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Solar Thermal Energy: Abstracts of a Special Seminar for Industry

February 3, 4, 1981

Robert L. Alvis, Editor

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SOLAR THERMAL ENERGY: ABSTRACTS OF A SPECIAL SEMINAR FOR INDUSTRY

February 3, 4, 1981

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PREFACE

This document is a compilation of the abstracts of the papers presented at the Modular Industrial Solar Retrofit (MISR) Conference, held at the Four Seasons Motor Inn, Albuquerque, New Mexico, under the sponsorship of the Department of Energy and Sandia National Laboratories.

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Session I - Technology Status and the MISR Project

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LINE-FOCUS SOLAR THERMAL SYSTEMS STATUS

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ABSTRACT

The primary purpose of the Solar Thermal Program has been to provide a sound technological and industrial base on which a viable solar thermal energy industry can be founded. In the Line-Focus Collector Project, all activities are designed to assist in establishing a line-focus solar resource option and a technological understanding which allows public decisions with high confidence. Consequently, a major objective is to reduce the uncertainty associated with the cost of energy produced by mature line-focus systems. The general strategy for fulfilling this objective involves (1) improving performance, reliability, and lifetime of hardware at the component, subsystem, and systems level; (2) reducing costs associated with fabrication and installation of systems; (3) demonstrating reliable system operation and maintenance; and (4) allowing opportunities for increased production levels.

Significant progress has been made in line with each of these strategies over the last five years. A number of commercial manufacturers are marketing parabolic trough collector hardware, and the total installed aperture area of this technology is rapidly approaching one million square feet. Advanced collector subsystem designs are demonstrating sunlight-to-thermal energy conversion efficiencies of over 60% at 315^{o}C, and much improved tracking and control concepts are being demonstrated.

As new engineering and manufacturing developments are being accomplished, not only is the performance of collector hardware improving, but the cost of collector hardware is decreasing. The next step is to develop and implement integrated system designs which stress reliability along with improved system performance and which can be installed with a minimum of site specific engineering and construction costs. This step is key to the development of a solar thermal industry which is equipped to make significant contributions to the U.S. energy economy.

THE SOLAR INDUSTRIAL PROCESS HEAT FIELD TEST PROGRAM

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ABSTRACT

Over the past three years, the Department of Energy has been engaged in the development and demonstration of solar energy to supply the thermal needs of industry with the Solar Industrial Process Heat Field Test Program. A total of nineteen projects have been funded for construction at actual industrial plants around the country. Of these, eleven are parabolic trough systems.

The IPH Field Test Program can be considered a predecessor to MISR in the sense that many of the lessons learned can be directly applied in order to avoid problems and obtain a substantial improvement in system economics and effectiveness. Some of the applicable lessons learned will be discussed in this presentation. For example, the importance of choosing a load which can use all, or most, of the energy supplied by the solar energy system is now better appreciated. Another insight is that environmental effects on reflector surfaces are very variable from site to site and can pose significant problems. Identifying potential mirror soiling or corrosion problems early in a project history, in order to take appropriate actions, is now considered to be an important step prior to construction of a system.

There are also a number of ways that MISR is distinctly different from the IPH program. First, it is more narrowly focused regarding both applications and technology. Second, there are separate selection processes for both systems and applications. These new concepts are based on a fundamental assumption: excellent performance can be obtained with the same solar energy system at many different sites if the nature of the thermal load falls within a specified parameter range. Thus, the only custom engineering required is the plant interface, which should be low in cost compared to the complete system design cost.

MISR MARKET SURVEY AND LAND USE

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ABSTRACT

A limited market survey is being conducted to ascertain that the size requirements for the MISR experimental systems are valid. This activity is not a market survey in the usual sense of the word but is sufficient for the purposes of the MISR project. Boiler locations are obtained from the appropriate local or state agency. All but industrial boilers are screened out. Depending on the agencies' record-keeping process, either or both pressure and heat rates of the boilers are known. The operators at the locations are then contacted to determine land availability. Data for Western, Texas; Albuquerque, NM; and Maricopa County, AZ were obtained. In addition to this survey, a land utilization study involving the spacing of collectors and the cost of land will be discussed.

MODULAR INDUSTRIAL SOLAR RETROFIT PROJECT (MISR)

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ABSTRACT

This paper describes the MISR project which is based on the premise that thermal energy is the basic solar thermal system output and that low-temperature, fossil-fuel applications are technically the first that should be retrofitted. A major Department of Energy (DOE) thrust is to bring line-focus solar thermal technology to commercial readiness. Commercial readiness is being approached in this project via the modular design of solar systems. Experience has shown the modular design approach offers potential for reducing engineering design costs, manufacturing installation time and expense, and for improving system operational reliability. The modular system design responsibility has been assigned to Sandia National Laboratories who will, in turn, contract industry to do final designs. Data on system operation, performance, and installation costs will be established by allowing selected industrial thermal energy users to purchase qualified MISR systems from suppliers and to operate them for a minimum of two years. Industries will be solicited by DOE/Albuquerque Operations Office to conduct these experiments on a cost-sharing basis. The project is divided into three development phases that represent three design and experiment cycles. The first cycle will use commercially available, trough-type solar collectors. Up to six awards will be made for system designs and up to ten experiments will be performed of up to 5,000 m^2 of collectors each. The project effort begins with this seminar and the first cycle is to be completed in 1985. Subsequent cycles will begin at 3-year intervals. The MISR project is success-oriented and, if the first cycle reaches commercial readiness, the project will be terminated. If not reached, a second, and possibly a third, development cycle will be conducted.

Session II - MISR System Design Request for Proposal

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MISR SYSTEM SPECIFICATIONS AND GUIDELINES

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ABSTRACT

Specifications and Guidelines governing the design and construction of MISR systems have been developed in order to insure improved potential for wide applicability, reliable operation, and reduced installation costs. They incorporate lessons learned from previous solar experiments and demonstrations, and are based on proven engineering practices from the power and process industries. The Specifications, demanding mandatory compliance, are presented in two parts. The first, Design Conditions, defines a reference environment for which systems will be designed. This includes climatological conditions, utility and steam interfaces between the MISR system and the industrial process plant, legal and regulatory restrictions, and economic conditions to be used for design tradeoffs. The second, Design Requirements, details the conceptual, system, hardware, and construction requirements that are to be included in the MISR designs. Finally, the Guidelines, which are advisory, detail aspects of design and construction that can be recommended to enhance the convenience, reliability, or performance of the MISR systems.

MISR SYSTEM
PRELIMINARY SAMPLE DESIGN AND CONSTRUCTION SPECIFICATION

STEARNS-ROGER SERVICES INC.

ABSTRACT

A sample design and specifications have been developed for a system capable of generating 5200 lb/hr. of saturated steam at 250 psig pressure during periods off maximum insolation. Included with the specifications are preliminary design drawings. The specifications are subdivided in general, mechanical, piping, insultion, electrical, instrumentation and structural sections. Included is a commentary section which provides some background and reasons for the criteria used in the design.

In order to determine a collector field layout for the sample design, a cost comparison study was performed using three different collector field return (hot) heat transfer fluid temperatures. The collector gross aperture area was fixed at a nominal 25,000 ft.^{2} for each of the three cases; the required heat transfer fluid flow rates differed widely and indicated different delta-T string lengths and field geometry for each case. A differential cost comparison was performed for each field layout; cost estimates were obtained for all components which were not common to the three designs.

As a result of the cost comparison, a design incorporating a central mainifold and 8 delta-T strings of 24 collectors each was selected; this design was required for the highest (550°F) hot heat transfer fluid case. A single API-610 horizontal centrifugal pump was selected to circulate Therminal 60 heat transfer fluid to the collectors; the steam generator chosen consists of a shell and tube heat exchanger similar to a reboiler. A separate shell and tube feedwater preheater was incorporated in the design.

Piping between the equipment skid and the collector field is supported on an elevated rack to insure piping flexibility. An additional benefit is that the elevated rack allows access for maintenance vehicles along the length of the collectors.

It is conceptualized the proposed MISR field under consideration can be adequately served by a standard 208Y/120 volt, three-phase cable distribution system. A system can be constructed using these utilization voltages, conventional circuit design approaches, and industry-standard minimum-size conductors, which will experience acceptable voltage regulation during the probable demands of the MISR equipment. The envisioned system would utilize eight multiple-tapped feeder circuits for serving the collector field drives. Each circuit would serve the four drives of one Delta-T string. The system loads would be segregated as to their need for electrical service immediately after and during normal supply outages. The critical loads would be supplied from a distribution panel that would be transferred to an emergency engine-generator unit in the event of such an outage. The non-critical loads would be supplied from another panel that would only be connected to the normal supply. The system's emergency supply facilities would be fully automatic in that normal supply abnormalities would be detected, the emergency

engine-generator unit would be started, the critical loads would be transferred to the emergency supply, and the collectors stowed in preselected groups without operator action. Also, upon restoration of normal supply this condition would be detected, the critical loads would be transferred back, the engine-generator would be shutdown, and the collectors would be released to acquire the sun without operator action.

Instrumentation on the MISR system has been designed to allow remote, unattended operation of the system including daily startup and shutdown. Protective interlocks shut down the system when out of limits process conditions are detected which might damage the system and indication of the cause of an abnormal shutdown is provided at the local control panel. Also provided is local alarming of conditions which, if left uncorrected, would result in a system shutdown. Remote alarming to a users central control room of system trouble is also incorporated. Immediate shutdown or "tripping" of the system in the event of an emergency, can be accomplished by pushing a single button either locally or remotely. The design utilizes a combination of microprocessor based logic and conventional relay logic for control. Provision is made for addition of instrumentation to allow system parameters to be measured and sent to a remote data acquisition system for study of system efficiencies.

MISR Contracting Procedures

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This presentation will include the contracting procedures which will be used to purchase the MISR Development.

The following information will be included in the presentation:

1. Number of system contracts to be awarded.
2. Type of contract to be utilized.
3. Approximate RFP schedule.

Session III - MISR Field Experiments

George Pappas, Chairman
Department of Energy/ALO

MODULAR INDUSTRIAL SOLAR RETROFIT PROJECT
SITE SELECTION/FIELD EXPERIMENTS

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ABSTRACT

This first cycle of MISR projects consists of two principal activities: 1) the designs of the modular systems and qualifications of the hardware being admininstered by SNLA, and 2) the selection of sites on which to perform the field experiments being administered by DOE.

This presentation describes the solicitation approach to be used in selecting the site participants for the experimental phase. A Program Research and Development Announcement (PRDA) will be issued by the Albuquerque Operations Office which will solicit proposals from prospective site participants. The site selection process is comprised of two phases. In the first phase, up to 20 sites will be selected and provided with some funding to enhance the quality of their final proposal for acquisition and installation of a qualified MISR system at their facility, without financially burdening these prospective site firms. The second phase of the site selection will be the evaluation of the 20 proposals. Up to ten industry users will be selected to acquire and install systems and operate them for a minimum of two years for the purpose of establishing and collecting cost and performance data.

The procurement strategy is aimed toward assigning responsibility to the site participant for prudent and efficient acquisition, installation, and operation of the MISR system. It is expected that agreements between industry and ALO will be of a cost-sharing type, and that the solar system will become the property of the participating industry at the end of the data collection period.

TECHNICAL REQUIREMENTS FOR SITE PARTICIPATION

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ABSTRACT

There will be a set of "hard" requirements for site participation. These requirements will be explicitly stated in the site PRDA and are a "must" for a potential site participant to be considered. Thus, they represent a set of minimum hurdles which must be met. These will be discussed along with their background. Some of the "softer" requirements will also be discussed. These requirements are somewhat intangible in nature but yet must be evaluated in order to obtain suitable sites fot the MISR experiments.

EVALUATION OF SELECTION PROCESS FOR SITE PARTICIPANTS

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ABSTRACT

This paper describes the evaluation criteria to be used for selecting industrial thermal energy users for the MISR project. The proposals received will be evaluated and selected in accordance with DOE regulations and criteria set forth in the Program Research and Development Announcement (PRDA). A preliminary review of each proposal will be made to determine whether: (1) sufficient cost, technical, and other information is included to make a meaningful and comprehensive evaluation, (2) it is responsive to the requirements of the PRDA, and (3) the proposal has been signed by a responsible official who is authorized to obligate the organization. After this review, a technical evaluation will be made resulting in a numeric score for all of the factors for award listed in the PRDA as well as a narrative evaluation describing the strengths and weaknesses of each proposal. For all technically acceptable proposals, a business management/cost review will be performed. This will include evaluation of such factors as probable cost to DOE, past performance, financial capability, and compliance with prerequisites of the PRDA. After the proposals have been ranked technically and the business management/cost review completed, the DOE Source Selection Official will select up to 20 proposers who have demonstrated the capability for advancing the overall Phase I MISR program goals.

DATA ACQUISITION SYSTEM AND RESULTS REPORTING

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ABSTRACT

Current solar industrial process heat field tests employ a variety of different types of data acquisition systems. In general, data acquisition has been unreliable for these projects; and, as a result, only a limited amount of performance data has been available. This paper discusses the problems encountered and the current program to develop a standardized data acquisition system for Modular Industrial Solar Retrofit and future industrial process heat field tests.

Final data acquisition system selection should be completed soon and implementation details will be discussed. Transducer selection and installation will be addressed, and performance reporting guidelines outlined.

Session IV - Seminar Attendees Participation

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SUPPLIER/USER SYSTEM EVALUATION DEVELOPMENT

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ABSTRACT

As outlined in the MISR project plan, two of the three major procurement activities - user site preliminary selections and supplier/user experiment team selections - will involve numerous contract awards. Because this will entail the solicitation and evaluation of a correspondingly numerous pool of proposals, it is important that a methodology be available to guide evaluators in making consistent and effective evaluations. It is anticipated that this can be achieved using a two-step evaluation process. First, individual proposals will be evaluated using a multi-attribute decision analysis technique. In this technique, each proposal is evaluated by examining and scoring each of a set of significant attributes. These individual attribute scores are then weighted relative to each other and combined to produce a single score for each proposal. Second, a portfolio analysis technique utilizing the results from this first evaluation will be used to identify a "best" or "most effective" subset of proposals to be recommended for selection. A questionnaire has been developed to assist Sandia National Laboratories in identifying these significant attributes of the individual solar systems, user sites, and experiment team proposals. Additionally, the questionnaires also seek to identify significant attributes describing groups of field experiments that will be perceived as effective in furthering the MISR project goals.

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