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# DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150640

## SOLAR HEATING AND COOLING SYSTEMS DESIGN AND DEVELOPMENT

Prepared by

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Under Contract NAS8-32093 with

National Aeronautics and Space Administration  
George C. Marshall Space Flight Center, Alabama

For the U. S. Department of Energy



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## Solar Energy

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This work was done under the technical management of Mr. A. Krupnick, George C. Marshall Space Flight Center, Alabama.

16. ABSTRACT  
Honeywell was awarded Contract NAS8-32093 by the George C. Marshall Space Flight Center effective 9 July 1976.

The program calls for the development and delivery of eight (was 12) prototype solar heating and cooling systems for installation and operational test. Two (was 6) heating and six heating and cooling units will be delivered for single-family residences (SFR), multiple-family residences (MFR) and commercial applications.

Lennox Industries, Marshalltown, Iowa, and Barber Nichols Engineering Company, Arvada, Colorado, are supporting Honeywell in subcontractor roles.

This document describes the progress of the program during the sixth program quarter, 1 October 1977 to 31 December 1977. It is submitted to MSFC for information per DR 500 Item 10 and has been edited for public release.

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## QUARTERLY SUMMARY

The William O'Brien single-family heating system has been installed and is operational. The system is waiting for SDAS completion and checkout before the Installation Acceptance Review. The New Castle single-family heating residence is under construction with collector installation scheduled for mid-January 1978. All equipment except a few SDAS components have been shipped.

The Kansas University (KU) system is in the final design stages. A preliminary design review is scheduled for 28 February 1978. No significant design problems have been encountered.

The 25-ton cooling subsystem for KU is in the debugging stage. Pressure drops that were greater than anticipated were encountered. These problems are expected to be resolved, and the subsystem is expected to be operational by January 20, 1978.

The 3-ton redesign is in preliminary design stages. The rotary compressor has been received and is being prepared for testing. The 3-ton simulation work is being finalized and the design parameters for the Rankine system have been determined from simulation output.

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## SITE ACTIVITY

### WILLIAM O'BRIEN SINGLE FAMILY HEATING (OTS #40)

The solar heating equipment installation was completed early in December and was checked out. The system was put into operation December 12, 1977 although some parts of the SDAS equipment were not delivered. The operating of Energy Transport Unit #1 (ETM) was verified. The system will remain operational, and SDAS data will be taken starting early in 1978.

### NEW CASTLE, PA SITE--SINGLE-FAMILY HEATING (OTS #39)

The general contractor has begun construction of the house. All government furnished equipment for the solar heating system has either arrived at the site or is in transit. Inclement weather during the month of December held up construction and caused a delay in completion of the solar heating system. The solar collectors will be installed as soon as the roof is completed. The rest of the system will be installed as rapidly as possible to expedite system operation so the SDAS subsystem can gather operational data for this heating season.

The Energy Transport Module (ETM) for OTS #39 has undergone thorough inspections. Tests were made by Honeywell Quality and DCAS personnel.

The control subsystem for the single-family residence at the New Castle, Pennsylvania, site has been completed and installed in the Energy Transport Module (Figure 1). All electrical wiring internal to the ETM was installed, and a functional checkout of all operating modes was completed prior to shipment of the ETM to the site. The control panel provides manual control for adjustment of collector plate temperature (direct heating mode), and toggle switches control each active component in the system (pumps, control valves and purge unit).

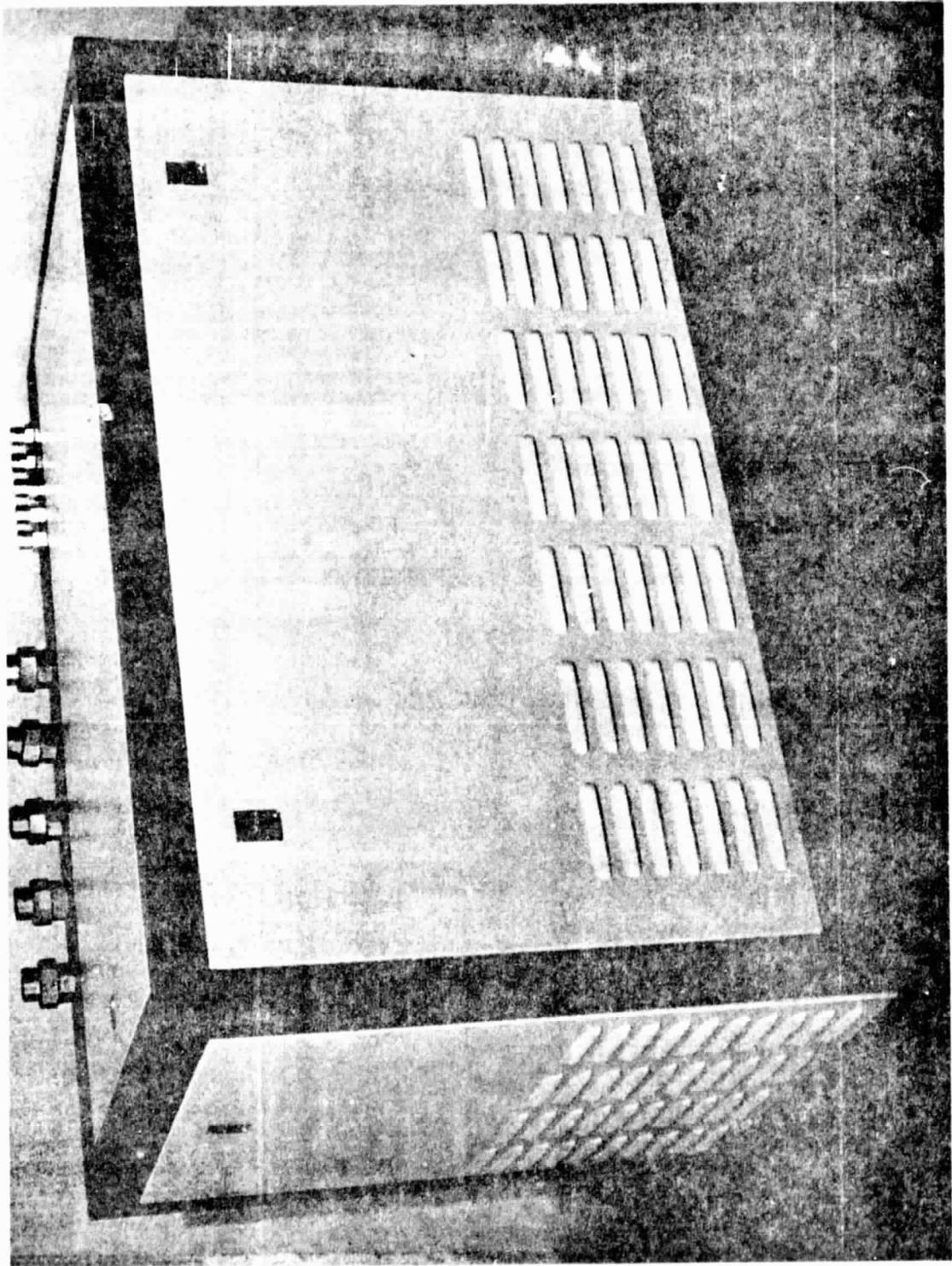


Figure 1. Energy Transport Module

This heating system is controlled by a two-stage heating thermostat. First-stage heating utilizes solar energy if available; second-stage heating will supply auxiliary energy. The system control logic is as follows:

- Collect solar energy when available. Store energy under no-load conditions.
- Provide energy directly to load on demand. Use direct solar energy before stored energy.
- Use storage energy when direct solar energy is not available.
- Use direct or stored solar energy before auxiliary energy.

#### KANSAS UNIVERSITY--MULTIFAMILY HEATING AND COOLING (OTS #43)

The Legal departments for both KU and Honeywell have reached agreement. Final drafts will be drawn up for approval on the contract for installation. Site work is expected to begin late in March 1978.

A preliminary plumbing layout for the solar H/C system at the Kansas University site has been completed. After corresponding piping sizes and fluid flow rates were selected, the pump requirements were determined. Internally located pump units are close-coupled, base-mounted, end-suction centrifugal pumps. Motors are open, drip-proof, 60 Hz/3-phase/230-volt/1750-rpm. The three-phase motor has been selected, even for the fractional horsepower size, due to lower power consumption. Cost and durability are the same as equivalent one-phase units.

Sump pumps are close-coupled general-service submersible units located in the sump below the cooling tower. Motors are 60-Hz/3-phase/230-volt/1150- or 1750-rpm.

The collector support structure design for two-high arrays has been completed. Modifications to reduce collector installation time were investigated during erection of the 45° structure at our Harding Solar Lab. Figure 2 shows the erected Harding structure.

Bid packages for the 30° support structure for the KU site were sent to steel supply houses and fabricators in the Kansas City and Minneapolis areas. A majority of the bids, along with an alternate design have been received.

The development testing on the number one 25-ton system at Barber-Nichols in Denver is complete.

Testing included necessary measurements to determine capacity, power input and coefficient of performance at design and off-design conditions. Other measurements were taken to confirm safe operation of components as well as to confirm proper equipment selection and sizing for efficient operation.

The 8,000-gallon storage tank for the Kansas University site has been specified. Bid packages were sent to tank manufacturers in the Kansas City and Minneapolis areas. Response has been received for both a lined steel and an unlined stainless steel design. Preliminary tank drawings have been sent to the KU site owner for tank foundation preparations.

SACRAMENTO--SFR H/C (OTS #41)

A simulation of the new 3-ton RC/AC system operating in Sacramento, California, has been run. Preliminary RC/AC performance data was utilized in this run to predict seasonal performance data.

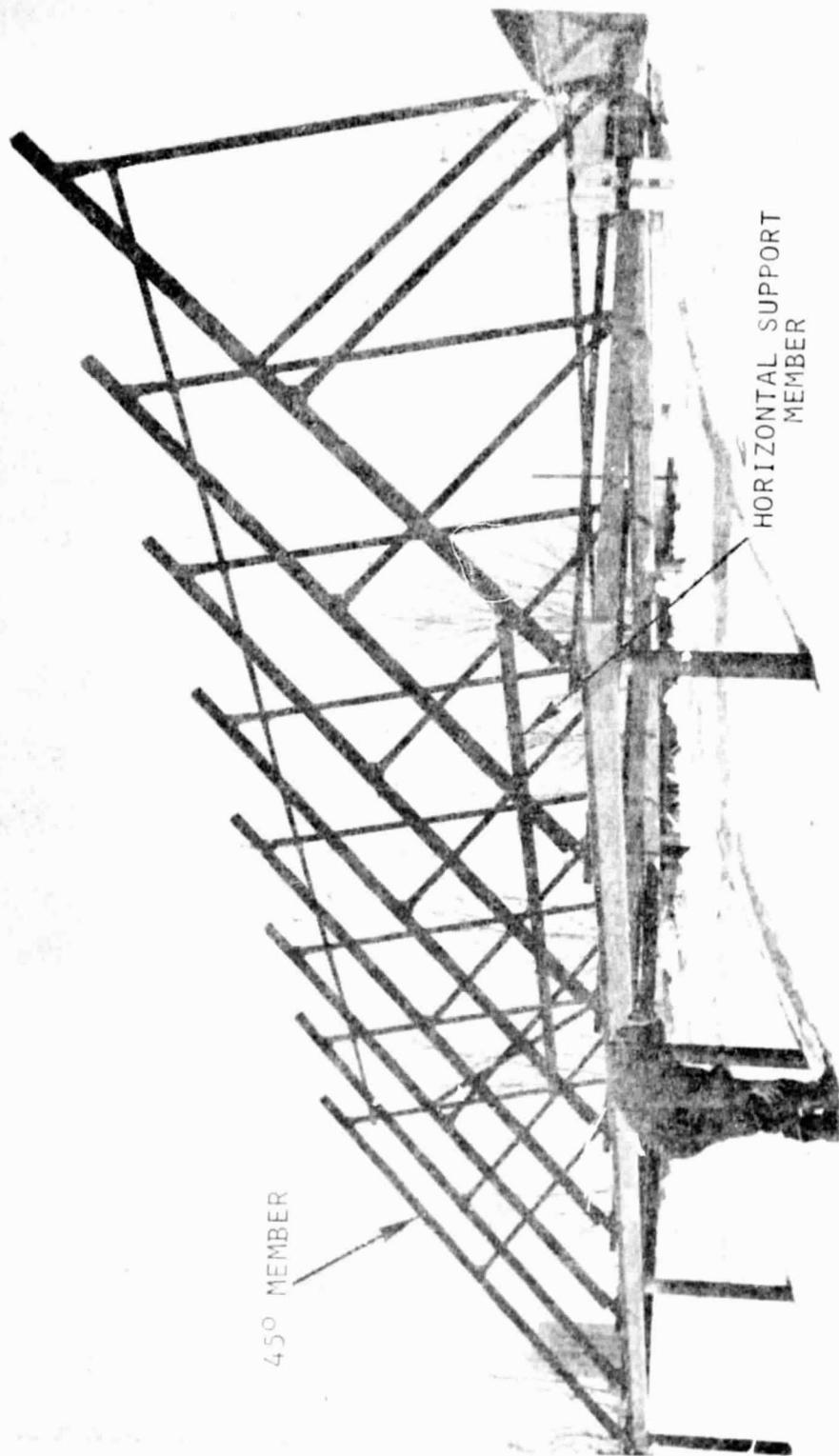


Figure 2. Hardening A-Frame Structure Showing Horizontal Support Member

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