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RELIABILITY AND MAINTAINABILITY PROGRAM

ANTHONY EDEN

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Solar Energy Research Institute
A Division of Midwest Research Institute

1617 Cole Boulevard
Golden, Colorado 80401

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DISCLAIMER

NOTICE

RELIABILITY AND MAINTAINABILITY PROGRAM

SOLAR ENERGY RESEARCH INSTITUTE

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OBJECTIVE

The objective of this program at the Solar Energy Research Institute (SERI) is to accelerate the adoption of active solar energy systems in building applications by improving the reliability and maintainability (R&M) of installed systems. The project is designed to accomplish this by providing the latest information from research and development to groups with R&M concerns; by assisting the industry in improving R&M; by assisting in design, manufacture, installation, and maintenance of reliable and durable systems; and by assisting in the development of codes and standards.

DESCRIPTION OF WORK

SERI has the lead managerial role in executing the Program Plan for Reliability and Maintainability in Active Solar Heating and Cooling Systems (DOE/CS/36010-01; Oct. 1980). As such, SERI developed a plan for attaining the objectives of the DOE program, concentrating on solar domestic hot water (SDHW) and space heating systems.

dhr, Inc., as a subcontractor, assessed the current state of R&M. This assessment illustrates the effects of existing programs in the Federal Government, universities, and industry. The subcontractor performed an R&M literature search and evaluated existing solar R&D activities for R&M application. Finally, they evaluated existing training, manufacturers, and design manuals for R&M content and quality. The National Solar Data Network (NSDN) program was reviewed to ascertain whether its present data and analysis are useful for R&M research. SERI proposed modifications of the data gathering system at selected sites.

SERI recognizes a need to be able to assess the reliability of systems in the field and to troubleshoot failed systems. The Field Assessment Coordinating Team (FACT) concept was developed. The FACT can go to a demonstration site and determine the performance of the system in a one- or two-day period. If a failure has been reported, the FACT may take samples of materials for research into the causes. The concept will apply first to SDHW and subsequently expand to space heating.

Much of the emphasis in the R&M Program is on materials research and development and R&M analysis. This portion of the program involves the coordinated efforts of SERI, Argonne National Laboratories (ANL), and Los Alamos National Laboratory. A laboratory method was developed for analyzing R&M data and problems encountered in the field. Using this method, causes of problems are discovered and solutions are developed to prevent material failures. The development of formats for data and field data requirements allows a unified approach to R&M information. The R&M libraries of ANL and the National Bureau of Standards (NBS) were examined for inclusion in a central library at SERI. The NSDN databanks were also evaluated for R&M data. SERI researchers then prepared the output of the materials effort for transfer to the industry. ANL also participated through the development of the SDHW guidelines handbook, fluid corrosion test loops, atmospheric corrosion experiments, and site examinations and failure analysis.

Workshops held at SERI and the four regional solar energy centers (RSECs) brought together R&M experts from industry, the national laboratories, national agencies, and universities to discuss the problems encountered in the field and to help SERI plan the program to solve them. Materials experts spent two days discussing problems and their solutions. The four regional R&M workshops gathered together manufacturers, installers, and designers for direct contact with the beneficiaries of the program. They discussed industry's requirements and offered suggestions for SERI's program and ANL's SDHW guidelines handbook. A product of these meetings was the Industry Directory, a listing of the R&M experts in the different regions to enable less experienced members of industry to find guidance.

Continued assessment and improvement of the technical training courses and manuals will enhance information transfer to industry. The R&M Quarterly Bulletin, instituted in response to suggestions by workshop attendees, provides direct contact with industry. It allows dissemination of current field data, analysis results, information, meeting schedules, laboratory findings, expert opinions, and R&M program status to the industry.

The SERI Quality Assurance and Standards Branch is developing codes and standards and the R&M program supports that activity through close coordination and assistance in developing draft standards or supplying data to the staff. The National Bureau of Standards works closely with SERI, supplying data and information from their R&M library and sharing their expertise. Members of the R&M group help local officials develop models for state legislatures to consider in the solar energy applications field.

SERI was requested to assist DOE/SAN in monitoring the demonstration sites of the Western Region in a technical management role. DOE Headquarters also requested SERI technical monitoring of the sites formerly monitored by NASA. This activity allows the R&M program to gain experience in field evaluation and to apply its expertise to actual system problems. The lessons learned are then relayed to industry through the Quarterly Bulletin. Fourteen western sites and two national ones were under SERI technical management by April 1981.

TECHNICAL ACCOMPLISHMENTS

- R&M kickoff meeting. Experts from industry, national laboratories, national agencies, and universities gathered at SERI to offer their views on the program; its approach, goals, and objectives; and the best ways to impact the industry.

- Materials workshop. The experts in the materials research and development field gathered at SERI for a two-day intensive workshop to discuss the status of materials in solar energy systems and components and to guide the development of the reliability R&D effort.
- Four RSEC regional R&M Workshops. Manufacturers, designers, and installers gathered in each region to discuss their needs and requirements and to review the ANL SDHW guidelines handbook.
- Development of a corrosion sensor for collector systems. Rockwell Science Corporation studied corrosion sensors to determine the most effective way to monitor the corrosivity of a solar collector system fluid. A monitor resembling a fuse was then developed and tested.
- Assessment of current R&M conditions. Upon completion of a subcontract with dhr, Inc., SERI consolidated the results and published an assessment of R&M for SDHW and space heating systems.
- R&M Quarterly Bulletin. The first issue of this newsletter presented the findings of the R&M program to industry in a concise and timely manner.
- Development and test of the Field Assessment Coordinating Team (FACT) concept in the field environment. This team was sent to SDHW sites to compare recorded data with data gathered by their nonintrusive, portable equipment and to evaluate the field procedures.
- Evaluation of inexpensive thermographic equipment for use by the FACT. The least expensive thermography techniques in use today were applied to typical solar collector array systems to ascertain their effectiveness in system analysis and fault detection during reliability evaluations and as a future maintenance tool.
- Performance of fluid corrosion and atmospheric corrosion research. A fluid test loop was operated to explore the corrosion characteristics of selected fluid and metal combinations under the operating conditions of a solar energy system. Samples of collector absorbers were exposed at demonstration sites to determine their deterioration characteristics in different field environments.
- Determination of the characteristics of typical solar collector parameters during system failure. This activity determined the least amount of monitoring required to warn the owner/operator of failure of a solar collector array.
- Modification of the NSDN to gather R&M data directly. The site data acquisition system was modified at selected NSDN SDHW sites to allow the gathering of reliability statistics and data for analysis of the performance and durability of current technology systems and applications.
- Development of the R&M library. A central library, consolidating those of NBS, ANL, and NSDN, was set up in the SERI computer to allow the technical community access to the data gathered by the program in past and present efforts. This data and information may then be used to make informed decisions on system configurations, component selection, material design, and maintenance schedules.
- Development of R&M analysis methodology. The SERI Materials Branch developed a method for evaluating reliability from gathered samples of materials and system components brought into a laboratory from the field. The researchers outlined the actions of an assessment team in the field examining a failed system to discover the cause of the failure. Postmortem laboratory analysis techniques were also developed.

FUTURE ACTIVITIES

SERI has developed a multiyear plan for DOE in the R&M area, expanding the FY 1981 effort in SDHW into solar heating and cooling (SHAC). The FACT will be expanded into SHAC and the commercial possibilities will be demonstrated by the use of inexpensive equipment, new techniques, new procedures, and technical personnel. Reliability R&D will continue to examine current technology, especially in SHAC. The fluid and atmospheric corrosion tests will result in improved understanding of the deterioration mechanisms of materials under the typical operating conditions of solar energy systems. The R&M Quarterly Bulletin will continue to relay the findings of the R&M program and others to industry so that past mistakes can be avoided through technology transfer. Continued scrutiny of controls and related problems will aid the development of more reliable systems and fault detection possibilities. The codes and standards activities will continue to be supported so that consensus committees and coding officials will have the most current information available to them.

PUBLICATIONS

- Assessment of R&M Status (SERI)
- R&M Quarterly Bulletin (SERI)
- Reliability Research and Development Methodology (SERI)
- SERI R&M Program Final Report, FY 1981 (SERI)
- Inexpensive Thermographic Techniques for Determining Reliable Solar Collector Array Performance (SERI)
- R&M Industry Directory (SERI)
- DOE/SAN Demonstration Sites Quarterly Reports (SERI)
- Reliability and Materials Design Guidelines for Solar Domestic Hot Water Systems (ANL/SDP-9)

CONTRACT INFORMATION

START DATE: 1 Oct. 1980 END DATE 30 Sept. 1981 CONTRACT VALUE $1,293,000

MILESTONES

Item:	Due date:
1. RSEC R&M Workshops, March 1981	
2. Assessment of R&M Status, April 1981	
3. Reliability R&M Methodology, June 1981	
4. R&M Quarterly Bulletin (No. 1), September 1981	
5. SERI R&M Program Final Report, FY 1981; September 1981	