. H.
Heat transfer problems associated with laser fusion
13 p0068 A77-18441
PENDLETON, R. L.
Evaluating a solar energy concentrator
13 p0047 A77-13505
PENNISI, A.
Thin film solar acceptors
13 p0072 A77-19053
PERCHERON, A.
A new hydrogen storage electrode
13 p0047 A77-13539
PERELSHTEIN, B. KH.
Analysis of parameters and characteristics of a bypass turbojet engine operating in a cycle with stepwise heat removal
13 p0063 A77-17765
PERI, G.
Contribution to the study of solar energy collectors - Selective plates and cells
13 p0072 A77-19051
PERL, L. J.
Is nuclear energy economically viable
13 p0045 A77-12933
PERRY, A. M.
Net energy from nuclear power
[PB-254059/9] 13 p0107 N77-12527
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594
PESOCHIN, V. R.
Evaporation of solution droplets in a high-temperature medium
13 p0046 A77-13254
PETERS, C. M. D.
Total energy systems
13 p0006 A77-11042
PETERS, W. A.
Basic studies of coal pyrolysis and hydrogasification
[PB-254878/2] 13 p0096 N77-11511
PETERSON, A. A.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
PETRIE, W.
Extended cryogenic performance of Lobar Wick heat pipe/radiator
13 p0119 N77-14379
PETUKHOV, B. S.
Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide
13 p0058 A77-16213
PFENDER, E.
Heat transfer - A review of 1975 literature
13 p0002 A77-10615
PHELPS, P. L.
Overview of the Imperial Valley environmental project
[UCID-17067] 13 p0132 N77-15533
PHILLIPS, W. F.
Axial conduction in a flat-plate solar collector
13 p0068 A77-18447
PIAN, C. C. P.
Boundary-layer separation from the electrode wall of an MHD generator
13 p0048 A77-13711
PICHE, B.
An experimental 200 kW vertical axis wind turbine for the Magdalen Islands
13 p0044 A77-12874
PIERSON, E. S.
Liquid-metal MHD - Cycle studies and generator experiments
13 p0034 A77-12785
PILLSBURY, P. W.
Advanced coal gasification system for electric power generation
[FE-1514-176] 13 p0088 N77-10653
PINES, H. S.
The use of program GEOTHM to design and optimize geothermal power cycles
13 p0031 A77-12758
PINKHASIK, M. S.
Study of the ionization of the additive in MHD installations
13 p0002 A77-10424
PITTINATO, G. F.
Some material considerations involved in the application of solar energy to electric power generation
13 p0049 A77-13739
PITTMAN, P. F.
New concepts in solar photovoltaic electric power systems design
13 p0038 A77-12817
PIVIROTTO, D. S.
Electric utility companies and geothermal power
13 p0031 A77-12759
PLOYART, R.
Procedure for characterizing flat plate solar collectors
13 p0073 A77-19056
PODESSER, E.
Solar heating projects at the Institute for Environmental Research
13 p0079 A77-19119

PODYMOV, V. N.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235
POLASEK, F.
Heat pipes for the temperature range from 200 to 600 C
13 p0119 N77-14381
Heat pipes with a non-condensable gas and their application in nuclear apparatus and instruments
13 p0120 N77-14387
POLIAKOV, O. L.
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668
POLLARD, W. G.
The long-range prospects for solar energy
13 p0017 A77-12237
The long-range prospects for solar-derived fuels
13 p0017 A77-12240
POLSTER, N. E.
Self-starting, intrinsically controlled Stirling engine
13 p0041 A77-12844
PONDER, W. H.
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597
PONTIER, L.
A surface thermal anomaly in the region of Chaudes-Aigues /France/ detected on aerial thermographs
13 p0014 A77-11591
POPOV, A. N.
Study of the properties of heat pipes with liquid-metal heat-transfer agents in low-temperature regimes
13 p0046 A77-13243
POST, R. E.
Evaluation of potassium titanate as a component of alkaline fuel cell matrices
[NASA-TN-D-8341] 13 p0094 N77-11175
POTTER, R. F.
Energy and Physics: General Conference of the European Physical Society
[AD-A026962] 13 p0131 N77-15511
POUZO, J. O.
A possible correlation of the neutron yield to the electromechanic work in Mather-type plasma focus devices
13 p0061 A77-17017
POWELL, C.
The migma high energy advanced fuel direct conversion fusion power plant
13 p0035 A77-12794
POWELL, J. R.
Closed Brayton cycle using hydrogen as a work fluid
[BNL-20899] 13 p0085 N77-10542
PRATHER, J.
Mechanisms of coal particle dissolution
13 p0059 A77-16475
PREBLE, D. M.
Geothermal flux through palagonitized tephra, Surtsey, Iceland - The Surtsey temperature-data-relay experiment via Landsat-1
13 p0048 A77-13648
PRESS, W. H.
Theoretical maximum for energy from direct and diffuse sunlight
13 p0064 A77-17845
PREISS, A. E.
Hypersonic technology-approach to an expanded program
13 p0051 A77-14597
PRIVESENTSEV, V. V.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
PROBSTEIN, R. F.
Water requirements for an integrated SNG plant and mine operation
13 p0060 A77-16651
PUESCHEL, R. F.
Aerosol formation during coal combustion - Condensation of sulfates and chlorides on flyash
13 p0054 A77-15778
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780
PUNWANI, D. V.
Hydrogen production by the steam-iron process
13 p0023 A77-12688
PURCELL, A. H.
Energy and environmental impacts of materials alternatives - An assessment of quantitative understanding
13 p0070 A77-18738
PURCELL, D. D.
Development of signal processing algorithms for ultrasonic detection of coal seam interfaces
[NASA-CR-150024] 13 p0085 N77-10610
PUSTOGAROV, A. V.
A 2-MW electric arc generator with porous cooling of the interelectrode insert
13 p0049 A77-13831
PYE, J. W.
UK, T5 ion engine thrust vector control considerations
[AIAA PAPER 76-1064] 13 p0045 A77-13030

Q

QUAGGIOTTI, V.
Pressure ratio optimization criteria in aircraft turbojet-engines design
13 p0062 A77-17258
QUAST, A.
Liquid hydrogen as propellant for commercial aircraft
[DGLR PAPER 76-188] 13 p0059 A77-16534
QUINCY, E. A.
Remote sensing of an underground coal-burn cavity with a wide-band induction system
13 p0007 A77-11050
QUINN, B.
The consumer's cost of electricity from windmills
13 p0043 A77-12866
QVALE, E. B.
Seasonal storage of thermal energy in water in the underground
13 p0028 A77-12734

R

RAAB, B.
The nuclear spinner for Satcom applications
13 p0041 A77-12838
Nuclear-powered Hysat spacecraft: Comparative design study
[ERDA-SNS-3063-8] 13 p0094 N77-11108
RABL, A.
Ideal concentrators for finite sources and restricted exit angles
13 p0003 A77-10835
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
RADICE, F. C., JR.
Siting of wind driven apparatus
13 p0043 A77-12865
RAETZ, J. E.
Collector field optimization for a solar thermal electric power plant
13 p0038 A77-12811
RAGAINI, R. C.
Methods in environmental sampling for radionuclides
[UCRL-77722] 13 p0091 N77-10697
RAJAKUMAR, A.
Transfer function analysis of heat pipes
13 p0119 N77-14385
RALEY, J. H.
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499
RALPH, E. L.
Photovoltaic systems using sunlight concentration
13 p0076 A77-19089
Meeting electric power needs with photovoltaic power systems
13 p0076 A77-19091
RAMAKUMAR, R.
Wind driven field modulated generator systems
13 p0044 A77-12869

RAMSEY, J. W.
Heat transfer - A review of 1975 literature
13 p0002 A77-10615
RANKEN, W. A.
The potential of the heat pipe in coal gasification processes
13 p0031 A77-12763
RANKIN, K.
The structure of building specifications
[PB-257581/9] 13 p0132 N77-15524
RAO, B. M. L.
Ambient temperature electric vehicle batteries based on lithium and titanium disulfide
13 p0025 A77-12706
RAO, D. P.
Solar water pump for lift irrigation
13 p0019 A77-12406
RAO, G. V.
Results of some geothermal studies in Singhbhum thrust belt, India
13 p0013 A77-11499
RAO, K. S.
Solar water pump for lift irrigation
13 p0019 A77-12406
RAO, R. U.
Results of some geothermal studies in Singhbhum thrust belt, India
13 p0013 A77-11499
RAPPAPORT, A.
Air quality considerations in transportation planning: Findings and recommendations on transportation control planning, phase 2
[PB-256424/3] 13 p0110 N77-12576
RASTEGAEV, B. I.
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666
RATH, L. K.
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689
RATZEL, A. C.
Optimal material selection for flat-plate solar energy collectors utilizing commercially available materials
13 p0068 A77-18444
RAUFER, R. K.
The air quality and economic implications of supplementary control systems in Illinois
[PB-255699/1] 13 p0101 N77-11588
RAUSCHENBACH, H. S.
Solar cell array design handbook, volume 1
[NASA-CR-149364] 13 p0118 N77-14193
RAVI, K. V.
The silicon ribbon solar cell
13 p0076 A77-19083
RAYNER, D. P.
Wind tunnel investigation of devices to reduce bus aerodynamic drag
[AIAA PAPER 77-307] 13 p0066 A77-18232
READER, K. E.
Test program for transmitter experiment package and heat pipe system for the communications technology satellite
[NASA-TM-X-3455] 13 p0095 N77-11268
REALE, F.
Wetting and surface properties of refrigerants to be used in heat pipes
13 p0119 N77-14386
REBER, S. A.
Comparative economics for the Arthur D. Little extractive coking process
13 p0022 A77-12684
REED, K.
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
REED, R. P.
Branched thermocouple circuits in underground coal gasification experiments
[SAND-75-5910] 13 p0130 N77-15504
REED, S. A.
Waste heat vs conventional systems for greenhouse environmental control: An economic assessment
[ORNL/TM-5069] 13 p0088 N77-10656
REED, T. B.
Electrochemical power and hydrogen generation from high temperature electrolytic cells
13 p0025 A77-12709
REEVES, E. M.
Measurements of Sc I gf-values
13 p0058 A77-16270
REILLY, J. J.
Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage
13 p0033 A77-12777
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201
REINKENHOF, J.
The storage of energy in future energy supply systems
[DGLR PAPER 76-182] 13 p0059 A77-16533
REISTER, D. B.
Net energy from nuclear power
[PB-254059/9] 13 p0107 N77-12527
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594
REITAN, D. K.
Superflywheel energy storage and nonsynchronous AC/DC/AC electric transmission supplements power system operation
13 p0002 A77-10638
RENNE, D. S.
Assessing low sulfur coal resources in Montana and Wyoming
13 p0058 A77-16374
REYNOLDS, G. T.
Energy research for physicists
13 p0054 A77-15350
REYNOLDS, S. L.
Field test sampling/analytical strategies and implementation cost estimates: Coal gasification and flue gas desulfurization
[PB-254166/2] 13 p0101 N77-11581
REYNOLDS, T. W.
A preliminary assessment of the feasibility of deriving liquid and gaseous fuels from grown and waste organics
13 p0021 A77-12673
RIBESSE, J.
A combined cycle with a partial-oxidation reactor
13 p0062 A77-17534
RIBOULET, M.
Testing and fabrication of solar absorbers for the D5A' satellite
[CNES-NT-37] 13 p0111 N77-13110
RICE, L. F.
Pressure drawdown and buildup analyses in geothermal reservoirs
13 p0030 A77-12753
RICHTER, E.
Desulfurization of flue gases with iron/III/ oxide on porous carrier material - Theoretical and experimental investigation concerning the modelling of semicontinuous solid bed reactors with gas-solid reactions
13 p0080 A77-19184
RICHTER, G.
Titanium-containing Raney nickel catalyst for hydrogen electrodes in alkaline fuel cell systems
13 p0064 A77-18019
RIDGWAY, S. L.
Underground storage of off-peak power
13 p0027 A77-12728
RIEBOLD, G.
Application of solar energy in the high-temperature range
13 p0063 A77-17636
RIOS-CASTELLON, L.
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
ROA, G.
Grain drying in stationary bins with solar heated air
13 p0019 A77-12411
ROBBINS, R. L.
Law and solar energy systems - Legal impediments and inducements to solar energy systems
13 p0018 A77-12401

ROBERTS, C. C., JR.
Cooling arrays of circuit cards using heat pipes and forced air diffusers
13 p0031 A77-12766
ROBERTS, F. S.
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13 p0008 A77-11233
ROBERTS, K. V.
Fusion power
13 p0005 A77-11034
ROBERTS, P. C.
Energy analysis in modelling
13 p0007 A77-11047
ROBERTSON, J. A. L.
Research and development for Canadian nuclear power
[AECL-5314] 13 p0097 N77-11533
ROBINSON, D. A.
Solar power array for the concentration of energy. Task 2: Modifications to a specular photometer
[COO-2699-3] 13 p0098 N77-11538
ROBISON, M. G.
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230
ROBSON, F. L.
Steam station repowering - A near-term method of energy conservation
13 p0022 A77-12679
RODGERS, B. R.
A laboratory evaluation of precoat filtration parameters for the solvent refined coal process
13 p0059 A77-16474
RODGERS, G.
Energy information activities at the FEA
[PB-253962/5] 13 p0099 N77-11553
ROESSLER, W. U.
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495
ROGERS, V. C.
Radiolytic hydrogen production from a laser fusion system
13 p0035 A77-12795
ROGULEV, A. I.
Isothermal surface in a radiation field
13 p0014 A77-11918
ROHR, F. J.
Electrode-connecting material as a central component of high-temperature fuel cells. II - Investigation of selected high-conductivity mixed oxides
13 p0056 A77-15817
ROHRBACK, B. G.
Thermal alteration of young kerogen in relation to petroleum genesis
13 p0053 A77-15044
ROLFO, A.
Flight results of a cryogenic cooler designed for Meteosat
[IAF PAPER 76-210] 13 p0003 A77-10942
ROLLAND, P.-A.
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
ROMEO, N.
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
RON, M.
Metal hydrides of improved heat transfer characteristics
13 p0033 A77-12775
ROPKE, A.
Study of emittance distribution along the walls of a cellular low-loss cell in the case of a base surface with arbitrary emission indicatrix
13 p0069 A77-18495
ROSE, D. J.
Nuclear power - Compared to what
13 p0017 A77-12234
The prospect for fusion
13 p0058 A77-16357
ROSE, I. B.
CCMS solar energy pilot study solar heating and cooling systems in buildings
[UMD-4908-5] 13 p0088 N77-10657
ROSELL, F. E., JR.
Test and evaluation of the Navy half-watt RTG
13 p0042 A77-12853
ROSENBERG, R.
A simplified method in flight test techniques for the determination of the range performance of jet aircraft
13 p0060 A77-16600
ROSSEN, W.
Benefits of hydrogen production research
13 p0032 A77-12768
ROTHBERG, J. E.
Energy consumption and conservation in the United States
13 p0005 A77-11028
ROTHMAN, A. J.
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499
ROTHWARF, A.
Theoretical prospects of the CdS-Cu2S solar cell
[PB-252409/8] 13 p0089 N77-10672
ROTTENKOLBER, P.
High-temperature ceramics for automobile gas turbines. II
13 p0063 A77-17591
ROTTIER, G.
Lumiducts for Ecopolis
13 p0079 A77-19116
ROTTY, R. M.
Net energy from nuclear power
[PB-254059/9] 13 p0107 N77-12527
ROUKLOVE, P. G.
Test and evaluation of the Navy half-watt RTG
13 p0042 A77-12853
ROUSSEAU, J.
Solar-powered Rankine-cycle heat pump system
13 p0036 A77-12800
ROWLEY, J. C.
Geothermal energy development
13 p0064 A77-17801
RUEDENAUER, F.
Application of solar heat to buildings in Austria
13 p0079 A77-19114
RUEGG, R.
Life-cycle costs and solar energy
13 p0047 A77-13501
RUPEH, F.
Advanced thermionic converter development
13 p0043 A77-12862
RUPP, R.
The solution of the garbage problem: New proposals for the utilization of refuse - Proposals and suggestions
13 p0015 A77-12061
RUSH, B.
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
RUSSELL, O. R.
Application of LANDSAT-2 data to the implementation and enforcement of the Pennsylvania Surface Mining Conservation and Reclamation Act
[E77-10007] 13 p0085 N77-10590
RUSSO, F. A.
KIPS - Kilowatt Isotope Power System
13 p0041 A77-12837
RUSTA, D.
Power source requirements of electric propulsion systems used for north-south stationkeeping of communication satellites
13 p0040 A77-12833
RUYSSEN, O.
Off-shore oil scenarios - Method and results
13 p0018 A77-12282
RYBKIN, B. I.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
RZAEV, P. F.
Contribution of the heat carried by solar radiation to the thermal balance of a room during the cold season and its effect on domestic fuel consumption
13 p0063 A77-17558

RZHEVSKII, V. M.
Optimization of the geometry of switching buses for thermoelements in thermoelectric generators
13 p0052 A77-14951

S

SAASKI, E. W.
An investigation of condensation heat transfer in a closed tube containing a soluble noncondensable gas
[NASA-CR-149095] 13 p0085 N77-10465
SABBAGH, J. A.
Thermo-chemical production of hydrogen
13 p0075 A77-19074
SABEL, W.
Energy from wastes
13 p0006 A77-11038
SACADURA, J. F. O.
Characteristic equations of unconcentrated flat solar cell panels
13 p0052 A77-14929
SAGATOV, E. S.
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
SAGER, P. H., JR.
Characteristics of a first generation commercial fusion power plant
[GA-A-13661] 13 p0093 N77-10891
SAIYLOV, N.
Calculations on an optimized faceted solar concentrator
13 p0015 A77-11921
SAKR, I. A.
Factors affecting the use of solar energy for cooling
13 p0078 A77-19108
SAKURAI, T.
Design and fabrication of solar concentrators
13 p0074 A77-19062
SALIEVA, R. B.
Design principles for solar and wind power installations
13 p0015 A77-11922
Optimization criteria for solar and wind power systems
13 p0015 A77-11923
SALISBURY, J. D.
Monitoring fluid flow by using high-frequency electromagnetic probing
[UCRL-51979] 13 p0120 N77-14393
SALLES, Y.
Industrial development of silicon solar cells
[NASA-TT-F-17139] 13 p0097 N77-11528
SALMER, G.
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
SALVADOR, L. A.
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689
Advanced coal gasification system for electric power generation
[PE-1514-176] 13 p0088 N77-10653
SALZANO, F. J.
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543
Closed Brayton cycle using hydrogen as a work fluid
[BNL-20899] 13 p0085 N77-10542
Prospects for hydrogen production by water electrolysis to be competitive with conventional methods
[BNL-20877] 13 p0087 N77-10648
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201
SANDQUIST, G. M.
Radiolytic hydrogen production from a laser fusion system
13 p0035 A77-12795
SANDROCK, G. D.
Metallurgical considerations in the production and use of FeTi alloys for hydrogen storage
13 p0033 A77-12777
SANTAMATO, E.
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
SANTOR, S. D.
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499
SARMA, S. C.
A fermentation process for converting plant materials into methane
13 p0121 N77-14583
SARRADIN, J.
A new hydrogen storage electrode
13 p0047 A77-13539
SARTAEV, T. S.
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance
13 p0020 A77-12657
SARVER, G. L.
Satellite communications for off-shore oil operations using WESTAR
13 p0053 A77-15130
SATER, B. L.
An integrated photovoltaic/thermal High Intensity Solar Energy System /HISES/ concept for residential applications
13 p0039 A77-12818
SATHER, N. F.
Compressed air energy storage - A near term option for utility application
13 p0027 A77-12727
SAUTER, G. D.
Will the large-scale production of hydrogen be part of the energy problem or part of its solution
[UCRL-76844] 13 p0087 N77-10652
SAVINO, J. M.
Wind tunnel measurements of the tower shadow on models of the ERDA/NASA 100 KW wind turbine tower
[NASA-TM-X-73548] 13 p0114 N77-13534
SAWALHA, H.
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088
SAWYER, R. F.
The formation of nitrogen oxides from fuel nitrogen
[PB-252462/7] 13 p0092 N77-10717
SAYIGH, A. M.
Thermo-chemical production of hydrogen
13 p0075 A77-19074
Preliminary design data for a solar house in Riyadh, Saudi Arabia
13 p0078 A77-19112
Geothermal energy in Saudi Arabia and its use in connection with solar energy
13 p0079 A77-19122
SAYLOR, W.
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678
SBERVEGLIERI, G.
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
SCARMOZZINO, R.
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
SCARRAH, W. P.
Startup solvent selection for the liquefaction of lignite
13 p0059 A77-16472
SCHAEFGEN, J. R.
Integrating community utilities for resource conservation
[PB-256898/8] 13 p0133 N77-15923
SCHAFER, C. T.
Survey of high temperature thermal energy storage
[SAND-75-8063] 13 p0088 N77-10655
SCHELKOPF, J. D.
Industrial energy conservation through integration of thermal energy storage into process energy dynamics
13 p0028 A77-12733
SCHENKEL, G.
Plastics for solar-energy collectors. I - General aspects, hot-water collectors, design variants
13 p0009 A77-11267

Plastics for solar-energy collectors. II - Typical operational data and model parameters, functional diagrams, optimization of layer thicknesses
13 p0009 A77-11269

SCHEPPAN, J. E.
MHD power generation - 1976 Status Report
13 p0033 A77-12782

SCHERTZ, W.
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812

SCHIMMEL, W. P., JR.
Focused solar collector analysis with axially varying input due to shadowing from adjacent collectors
13 p0069 A77-18450
Synergistic effects of shadowing on a solar collector matrix
[SAND-76-0012] 13 p0122 N77-14587

SCHIPPER, L.
Explaining energy: A manual of non-style for the energy outsider who wants in
[LBL-4458] 13 p0122 N77-14592

SCHLAPBACH, L.
A new hydrogen storage electrode
13 p0047 A77-13539

SCHLESINGER, R. J.
Hybrid simulation of solar HVAC system for house retro-fit design
[PB-252608/5] 13 p0090 N77-10676

SCHMERZLER, L. J.
Energy and environmental considerations in extending heat pump applications
13 p0062 A77-17058

SCHMIDT, E. W.
Thermochemical energy storage systems
13 p0028 A77-12738

SCHMIDT, F. W.
Transient behavior of solid sensible heat thermal storage units for solar energy systems
13 p0057 A77-16208

SCHMIDT, G.
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678

SCHMIDT, R. E.
Prerequisites for military/civilian geopressured geothermal resource development
13 p0031 A77-12761

SCHMITT, R. C.
Direct applications of geothermal energy
13 p0030 A77-12755

SCHMOEDE, P.
Electric current from the direct conversion of low molecular weight C,H,O-compounds
13 p0055 A77-15814

SCHNAKENBERG, G.
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380

SCHNELL, R. C.
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780

SCHOCK, A.
Isotope heat source for dynamic power systems
13 p0036 A77-12796

SCHORA, F. C.
Hydrocarbon fuels from oil shale
13 p0023 A77-12692

SCHRADER, O. E.
Application of advanced technology to future long-range aircraft
[SAWE PAPER 1126] 13 p0016 A77-12194

SCHRAG, M. P.
Performance of emission control devices on boilers firing municipal solid waste and oil
[PB-257136/2] 13 p0133 N77-15550

SCHRECK, H.
Hybrid drive with kinetic energy store as vehicle drive
[UCRL-TRANS-11018] 13 p0120 N77-14486

SCHREINER, F.
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740

SCHRENK, G. L.
Fuel economy potential of a combined engine cooling and waste heat driven automotive air-conditioning system
13 p0020 A77-12665
The role of simulation in the development of solar-thermal energy conversion systems
13 p0037 A77-12809

SCHRIDER, L. A.
Environmental impact studies related to underground coal gasification
[TID-27003] 13 p0100 N77-11573

SCHUELER, D. G.
The ERDA Photovoltaic Systems Definition Project
13 p0038 A77-12815

SCHUH, R.
Space-to-earth power transmission system
[NASA-TM-X-73489] 13 p0105 N77-12517

SCHULLER, T. L.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513

SCHULTZ, L. A.
Tests of oil recovery devices in broken ice fields, phase 2
[AD-A025748] 13 p0110 N77-12572

SCHULTZ, R. J.
Direct applications of geothermal energy
13 p0030 A77-12755

SCHULZ, H. W.
Resource recovery technology for urban decision-makers
[PB-252458/5] 13 p0093 N77-10964

SCHUTTE, A. H.
Comparative economics for the Arthur D. Little extractive coking process
13 p0022 A77-12684

SCOTT, C. J.
Heat transfer - A review of 1975 literature
13 p0002 A77-10615

SCOTT, J. E.
The solar water heater industry in South Florida - History and projections
13 p0018 A77-12403

SCOTT, M. H.
On the nature of fluctuations in an open cycle magnetohydrodynamic generator
13 p0117 N77-13841

SCOTT, M. W.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513

SCOTT, R. E.
Energy considerations in HHE power systems
13 p0077 A77-19099

SEGASER, C. L.
Energy conservation potential of Modular Integrater Utility Systems /MIUS/
13 p0026 A77-12724

SEIFERT, W. W.
Formulation of energy policies - The case of West Africa
13 p0080 A77-19124

SEIKEL, G. R.
A summary of the ECAS MHD power plant results
[NASA-TM-X-73491] 13 p0086 N77-10642

SELCUK, M. K.
A fixed collector employing reversible vee-trough concentrator and a vacuum tube receiver for high temperature solar energy systems
13 p0038 A77-12813

SELLMAN, A. N.
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121

SELPH, C.
Laser propulsion
[IAP PAPER 76-166] 13 p0003 A77-10931

SEMENA, M. G.
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326

SEMIKOLENNYKH, N. L.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235
SERAPHIN, B. O.
Symposium on the Fundamental Optical Properties of Solids Relevant to Solar Energy Conversion
[PB-256615/6] 13 p0108 N77-12538
SERBIN, V. I.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
SERGEEV, Y. Y.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
SERPER, A.
Selected aspects of waste heat management: A state-of-the-art study
[PB-255697/5] 13 p0100 N77-11563
Selected aspects of waste heat management
[PB-254401/3] 13 p0109 N77-12568
SETH, B. M.
Spectral response of a laterally illuminated p-n junction
13 p0062 A77-17478
SHAH, R. D.
Operation of the Westinghouse Coal Gasification Process Development Unit
13 p0023 A77-12689
SHAHRYAR, I. M.
Meeting electric power needs with photovoltaic power systems
13 p0076 A77-19091
SHANKLIN, R. V.
MHD power generation - 1976 Status Report
13 p0033 A77-12782
SHARP, R. D.
Advanced fuels for inertial confinement
13 p0061 A77-17016
SHAW, H.
A preliminary engineering assessment of jet fuel production from domestic coal and shale derived oils
13 p0023 A77-12690
SHCHELOKOV, Y. M.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4F)] 13 p0112 N77-13235
SHCHUKIN, V. K.
Heat-pipe regenerator for gas turbine engine
13 p0020 A77-12528
SHEFT, I.
HYCSOS - A solar heating, cooling and energy conversion system based on metal hydrides
13 p0029 A77-12740
SHEIBLEY, D. W.
New separators for nickel-zinc batteries
[NASA-TM-X-3465] 13 p0121 N77-14585
SHEINBAUM, I.
Power production from high temperature geothermal waters
13 p0030 A77-12751
SHEKRILADZE, I. G.
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924
SHELDON, W. W.
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719
SHEPARD, N. F.
Definition study for photovoltaic residential prototype system
[NASA-CR-135039] 13 p0113 N77-13532
SHEPARD, N. F., JR.
Performance and cost analysis of photovoltaic power systems for on-site residential applications
13 p0038 A77-12816
SHEPHERD, B. P.
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
SHERBIN, W. C.
Atlanta /Towns/ solar experiment - The lessons we learned
13 p0047 A77-13503
SHERMAN, A.
The International Heat Pipe Experiment
13 p0120 N77-14389
SHERMAZANIAN, IA. T.
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
SHEVCHUK, M. S.
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326
SHEWCHUN, J.
A sulfurization process for the preparation of photovoltaic Cu/x/S and CuInS2 thin films
13 p0076 A77-19087
SHIKOV, V. K.
Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide
13 p0058 A77-16213
SHINN, B.
Evaluating revenue sources for public transit - A new frontier for environmental planners
13 p0070 A77-18723
SHIRLAND, F. A.
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
SHNYREV, A. D.
Gas release during long-term operation of heat pipes
13 p0050 A77-14328
SHOFFSTALL, D. R.
Burner design criteria for control of NOx from natural gas combustion. Volume 1: Data analysis and summary of conclusions
[PB-254167/0] 13 p0091 N77-10686
Burner design criteria for control of NOx from natural gas combustion. Volume 2: Raw data and experimental results
[PB-256806/1] 13 p0115 N77-13549
SHRODT, J. T.
Hot fuel gas desulfurization
[PB-257036/4] 13 p0133 N77-15539
SHULMAN, G. M.
Energy equivalents for current and prospective automotive fuels in Canada
[AD-A026195] 13 p0124 N77-14609
SHUM, J.
Fine shredding of municipal solid waste
[PB-257105/7] 13 p0133 N77-15919
SHUPE, J. W.
Geothermal energy in Hawaii - Hydrothermal systems
13 p0029 A77-12741
SHVALEVA, O. L.
Some features of the operation of a solar installation acting as a low-temperature source of heat for a heat pump
13 p0015 A77-11924
Calculation of the radiation entering a 'hot box' type solar set-up
13 p0051 A77-14581
SIDORENKO, E. M.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
SIEGEL, H. M.
Catalytic coal gasification for SNG production
13 p0022 A77-12683
SIEGMUND, C. W.
Influence of heavy fuel oil composition and boiler combustion conditions on particulate emissions
13 p0008 A77-11162
SIGNORELLI, R. A.
Cost/benefit assessment of the application of composite materials to subsonic commercial transport engines
[NASA-TM-X-73557] 13 p0111 N77-13064
SIGURDSSON, S.
The utility of waters from the high-temperature areas in Iceland for space heating as determined by their chemical composition
13 p0012 A77-11496

SILVER, E. G.
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594
SIMON, A. J.
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
SIMON, F.
Evaluation of flat-plate collector efficiency under controlled conditions in a solar simulator
[NASA-TM-X-73520] 13 p0097 N77-11530
SIMON, J.
Testing and fabrication of solar absorbers for the D5A' satellite
[CNES-NT-37] 13 p0111 N77-13110
SIMONETT, D.
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497
SIMONIANTS, A. A.
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
SIMPSON, P. B.
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines
13 p0033 A77-12779
SIMS, C. T.
Superalloys for advanced energy systems
13 p0061 A77-16824
SINGH, P.
Temperature optimization for power production of infinite heat transfer solar absorbers
13 p0073 A77-19055
SINGH, S.
Fuel contaminants. Volume 1: Chemistry
[PB-256020/9] 13 p0103 N77-12231
SINIAVSKII, V. V.
Anomalous current-voltage characteristics observed during reactor tests of multielement thermionic assemblies
13 p0018 A77-12361
SINKEVICH, O. A.
Construction of two-dimensional steady-state solution of equations of a nonequilibrium magnetized plasma
13 p0065 A77-18130
SITTON, O. C.
Solar energy collection by bioconversion
13 p0021 A77-12672
SIVINTSEV, IU. V.
Relative hazard of nuclear power stations and fossil-fuel power stations to the environment
13 p0067 A77-18323
SKABIN, A. P.
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668
SKAMSER, R.
Coal gasification commercial concepts: Gas cost guidelines
[PB-1235-1] 13 p0130 N77-15500
SKINROOD, A. C.
Coming - Solar power plants
13 p0016 A77-12125
SLATTERY, J. C.
Interfacial effects in the recovery of residual oil by displacement: Studies at Northwestern University
[COO-0019-5] 13 p0122 N77-14595
SLIEMERS, F. A.
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
SMEDES, H. W.
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121
SMETANA, F. O.
Solar assisted heat pumps: A possible wave of the future
[NASA-CR-2771] 13 p0121 N77-14584
SMITH, F. L.
Energy and environmental impacts of materials alternatives - An assessment of quantitative understanding
13 p0070 A77-18738
SMITH, I. E.
Energy storage
13 p0006 A77-11040
SMITH, P. R.
Parametric studies of the thermal trap flat plate collector
13 p0068 A77-18443
SMITH, R. H.
Solergy collector concept
13 p0073 A77-19061
Cylindrical mirror collector field
13 p0074 A77-19071
SMITH, R. T.
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
SMITH, T. B.
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California
[PB-254449/2] 13 p0092 N77-10720
SNOW, D. R.
Mathematics for energy
[PB-252463/5] 13 p0098 N77-11543
SOHN, R. L.
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497
SOKOLOV, IU. M.
Effect of nonuniform conductivity in the boundary layer at the electrode wall on local characteristics of an MHD generator with a diagonal electrode configuration and a subsonic stream
13 p0001 A77-10423
SOKOLSII, D. V.
Highly dispersed tungsten carbide for fuel cells with an acidic electrolyte
13 p0055 A77-15815
SOLASH, J.
Evaluation of a JP-5 type fuel derived from oil shale
[AD-A025417] 13 p0112 N77-13231
SOLIMAN, M. A.
Stage efficiency in the analysis of thermochemical water decomposition processes
13 p0047 A77-13538
Hydrogen production via thermochemical cycles based on sulfur chemistry
13 p0048 A77-13541
SOLOVYEVA, L. I.
Cross structural plan of the earth's crust and the problem of the manifestation of its plutonic elements on the surface (Tyan-Shan and Turan plate as examples)
[NASA-TT-F-16938] 13 p0117 N77-13590
SOM, P.
An alternative fuel for cars
13 p0050 A77-14530
SOMMER, A. H.
Advanced thermionic converter development
13 p0043 A77-12862
SORENSEN, B.
Dependability of wind energy generators with short-term energy storage
13 p0046 A77-13323
SOROKIN, V. P.
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
SOSHNIKOV, V. N.
Diffuse thermal model of electrode erosion for MHD generators
13 p0049 A77-14319
SOUKUP, R. J.
The lensed high-voltage vertical multijunction solar cell
13 p0069 A77-18489

Reply to 'New analysis of a high-voltage vertical multijunction solar cell'
13 p0069 A77-18491

SOUSSOU, J. E.
Heliotechnique and development; Proceedings of the International Conference, Dhahran, Saudi Arabia, November 2-6, 1975. Volumes 1 & 2
13 p0072 A77-19043
Formulation of energy policies - The case of West Africa
13 p0080 A77-19124

SOUTHERLAND, S. R.
An energy center in Sri Lanka
13 p0021 A77-12669

SPACKMAN, W.
The influence of the properties of coals on their conversion into clean fuels
13 p0009 A77-11245

SPARROW, E. M.
Heat transfer - A review of 1975 literature
13 p0002 A77-10615

SPEIDEL, T. O. P.
Thermionic topping of a steam power plant
13 p0034 A77-12789

SPENDLOVE, M. J.
Recycling trends in the United States: A review
[PB-254222/3] 13 p0085 N77-10391

SPRINGER, T. H.
Central station solar electric power using liquid metal heat transport
13 p0037 A77-12806

SPYRIDONOS, A.
Heating a building by means of solar and electrical energy
13 p0078 A77-19113

SQUIRE, W.
Numerical solution for the unsteady lifting characteristics of variable pitch cross-flow wind turbines
13 p0044 A77-12871

SRAMEK, H. M.
Analysis of state solar energy options
[PB-254730/5] 13 p0091 N77-10688

SRINIVASAN, S.
Prospects for hydrogen production by water electrolysis to be competitive with conventional methods
[BNL-20877] 13 p0087 N77-10648
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201

SROBAR, F.
Photovoltaic conversion of solar energy
13 p0058 A77-16368

STADLER, H. L.
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708

STANLEY, W. L.
Some cost, energy, environmental, and resource implications of synthetic fuels produced from coal for military aircraft
[AD-A026667] 13 p0118 N77-14271

STARLING, K. E.
Resource utilization efficiency improvement of geothermal binary cycles, phase 1
[ORO-4944-3] 13 p0123 N77-14600

STARR, V. P.
Electric energy from atmospheric water vapor
13 p0077 A77-19097

STASKUS, J. V.
Test program for transmitter experiment package and heat pipe system for the communications technology satellite
[NASA-TM-X-3455] 13 p0095 N77-11268

STEELE, R. V.
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534

STEINBERG, M.
Nuclear power for the production of synthetic fuels and feedstocks
13 p0035 A77-12790
Air, water, nuclear power make gasoline
13 p0045 A77-12935

STEINBORN, G.
Hydrogen production using nuclear heat
13 p0057 A77-16211

STELLA, P.
Low reflectivity solar cells
[AD-A025922] 13 p0108 N77-12539

STENBERG, V. I.
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243

STERN, R. D.
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597

STERNFELD, J.
The storage of energy in future energy supply systems
[DGLR PAPER 76-182] 13 p0059 A77-16533

STEVENS, G. H.
Space-to-earth power transmission system
[NASA-TM-X-73489] 13 p0105 N77-12517

STEVENS, N. J.
Preliminary report on the CTS transient event counter performance through the 1976 spring eclipse season
[NASA-TM-X-73487] 13 p0083 N77-10116

STEWART, G. S.
Dual purpose nuclear power plants for military installations
[AD-A026141] 13 p0132 N77-15521

STEWART, H. J.
Dual optimum aerodynamic design for a conventional windmill
13 p0048 A77-13704

STICKLE, J. W.
Technical highlights in general aviation
[AIAA PAPER 77-312] 13 p0066 A77-18237

STINNETT, L. A.
Availability of potential coal supply through 1985 by quality characteristics
[PB-256680/0] 13 p0121 N77-14573

STITT, W. C.
Summary of EPA energy policy analysis
[PB-253361/0] 13 p0089 N77-10669

STOKES, B.
Survey of alcohol fuel technology, volume 1
[PB-256007/6] 13 p0112 N77-13232
Survey of alcohol fuel technology, Volume 2
[PB-256008/4] 13 p0112 N77-13233

STOLARSKI, R. S.
Energetics of the midlatitude thermosphere
13 p0012 A77-11492

STORTI, G.
CdS-Cu2S solar cells fabricated on Cd2SnO4-silica substrates
13 p0007 A77-11110

STOUT, N. D.
Pyrolysis of oil shale: The effects of thermal history on oil yield
[UCRL-77831] 13 p0129 N77-15499

STRAUGHAN, D.
Temperature effects of crude oil in the upper intertidal zone
[PB-255956/5] 13 p0110 N77-12581

STREED, E. R.
A method of testing for rating solar collectors based on thermal performance
13 p0019 A77-12408

STRICKLAND, G.
Hydrogen for energy storage: A progress report of technical developments and possible applications
[BNL-20931] 13 p0094 N77-11201

STUBKIER, B.
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106

STUCKEY, D. C.
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577

STULC, P.
Heat pipes for the temperature range from 200 to 600 C
13 p0119 N77-14381
Heat pipes with a non-condensable gas and their application in nuclear apparatus and instruments
13 p0120 N77-14387

SU, T. T.
The intersectoral feedback model
[PB-255859/1] 13 p0125 N77-14950
SUBBOTIN, V. I.
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383
SUBOTOWICZ, M.
Satellite solar power stations and energy relay satellites
13 p0052 A77-14901
SUDAR, S.
Electric vehicle performance with alternate batteries
13 p0025 A77-12707
SUDWORTH, J. L.
Sodium/sulphur battery development in the United Kingdom
13 p0026 A77-12717
SUKHOJA, R.
A study of inplant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255658/7] 13 p0115 N77-13542
A study of implant electric power generation in the chemical, petroleum refining, and paper and pulp industries
[PB-255659/5] 13 p0115 N77-13543
SULZBERGER, V. T.
The potential for application of energy storage capacity on electric utility systems in the United States. I
13 p0054 A77-15625
SUPRONENKO, M. N.
A 2-MW electric arc generator with porous cooling of the interelectrode insert
13 p0049 A77-13831
SUUBERG, E. M.
Basic studies of coal pyrolysis and hydrogasification
[PB-254878/2] 13 p0096 N77-11511
SVERDRUP, E. F.
Advanced coal gasification system for electric power generation
[FE-1514-176] 13 p0088 N77-10653
SWANSON, R. K.
Operational, cost, and technical study of large windpower systems integrated with existing electric utility
13 p0043 A77-12867
SWARTMAN, R. K.
Survey of absorption refrigeration systems
13 p0078 A77-19105
SWATTON, S.
Advanced helicopter structural design investigation. Volume 1: Investigation of advanced structural component design concepts
[AD-A024662] 13 p0102 N77-12052
SWEENEY, J. L.
Economics of depletable resources: Market forces and intertemporal bias
[PB-255623/1] 13 p0111 N77-12930
SWIFT-HOOK, D. T.
The atmosphere and the oceans as energy sources
13 p0005 A77-11036
SWIFT, R.
A cylindrical blackbody solar energy receiver
13 p0018 A77-12404
SWINEHART, R. M.
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
SWITZER, D.
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207
SWOPE, D. R.
A guide for the conversion to and maintenance of hydrogen-fueled, spark-ignited engines
13 p0033 A77-12779
SZEGO, J.
Transient behavior of solid sensible heat thermal storage units for solar energy systems
13 p0057 A77-16208
SZOSTAK, R. M.
Resource recovery technology for urban decision-makers
[PB-252458/5] 13 p0093 N77-10964
SZULMAYER, W.
Stationary solar concentrators for industrial heating and cooling
13 p0074 A77-19069

T

TABACZYNSKII, R. J.
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150
TAHERI, E. H. Z.
Applied research on II-VI compound
[PB-254637/2] 13 p0098 N77-11547
TAKETANI, H.
Some material considerations involved in the application of solar energy to electric power generation
13 p0049 A77-13739
TALIB, A.
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773
TAN, W. P. S.
Muon catalysed fusion for pellet ignition
13 p0012 A77-11468
TARASIUK, V. A.
Acoustic properties of subsonic MHD channel
13 p0054 A77-15668
TARMAN, P. B.
Hydrogen production by the steam-iron process
13 p0023 A77-12688
Hydrocarbon fuels from oil shale
13 p0023 A77-12692
TARRER, A.
Mechanisms of coal particle dissolution
13 p0059 A77-16475
TARRICONE, L.
Preparation and characteristics of CuGaSe2/CdS solar cells
13 p0069 A77-18517
TASHENEV, S. ZH.
Method of accounting for the ambiguity of initial information in the optimization of regional fuel/energy balance
13 p0020 A77-12657
TAYLOR, C. S.
An inflatable solar concentrator for a high temperature storage system
13 p0074 A77-19064
TAYLOR, K.
The influence of subsurface energy storage on seasonal temperature variations
13 p0067 A77-18351
TAYLOR, L., JR.
Mechanisms of coal particle dissolution
13 p0059 A77-16475
TAYLOR, W. E.
Demonstration of the feasibility of automated silicon solar cell fabrication
[NASA-CR-135095] 13 p0129 N77-15492
TAYLOR, W. F.
A preliminary engineering assessment of jet fuel production from domestic coal and shale derived oils
13 p0023 A77-12690
TCHULKOV, H. A.
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383
TEAGAN, W. P.
Solar thermal power generation
13 p0077 A77-19095
TEGGERS, H.
Gasification of coal and its future aspects regarding the use of heat from high-temperature nuclear reactors
[INIS-MF-1965] 13 p0084 N77-10228
TELEGIN, E. M.
Investigation of the mechanism of cleaning heating surfaces by the pulsation method
[BLL-M-25448-(5828.4P)] 13 p0112 N77-13235
TEMPELMEYER, K. E.
Investigation of direct coal-fired MHD power generation
13 p0034 A77-12783
TEPLIAKOV, D. I.
Problems of energy storage in solar power stations
13 p0063 A77-17555

TESCHE, T. W.
Theoretical, numerical, and physical techniques for characterizing power plant plumes
[PB-253099/6] 13 p0101 N77-11599
TESTER, J. W.
Geothermal energy as a source of electric power: Thermodynamic and economic design criteria
13 p0060 A77-16623
Geothermal energy for power generation
[LA-UR-76-369] 13 p0087 N77-10650
Geothermal energy for electrical and nonelectrical applications
[LA-UR-76-418] 13 p0123 N77-14601
TEVEROVSKII, E. N.
Relative hazard of nuclear power stations and fossil-fuel power stations to the environment
13 p0067 A77-18323
THALLER, L. H.
Electrically rechargeable REDOX flow cell
[NASA-CASE-LEW-12220-1] 13 p0121 N77-14581
THEKAEKARA, M. P.
Survey of quantitative data on the solar energy and its spectra distribution
13 p0072 A77-19044
THOMAS, C. O.
Methanol from coal fuel and other applications
[ORAU-126] 13 p0094 N77-11200
THOMAS, G.
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088
THOMAS, J.
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981
THOMPSON, K. C.
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
THOMPSON, P. M.
Underground gasification of coal: A National Coal Board reappraisal. 1976
13 p0044 A77-12926
THOMPSON, S. J.
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848
THOMSON, W.
Electric vehicle performance with alternate batteries
13 p0025 A77-12707
THOMSON, W. B.
Uranium zirconium hydride reactor space power systems
[IAF PAPER 76-256] 13 p0004 A77-10953
Central station solar electric power using liquid metal heat transport
13 p0037 A77-12806
THORNHILL, J.
Demonstration of the feasibility of automated silicon solar cell fabrication
[NASA-CR-135095] 13 p0129 N77-15492
THRESHER, R. W.
Design consideration for the Darrieus rotor
13 p0044 A77-12872
TIKHOTSKII, A. S.
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666
TING, P.
The fuel efficiency potential of a flywheel hybrid vehicle for urban driving
13 p0020 A77-12664
TITZE, I. R.
Solar-powered housing unit - Simulation of solar heating and cooling in Saudi Arabia
13 p0078 A77-19110
TOLLE, H. E.
The seat belt light is on
13 p0080 A77-19175
TOMITA, A.
Differential scanning calorimetry studies on coal. II - Hydrogenation of coals
13 p0070 A77-18583
TOMKINS, F. S.
Measurements of Sc I gf-values
13 p0058 A77-16270
TOMLINSON, G.
Energy fact book 1975. Parts 1-5: Appendixes A-H
[AD-A023010] 13 p0089 N77-10664
TONG, G.
Resource recovery technology for urban decision-makers
[PB-252458/5] 13 p0093 N77-10964
TOPURIIA, I. I.
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924
TORKILDSEN, R. A.
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380
TORRES, F.
Hybrid drive with kinetic energy store as vehicle drive
[UCRL-TRANS-11018] 13 p0120 N77-14486
TOTH, G. W.
Availability of potential coal supply through 1985 by quality characteristics
[PB-256680/0] 13 p0121 N77-14573
TOUCHAIS, M.
The two enemies of industrial development of solar energy - Simplicity and economy
13 p0078 A77-19109
TOURE, I.
Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity
13 p0073 A77-19057
TRAORE, C.
The role of solar energy in developing nations - The perspectives in Mali
13 p0080 A77-19125
TRAYSER, D. A.
Chemical and physical characterization of automotive exhaust particulate matter in the atmosphere
[PB-253375/0] 13 p0092 N77-10715
TRILLING, C. A.
Low-Btu gasification of coal by Atomics International's molten salt process
13 p0023 A77-12687
TRIVICH, D.
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088
TROIA, S. O.
Thin film solar acceptors
13 p0072 A77-19053
TRUKHOV, V. S.
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up
13 p0051 A77-14580
TRUSCELLO, V. C.
Solar thermal electric power plants - Their performance characteristics and total social costs
13 p0037 A77-12804
Test and evaluation of the Navy half-watt RTG
13 p0042 A77-12853
TSOUKALAS, T. C.
Solid state applications of direct energy conversion and heat pumping for a small automotive vehicle
[AD-A026321] 13 p0124 N77-14607
TUCKER, W. K.
PULSAR, an unconventional topping stage
13 p0034 A77-12788
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293
TUKHTASINOV, I.
Thermoelectric power of pseudoternary solid solutions
13 p0014 A77-11917
TURNER, A. H.
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
TURNER, G. S.
Some considerations in determining oxides of nitrogen in stack gases by chemiluminescence analyzer
13 p0062 A77-17541

TURNER, R. H.
Economic optimization of the energy transport component of a large distributed solar power plant
13 p0037 A77-12807
TURSUNBAEV, I. A.
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up
13 p0051 A77-14580
TWEEDIE, A. T.
Two component thermal energy storage material [PB-252592/1]
13 p0090 N77-10675

U

UCAR, N.
Commercial building unitary heat pump system with solar heating [PB-255488/9]
13 p0099 N77-11551
ULBRICH, E. A.
Application of a shunt motor and a 2 cylinder gasoline engine as a hybrid drive for an automobile
13 p0025 A77-12703
UMAROV, G. IA.
Radiant-vector distribution in the radiant field of a parabolocylindric concentrator
13 p0015 A77-11920
Thermodynamic analysis and selection of optimal parameters of a dynamic converter for a solar energy set-up
13 p0051 A77-14580
A Cassegrain system for solar radiation
13 p0063 A77-17561
UNDERHILL, G.
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752
UNNEWEHR, L. E.
Energy saving potential of engine-electric vehicular drives
13 p0025 A77-12708
UOSAKI, K.
The theory of hydrogen production in a photoelectrochemical cell
13 p0075 A77-19075
UPHALIS, A.
The overcoming of energy deficiencies with the aid of wind power
13 p0008 A77-11174
URBACH, H. B.
Aluminum-based anodes for underwater fuel cells: A phase report [AD-A026405]
13 p0131 N77-15512

V

VACHON, R. I.
Diversification as an energy conservation strategy
13 p0027 A77-12725
VAKIL, H. B.
Design analyses of a methane-based chemical heat pipe
13 p0028 A77-12737
VAN HESSEN, P.
The Osmotic power plant
13 p0021 A77-12668
VAN HORN, A. J.
Aspects of energy conversion; Proceedings of the Summer School, Lincoln College, Oxford, England, July 14-25, 1975
13 p0004 A77-11026
VAN OSDOL, J. H.
Uranium zirconium hydride reactor space power systems [IAF PAPER 76-256]
13 p0004 A77-10953
VAN VALIN, C. C.
Atmospheric ice nuclei - No detectable effects from a coal-fired powerplant plume
13 p0054 A77-15780
VAN VUCHT, J. H. N.
Intermetallic compounds - Background and results of twenty years of research
13 p0014 A77-11600
VAN WAKEREN, J. H. A.
Waveguide high pass filter for thermal conversion of solar energy
13 p0073 A77-19054
VANSANT, J. H.
An experimental 200 kW vertical axis wind turbine for the Magdalen Islands
13 p0044 A77-12874
VANT-HULL, L. L.
Collector field optimization for a solar thermal electric power plant
13 p0038 A77-12811
A new method for collector field optimization
13 p0074 A77-19070
VARTANIAN, A. V.
Design of a tracking system for a solar-energy installation
13 p0015 A77-11919
VATAZHIN, A. B.
Calculation of turbulent magnetohydrodynamic boundary layers in MHD generator channels
13 p0046 A77-13242
VATERKOWSKI, J. L.
New modes of operation for avalanche diodes - Frequency multiplication and upconversion
13 p0049 A77-14261
VELIKANOV, D. P.
Transport of the future and the tasks of science
13 p0048 A77-13643
VENKATESETTY, H. V.
Thermal energy storage for solar power plants
13 p0027 A77-12731
VENTURA, M.
The Osmotic power plant
13 p0021 A77-12668
VERHOEVEN, J.
Waveguide high pass filter for thermal conversion of solar energy
13 p0073 A77-19054
VERNON, S. M.
Schottky solar cells on thin epitaxial silicon
13 p0047 A77-13509
VEZIROGLU, T. N.
Hydrogen production using solar radiation
13 p0048 A77-13540
Solar production of hydrogen as a means of storing solar energy
13 p0075 A77-19072
VIDT, E. J.
Advanced coal gasification system for electric power generation [FE-1514-176]
13 p0088 N77-10653
VIEHBOECK, F.
Application of solar heat to buildings in Austria
13 p0079 A77-19114
VILENSKII, V. D.
Heat transfer and resistance in the flow of nonequilibrium dissociating nitrogen dioxide
13 p0058 A77-16213
VIRAMONTES, F. A.
Multi-year time frame optimization of power systems with fossil, nuclear, hydro, pumped storage and peaking units
13 p0096 N77-11525
VISENTIN, R.
Efficiency tests on a linear parabolic concentrator for medium and high temperatures
13 p0077 A77-19103
VISSERS, D. R.
Performance characteristics of solid lithium-aluminum alloy electrodes
13 p0007 A77-11107
VLASOV, D. S.
Increase in the efficiency of heat and power systems using large artificial accumulators of heat
13 p0064 A77-17939
VLASOV, V. M.
Optimisation of current source operation in pulse mode [IAF PAPER 76-255]
13 p0003 A77-10952
VLEGHERT, J. P. K.
Fuel consumption of civil jet transport aircraft
13 p0062 A77-17234
VON STURM, F.
Titanium-containing Raney nickel catalyst for hydrogen electrodes in alkaline fuel cell systems
13 p0064 A77-18019
VON TIESENHAUSEN, G. F.
Photovoltaic and thermal energy conversion for solar powered satellites [IAF PAPER 76-117]
13 p0003 A77-10913

W

WADDINGTON, D.
Calorimetry of large solar concentrators
13 p0038 A77-12814

WAGNER, G. L.
R&M - Today's heating and cooling vs. solar energy
13 p0002 A77-10482

WAGNER, K. L.
Fluidized bed heat exchangers for geothermal applications
13 p0029 A77-12748

WAGNER, L. H.
Wind tunnel measurements of the tower shadow on models of the ERDA/NASA 100 KW wind turbine tower
[NASA-TM-X-73548] 13 p0114 N77-13534

WALDMAN, B. H.
Definition study for photovoltaic residential prototype system
[NASA-CR-135056] 13 p0113 N77-13533

WALKER, G. W.
An improved electrolyte for direct oxidation fuel cells
[AD-A026164] 13 p0131 N77-15518

WALKER, P. L., JR.
Differential scanning calorimetry studies on coal. II - Hydrogenation of coals
13 p0070 A77-18583

WALKER, S. N.
Aerodynamics of the Darrieus rotor
13 p0050 A77-14559

WALL, J. C.
Performance and NOx emissions modeling of a jet ignition prechamber stratified charge engine
[SAE PAPER 760161] 13 p0016 A77-12150

WALSH, P. W.
Nuclear power - Compared to what
13 p0017 A77-12234

WALTER, R. A.
Economic optimization of binary fluid cycle power plants for geothermal systems
13 p0029 A77-12744

WALTON, B. L.
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534

WALTON, G.
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606

WALTON, G. N.
Method for estimating solar heating and cooling system performance
[AD-A026041] 13 p0116 N77-13557

WALZER, P.
High-temperature ceramics for automobile gas turbines. II
13 p0063 A77-17591

WANG, E. Y.
An analysis of silicon solar cell parameters for terrestrial applications
13 p0076 A77-19081
Cuprous oxide Schottky photovoltaic cells as potential solar energy converters
13 p0076 A77-19088

WANG, K. L.
Proceedings of the Mineral Economics Symposium: Winning the high stakes at the critical commodity game
[PB-255607/4] 13 p0105 N77-12502

WANNER, J.-C.
Air transportation and fuel consumption
13 p0051 A77-14563

WANTROBA, A.
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812

WATANABE, S.
Organic Rankine Cycle Engine development and solar energy utilization
13 p0077 A77-19096

WATERS, E. D.
Heat pipes for the trans-Alaska pipeline
13 p0120 N77-14388

WEAVER, L. K.
A survey of salt deposits and salt caverns: Their relevance to the strategic petroleum reserve
[PB-255948/2] 13 p0105 N77-12500

WEDDIGEN, G.
Development of sodium/sulfur-cells
13 p0026 A77-12716
Some studies on sodium/sulfur cells
13 p0055 A77-15813

WEDEL, R. K.
Use of Lexan and Kapton honeycombs to increase solar collector efficiency
13 p0068 A77-18448

WEERTMAN, J.
Heat extraction from hot dry rock masses
[PB-256775/8] 13 p0116 N77-13556

WEIL, S. A.
Hydrocarbon fuels from oil shale
13 p0023 A77-12692

WEIN, D.
Multipurpose insulation system for a radioisotope fueled Mini-Brayton Heat Source Assembly
13 p0022 A77-12678

WEINHOLD, J. F.
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594

WEINSTEIN, A.
Atlanta /Towns/ solar experiment - The lessons we learned
13 p0047 A77-13503

WEISS, R. F.
Production of atmospheric nitrous oxide by combustion
13 p0061 A77-16922

WELLMAN, P.
Oil shale development
13 p0023 A77-12693

WELSH, L. B.
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529

WEN, L.
Comparative performance of solar thermal power generation concepts
13 p0036 A77-12803

WENTWORTH, R. L.
Fuel gas recovery from controlled landfilling of municipal wastes
13 p0070 A77-18739

WENZEL, J. G.
OTEC - Aerospace and ocean engineering in partnership
[AIAA PAPER 77-296] 13 p0066 A77-18227

WERTWIJN, R.
Thermostatics and thermokinetics of a flat plate solar collector with constant heat capacity
13 p0073 A77-19057

WESELY, M. L.
A method for estimating hourly averages of diffuse and direct solar radiation under a layer of scattered clouds
13 p0019 A77-12412

WESENBERG, D. L.
PULSAR, an unconventional topping stage
13 p0034 A77-12788
Pulsed energy conversion with a dc superconducting magnet
13 p0081 A77-19293

WEST, R. E.
An engineering feasibility study of using low temperature geothermal sources in Colorado
13 p0031 A77-12762

WEXLER, H. J.
Regulatory reform of air transportation
[AIAA PAPER 77-276] 13 p0065 A77-18215

WHARTON, H. E.
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008

WHELPDALE, D. M.
Effects of anthropogenic emissions on climate - A review of selected topics
13 p0067 A77-18295

WHITBECK, J. F.
Making electricity from moderate temperature fluids
13 p0002 A77-10649

The economic generation of electricity from moderate temperature geothermal resources
13 p0030 A77-12749

WHITE, H. M.
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495

WHITE, P. C.
Fossil energy research and development in ERDA
13 p0063 A77-17551

WHITE, W. H.
The chemistry, dispersion, and transport of air pollutants emitted from fossil fuel power plants in California
[PB-254449/2] 13 p0092 N77-10720

WHITTEN, G. Z.
Theoretical, numerical, and physical techniques for characterizing power plant plumes
[PB-253099/6] 13 p0101 N77-11599

WHITTLE, C. E.
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594

WIDGER, W. K., JR.
Estimating wind power feasibility
13 p0010 A77-11315
New England wind power...coastal or mountain
13 p0058 A77-16250

WIENER, A. J.
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981

WILDES, P. D.
A multilayer iron-thionine photogalvanic cell
13 p0007 A77-11108

WILLETT, D. C.
Underground pumped storage research priorities
[PB-254413/8] 13 p0089 N77-10667

WILLIAMS, D. L.
Submarine geothermal resources
13 p0010 A77-11322

WILLIAMS, F.
Underground gasification of coal: A National Coal Board reappraisal. 1976
13 p0044 A77-12926

WILLIAMS, J. M.
Current status of the magnetic fusion program
13 p0035 A77-12792
Overview of the ERDA fusion power program
13 p0068 A77-18446

WILLIAMS, L. J.
Air transportation energy efficiency - Alternatives and implications
[SAWE PAPER 1124] 13 p0016 A77-12192

WILLIAMS, R. S., JR.
Thermographic mosaic of Yellowstone National Park
p0001 A77-10121

WILSON, D. E.
Development of thermal control methods for specialized components and scientific instruments at very low temperatures (follow-on)
[NASA-CR-150152] 13 p0127 N77-15347

WILSON, J. S.
Preliminary analysis of electric generation utilizing geopressured geothermal fluids
13 p0030 A77-12752

WILSON, R.
Sulphur pollution and emission charges
13 p0005 A77-11033

WILSON, R. E.
Aerodynamics of the Darrieus rotor
13 p0050 A77-14559

WILSON, R. W.
Design consideration for the Darrieus rotor
13 p0044 A77-12872

WILSON, S. W.
Economic optimization of binary fluid cycle power plants for geothermal systems
13 p0029 A77-12744

WINER, B.
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773

WINSTON, R.
Ideal concentrators for finite sources and restricted exit angles
13 p0003 A77-10835
Development of compound parabolic concentrators for solar-thermal electric and process heat applications
13 p0038 A77-12812
Performance of two fixed-mirror solar concentrators for process heat
13 p0074 A77-19065

WINTRELL, R.
The commercial production of hydrogen by the K-T process
13 p0032 A77-12769

WISE, D. L.
Fuel gas recovery from controlled landfilling of municipal wastes
13 p0070 A77-18739

WISE, J. J.
Design of a 100 BPD pilot plant to convert methanol to gasoline using the Mobil process
13 p0023 A77-12691

WISINSKI, L. J.
Synthesis and analysis of jet fuel from shale oil and coal syncrudes
[NASA-CR-135112] 13 p0103 N77-12230

WISLER, B. B., JR.
Hydrodynamic equilibrium conditions for AG(EH) main strut-pod foil system using flap incidence control
[AD-A027521] 13 p0127 N77-15220

WITCOPSKI, R. D.
Hydrogen-fueled subsonic aircraft: A perspective
13 p0084 N77-10344

WITHERSPOON, J. W.
Air transport propulsion for the 1980's
13 p0117 N77-13980

WITWER, J. G.
Costs of alternative sources of electricity
[PB-255765/0] 13 p0107 N77-12528

WOLLENBERG, H. A.
Geothermal studies in northern Nevada
13 p0029 A77-12742

WOLNER, H. A.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513

WOODCOCK, C. R.
Satellite power systems for large-scale power generation
[IAF PAPER 76-118] 13 p0003 A77-10914

WOODCOCK, G. R.
Transportation options for solar power satellites
13 p0040 A77-12829
Solar power satellites - Opportunity and challenge
[AIAA PAPER 77-291] 13 p0065 A77-18224

WOOLLEY, R. L.
Performance of a hydrogen-powered transit vehicle
13 p0033 A77-12781

WOOLSEY, N. F.
Catalytic hydrogenation of solvent-refined lignite to liquid fuels
13 p0008 A77-11243

WORSOE-SCHMIDT, P.
Solar-powered refrigeration by intermittent solid absorption systems
13 p0078 A77-19106

WRIGHT, J. K.
Large-scale electrical power generation and storage
13 p0006 A77-11039

WRIGHT, J. P.
Development of thermal control methods for specialized components and scientific instruments at very low temperatures (follow-on)
[NASA-CR-150152] 13 p0127 N77-15347

WRIGHTON, M. S.
Photoassisted electrolysis of water - Conversion of optical to chemical energy
13 p0021 A77-12666

WU, Y. C.
Comparative performance of solar thermal power generation concepts
13 p0036 A77-12803

WU, Y. C. L.
Performance theory of diagonal conducting wall MHD generators
13 p0001 A77-10202
Investigation of direct coal-fired MHD power generation
13 p0034 A77-12783

WUESTER, G.
Hydrogen production using nuclear heat
13 p0057 A77-16211

WYBERG, G. R.
Transport theory of 3M high-performance thermoelectric materials
13 p0042 A77-12848

Y

YADAVALLI, S. R.
A new generation scheme for large wind energy conversion systems
13 p0043 A77-12868

YAGODKIN, I. V.
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383

YARZAB, R. F.
Problems and solutions in the use of coal analyses
[FE-0390-1] 13 p0097 N77-11535

YCAS, J. W.
The palirrhotrophic origin of energy metabolism
13 p0064 A77-17895

YEH, H.
Thermal energy storage considerations for solar-thermal power generation
13 p0027 A77-12732

YEH, W.
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586

YEH, W. W. G.
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497

YEN, T. F.
Evaluation of coal liquefaction efficiency based on various ranks
13 p0009 A77-11244

YEW, H.-C.
Small electric vehicle considerations in view of performance and energy usage
13 p0024 A77-12698

YIEH, D.
Resource utilization efficiency improvement of geothermal binary cycles, phase 1
[ORO-4944-3] 13 p0123 N77-14600

YIFTAH, S.
The contribution of nuclear technology toward the solution of energy problems
[INIS-MF-1867] 13 p0100 N77-11565

YOCKE, M. A.
Theoretical, numerical, and physical techniques for characterizing power plant plumes
[PB-253099/6] 13 p0101 N77-11599

YOUNG, L. E.
SEP solar array technology development
13 p0040 A77-12825

YOUNG, L. Y.
Heat treatment of refuse for increasing anaerobic biodegradability
[PB-252924/6] 13 p0101 N77-11577

YOUNG, R. B.
Production of methane using offshore wind energy
13 p0026 A77-12722

YU, O. S.
Nuclear power, coal and energy conservation /with a note on the costs of a nuclear moratorium/
13 p0013 A77-11524

YU, W. S.
Hydrogen storage via iron-titanium for a 26 MW/e/ peaking electric plant
13 p0048 A77-13543
Closed Brayton cycle using hydrogen as a work fluid
[BNL-20899] 13 p0085 N77-10542

YUAN, S. W.
A central solar energy utilization system
13 p0057 A77-16210

YUDOW, B.
Energy transmission from ocean thermal energy conversion plants
13 p0032 A77-12773

YUEN, P. C.
Geothermal energy in Hawaii - Hydrothermal systems
13 p0029 A77-12741

Z

ZAITSEVA, A. K.
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916

ZAKHARKO, IU. A.
Study of the ionization of the additive in MHD installations
13 p0002 A77-10424

ZAKHIDOV, R. A.
Radiant-vector distribution in the radiant field of a parabolocylindric concentrator
13 p0015 A77-11920
Energetic calculation of the concentrating capacity of paraboloidal facets
13 p0051 A77-14579
Standard-size facets for the reflecting surface of a solar concentrator
13 p0063 A77-17557

ZALKIND, V. I.
Study of cathode spots in the presence of slag films on the electrodes of an open-cycle MHD generator
13 p0053 A77-15005
Study of the electrical characteristics of the boundary layer on the metal surfaces in the channels of an open cycle MHD generator
13 p0054 A77-15666

ZARIPOV, V. K.
Investigation of the thermophysical characteristics of low-temperature heat pipes with metal-fiber wicks
13 p0050 A77-14321
Structural heat conductivity of fiber metal wicks for heat pipes
13 p0050 A77-14326

ZAUDERER, B.
System studies of coal fired-closed cycle MHD for central station power plants
13 p0034 A77-12786

ZEITNER, E. J.
Development of compact lithium/iron disulfide electrochemical cells
13 p0026 A77-12715

ZEMKOSKI, J.
The potential for application of energy storage capacity on electric utility systems in the United States. I
13 p0054 A77-15625

ZHIDKOVA, E. V.
Influence of doped-layer parameters on photoelectric characteristics of silicon photovoltaic cells
13 p0014 A77-11916

ZHIRKOV, P. V.
Thermal explosion of moving reacting fluids of variable viscosity
13 p0052 A77-14980

ZHORZHOLIANI, G. I.
The analysis of the temperature regimes of the operation of a gas-regulated heat pipe
13 p0064 A77-17924

ZIENER, H.
Manufacturing and evaluation of phthalocyanines as catalysts for fuel cells
[BMFT-FB-T-76-25] 13 p0114 N77-13540

ZIMMERMAN, M. B.
The supply of coal in the long run: The case of eastern deep coal
[PB-252642/4] 13 p0086 N77-10626

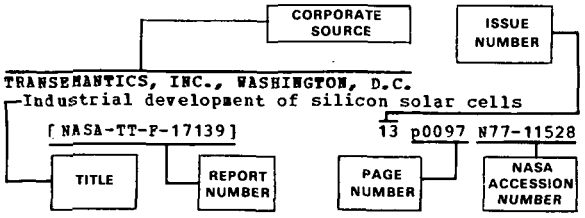
ZIMMERMAN, W. F.
Alkali metal space power technology applicable to national energy research and development
[AIAA PAPER 77-289] 13 p0065 A77-18223

ZINK, R. A.
Impacts of synthetic liquid fuel development. Automotive market. Volume 1: Summary
[PB-255994/6] 13 p0107 N77-12533
Impacts of synthetic liquid fuel development. Automotive market. Volume 2
[PB-255995/3] 13 p0108 N77-12534

ZOOK, J. D.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513

ZYGIELBAUM, P. S.
MHD power generation - 1976 Status Report
13 p0033 A77-12782

Typical Corporate Source Index Listing



The title of the document is used to provide a brief description of the subject matter. The issue, page number and NASA or AIAA accession number are included in each entry to assist the user in locating the abstract in the abstract section of an individual supplement of *Energy*. If applicable, a report number is also included as an aid in identifying the document.

A

ABCOR, INC., CAMBRIDGE, MASS.
Growth effects of major land use projects. Volume 2: Compilation of land use based emission factors
[PB-255302/2] 13 p0092 N77-10709

ACE-FEDERAL REPORTERS, INC., WASHINGTON, D. C.
Creating energy choices for the future
[CONF-751228-P1] 13 p0087 N77-10647

ACRES AMERICAN, INC., BUFFALO, N. Y.
Underground pumped storage research priorities
[PB-254413/8] 13 p0089 N77-10667

ADAPT SERVICE CORP., READING, MASS.
Effect of mechanical cooling devices on ambient salt concentration
[PB-256679/2] 13 p0125 N77-14631

ADDIS TRANSLATIONS INTERNATIONAL, PORTOLA VALLEY, CALIF.
Underground fuel gasification
[UCRL-TRANS-10998] 13 p0088 N77-10659
Hybrid drive with kinetic energy store as vehicle drive
[UCRL-TRANS-11018] 13 p0120 N77-14486

AEROJET NUCLEAR CO., IDAHO FALLS, IDAHO.
Geothermal R and D project report
[ANCR-1283] 13 p0124 N77-14605

AEROSPACE CORP., EL SEGUNDO, CALIF.
Personal rapid transit research conducted at the Aerospace Corporation
[PB-256846/7] 13 p0111 N77-12946
Research plan for achieving reduced automotive energy consumption
[PB-255929/2] 13 p0121 N77-14495

AIR FORCE AERO PROPULSION LAB., WRIGHT-PATTERSON AFB, OHIO.
The impact of JP-4/JP-8 conversion on aircraft engine exhaust emissions
[AD-A026546] 13 p0112 N77-13234

AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
An exploratory study to determine the integrated technological air transportation system ground requirements of liquid-hydrogen-fueled subsonic, long-haul civil air transports
[NASA-CR-2699] 13 p0083 N77-10033

AIRESEARCH MFG. CO., PHOENIX, ARIZ.
Study of small turbofan engines applicable to single-engine light airplanes
[NASA-CR-137944] 13 p0093 N77-11054

AMERICAN AIRLINES, INC., NEW YORK.
Future aircraft requirements: A notebook of airline thoughts
13 p0117 N77-13976

AMERICAN CYANAMID CO., BOUND BROOK, N.J.
Concept for fluidized bed combustion of Consol char using a closed-cycle helium power plant with an estimate of the price of electric power
[ERDA-76-69] 13 p0130 N77-15506

AMERICAN CYANAMID CO., STAMFORD, CONN.
Cadmium stannate selective optical films for solar energy applications
[PB-254879/0] 13 p0090 N77-10678

AMERICAN INST. OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS, INC., WASHINGTON, D. C.
Proceedings of the Mineral Economics Symposium: Winning the high stakes at the critical commodity game
[PB-255607/4] 13 p0105 N77-12502

AMERICAN UNIV., WASHINGTON, D.C.
Research on electrochemical energy conversion systems
[AD-A023689] 13 p0090 N77-10681

APPLIED PHYSICS LAB., JOHNS HOPKINS UNIV., LAUREL, MD.
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships
[PB-255639/7] 13 p0109 N77-12552
Maritime and construction aspects of Ocean Thermal Energy Conversion (OTEC) plant ships, detailed report
[PB-257444/0] 13 p0116 N77-13554

APPLIED SYSTEMS CORP., VIENNA, VA.
The production and refining of crude oil into military fuels
[AD-A024652] 13 p0095 N77-11207

ARTEC, INC., COLUMBIA, MD.
Tests of oil recovery devices in broken ice fields, phase 2
[AD-A025748] 13 p0110 N77-12572

ARGONNE NATIONAL LAB., ILL.
Explaining energy: A manual of non-style for the energy outsider who wants in
[LBL-4458] 13 p0122 N77-14592
Investment planning in the energy sector
[LBL-4474] 13 p0125 N77-14948

ARIZONA UNIV., TUCSON.
A basis for analyzing prospective power generation in terms of environmental management and energy use
13 p0096 N77-11526
Symposium on the Fundamental Optical Properties of Solids Relevant to Solar Energy Conversion
[PB-256615/6] 13 p0108 N77-12538
Feasibility study of a nuclear power-sewage treatment system for the conservation and reclamation of water resources
[PB-255630/6] 13 p0126 N77-14960
The optical properties of chromium oxide films and the high temperature stabilization of silver films for photothermal solar energy conversion
13 p0128 N77-15484

ARMY COLD REGIONS RESEARCH AND ENGINEERING LAB., HANOVER, N. H.
Concrete placing techniques used during the construction of the kasnoyarsk hydroelectric power plant
[AD-A026967] 13 p0121 N77-14528
Utility distribution systems in Iceland
[AD-A026956] 13 p0126 N77-14957

ARMY CONSTRUCTION ENGINEERING RESEARCH LAB., CHAMPAIGN, ILL.
Method for estimating solar heating and cooling system performance
[AD-A026041] 13 p0116 N77-13557
Interim feasibility assessment method for solar heating and cooling of Army buildings
[AD-A026588] 13 p0124 N77-14606

Nuclear unit productivity analysis
[PB-257553/8] 13 p0132 N77-15528
ENERGY AND ENVIRONMENTAL ANALYSIS, INC., ARLINGTON, VA.
Laws and regulations affecting coal with summaries of Federal, State, and local laws and regulations pertaining to air and water pollution control, reclamation, diligence and health and safety, part 1
[PB-255927/6] 13 p0110 N77-12592
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, LARAMIE, WYO.
Environmental impact studies related to underground coal gasification
[TID-27003] 13 p0100 N77-11573
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, OAK RIDGE, TENN.
ERDA energy information data base: Magnetic tape description
[TID-4581-R3] 13 p0102 N77-11695
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, WASHINGTON, D.C.
Creating energy choices for the future. Public meeting on A National Plan for Energy Research, Development, and Demonstration
[CONF-751228-P2] 13 p0087 N77-10646
National program for solar heating and cooling (residential and commercial applications)
[ERDA-23A] 13 p0098 N77-11540
ENERGY RESEARCH CORP., DANBURY, CONN.
Fuel cell stacks
[AD-A024216] 13 p0090 N77-10684
ENVIRONMENTAL HEALTH LAB., MCCLELLAN AFB, CALIF.
A bioenvironmental study of emissions from refuse derived fuel
[AD-A024661] 13 p0110 N77-12571
ENVIRONMENTAL PROTECTION AGENCY, PHILADELPHIA, PA.
Characterization and evaluation of wastewater sources United States Steel Corporation, Clairton Works, Pittsburgh, Pennsylvania, 28-31 January 1976
[PB-255586/0] 13 p0116 N77-13566
ENVIRONMENTAL PROTECTION AGENCY, RESEARCH TRIANGLE PARK, N.C.
National Emissions Data Systems (NEDS) fuel use report, 1973
[PB-253908/8] 13 p0083 N77-10220
Compilation of air pollutant emission factors. Supplement
[PB-254274/4] 13 p0093 N77-10731
ENVIRONMENTAL TECHNOLOGY ASSESSMENT, INC., OAK BROOK, ILL.
The air quality and economic implications of supplementary control systems in Illinois
[PB-255699/1] 13 p0101 N77-11588
EQUITABLE ENVIRONMENTAL HEALTH, INC., WOODBURY, N.Y.
Selected aspects of waste heat management: A state-of-the-art study
[PB-255697/5] 13 p0100 N77-11563
Selected aspects of waste heat management
[PB-254401/3] 13 p0109 N77-12568
ERNST AND ERNST, WASHINGTON, D.C.
Energy-economy relationships
[PB-255171/1] 13 p0099 N77-11552
Review of energy forecasting methodologies and assumptions
[PB-255170/3] 13 p0107 N77-12526
EUROPEAN SPACE AGENCY, PARIS (FRANCE).
Heat pipes, volume 2
[ESA-SP-112-VOL-2] 13 p0119 N77-14378
EXXON RESEARCH AND ENGINEERING CO., LINDEN, N.J.
Photochemical conversion of solar energy
[PB-255703/1] 13 p0090 N77-10685
Investigation and assessment of light-duty-vehicle evaporative emission sources and control
[PB-255813/8] 13 p0102 N77-11603
Carbon oxidation catalyst mechanism study for fuel cells
[PB-256420/1] 13 p0115 N77-13551
Evaluation of pollution control in fossil fuel conversion processes
[PB-255842/7] 13 p0125 N77-14638

F

FAIRCHILD SPACE AND ELECTRONICS CO., GERMANTOWN, MD.
Nuclear-powered Hysat spacecraft: Comparative design study
[ERDA-SNS-3063-8] 13 p0094 N77-11108
FEDERAL ENERGY ADMINISTRATION, WASHINGTON, D. C.
National petroleum product supply and demand, 1976 - 1978
[PB-254969/9] 13 p0084 N77-10224
Directory of Federal energy data sources: Computer products and recurring publications
[PB-254163/9] 13 p0093 N77-10941
Mandatory Canadian crude oil allocation regulations
[PB-255319/6] 13 p0096 N77-11509
Strategic petroleum reserve
[PB-255476/4] 13 p0098 N77-11546
Energy information activities at the FEA
[PB-253962/5] 13 p0099 N77-11553
A survey of salt deposits and salt caverns: Their relevance to the strategic petroleum reserve
[PB-255948/2] 13 p0105 N77-12500
Crude oil supply alternatives for the Northern Tier states
[PB-255991/2] 13 p0107 N77-12530
Petroleum market shares. Report on sales of propane to ultimate consumers, 1975
[PB-255624/9] 13 p0108 N77-12540
Implementing coal utilization provisions of Energy Supply and Environmental Coordination Act
[PB-255855/9] 13 p0109 N77-12549
Economics of depletable resources: Market forces and intertemporal bias
[PB-255623/1] 13 p0111 N77-12930
Final assessment of the environmental impacts of the State Energy Conservation Program (Public law 94-163, Title III, part C, The Energy Policy and Conservation Act)
[PB-256044/9] 13 p0116 N77-13555
Weekly petroleum statistics reports, 1974-1975
[PB-255920/1] 13 p0124 N77-14608
The exploration, development, and production of Naval Petroleum Reserve Number 4
[PB-255947/4] 13 p0124 N77-14610
Trends in refinery capacity and utilization: Petroleum refineries in the United States; foreign refinery exporting centers
[PB-256966/3] 13 p0132 N77-15523
Rapid growth from energy projects: Ideas for state and local action. A program guide
[PB-257374/9] 13 p0132 N77-15527
FOSTER WHEELER CORP., LIVINGSTON, N.J.
Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant, phase 2
[PE-1521-13] 13 p0130 N77-15501

G

GEC-MARCONI ELECTRONICS LTD., CHELMSFORD (ENGLAND).
Heat pipe and space radiator developments
13 p0120 N77-14391
GENERAL ATOMIC CO., SAN DIEGO, CALIF.
Characteristics of a first generation commercial fusion power plant
[GA-A-13661] 13 p0093 N77-10891
GENERAL ELECTRIC CO., CINCINNATI, OHIO.
Study of unconventional aircraft engines designed for low energy consumption
[NASA-CR-135136] 13 p0127 N77-15043
GENERAL ELECTRIC CO., PHILADELPHIA, PA.
Two component thermal energy storage material
[PB-252592/1] 13 p0090 N77-10675
Definition study for photovoltaic residential prototype system
[NASA-CR-135039] 13 p0113 N77-13532
GENERAL ELECTRIC CO., SCHENECTADY, N.Y.
High temperature gas turbine engine
[PE-1765-8] 13 p0120 N77-14488
Economic and technical feasibility study of compressed air storage
[COO-2559-1] 13 p0122 N77-14593

High temperature gas turbine engine component materials testing program
[PE-1765-7] 13 p0127 N77-15401
GENERAL ELECTRIC CO., WILMINGTON, MASS.
Development of fuel cell CO detection instruments for use in a mine atmosphere
[PB-254823/8] 13 p0095 N77-11380
Solid Polymer Electrolyte (SPE) fuel cell technology, program review, phase 2
[NASA-CR-150957] 13 p0097 N77-11532
GEORGE WASHINGTON UNIV., WASHINGTON, D.C.
Underground coal mining: An assessment of technology
[PB-255726/2] 13 p0093 N77-10974
GILBERT ASSOCIATES, INC., READING, PA.
Design phase utility analysis for gas turbine and combined cycle plants
[PB-256665/1] 13 p0115 N77-13553
Participating surveillance services for electric power program. Coal conversion and utilization: Direct combustion of coal-90e, advanced power-90f. Summary for ERDA annual report, CY 1975
[FE-1236-4] 13 p0130 N77-15507
GORDIAN ASSOCIATES, INC., NEW YORK.
Evaluation of the air-to-air heat pump for residential space conditioning
[PB-255652/0] 13 p0108 N77-12545
GRUMMAN AEROSPACE CORP., BETHPAGE, N.Y.
Space-based solar power conversion and delivery systems study. Volume 2: Engineering analysis of orbital systems
[NASA-CR-150147] 13 p0129 N77-15495

H

HANFORD ENGINEERING DEVELOPMENT LAB., RICHLAND, WASH.
Economic analysis of the need for advanced power sources
[HEDL-SA-989] 13 p0131 N77-15509
HARBRIDGE HOUSE, INC., BOSTON, MASS.
Cost analysis of two air quality attainment strategies
[PB-254182/9] 13 p0092 N77-10719
HITTMAN ASSOCIATES, INC., COLUMBIA, MD.
Underground coal mining: An assessment of technology
[PB-255726/2] 13 p0093 N77-10974
Comparative evaluation of solar heating alternatives
[COO-2703-2] 13 p0129 N77-15498
HONEYWELL CORPORATE RESEARCH CENTER, BLOOMINGTON, MINN.
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
HONEYWELL, INC., MINNEAPOLIS, MINN.
Design, fabrication, testing, and delivery of a solar energy collector system for residential heating and cooling
[NASA-CR-150032] 13 p0086 N77-10638
HUDSON INST., INC., CROTON-ON-HUDSON, N.Y.
Domestic and world trends (1980 - 2000) affecting the future of aviation
[NASA-CR-144838] 13 p0126 N77-14981

I

ICF, INC., WASHINGTON, D.C.
Summary of EPA energy policy analysis
[PB-253361/0] 13 p0089 N77-10669
Gasoline and distillate shortage situation: 1972-1976
[PB-253322/2] 13 p0089 N77-10670
ILLINOIS UNIV., URBANA-CHAMPAIGN.
Isotopic characterization of Illinois natural gas
13 p0113 N77-13484
INDIAN INST. OF TECH., MADRAS.
Transfer function analysis of heat pipes
13 p0119 N77-14385
INDUSTRIAL ENVIRONMENTAL RESEARCH LAB., RESEARCH TRIANGLE PARK, N. C.
Proceedings: Symposium on Flue Gas Desulfurization, volume 1
[PB-255317/0] 13 p0110 N77-12597
Proceedings of the Stationary Source Combustion Symposium. Volume 1. Fundamental research
[PB-256320/3] 13 p0116 N77-13569

Proceedings of the Stationary Source Combustion Symposium. Volume 2. Fuels and process research and development
[PB-256321/1] 13 p0116 N77-13570
Proceedings of the Stationary Source Combustion Symposium. Volume 3: Field Testing and Surveys
[PB-257146/1] 13 p0125 N77-14643
INSTITUTE FOR ENERGY ANALYSIS, OAK RIDGE, TENN.
Methanol from coal fuel and other applications
[ORAU-126] 13 p0094 N77-11200
IEA energy simulation model: A framework for long-range US energy analysis
[ORAU-125] 13 p0122 N77-14594
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
Burner design criteria for control of NOx from natural gas combustion. Volume 1: Data analysis and summary of conclusions
[PB-254167/0] 13 p0091 N77-10686
Burner design criteria for control of NOx from natural gas combustion. Volume 2: Raw data and experimental results
[PB-256806/1] 13 p0115 N77-13549
INSTITUTE OF PHYSICS AND POWER ENGINEERING, OBNINSK (USSR).
Operation peculiarities of low temperature heat pipes with crimped capillary structure
13 p0119 N77-14380
Some features of start-up of alkali metal heat pipes
13 p0119 N77-14383
Investigations of nonsteady-state processes at cryogenic heat pipe operation
13 p0119 N77-14384
ISRAEL ATOMIC ENERGY COMMISSION, YAVNEH.
The contribution of nuclear technology toward the solution of energy problems
[INIS-MF-1867] 13 p0100 N77-11565
ISTITUTO SUPERIORE DI SANITA, ROME (ITALY).
Physical and biological aspects of thermal pollution in sea water
[ISS-L-75/14] 13 p0109 N77-12560

J

JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA.
High-efficiency solar concentrator
13 p0083 N77-10104
A two-dimensional finite difference solution for the transient thermal behavior of tubular solar collector
13 p0083 N77-10105
Hydrogen-rich gas generator
[NASA-CASE-NPO-13560-1] 13 p0086 N77-10636
LSSA (Low-cost Silicon Solar Array) project
[NASA-CR-149091] 13 p0086 N77-10637
Reduction of gaseous pollutant emissions from gas turbine combustors using hydrogen-enriched jet fuel
[NASA-CR-149146] 13 p0094 N77-11198
Wind power prediction models
[NASA-CR-149235] 13 p0105 N77-12509
Dip coating process: Silicon sheet growth development for the large-area silicon sheet task of the low-cost silicon solar array project
[NASA-CR-149242] 13 p0105 N77-12513
Review of world experience and properties of materials for encapsulation of terrestrial photovoltaic arrays
[NASA-CR-149451] 13 p0106 N77-12524
Solar cell array design handbook, volume 1
[NASA-CR-149364] 13 p0118 N77-14193
Solar cell array design handbook, volume 2
[NASA-CR-149365] 13 p0118 N77-14194
Analysis of information systems for hydropower operations: Executive summary
[NASA-CR-149342] 13 p0122 N77-14586
Analysis of information systems for hydropower operations
[NASA-CR-149373] 13 p0129 N77-15497

K

KANNER (LEO) ASSOCIATES, REDWOOD CITY, CALIF.
Bosch technical instruction. Gasoline injection D and L-jetronic
[NASA-TT-F-17111] 13 p0095 N77-11399
KENTUCKY UNIV., LEXINGTON.
Hot fuel gas desulfurization
[PB-257036/4] 13 p0133 N77-15539

L

LEWIN AND ASSOCIATES, INC., WASHINGTON, D. C.
The potential and economics of enhanced oil recovery
[PB-254991/3] 13 p0086 N77-10633
Economic limits of OCS production wells
[PB-255320/4] 13 p0096 N77-11515
LITTLE (ARTHUR D.), INC., CAMBRIDGE, MASS.
A location matrix plan for the residential solar heating and cooling demonstration program. Volume 1: Findings and recommendations
[PB-253784/3] 13 p0089 N77-10673
Study of the feasibility of federal procurement of fuels produced from solid wastes
[PB-255695/9] 13 p0096 N77-11513
Outlook for research and development in the underground gasification of coal
[PB-256155/3] 13 p0109 N77-12555
LOCKHEED-CALIFORNIA CO., BURBANK.
LH2 airport requirements study
[NASA-CR-2700] 13 p0083 N77-10032
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137926] 13 p0126 N77-15007
Study of the cost/benefit tradeoffs for reducing the energy consumption of the commercial air transportation system
[NASA-CR-137927] 13 p0126 N77-15008
LOCKHEED MISSILES AND SPACE CO., PALO ALTO, CALIF.
Effectiveness of heat-emitting coatings with variable degree of blackness
13 p0111 N77-12893
LOS ALAMOS SCIENTIFIC LAB., N. MEX.
Geothermal energy for power generation
[LA-UR-76-369] 13 p0087 N77-10650
Geothermal energy for electrical and nonelectrical applications
[LA-UR-76-418] 13 p0123 N77-14601
LUMMUS CO., NEW YORK.
Hot and dry char let down system for the Synthane demonstration plant, phase 1
[PERC-0058-4] 13 p0130 N77-15505

M

MARTIN MARIETTA CORP., DENVER, COLO.
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[NASA-CR-135056] 13 p0113 N77-13533
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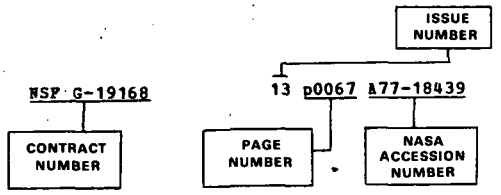
[PB-255956/5] 13 p0110 N77-12581
UOP, INC., DES PLAINES, ILL.
Optimization of PT-doped Kocite (trademark) electrodes in H3 PO4 fuel cells
[AD-A025326] 13 p0107 N77-12529
URBAN MASS TRANSPORTATION ADMINISTRATION, WASHINGTON, D.C.
Future scenarios for urban transportation
[PB-255349/3] 13 p0102 N77-11930
URBAN SYSTEMS RESEARCH AND ENGINEERING, INC., CAMBRIDGE, MASS.
Baseline energy forecasts and analysis of alternative strategies for airline fuel conservation
[PB-255351/9] 13 p0091 N77-10690
UTAH STATE UNIV., LOGAN.
A fermentation process for converting plant materials into methane
13 p0121 N77-14583

W

WASHINGTON STATE UNIV., PULLMAN.
An investigation of condensation heat transfer in a closed tube containing a soluble noncondensable gas
[NASA-CR-149095] 13 p0085 N77-10465
Societal implications of energy scarcity. Social and technological priorities in steady state and constricting systems
[PB-253097/0] 13 p0099 N77-11556
WASHINGTON UNIV., SEATTLE.
Assessing the relationship between urban form and travel requirements: A literature review and conceptual framework
[PB-254988/9] 13 p0102 N77-11923
WEST VIRGINIA UNIV., MORGANTOWN.
The use of an interactive energy model for technology assessment with special reference to underground coal gasification
[PB-255543/1] 13 p0098 N77-11545
WESTINGHOUSE ELECTRIC CORP., LESTER, PA.
Advanced coal gasification system for electric power generation
[FE-1514-176] 13 p0088 N77-10653
WESTINGHOUSE RESEARCH LABS., PITTSBURGH, PA.
Thin film solar cells for terrestrial applications
[PB-255606/6] 13 p0109 N77-12553
WISCONSIN UNIV., MADISON.
Increased fuel economy in transportation systems by use of energy management: Second year's program. Executive summary
[PB-256117/3] 13 p0108 N77-12536
A design procedure for solar heating systems
13 p0128 N77-15485
Increased fuel economy in transportation systems by use of energy management - second year's program
[PB-257177/6] 13 p0133 N77-15930

CONTRACT NUMBER INDEX

Typical Contract Number Index Listing



Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the *IAA* accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the *IAA* or *STAR* section. Preceding the accession number are the issue and page number in the particular supplement in which the citation may be found.

AF PROJ. 3048
13 p0112 N77-13234
AF PROJ. 3145
13 p0108 N77-12539
13 p0111 N77-12879
AF PROJ. 6302
13 p0127 N77-15213
AF PROJ. 6813
13 p0133 N77-15845
AF PROJ. 9752
13 p0133 N77-15845
ARB-3-929
13 p0092 N77-10720
AT(04-3)-1075
13 p0044 A77-12872
AT(04-03)-1086
13 p0030 A77-12750
AT(29-1)-789
13 p0088 N77-10655
13 p0097 N77-11537
13 p0122 N77-14587
AT(40-1)-4908
13 p0088 N77-10657
AT(45-1)-2170
13 p0131 N77-15509
AT(49-15)-3063
13 p0094 N77-11108
AT(49-15)-3069
13 p0041 A77-12840
BMFT-NT-4471
13 p0026 A77-12716
DA PROJ. 1F2-62208-AH-90
13 p0102 N77-12052
DA PROJ. 1G7-62708-AH-67
13 p0107 N77-12529
DA PROJ. 1T1-61102-A-34A
13 p0090 N77-10681
13 p0132 N77-15519
DA PROJ. 4A7-62719-AT-06
13 p0126 N77-14957
DA PROJ. 4A7-63734-DT-08
13 p0124 N77-14606
DAAG53-76-C-0014
13 p0107 N77-12529
DAAJ02-74-C-0066
13 p0102 N77-12052
DAAK02-72-C-0084
13 p0090 N77-10681
DAAK02-74-C-0367
13 p0090 N77-10684
DACA23-74-C-009
13 p0021 A77-12671
DGRST-73-7-1322
13 p0014 A77-11591
DGRST-74-7-1375
13 p0014 A77-11591
DI-BM-HO-357078
13 p0095 N77-11380
DI-14-01-0001-1664
13 p0099 N77-11557
13 p0099 N77-11558
13 p0100 N77-11559
DI-14-01-0001-2115
13 p0110 N77-12592
DI-14-03-6100N
13 p0115 N77-13550
DI-14-03-6101N
13 p0099 N77-11552
13 p0107 N77-12526
DI-14-03-6108N
13 p0107 N77-12528
DI-14-06-300-2479
13 p0132 N77-15520
DI-14-31-0001-3503
13 p0126 N77-14960
DI-14-32-001-1225
13 p0008 A77-11242
DI-14-32-0001-1224
13 p0008 A77-11243
DOT-CG-51487-A
13 p0110 N77-12572
DOT-OS-30112
13 p0020 A77-12664
13 p0108 N77-12536
13 p0133 N77-15930
DOT-OS-60072
13 p0125 N77-14939
DOT-TSC-989
13 p0066 A77-18232
DOT-UT-60006
13 p0111 N77-12946
E(04-3)-167
13 p0093 N77-10891
E(04-3)-1081
13 p0068 A77-18448
E(10-1)-1375
13 p0124 N77-14605
E(11-1)-1523
13 p0029 A77-12747
E(11-1)-2331
13 p0042 A77-12848
E(11-1)-2559
13 p0122 N77-14593
E(11-1)-2590
13 p0004 A77-11000
E(11-1)-2601
13 p0029 A77-12747
E(11-1)-2621
13 p0043 A77-12867
E(11-1)-2676
13 p0028 A77-12737
E(11-1)-2683
13 p0039 A77-12821
E(11-1)-2699
13 p0087 N77-10651
13 p0098 N77-11538
E(11-1)-2703
13 p0129 N77-15498
E(11-1)-2824
13 p0036 A77-12799
E(11-1)-3056
13 p0034 A77-12789
13 p0043 A77-12862
E(30-1)-16
13 p0098 N77-11539
E(34-1)-0019
13 p0122 N77-14595
E(36-2)-0058
13 p0130 N77-15505
E(40-1)-4944
13 p0123 N77-14600
E(40-1)-4976
13 p0039 A77-12824
E(45-1)-1830
13 p0058 A77-16374
13 p0123 N77-14602
E(49-15)-3063
13 p0041 A77-12838
E(49-18)-390
13 p0097 N77-11535
E(49-18)-1235
13 p0130 N77-15500
E(49-18)-1236
13 p0130 N77-15507
E(49-18)-1514
13 p0088 N77-10653
E(49-18)-1521
13 p0130 N77-15501
E(49-18)-1760
13 p0001 A77-10202
E(49-18)-1765
13 p0120 N77-14488
13 p0127 N77-15401
E(49-18)-1770
13 p0093 N77-10812
E(49-18)-1772
13 p0088 N77-10658
E(49-18)-1773
13 p0023 A77-12691
E(49-18)-1775
13 p0130 N77-15502
E(49-18)-1814
13 p0130 N77-15503
E(49-18)-2031
13 p0009 A77-11244
E(49-18)-2201
13 p0130 N77-15506
E(49-18)-2234
13 p0070 A77-18585
E(49-19)-1760
13 p0034 A77-12783
EPA-EOA-TAG-E693(78-BEG)
13 p0054 A77-15780
EPA-IAG-D4-0569
13 p0133 N77-15540
EPA-68-01-0432
13 p0084 N77-10222
EPA-68-01-0590
13 p0089 N77-10669
13 p0089 N77-10670
EPA-68-01-1561
13 p0092 N77-10719
EPA-68-01-1981
13 p0099 N77-11549
EPA-68-01-2476
13 p0110 N77-12576
EPA-68-01-2940
13 p0101 N77-11602
EPA-68-01-2951
13 p0096 N77-11513
EPA-68-02-0629
13 p0125 N77-14638
EPA-68-02-1275
13 p0084 N77-10221
EPA-68-02-1323
13 p0092 N77-10722
EPA-68-02-1324
13 p0133 N77-15550
13 p0133 N77-15919
EPA-68-02-1325
13 p0125 N77-14645
EPA-68-02-1360
13 p0091 N77-10686
13 p0115 N77-13549
EPA-68-02-1412
13 p0101 N77-11581
EPA-68-02-1729
13 p0124 N77-14630
EPA-68-02-1831
13 p0115 N77-13551
EPA-68-02-2076
13 p0092 N77-10709
EPA-68-02-2112
13 p0103 N77-12231
EPA-68-02-2315
13 p0101 N77-11589
EPA-68-03-2016
13 p0107 N77-12533
13 p0108 N77-12534
EPA-68-03-2172
13 p0102 N77-11603
EPA-68-03-2176
13 p0125 N77-14631
EPA-68-03-2207
13 p0060 A77-16651
EPRI PROJ. 572-2
13 p0101 N77-11599
ERDA WA-76-3104
13 p0071 A77-18790
ERDA-14-01-0001-1699
13 p0122 N77-14594
ERDA-75-S-134
13 p0099 N77-11551
FEA-C-04-50041-00
13 p0110 N77-12587
FEA-C-04-50088-00
13 p0091 N77-10690
FEA-CA-05-50078-00
13 p0096 N77-11516
FEA-CO-03-50222-00
13 p0096 N77-11515
FEA-CO-03-50222-000
13 p0086 N77-10633
FEA-CO-04-50224-00
13 p0115 N77-13542
13 p0115 N77-13543
FEA-CO-05-60574-00
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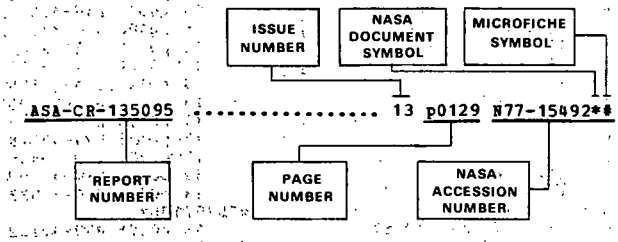
13 p0115 N77-13553
FEA-CO-12-60496-00
13 p0091 N77-10688
FEA-CO-50171-00
13 p0108 N77-12545
FEA-CR-05-60579-00
13 p0113 N77-13516
FEA-CR-05-60593-00
13 p0107 N77-12531
13 p0107 N77-12532
FWPCA-WA-11-0003
13 p0102 N77-11923
F33615-72-C-1088
13 p0111 N77-12879
F33615-73-C-4059
13 p0127 N77-15213
F33615-74-C-2036
13 p0023 A77-12690
F33615-74-C-2044
13 p0108 N77-12539
F44620-76-C-0024
13 p0133 N77-15845

H-2350
13 p0089 N77-10673
HUD-H-22026R
13 p0019 A77-12407
JPL-953913
13 p0118 N77-14193
JPL-954328
13 p0106 N77-12524
MA-5-38054
13 p0116 N77-13554
NASW-2558
13 p0104 N77-12476
NASW-2791
13 p0117 N77-13590
NASW-2792
13 p0097 N77-11528
NASW-2970
13 p0095 N77-11399
NAS1-14137
13 p0083 N77-10032
NAS1-14159
13 p0083 N77-10033
NAS1-14208
13 p0121 N77-14584
NAS2-8310
13 p0118 N77-14374
13 p0118 N77-14375
NAS2-8582
13 p0093 N77-11054
NAS2-8612
13 p0126 N77-15007
13 p0126 N77-15008
NAS2-9104
13 p0118 N77-14029
13 p0118 N77-14030
NAS3-18541
13 p0022 A77-12678
NAS3-18566
13 p0129 N77-15492
NAS3-18934
13 p0035 A77-12791
NAS3-19128
13 p0103 N77-12182
NAS3-19406
13 p0034 A77-12786
NAS3-19407
13 p0034 A77-12784
NAS3-19519
13 p0127 N77-15043
NAS3-19747
13 p0103 N77-12230
NAS3-19768
13 p0113 N77-13533
NAS3-19769
13 p0113 N77-13532
NAS3-19866
13 p0043 A77-12862
NAS5-20852
13 p0126 N77-14981
NAS5-21998
13 p0085 N77-10590
NAS5-22399
13 p0104 N77-12475
NAS7-100
13 p0014 A77-11818
13 p0020 A77-12663
13 p0029 A77-12745
13 p0031 A77-12759
13 p0032 A77-12768
13 p0036 A77-12803
13 p0037 A77-12804
13 p0037 A77-12807
13 p0038 A77-12813
13 p0039 A77-12819
13 p0041 A77-12836
13 p0065 A77-18225
13 p0070 A77-18721
13 p0086 N77-10637
13 p0094 N77-11198
13 p0105 N77-12509
13 p0105 N77-12513
13 p0106 N77-12524
13 p0118 N77-14193
13 p0118 N77-14194
13 p0122 N77-14586
13 p0129 N77-15497
NAS8-21812
13 p0040 A77-12835
NAS8-31308
13 p0129 N77-15494
13 p0129 N77-15495
13 p0129 N77-15496
NAS8-31324
13 p0127 N77-15347
NAS8-31327
13 p0086 N77-10638
NAS8-31352
13 p0040 A77-12825
NAS8-31782
13 p0085 N77-10610
NAS9-14323
13 p0040 A77-12829
NAS9-14345
13 p0097 N77-11532
NAS9-14958
13 p0094 N77-11084
13 p0094 N77-11085
NGL-22-007-006
13 p0058 A77-16270
NGR-18-001-086
13 p0047 A77-13538
13 p0048 A77-13541
NRL PROJ. C01-03A
13 p0127 N77-15121
NSF AER-72-03478
13 p0089 N77-10674
NSF AER-72-03478-A04
13 p0089 N77-10672
NSF AER-72-03579-A05
13 p0090 N77-10685
NSF AER-73-07199
13 p0025 A77-12708
NSF AER-73-07957
13 p0007 A77-11110
13 p0090 N77-10678
NSF AER-74-04014A03
13 p0050 A77-14559
NSF AER-74-09186
13 p0090 N77-10675
NSF AER-74-13292
13 p0099 N77-11548
NSF AER-74-14718-A01
13 p0109 N77-12553
NSF AER-74-17940-A01
13 p0101 N77-11577
NSF AER-74-19931
13 p0123 N77-14603
NSF AER-75-1679
13 p0098 N77-11547
NSF AER-75-00187
13 p0116 N77-13556
NSF AER-75-00647
13 p0044 A77-12869
NSF AER-75-00826
13 p0084 N77-10271
13 p0115 N77-13552
NSF AER-75-13673
13 p0096 N77-11511
NSF AER-75-14492
13 p0030 A77-12753
NSF AER-75-19712
13 p0109 N77-12553
NSF AER-75-000653
13 p0043 A77-12868
NSF AER-76-09748
13 p0098 N77-11544
NSF APR-74-21034
13 p0018 A77-12401
NSF ATM-75-00351
13 p0067 A77-18351
NSF BMS-75-04108
13 p0064 A77-17895
NSF C-805
13 p0025 A77-12708
NSF C-925
13 p0112 N77-13232
13 p0112 N77-13233
NSF C-993
13 p0026 A77-12722
NSF DMR-75-18134
13 p0108 N77-12538
NSF ENG-74-018062
13 p0031 A77-12765
NSF G-6542
13 p0067 A77-18439
NSF G-8748
13 p0067 A77-18439
NSF G-13657
13 p0067 A77-18439
NSF G-17168
13 p0067 A77-18439
NSF G-19168
13 p0067 A77-18439
NSF GA-873
13 p0067 A77-18439
NSF GA-13645
13 p0067 A77-18439
NSF GA-13839
13 p0067 A77-18439
NSF GA-31324X
13 p0067 A77-18439
NSF GI-44
13 p0085 N77-10625
13 p0090 N77-10680
NSF GI-27976
13 p0057 A77-16206
NSF GI-29729
13 p0057,A77-16206
NSF GI-32724
13 p0098 N77-11545
NSF GI-34782
13 p0089 N77-10672
NSF GI-38102X
13 p0076 A77-19087
NSF GI-38103
13 p0090 N77-10685
NSF GI-38701
13 p0059 A77-16475
NSF GI-38974
13 p0070 A77-18583
NSF GI-41470
13 p0098 N77-11544
NSF GI-41898
13 p0076 A77-19089
NSF GI-43090
13 p0108 N77-12548
NSF GI-43895
13 p0099 N77-11551
NSF GI-43896
13 p0090 N77-10676
NSF GI-44381
13 p0091 N77-10689
NSF GP-4193
13 p0067 A77-18439
NSF IOP-74-12932
13 p0061 A77-17014
NSF MPS-75-05769
13 p0098 N77-11543
NSF SE-AER-72-03579
13 p0007 A77-11108
NSF SIA-73-07871-A02
13 p0086 N77-10626
NSF SIA-74-17662-A02
13 p0121 N77-14495
NSF SIA-74-18660
13 p0085 N77-10625
13 p0090 N77-10680
NSF SIA-74-19080A01
13 p0060 A77-16651
NSF SIA-75-18811
13 p0089 N77-10665
13 p0089 N77-10666
NSF ST-40016000
13 p0017 A77-12234
NSF Y-910132
13 p0067 A77-18439
NSG-1186
13 p0117 N77-13913
NSG-2015
13 p0085 N77-10465
NSG-2064
13 p0095 N77-11340
N00014-74-C-0348
13 p0089 N77-10664
N00014-75-C-0055
13 p0095 N77-11207
N00014-75-C-0220
13 p0033 A77-12780
N00014-75-C-0539
13 p0052 A77-14890
N00024-74-C-5136
13 p0120 N77-14492
SRI PROJ. 4963-100
13 p0107 N77-12528
STU-75-3130
13 p0114 N77-13539
W-7405-ENG-26
13 p0060 A77-16623
13 p0086 N77-10643
13 p0088 N77-10656
13 p0113 N77-13525
13 p0113 N77-13526
13 p0113 N77-13527
13 p0113 N77-13528
W-7405-ENG-36
13 p0002 A77-10634
13 p0060 A77-16623
13 p0068 A77-18441
13 p0087 N77-10650
13 p0123 N77-14601
W-7405-ENG-48
13 p0087 N77-10652
13 p0091 N77-10697
13 p0100 N77-11572
13 p0105 N77-12506
13 p0106 N77-12525
13 p0123 N77-14596
13 p0123 N77-14604
13 p0124 N77-14611
13 p0125 N77-14948
13 p0129 N77-15499
13 p0131 N77-15508
13 p0132 N77-15533
WP57571301
13 p0103 N77-12232
506-23
13 p0094 N77-11175
13 p0121 N77-14585
610-22
13 p0095 N77-11268
647-10-00-00-72
13 p0126 N77-14955

Typical Report/Accession Number Index Listing



Listings in this index are arranged alphanumerically by report number. The issue and page number indicate the actual Supplement and page where the citation may be located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche. A plus sign (+) indicates a document that cannot be microfiched but for which one-to-one facsimile is available.

AD-A023010 ..... 13 p0089 N77-10664 #
AD-A023689 ..... 13 p0090 N77-10681 #
AD-A023763 ..... 13 p0095 N77-11208 #
AD-A024042 ..... 13 p0102 N77-11927 #
AD-A024216 ..... 13 p0090 N77-10684 #
AD-A024652 ..... 13 p0095 N77-11207 #
AD-A024661 ..... 13 p0110 N77-12571 #
AD-A024662 ..... 13 p0102 N77-12052 #
AD-A024832 ..... 13 p0115 N77-13548 #
AD-A025119 ..... 13 p0108 N77-12535 #
AD-A025326 ..... 13 p0107 N77-12529 #
AD-A025417 ..... 13 p0112 N77-13231 #
AD-A025472 ..... 13 p0095 N77-11417 #
AD-A025684 ..... 13 p0103 N77-12232 #
AD-A025716 ..... 13 p0120 N77-14492 #
AD-A025748 ..... 13 p0110 N77-12572 #
AD-A025922 ..... 13 p0108 N77-12539 #
AD-A025949 ..... 13 p0111 N77-12879 #
AD-A026041 ..... 13 p0116 N77-13557 #
AD-A026053 ..... 13 p0131 N77-15517 #
AD-A026059 ..... 13 p0128 N77-15409 #
AD-A026141 ..... 13 p0132 N77-15521 #
AD-A026164 ..... 13 p0131 N77-15518 #
AD-A026195 ..... 13 p0124 N77-14609 #
AD-A026321 ..... 13 p0124 N77-14607 #
AD-A026405 ..... 13 p0131 N77-15512 #
AD-A026546 ..... 13 p0112 N77-13234 #
AD-A026582 ..... 13 p0131 N77-15510 #
AD-A026588 ..... 13 p0124 N77-14606 #
AD-A026666 ..... 13 p0118 N77-14272 #
AD-A026667 ..... 13 p0118 N77-14271 #
AD-A026859 ..... 13 p0132 N77-15519 #
AD-A026956 ..... 13 p0126 N77-14957 #
AD-A026962 ..... 13 p0131 N77-15511 #
AD-A026967 ..... 13 p0121 N77-14528 #
AD-A027258 ..... 13 p0117 N77-14016 #
AD-A027411 ..... 13 p0127 N77-15121 #
AD-A027521 ..... 13 p0127 N77-15220 #
AD-A027594 ..... 13 p0127 N77-15213 #
AD-A027654 ..... 13 p0133 N77-15845 #
AD-A034359 ..... 13 p0127 N77-15210 #

ADAPT-75-8 ..... 13 p0125 N77-14631 #

ADL-C-78534-VOL-1 ..... 13 p0089 N77-10673 #

ADL-760012 ..... 13 p0109 N77-12555 #

AECL-5314 ..... 13 p0097 N77-11533 #

AFAPL-TR-75-98 ..... 13 p0108 N77-12539 #
AFAPL-TR-76-20 ..... 13 p0112 N77-13234 #

AFAPL-TR-76-21 ..... 13 p0111 N77-12879 #

AFOSR-76-0171TR ..... 13 p0133 N77-15845 #

AIAA PAPER 76-1064 ..... 13 p0045 A77-13030 #
AIAA PAPER 76-1068 ..... 13 p0045 A77-13033*#
AIAA PAPER 77-276 ..... 13 p0065 A77-18215 #
AIAA PAPER 77-286 ..... 13 p0065 A77-18222 #
AIAA PAPER 77-289 ..... 13 p0065 A77-18223 #
AIAA PAPER 77-291 ..... 13 p0065 A77-18224 #
AIAA PAPER 77-293 ..... 13 p0065 A77-18225*#
AIAA PAPER 77-294 ..... 13 p0065 A77-18226 #
AIAA PAPER 77-296 ..... 13 p0066 A77-18227 #
AIAA PAPER 77-307 ..... 13 p0066 A77-18232 #
AIAA PAPER 77-312 ..... 13 p0066 A77-18237*#
AIAA PAPER 77-346 ..... 13 p0066 A77-18254 #
AIAA PAPER 77-352 ..... 13 p0066 A77-18257 #
AIAA PAPER 77-353 ..... 13 p0066 A77-18258*#
AIAA PAPER 77-354 ..... 13 p0066 A77-18259 #
AIAA PAPER 77-356 ..... 13 p0067 A77-18260 #

AIRESEARCH-76-211893 ..... 13 p0093 N77-11054*#

AMRL-TR-76-50 ..... 13 p0127 N77-15213 #

ANCR-1283 ..... 13 p0124 N77-14605 #

AP-42-SUPPL-6 ..... 13 p0093 N77-10731 #

APL/JHU-SR-76-1A ..... 13 p0109 N77-12552 #
APL/JHU-SR-76-1B ..... 13 p0116 N77-13554 #

AR-1 ..... 13 p0105 N77-12513*#

ARB-R-3-929-75-48 ..... 13 p0092 N77-10720 #

ASR-5 ..... 13 p0092 N77-10715 #

ASRL-TR-184-2 ..... 13 p0115 N77-13552 #

ATR-76(7467)-1 ..... 13 p0121 N77-14495 #

BLL-M-25448-(5828.4F) 13 p0112 N77-13235

BM-IC-8704 ..... 13 p0112 N77-13229 #
BM-IC-8705 ..... 13 p0112 N77-13230 #
BM-IC-8708 ..... 13 p0085 N77-10623 #
BM-IC-8711 ..... 13 p0085 N77-10391 #

BM-OFR-77-76 ..... 13 p0095 N77-11380 #

BM-RI-8151 ..... 13 p0096 N77-11518 #

BM-SP-2-75 ..... 13 p0085 N77-10624 #

BMFT-FB-T-76-25 ..... 13 p0114 N77-13540 #

BMFT-NT-145 ..... 13 p0114 N77-13540 #

BNL-20877 ..... 13 p0087 N77-10648 #
BNL-20899 ..... 13 p0085 N77-10542 #
BNL-20931 ..... 13 p0094 N77-11201 #
BNL-50493 ..... 13 p0098 N77-11539 #

BNWL-1989 ..... 13 p0123 N77-14602 #

C-781-B-VOL-2 ..... 13 p0092 N77-10709 #
C-1037-2-6 ..... 13 p0085 N77-10590*#

CE-TR-205 ..... 13 p0101 N77-11577 #

CERL-TR-E-91 ..... 13 p0124 N77-14606 #

CN-ISSN-0082-5247 ..... 13 p0087 N77-10644 #

NASA-CR-135112 ..... 13 p0103 N77-12230*#
NASA-CR-135136 ..... 13 p0127 N77-15043*#
NASA-CR-137912 ..... 13 p0095 N77-11340*#
NASA-CR-137926 ..... 13 p0126 N77-15007*#
NASA-CR-137927 ..... 13 p0126 N77-15008*#
NASA-CR-137937 ..... 13 p0118 N77-14029*#
NASA-CR-137938 ..... 13 p0118 N77-14030*#
NASA-CR-137944 ..... 13 p0093 N77-11054*#
NASA-CR-137953 ..... 13 p0118 N77-14374*#
NASA-CR-137954 ..... 13 p0118 N77-14375*#
NASA-CR-144838 ..... 13 p0126 N77-14981*#
NASA-CR-148978 ..... 13 p0085 N77-10590*#
NASA-CR-149091 ..... 13 p0086 N77-10637*#
NASA-CR-149095 ..... 13 p0085 N77-10465*#
NASA-CR-149131 ..... 13 p0096 N77-11491*#
NASA-CR-149146 ..... 13 p0094 N77-11198*#
NASA-CR-149181 ..... 13 p0104 N77-12475*#
NASA-CR-149208 ..... 13 p0104 N77-12486*#
NASA-CR-149228 ..... 13 p0104 N77-12476*#
NASA-CR-149235 ..... 13 p0105 N77-12509*#
NASA-CR-149242 ..... 13 p0105 N77-12513*#
NASA-CR-149342 ..... 13 p0122 N77-14586*#
NASA-CR-149364 ..... 13 p0118 N77-14193*#
NASA-CR-149365 ..... 13 p0118 N77-14194*#
NASA-CR-149373 ..... 13 p0129 N77-15497*#
NASA-CR-149451 ..... 13 p0106 N77-12524*#
NASA-CR-150024 ..... 13 p0085 N77-10610*#
NASA-CR-150032 ..... 13 p0086 N77-10638*#
NASA-CR-150146 ..... 13 p0129 N77-15494*#
NASA-CR-150147 ..... 13 p0129 N77-15495*#
NASA-CR-150148 ..... 13 p0129 N77-15496*#
NASA-CR-150152 ..... 13 p0127 N77-15347*#
NASA-CR-150957 ..... 13 p0097 N77-11532*#
NASA-CR-151102 ..... 13 p0094 N77-11084*#
NASA-CR-151103 ..... 13 p0094 N77-11085*#

NASA-TM-X-3455 ..... 13 p0095 N77-11268*#
NASA-TM-X-3465 ..... 13 p0121 N77-14585*#
NASA-TM-X-58188 ..... 13 p0126 N77-14955*#
NASA-TM-X-71601 ..... 13 p0086 N77-10640*#
NASA-TM-X-73344 ..... 13 p0128 N77-15486*#
NASA-TM-X-73355 ..... 13 p0128 N77-15489*#
NASA-TM-X-73408 ..... 13 p0127 N77-15208*#
NASA-TM-X-73415 ..... 13 p0114 N77-13536*#
NASA-TM-X-73487 ..... 13 p0083 N77-10116*#
NASA-TM-X-73489 ..... 13 p0105 N77-12517*#
NASA-TM-X-73491 ..... 13 p0086 N77-10642*#
NASA-TM-X-73496 ..... 13 p0105 N77-12518*#
NASA-TM-X-73498 ..... 13 p0097 N77-11529*#
NASA-TM-X-73501 ..... 13 p0083 N77-10149*#
NASA-TM-X-73520 ..... 13 p0097 N77-11530*#
NASA-TM-X-73531 ..... 13 p0106 N77-12519*#
NASA-TM-X-73543 ..... 13 p0104 N77-12406*#
NASA-TM-X-73546 ..... 13 p0128 N77-15487*#
NASA-TM-X-73547 ..... 13 p0106 N77-12520*#
NASA-TM-X-73548 ..... 13 p0114 N77-13534*#
NASA-TM-X-73549 ..... 13 p0106 N77-12521*#
NASA-TM-X-73553 ..... 13 p0114 N77-13535*#
NASA-TM-X-73557 ..... 13 p0111 N77-13064*#
NASA-TM-X-73562 ..... 13 p0106 N77-12522*#
NASA-TM-X-73563 ..... 13 p0106 N77-12523*#
NASA-TM-X-73567 ..... 13 p0114 N77-13537*#
NASA-TM-X-73581 ..... 13 p0126 N77-15037*#
NASA-TM-X-73964 ..... 13 p0117 N77-13913*#
NASA-TM-X-74295 ..... 13 p0093 N77-11055*#

NASA-TN-D-8341 ..... 13 p0094 N77-11175*#
NASA-TN-D-8393 ..... 13 p0128 N77-15491*#

NASA-TT-F-16938 ..... 13 p0117 N77-13590*#
NASA-TT-F-17111 ..... 13 p0095 N77-11399*#
NASA-TT-F-17139 ..... 13 p0097 N77-11528*#

NBS-BSS-90 ..... 13 p0132 N77-15524 #

NBSIR-75-1049 ..... 13 p0103 N77-12166 #
NBSIR-76-1056 ..... 13 p0091 N77-10687 #
NBSIR-76-1059 ..... 13 p0132 N77-15525 #

NOAA-76052603 ..... 13 p0108 N77-12547 #

NRC-15233 ..... 13 p0124 N77-14609 #
NRC-15638 ..... 13 p0127 N77-15210 #

NRL-MR-3294 ..... 13 p0103 N77-12232 #

NRL-8013 ..... 13 p0127 N77-15121 #

NSF/DP-76-001A ..... 13 p0098 N77-11544 #

NSF/ERG-76-4 ..... 13 p0098 N77-11543 #
NSF/ERGSS-76-6 ..... 13 p0099 N77-11556 #
NSF/RA-760008 ..... 13 p0121 N77-14495 #
NSF/RA-760026 ..... 13 p0093 N77-10964 #
NSF/RA-760059 ..... 13 p0089 N77-10672 #
NSF/RA-760100 ..... 13 p0091 N77-10689 #
NSF/RA-760101 ..... 13 p0090 N77-10678 #
NSF/RA-760102 ..... 13 p0098 N77-11547 #
NSF/RA-760120-VOL-1 ..... 13 p0089 N77-10665 #
NSF/RA-760121-VOL-2 ..... 13 p0089 N77-10666 #
NSF/RA-760129 ..... 13 p0109 N77-12553 #
NSF/RA-760130 ..... 13 p0098 N77-11545 #
NSF/RA-760156 ..... 13 p0096 N77-11511 #
NSF/RA-760160 ..... 13 p0115 N77-13552 #
NSF/RA-760162 ..... 13 p0105 N77-12502 #
NSF/RA-760163 ..... 13 p0090 N77-10685 #
NSF/RA-760181 ..... 13 p0116 N77-13556 #
NSF/RA-760185 ..... 13 p0098 N77-11544 #
NSF/RA/N-75-049 ..... 13 p0123 N77-14603 #
NSF/RA/N-75-224 ..... 13 p0090 N77-10676 #
NSF/RA/N-75-225 ..... 13 p0085 N77-10625 #
NSF/RA/N-75-231 ..... 13 p0090 N77-10675 #
NSF/RA/N-75-233 ..... 13 p0089 N77-10674 #
NSF/RA/N-75-283 ..... 13 p0101 N77-11577 #
NSF/RA/N-75-285 ..... 13 p0099 N77-11548 #
NSF/RA/N-75-301 ..... 13 p0090 N77-10680 #
NSF/RA/N-75-309 ..... 13 p0108 N77-12548 #
NSF/RA/N-75-310 ..... 13 p0099 N77-11551 #
NSF/RANN/AER-72-03478-A03/PR/7 ... 13 p0089 N77-10674 #
NSF/RANN/AER-72-03478-A04/TR76 ... 13 p0089 N77-10672 #
NSF/RANN/SE/AER-72-03579/A05 ... 13 p0090 N77-10685 #
NSF/RANN/SE/AER-74-09186 ..... 13 p0090 N77-10675 #
NSF/RANN/SE/AER-74-17940-A01 ... 13 p0101 N77-11577 #
NSF/RANN/SE/AER73-07957/PR-76 ... 13 p0090 N77-10678 #
NSF/RANN/SE/AER74-14918-A01/PR ... 13 p0109 N77-12553 #
NSF/RANN/SE/GI-43090/PR-75-2 ... 13 p0108 N77-12548 #
NSF/RANN/SE/GI-43895/PR-74-4 ... 13 p0099 N77-11551 #

NUREG-0109 ..... 13 p0125 N77-14740 #

NUS-1725 ..... 13 p0121 N77-14573 #

NYSERDA-75/02 ..... 13 p0101 N77-11575 #

ONRL-C-14-76 ..... 13 p0131 N77-15511 #

ORAU-125 ..... 13 p0122 N77-14594 #
ORAU-126 ..... 13 p0094 N77-11200 #

ORNL-5198 ..... 13 p0086 N77-10643 #

ORNL/TM-5069 ..... 13 p0088 N77-10656 #

ORO-4944-3 ..... 13 p0123 N77-14600 #

OSURF-4122-1 ..... 13 p0099 N77-11548 #

OUEL-1146/76 ..... 13 p0094 N77-11158 #

OWRT-A-028-ARIZ(4) ..... 13 p0126 N77-14960 #

P-5547 ..... 13 p0131 N77-15510 #
P-5577 ..... 13 p0118 N77-14272 #
P-5578 ..... 13 p0118 N77-14271 #

PAS-76-5 ..... 13 p0131 N77-15512 #

PB-245422/1 ..... 13 p0099 N77-11557 #
PB-245423/9 ..... 13 p0099 N77-11558 #
PB-245424/7 ..... 13 p0100 N77-11559 #
PB-249881/4 ..... 13 p0101 N77-11575 #
PB-252409/8 ..... 13 p0089 N77-10672 #
PB-252458/5 ..... 13 p0093 N77-10964 #
PB-252462/7 ..... 13 p0092 N77-10717 #
PB-252463/5 ..... 13 p0098 N77-11543 #
PB-252473/4 ..... 13 p0085 N77-10623 #
PB-252485/8 ..... 13 p0088 N77-10662 #
PB-252486/6 ..... 13 p0089 N77-10663 #
PB-252504/6 ..... 13 p0085 N77-10625 #
PB-252539/2 ..... 13 p0089 N77-10674 #
PB-252592/1 ..... 13 p0090 N77-10675 #
PB-252608/5 ..... 13 p0090 N77-10676 #
PB-252642/4 ..... 13 p0086 N77-10626 #
PB-252837/0 ..... 13 p0099 N77-11548 #
PB-252924/6 ..... 13 p0101 N77-11577 #
PB-252994/9 ..... 13 p0085 N77-10624 #
PB-253097/0 ..... 13 p0099 N77-11556 #
PB-253099/6 ..... 13 p0101 N77-11599 #
PB-253322/2 ..... 13 p0089 N77-10670 #

PB-253361/0 ..... 13 p0089 N77-10669 #
PB-253363/6 ..... 13 p0084 N77-10221 #
PB-253375/0 ..... 13 p0092 N77-10715 #
PB-253661/3 ..... 13 p0092 N77-10707 #
PB-253713/2 ..... 13 p0096 N77-11475 #
PB-253784/3 ..... 13 p0089 N77-10673 #
PB-253908/8 ..... 13 p0083 N77-10220 #
PB-253962/5 ..... 13 p0099 N77-11553 #
PB-254059/9 ..... 13 p0107 N77-12527 #
PB-254088/8 ..... 13 p0084 N77-10222 #
PB-254163/9 ..... 13 p0093 N77-10941 #
PB-254166/2 ..... 13 p0101 N77-11581 #
PB-254167/0 ..... 13 p0091 N77-10686 #
PB-254168/8 ..... 13 p0092 N77-10722 #
PB-254179/5 ..... 13 p0091 N77-10687 #
PB-254182/9 ..... 13 p0092 N77-10719 #
PB-254222/3 ..... 13 p0085 N77-10391 #
PB-254278/4 ..... 13 p0093 N77-10731 #
PB-254314/8 ..... 13 p0090 N77-10680 #
PB-254401/3 ..... 13 p0109 N77-12568 #
PB-254413/8 ..... 13 p0089 N77-10667 #
PB-254449/2 ..... 13 p0092 N77-10720 #
PB-254466/6 ..... 13 p0089 N77-10665 #
PB-254467/4 ..... 13 p0089 N77-10666 #
PB-254637/2 ..... 13 p0098 N77-11547 #
PB-254665/3 ..... 13 p0091 N77-10689 #
PB-254730/5 ..... 13 p0091 N77-10688 #
PB-254823/8 ..... 13 p0095 N77-11380 #
PB-254878/2 ..... 13 p0096 N77-11511 #
PB-254879/0 ..... 13 p0090 N77-10678 #
PB-254925/1 ..... 13 p0096 N77-11516 #
PB-254969/9 ..... 13 p0084 N77-10224 #
PB-254988/9 ..... 13 p0102 N77-11923 #
PB-254991/3 ..... 13 p0086 N77-10633 #
PB-255117/4 ..... 13 p0099 N77-11549 #
PB-255170/3 ..... 13 p0107 N77-12526 #
PB-255171/1 ..... 13 p0099 N77-11552 #
PB-255172/9 ..... 13 p0125 N77-14939 #
PB-255176/0 ..... 13 p0112 N77-13229 #
PB-255177/8 ..... 13 p0112 N77-13230 #
PB-255302/2 ..... 13 p0092 N77-10709 #
PB-255317/0 ..... 13 p0110 N77-12597 #
PB-255319/6 ..... 13 p0096 N77-11509 #
PB-255320/4 ..... 13 p0096 N77-11515 #
PB-255349/3 ..... 13 p0102 N77-11930 #
PB-255351/9 ..... 13 p0091 N77-10690 #
PB-255401/2 ..... 13 p0117 N77-13922 #
PB-255476/4 ..... 13 p0098 N77-11546 #
PB-255488/9 ..... 13 p0099 N77-11551 #
PB-255497/0 ..... 13 p0096 N77-11518 #
PB-255543/1 ..... 13 p0098 N77-11545 #
PB-255550/6 ..... 13 p0110 N77-12598 #
PB-255556/3 ..... 13 p0101 N77-11589 #
PB-255586/0 ..... 13 p0116 N77-13566 #
PB-255590/2 ..... 13 p0104 N77-12486*#
PB-255606/6 ..... 13 p0109 N77-12553 #
PB-255607/4 ..... 13 p0105 N77-12502 #
PB-255623/1 ..... 13 p0111 N77-12930 #
PB-255624/9 ..... 13 p0108 N77-12540 #
PB-255630/6 ..... 13 p0126 N77-14960 #
PB-255635/5 ..... 13 p0093 N77-10970 #
PB-255639/7 ..... 13 p0109 N77-12552 #
PB-255646/2 ..... 13 p0109 N77-12551 #
PB-255652/0 ..... 13 p0108 N77-12545 #
PB-255658/7 ..... 13 p0115 N77-13542 #
PB-255659/5 ..... 13 p0115 N77-13543 #
PB-255695/9 ..... 13 p0096 N77-11513 #
PB-255696/7 ..... 13 p0100 N77-11561 #
PB-255697/5 ..... 13 p0100 N77-11563 #
PB-255699/1 ..... 13 p0101 N77-11588 #
PB-255703/1 ..... 13 p0090 N77-10685 #
PB-255726/2 ..... 13 p0093 N77-10974 #
PB-255765/0 ..... 13 p0107 N77-12528 #
PB-255813/8 ..... 13 p0102 N77-11603 #
PB-255842/7 ..... 13 p0125 N77-14638 #
PB-255855/9 ..... 13 p0109 N77-12549 #
PB-255857/5 ..... 13 p0100 N77-11562 #
PB-255859/1 ..... 13 p0125 N77-14950 #
PB-255903/7 ..... 13 p0108 N77-12548 #
PB-255920/1 ..... 13 p0124 N77-14608 #
PB-255927/6 ..... 13 p0110 N77-12592 #
PB-255929/2 ..... 13 p0121 N77-14495 #
PB-255937/5 ..... 13 p0110 N77-12587 #
PB-255947/4 ..... 13 p0124 N77-14610 #
PB-255948/2 ..... 13 p0105 N77-12500 #
PB-255956/5 ..... 13 p0110 N77-12581 #
PB-255991/2 ..... 13 p0107 N77-12530 #
PB-255992/0 ..... 13 p0107 N77-12531 #
PB-255993/8 ..... 13 p0107 N77-12532 #
PB-255994/6 ..... 13 p0107 N77-12533 #
PB-255995/3 ..... 13 p0108 N77-12534 #
PB-256007/6 ..... 13 p0112 N77-13232 #
PB-256008/4 ..... 13 p0112 N77-13233 #
PB-256020/9 ..... 13 p0103 N77-12231 #
PB-256034/0 ..... 13 p0109 N77-12554 #
PB-256044/9 ..... 13 p0116 N77-13555 #
PB-256093/6 ..... 13 p0108 N77-12547 #
PB-256117/3 ..... 13 p0108 N77-12536 #
PB-256155/3 ..... 13 p0109 N77-12555 #
PB-256198/3 ..... 13 p0115 N77-13552 #
PB-256264/3 ..... 13 p0103 N77-12166 #
PB-256293/2 ..... 13 p0101 N77-11602 #
PB-256320/3 ..... 13 p0116 N77-13569 #
PB-256321/1 ..... 13 p0116 N77-13570 #
PB-256420/1 ..... 13 p0115 N77-13551 #
PB-256424/3 ..... 13 p0110 N77-12576 #
PB-256615/6 ..... 13 p0108 N77-12538 #
PB-256635/4 ..... 13 p0098 N77-11544 #
PB-256649/5 ..... 13 p0124 N77-14630 #
PB-256665/1 ..... 13 p0115 N77-13553 #
PB-256679/2 ..... 13 p0125 N77-14631 #
PB-256680/0 ..... 13 p0121 N77-14573 #
PB-256691/7 ..... 13 p0133 N77-15540 #
PB-256714/7 ..... 13 p0113 N77-13516 #
PB-256766/7 ..... 13 p0115 N77-13550 #
PB-256775/8 ..... 13 p0116 N77-13556 #
PB-256806/1 ..... 13 p0115 N77-13549 #
PB-256846/7 ..... 13 p0111 N77-12946 #
PB-256898/8 ..... 13 p0133 N77-15923 #
PB-256966/3 ..... 13 p0132 N77-15523 #
PB-256997/8 ..... 13 p0103 N77-12203 #
PB-257036/4 ..... 13 p0133 N77-15539 #
PB-257054/7 ..... 13 p0125 N77-14740 #
PB-257086/9 ..... 13 p0132 N77-15525 #
PB-257105/7 ..... 13 p0133 N77-15919 #
PB-257136/2 ..... 13 p0133 N77-15550 #
PB-257137/0 ..... 13 p0133 N77-15541 #
PB-257146/1 ..... 13 p0125 N77-14643 #
PB-257177/6 ..... 13 p0133 N77-15930 #
PB-257182/6 ..... 13 p0125 N77-14645 #
PB-257225/3 ..... 13 p0132 N77-15520 #
PB-257374/9 ..... 13 p0132 N77-15527 #
PB-257444/0 ..... 13 p0116 N77-13554 #
PB-257553/8 ..... 13 p0132 N77-15528 #
PB-257581/9 ..... 13 p0132 N77-15524 #

PERC-0058-4 ..... 13 p0130 N77-15505 #

PFTR-1030-76-8 ..... 13 p0085 N77-10610*#

QPR-1 ..... 13 p0086 N77-10637*#
QPR-1 ..... 13 p0090 N77-10678 #
QPR-3 ..... 13 p0109 N77-12553 #
QPR-4 ..... 13 p0096 N77-11511 #
QPR-5 ..... 13 p0104 N77-12475*#

QTPR-2 ..... 13 p0127 N77-15401 #

R-1590-NSF ..... 13 p0085 N77-10625 #
R-1591-NSF/EPA ..... 13 p0090 N77-10680 #

RA-75-46C ..... 13 p0096 N77-11516 #

RAH-070-VOL-2 ..... 13 p0107 N77-12532 #
RAH-070A-VOL-1 ..... 13 p0107 N77-12531 #

REPT-76-9G9-TFSOL-R2 ..... 13 p0109 N77-12553 #
REPT-76-112-1 ..... 13 p0104 N77-12476*#
REPT-76-145-2-VOL-1 ..... 13 p0129 N77-15494*#
REPT-76-145-2-VOL-2 ..... 13 p0129 N77-15495*#
REPT-76-145-2-VOL-3 ..... 13 p0129 N77-15496*#
REPT-114 ..... 13 p0130 N77-15502 #
REPT-273-C ..... 13 p0110 N77-12572 #
REPT-380-4686F ..... 13 p0108 N77-12539 #
REPT-3884-FR ..... 13 p0129 N77-15492*#

RE5429-97-76 ..... 13 p0115 N77-13543 #

RR-2 ..... 13 p0118 N77-14374*#

RTOP-777-30-01 ..... 13 p0122 N77-14586*#
RTOP-777-30-01 ..... 13 p0129 N77-15497*#

R76AEG597 ..... 13 p0127 N77-15043*#

SAE PAPER 760161 ..... 13 p0016 A77-12150

SAND-75-5910 ..... 13 p0130 N77-15504 #

SAND-75-8063 ..... 13 p0088 N77-10655 #
SAND-76-0009 ..... 13 p0097 N77-11537 #
SAND-76-0012 ..... 13 p0122 N77-14587 #

SAWE PAPER 1101 ..... 13 p0016 A77-12181 #
SAWE PAPER 1124 ..... 13 p0016 A77-12192*#
SAWE PAPER 1126 ..... 13 p0016 A77-12194*#
SAWE PAPER 1127 ..... 13 p0016 A77-12195 #

SD-76-SA-0230 ..... 13 p0127 N77-15347*#

SPD-332-03 ..... 13 p0127 N77-15220 #

SRI-EGU-3505-UR-1-VOL-1 ..... 13 p0107 N77-12533 #
SRI-EGU-3505-VOL-2 ..... 13 p0108 N77-12534 #

SSC-258 ..... 13 p0120 N77-14492 #

SU-HTGL-104 ..... 13 p0111 N77-12879 #

SU-SRI-3570-17 ..... 13 p0101 N77-11602 #

TETRAT-A-412-75-011-APP-A ..... 13 p0099 N77-11558 #
TETRAT-A-412-75-011-APP-B ..... 13 p0100 N77-11559 #
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TE5429-97-76 ..... 13 p0115 N77-13542 #

TID-4581-R3 ..... 13 p0102 N77-11695 #
TID-27003 ..... 13 p0100 N77-11573 #

TK-75-0016 ..... 13 p0110 N77-12587 #

TR-1 ..... 13 p0110 N77-12598 #

TRB/SR-166 ..... 13 p0096 N77-11475 #
TRB/TRR-571 ..... 13 p0093 N77-10970 #

TRW-24916-6041-RU-00 ..... 13 p0101 N77-11581 #
TRW-26148-6004-RU-00 ..... 13 p0103 N77-12182*#
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