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Midtemperature Solar System Test Facility Program Status Report

John V. Otts

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MIDTEMPERATURE SOLAR SYSTEM TEST FACILITY PROGRAM STATUS REPORT

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ABSTRACT

This document outlines the current solar test programs at the Midtemperature Solar System Test Facility (MSSTF), which is operated for the Department of Energy by Sandia National Laboratories. Approximately thirty programs are currently under way. The objectives of each program are described, the current status is noted, and future plans are outlined. Test data/results are not included, but references and test engineers names are listed for each project. Interested persons are encouraged to solicit further information.

This document will be published semiannually.

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MIDTEMPERATURE SOLAR SYSTEM TEST FACILITY
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Introduction

The Midtemperature Solar System Test Facility (MSSTF) is operated by the Experimental Systems Operations Division, Sandia National Laboratories, Albuquerque, New Mexico. Operation is sponsored by the Solar Thermal Program under the Division of Solar Thermal Energy Systems for the Department of Energy.

The MSSTF is primarily dedicated to support of the following projects/activities:

- Line Focus Component and Subsystem Development
- Line Focus System/Applications Development
- Commercial Products and Development Activities
- Thermal Storage Development
- Other development requiring unique capabilities, experience, etc.

The MSSTF includes a Subsystem Test Facility (STF) and a Collector Module Test Facility (CMTF) (see Figure 1).

- STF -- research, development, characterization, short/long term evaluation and integration of components, subsystems, and systems.
- CMTF -- characterization and evaluation of collector components, subsystems, and systems.

Currently, the STF is undergoing a transition from a total energy demonstration facility to a multipurpose test facility. In excess of twenty major test programs are simultaneously under way.

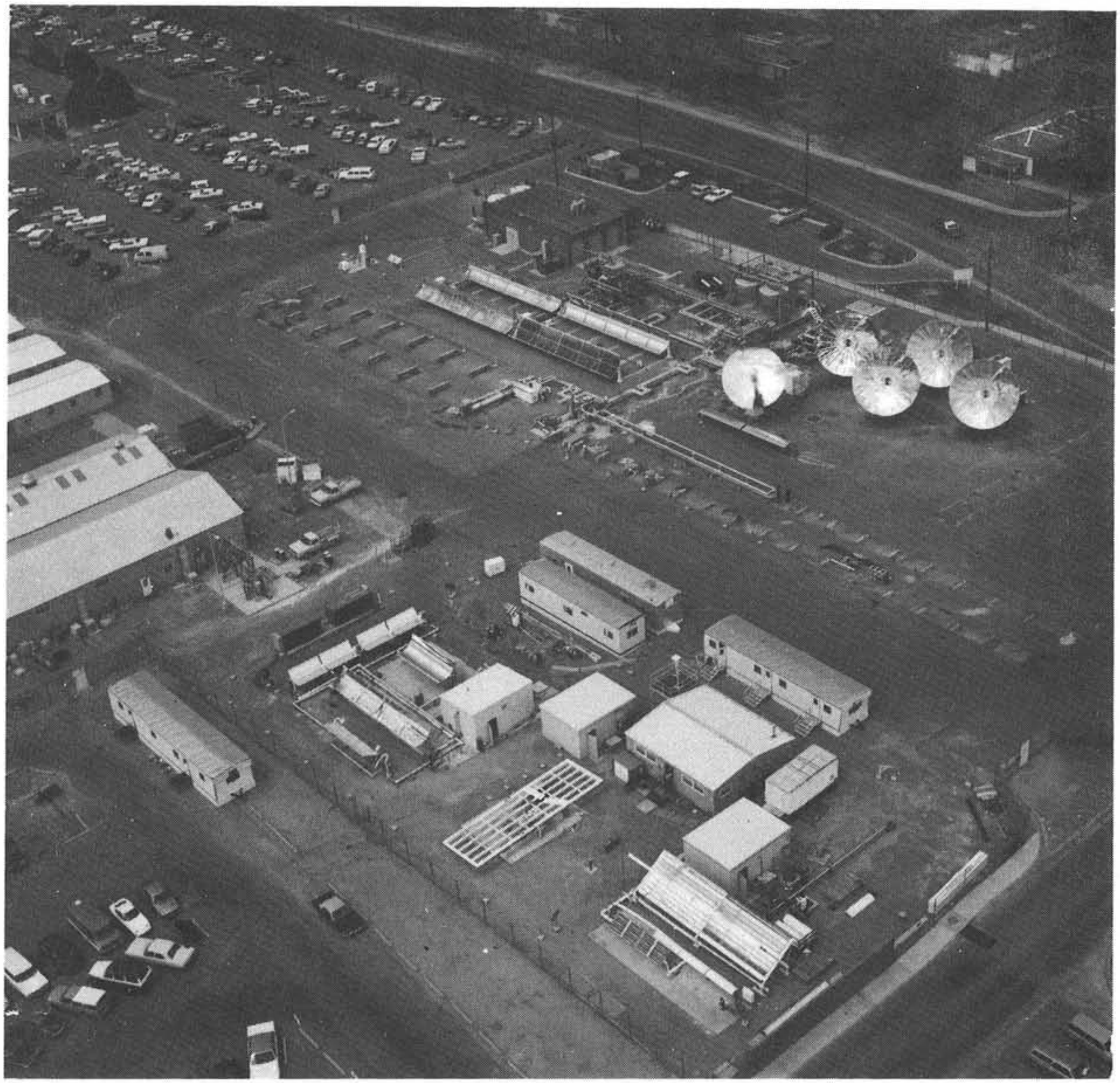

Figure 1. Photograph of MSSTF

The CMTF continues to support commercial programs as well as line focus development effort. However, with the recent establishment of Wyle, Huntsville, and DSET, Phoenix, as commercial test laboratories, the CMTF will shift its major effort over to development support. Commercial support will continue where a unique CMTF capability is required or the schedule dictates.

This is the first of a series of semiannual status reports which will continue throughout MSSTF operations. The reports are intended to

- Inform the solar community of current activities
- Provide the names and telephone numbers of responsible test engineers
- Provide a current list of references and/or data pertinent to the project
- Outline future activities on the project

It should be emphasized that this report is intended to outline activities under way at the MSSTF. Interested parties are encouraged to request relative information and data and/or visit the MSSTF for observation and discussion.

I. PIPE HEAT LOSS -- T. Harrison (505) 844-6394

OBJECTIVE

To determine the heat loss from an energy distribution system under varying conditions by the following tests.

a. Insulated pipe containing Therminol 66 (T-66).
b. Insulated pipe with insulated flanges.
c. Insulated pipe with insulated flanges and pipe anchors.
d. Insulated pipe with insulated flanges, pipe anchors, and uninsulated valves.
e. Insulated pipe with insulated flanges, pipe anchors, and insulated valves.

All experimental data will be compared with analytical analyses. Current analytical models will be modified (if necessary) to reflect experimental data. These results will have an immediate impact on a Jacobs A&E design study of fluid distribution systems for 50,000 ft^2 of collectors. The results will also contribute to the Modular Industrial Solar Retrofit (MISR) Project designs performed by industry.

STATUS AS OF 1 JULY 1980

1. A 180-foot section of 2-inch pipe has been installed, instrumented, and insulated (see Figure 2).
2. Insulated pipe tests have been completed for a matrix of no flow, three flow rates, and four temperatures up to 285°C (600°F).
3. Test data from item 2 is being analyzed. It will be available 1 August 1980.
4. Insulated pipe with insulated flanges tests (test b) have been completed under the same matrix as in item 2.
5. Test data from item 4 is being analyzed. It will be available 1 August 1980.
6. Analytical comparison of items 2 and 4 are under way. It will be available 1 August 1980.

FUTURE ACTIVITIES

- Prepare and conduct tests c, d, and e.
- Review all test results and determine need for additional tests.
- Issue final report.

REFERENCE

1. Figure 2. Pipe Heat Loss Test Setup.

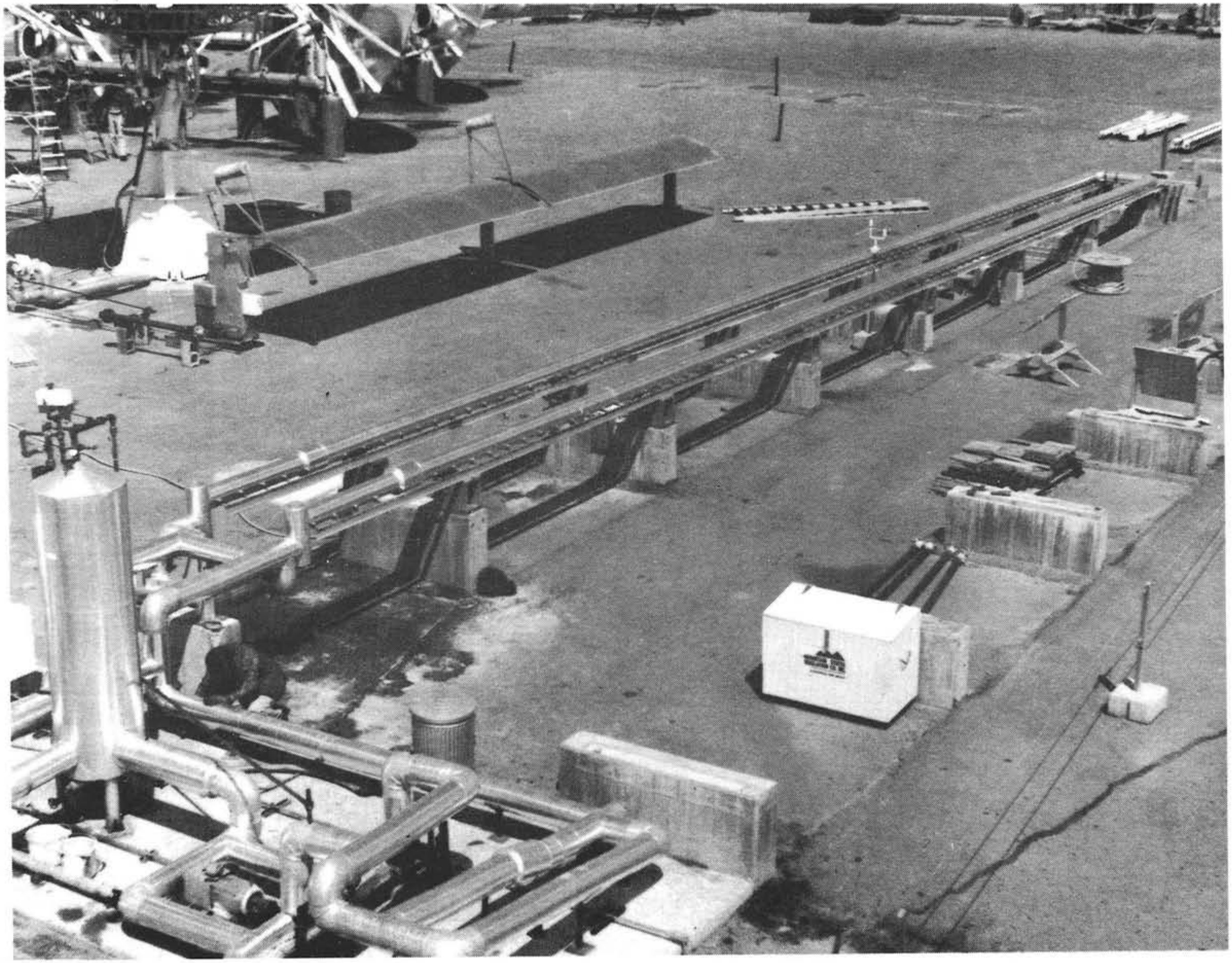

Figure 2. Pipe Heat Loss Test Setup

II. THERMAL SIPHON* PROGRAM -- T. Harrison (505) 844-6394

OBJECTIVES

a. To investigate thermal siphon phenomena.
b. To determine thermal siphon effects on solar systems.
c. To quantify thermal siphon effects.
d. To develop techniques to prevent thermal siphoning.

STATUS AS OF 1 JULY 1980

1. Thermal siphoning has been demonstrated/photographed in the laboratory. Movie will be available in October 1980.
2. A U-trap has been used to stop thermal siphoning in the laboratory. Letter report will be available in September 1980.
3. The pipe heat loss test loop (see Figure 3) has been modified to include a receiver tube which will serve as the heat sink for establishing siphoning.
4. Jacobs A&E has designed an optimum 50,000-ft^2 collector field independent of thermal siphon losses or prevention.

FUTURE ACTIVITIES

- Quantify thermal siphoning and develop ways to prevent thermal siphoning, using the setup in item 3.
- Repeat items 3 and a, using valves as the heat sink.
- Modify Jacobs A&E optimum field design in item 4 to reflect thermal siphon test results.
- Publish final report. Main thrust will be techniques used to eliminate thermal siphoning.

REFERENCE

1. Figure 3. Thermal Siphon Test Setup.

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*Thermal siphoning is the loss of thermal energy in an energy transmission system as a result of convective fluid loops (fluid flow between a hot and a cold source).

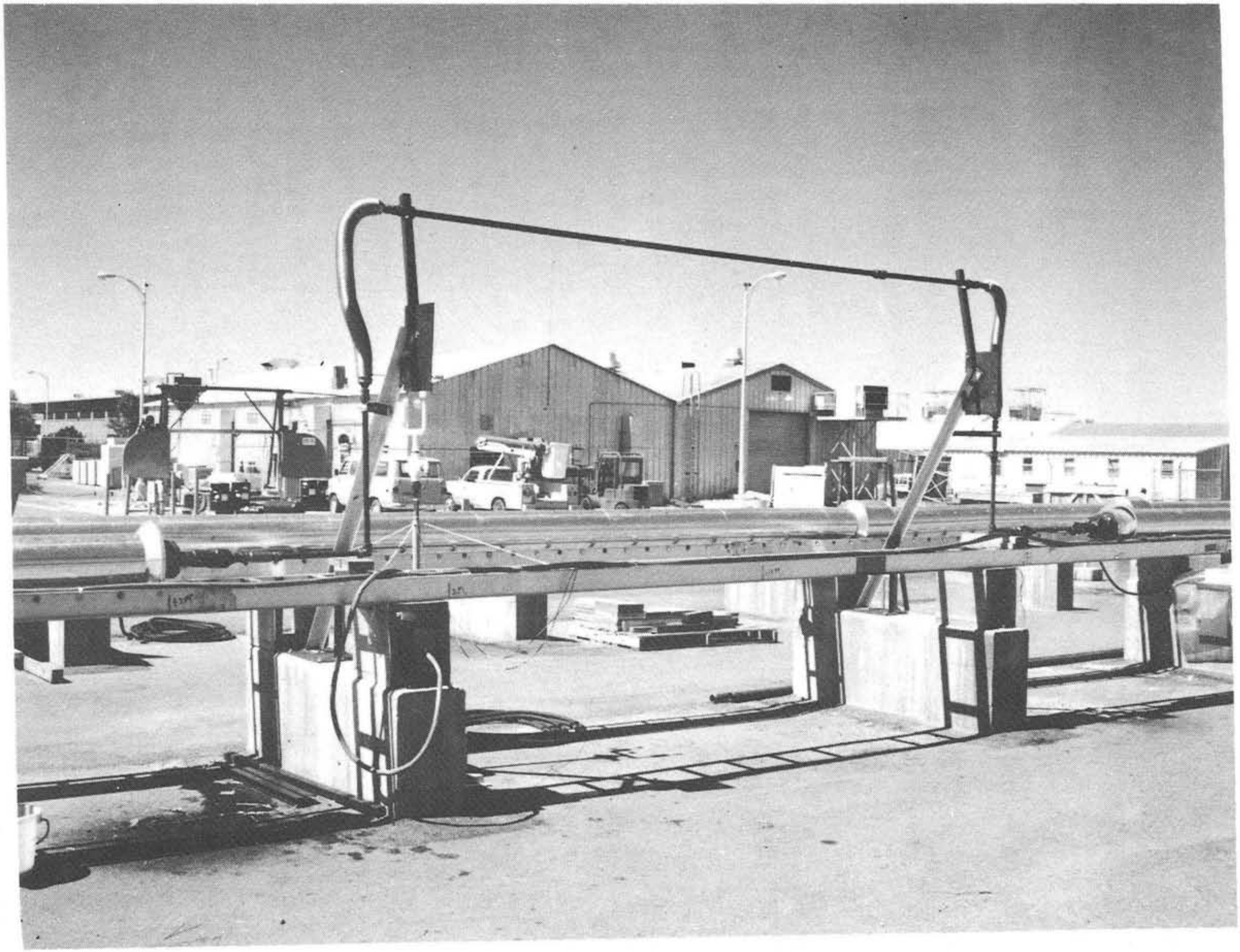

Figure 3. Thermal Siphon Test Setup

III. PERFORMANCE PROTOTYPE TROUGHS -- R. Lundgren (505) 844-3338

OBJECTIVES

To characterize and perform long-term evaluation of performance prototype trough (PPT) structures and tracking/control subsystems currently under development and fabrication by industry.[1] Four individual trough designs will be included in this test program. Each trough design will consist of different reflector structures and reflector materials, but will utilize identical receivers, drives, controls, and supports.

STATUS AS OF 1 JULY 1980

1. SLATS and GA collector fields have been removed from MSSTF.
2. Initial survey and layout work has been completed for locating troughs at MSSTF.
3. Jacobs Engineering has been placed under contract to provide working drawings relative to field layout and facilities interface.

FUTURE ACTIVITIES

- Design and procure heat rejection, instrumentation, and control systems.
- Let contract for site construction.
- Receive, install, and begin testing PPTs.

REFERENCE

1. SAND79-1786, FY80 Operating Plan--Line Focus Concentrating Collector Technology Development and Applications Management Project.

IV. PERFORMANCE PROTOTYPE TROUGH COMPONENT LIFE TEST -- R. Lundgren (505) 844-3338

OBJECTIVE

To evaluate, on a life cycle basis, components common to the four performance prototype trough structures currently under development. The MSSTF site will be modified to include an 80-foot drive string which will be cycled on an accelerated basis under conditions yet to be defined.

STATUS AS OF 1 JULY 1980

1. Initial survey and layout work has been completed.
2. Jacobs Engineering has been contracted to provide working drawings relative to field layout and facility interface.

FUTURE ACTIVITIES

- Complete test plan.
- Design and procure heat rejection, instrumentation, etc.
- Let contracts for site construction.
- Receive, install, and begin testing PPT component drive string.

V. MODULAR INDUSTRIAL SOLAR RETROFIT SYSTEMS QUALIFICATION -- R. Lundgren (505) 844-3338

OBJECTIVE

To characterize and perform long-term evaluation of modular collector systems currently under design as part of the Modular Industrial Solar Retrofit (MISR) program.[1] The MISR project is a program to develop a modular system which reduces site specific costs and custom design costs, providing a vehicle for the application of new generation technology, developing a broad system supplier capability which can be self-sustaining, and providing the opportunity to manufacture and evaluate quasi-mass-produced solar collectors. Up to six systems will be tested at the MSSTF.

STATUS AS OF 1 JULY 1980

1. SLATS and GA collector fields have been removed from MSSTF.
2. Survey and layout work is under way at MSSTF.

FUTURE ACTIVITIES

- Complete survey and layout work.
- Place A&E contract for field layout and facilities interface design.
- Place contract for site construction and procure support test equipment.
- Establish test requirements.
- Receive, install, and begin testing.

REFERENCE

1. MISR Project Plan--Special Projects Division, DOE/ALO.

VI. <u>COLLECTOR DRIVE TEST PROGRAM</u> -- R. Lundgren (505) 844-3338

OBJECTIVES

To design, construct, and implement a collector drive test facility which will be used for R&D, checkout, and evaluation of collector drive subsystems. The facility will simultaneously simulate steady and transient loads on the collector drive train. Initially, to evaluate collector drive techniques which will be considered for the production prototype trough.

STATUS AS OF 1 JULY 1980

1. Test facility has been designed, fabricated, and installed at the MSSTF (see Figure 4).
2. Control/data console being built.
3. System checkout will begin.

FUTURE ACTIVITIES

- Initial testing is scheduled for July 1980.

REFERENCE

1. Figure 4. Collector Drive Test Facility.

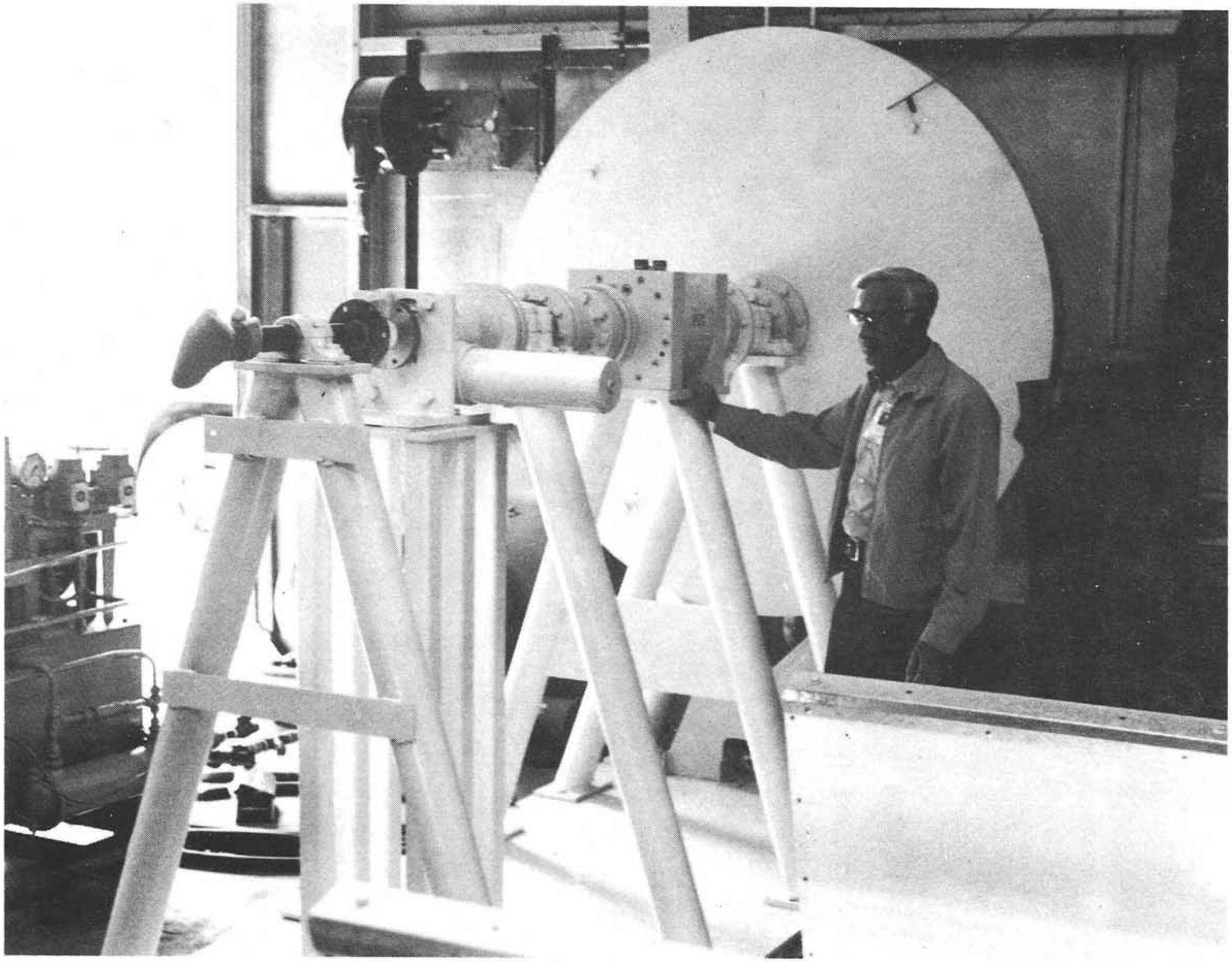

Figure 4. Collector Drive Test Facility

VII. FLEX HOSE TEST PROGRAM -- R. Lundgren (505) 844-3338

OBJECTIVES

To design, construct, and implement a flex hose test facility. Initially, to evaluate the fatigue properties of flex hoses being considered for trough designs. Tests will produce flex hose motion at an accelerated rate with 600°F oil circulating continuously.

STATUS AS OF 1 JULY 1980

1. A remote test site has been designated and is currently being modified.
2. The flex hose test stand has been designed and is being fabricated.
3. Test equipment checkout has started.

FUTURE ACTIVITIES

- Complete fabrication by 1 August 1980.
- Complete installation and checkout of equipment at test site.
- Evaluate candidate flex hoses.
- Issue report at end of selection program.
- Consider future applications for facility.

REFERENCE

1. Figure 5. Flex Hose Attached to Collector.

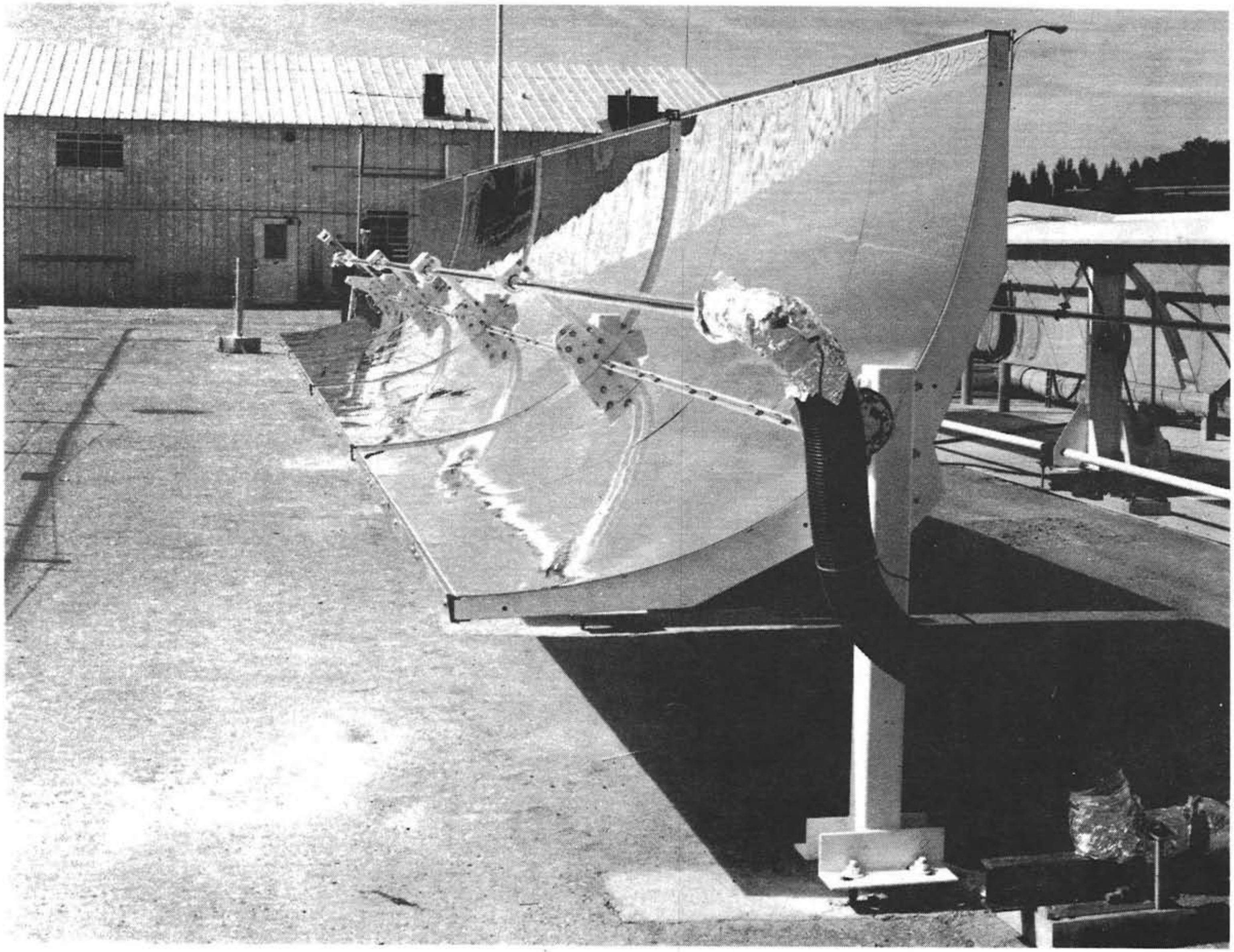

Figure 5. Flex Hose Attached to Collector

VIII. LONG-TERM RECEIVER EVALUATION -- J. Zimmerman (505) 844-3338

OBJECTIVES

To use the 100 m^2 of Custom Engineering troughs as a test bed for receiver tubes. Initially, to evaluate an evacuated receiver design, the receiver design demonstrated with the performance prototype troughs (PPTs) and a Corning evacuated receiver design. The collector performance (efficiency) will allow comparison of receiver tube designs, while long-term observation and performance trends will provide a measure of durability.

STATUS AS OF 1 JULY 1980

1. The Custom Engineering (CE) troughs have been installed and checked out and are ready for operation (see Figure 6).
2. Advanced evacuated receiver tubes have been built and installed on the CE troughs.
3. The receiver tubes to be used with the PPT's have been built and installed on the CE troughs.
4. Testing was started after summer solstice.

FUTURE ACTIVITIES

- Continue testing items 1 and 2.
- Install and test Corning evacuated receiver tubes following completion of testing.

REFERENCES

1. Figures 6 and 7. Receiver Tubes Mounted to CE Trough.
2. Ratzel, Evaluation of the Evacuated Solar Annual Receivers Used at the MSSTF, SAND78-0983 (Albuquerque: Sandia National Laboratories, July 1977).

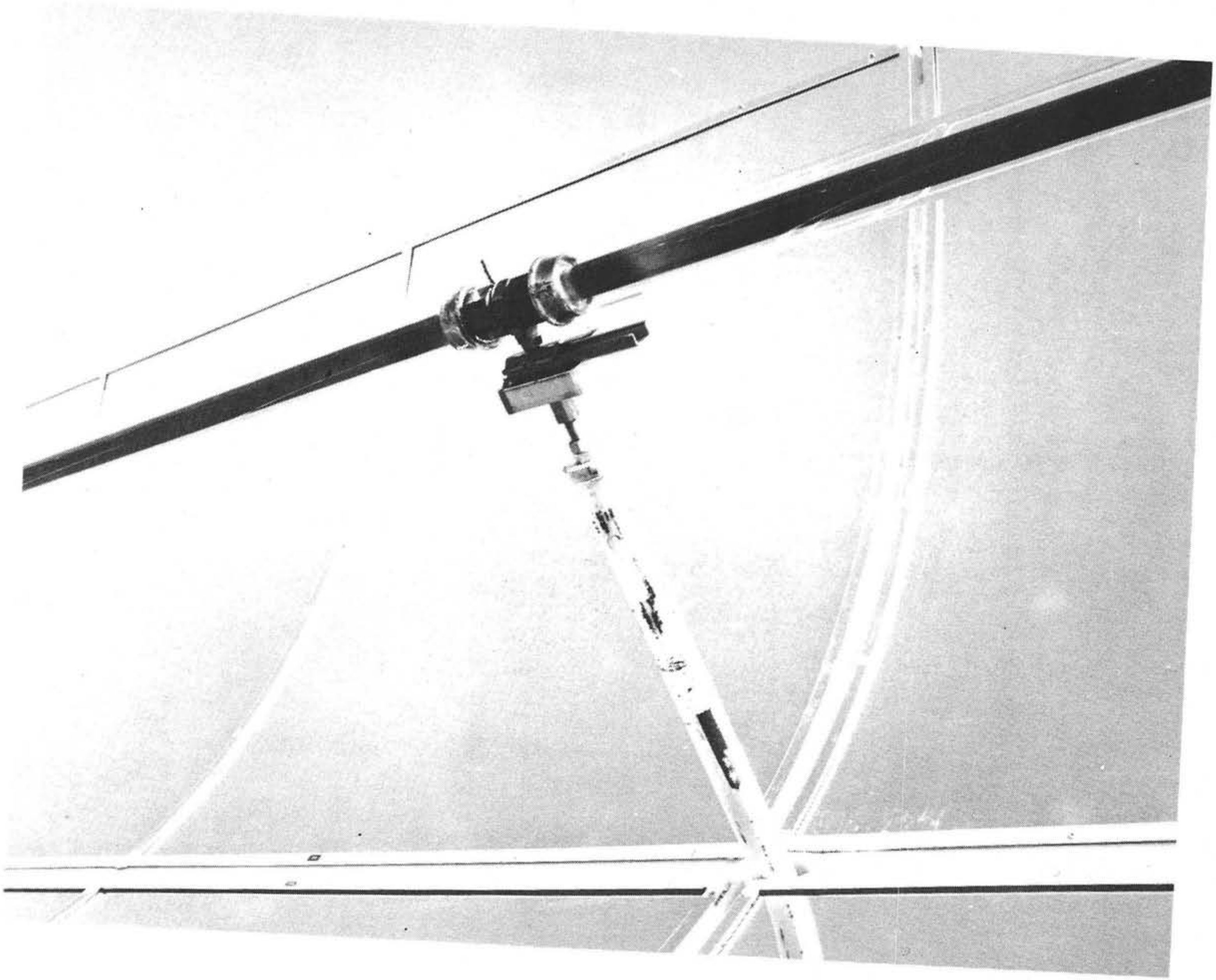

Figure 6. Receiver Tubes Mounted to CE Trough

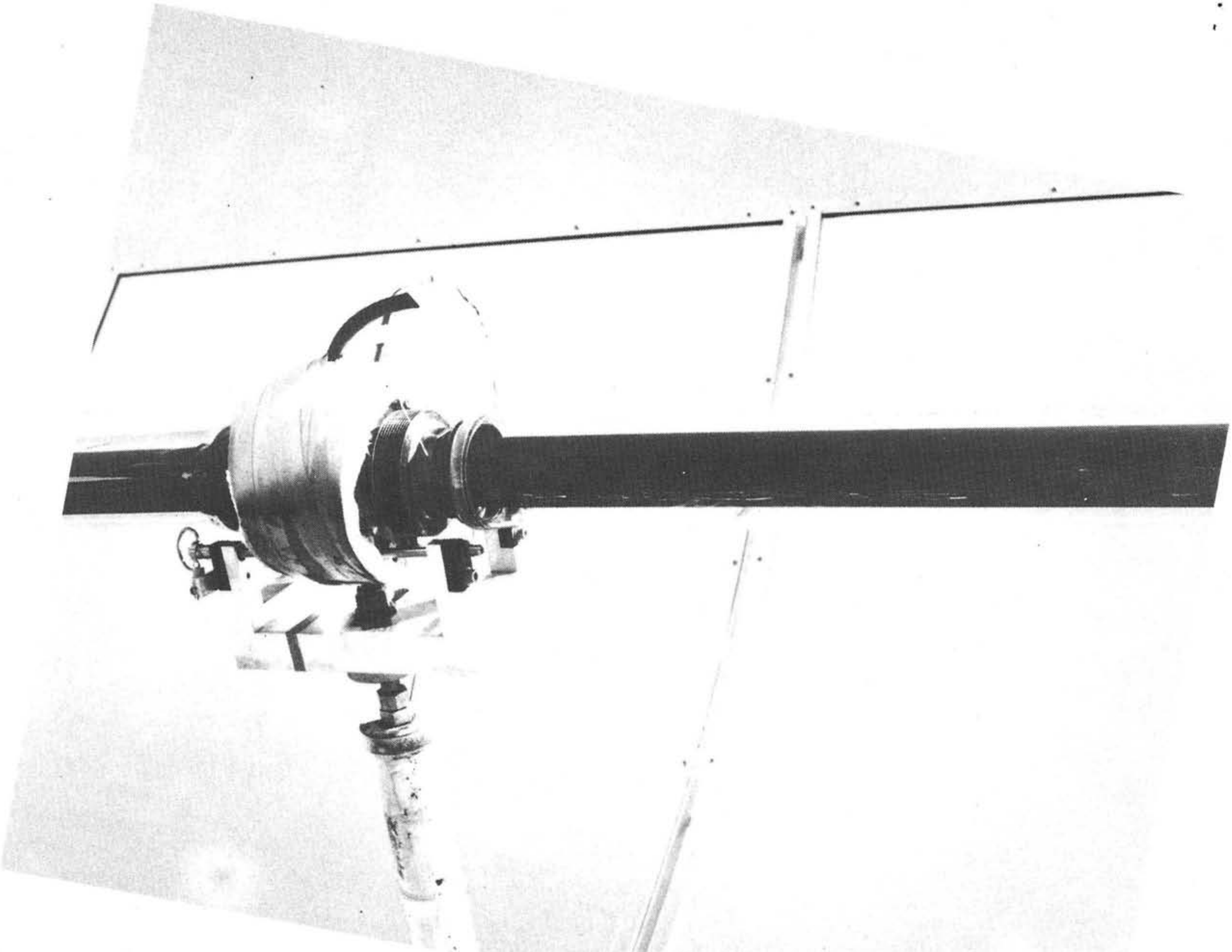

Figure 7. Receiver Tubes Mounted to CE Trough

IX. BLACK CHROME THERMAL AGING STUDY -- L. Torkelson (505) 844-8643

OBJECTIVES

To use 280 ft^2 of SKI T-700 troughs as a test bed for black chrome thermal aging studies. Various black chrome coatings will be simultaneously evaluated at 600°F and Reynolds numbers of 30,000 and 10,000 at solar noon and early/late time, respectively. Continuous operation is desirable.

Collector aging will be correlated with aging tests being carried out in laboratory furnaces. Tests will determine collector aging of black chrome coatings obtained from different plating baths and applied to various substrates (nickel, stainless steel, chromium, etc.).

STATUS AS OF 1 JULY 1980

1. SKI T-700 collectors have been installed, checked out, and determined to be ready for testing.
2. Fluid distribution system has been insulated.
3. Eight black chrome samples have been mounted to the tubes, instrumented, and determined to be ready for testing.

FUTURE ACTIVITIES

- Test series will begin in July 1980.

REFERENCES

1. R. Pettit, R. Sowell, and R. A. Mahoney, "Program Plan for Black Chrome Solar Coating," SNL correspondence, 31 March 1980.

2. Figure 8. Test Setup for Black Chrome Thermal Aging Study.

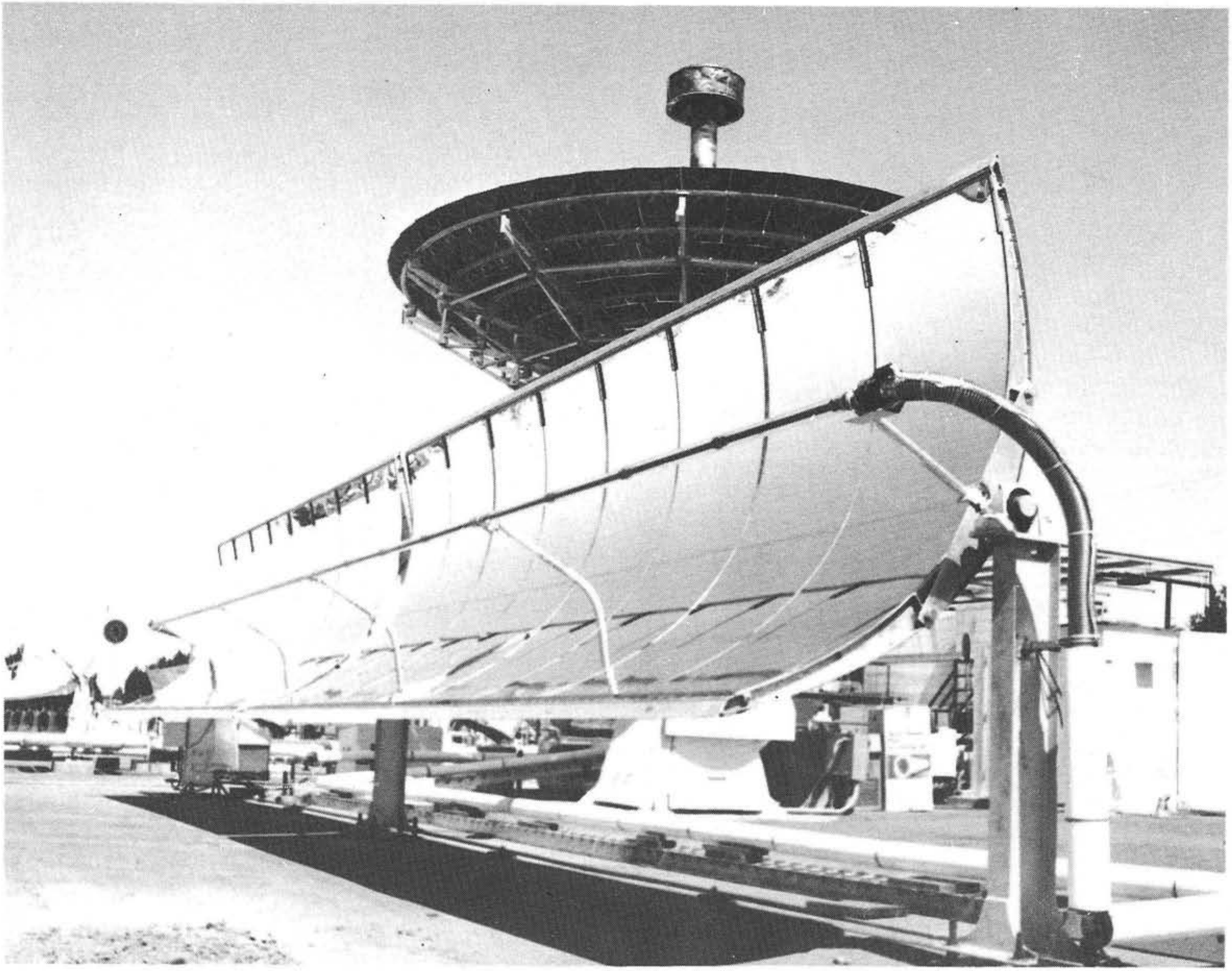

Figure 8. Test Setup for Black Chrome Thermal Aging Study

X. FLUID CONTROL SYSTEMS TEST -- T. Harrison (505) 844-6394

OBJECTIVES

To demonstrate that proposed fluid control systems could maintain the fluid output temperature within ±5°F of a desired set point under steady-state conditions, and that temperature overshoots during transient conditions, such as startup and full or partial cloud cover, do not exceed 50°F.

STATUS

Fluid control system tests were run between 3 April and 8 April 1980 on a string of collectors consisting of two Custom Engineering collectors and the two original parabolic trough collectors. A memo[1] describes the test configuration and discusses the results of the tests.

Fluid flow was controlled by a motor-driven control valve placed in series with the collector string. Valve stem position was computer-controlled, using a proportional control algorithm operating off the string output temperature. In addition, an override capability has been provided which commands maximum flow whenever the midrow temperature exceeds a set point which is 20° above the nominal midrow temperature.

A variable speed centrifugal pump was used to provide the required fluid flow. The pump speed was not varied during the test and was preset to obtain a flow of 10 gpm with the control valve wide open. The 10-gpm flow is 25% greater than the flow required for maximum insolation conditions.

FUTURE ACTIVITIES

- No additional tests are planned. The test results indicate that the motor-driven valve in conjunction with a proportional control algorithm provides good temperature control under both steady-state and transient conditions. Several discrepancies from expected performance were noted, but these have been attributed to test configuration peculiarities which will not typically exist.

REFERENCE

1. R. Schindwolf, "Fluid Control System Test Results," Letter to Distribution, Sandia National Laboratories, 15 May 1980.

XI. PUMP HEAT LOSS -- L. Torkelson (505) 844-8643

OBJECTIVE

To measure experimentally heat loss from a centrifugal pump while pumping high-temperature Therminol 66 fluid. The test will be conducted under a variety of flow rates and temperatures. Also, various insulation schemes will be evaluated.

STATUS AS OF 1 JULY 1980

1. The test setup is designed, assembled, and installed (see Figure 9).
2. Instrumentation has been checked out.
3. Testing is under way as of 22 June 1980.

FUTURE ACTIVITIES

- Complete test series.
- Publish final report.

REFERENCE

1. Figure 9. Pump Heat Loss Test Setup.

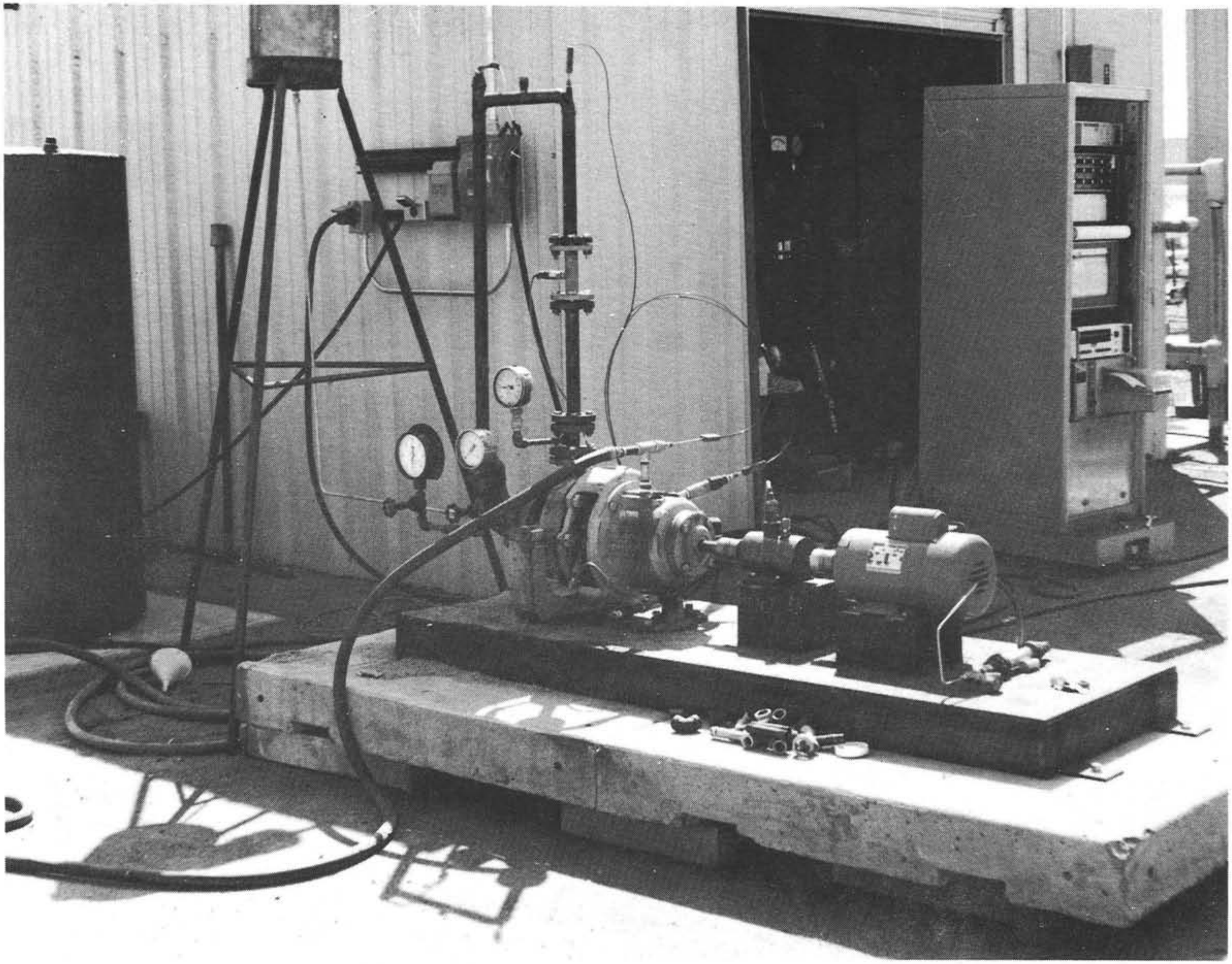

Figure 9. Pump Heat Loss Test Setup

XII. <u>PUMP POWER TEST</u> -- L. Torkelson (505) 844-8643

OBJECTIVES

a. To compare efficiency of gear pumps versus centrifugal pump.

b. To compare efficiency of fixed speed versus variable speed pumping.

STATUS AS OF 1 JULY 1980

1. Test series complete.
2. Data available upon request.

FUTURE ACTIVITIES

- Test report will be published by 1 August 1980.

REFERENCE

1. L. Torkelson, Handout used during Department presentation.

XIII. MIRROR CLEANING TEST SERIES -- L. Larsen (505) 844-1678

OBJECTIVE

To determine suitable, cost-effective cleaning materials, procedures, techniques, and equipment required to clean solar collector reflective surfaces.

This program is a continuation of a cleaning study performed by McDonnell Douglas.[1]

STATUS AS OF 1 JULY 1980

1. Eight 2- by 2-foot glass mirror samples have been exposed to Albuquerque environment since November 1979.
2. Six 2- by 2-foot glass and two 2- by 2-foot FEK samples have been exposed since May 1980.
   - Specular reflectance measurements every week.
   - Wash and rinse cycles are being conducted at 4- and 8-week intervals.
   - Cleaning variables, include spray flow/pressure, detergents, deionized water, tap water, soft water, and sheeting agent rinse.

FUTURE ACTIVITIES

As procedures and techniques evolve, these cleaning activities will be expanded to include full-scale modules (CE troughs) located in the Sandia MSSTF. The cleaning procedures will ultimately be finalized on the three PPT designs which are scheduled for installation at the MSSTF in January 1981.

REFERENCES

1. M. B. Sheratte, Cleaning Agents and Techniques for Concentrating Solar Collectors, SAND79-7052 (Albuquerque: Sandia National Laboratories, May 1980).

XIV. THERMOCLINE STORAGE TEST SERIES -- T. Harrison (505) 844-6394

OBJECTIVES

a. To design, fabricate, install, and instrument a thermocline storage tank at the MSSTF.

b. Once the tank is operational, to characterize the storage system and to study the thermocline behavior under static and dynamic conditions.[2]

c. To use above results to specify design requirements for mid-temperature thermal storage facilities and, further, document the requirements in a design handbook.

STATUS AS OF 1 JULY 1980

1. Thermocline tank designed, fabricated, installed, and instrumented (392 thermocouples).
2. Checkout is under way.
3. Test plan has been written.
4. Oil heaters and diffuser have been modified as a result of initial testing.

FUTURE ACTIVITIES

- Instrumentation checkout will continue through July 1980.
- Testing will begin following system checkout.

REFERENCES

1. Figure 10. Thermocline Storage Tank.

2. L. Radosevich, Thermal Energy Storage for Solar Thermal Applications Program Progress Report, SAND80-8218 (Albuquerque: Sandia National Laboratories, May 1980) pp 36, 82.

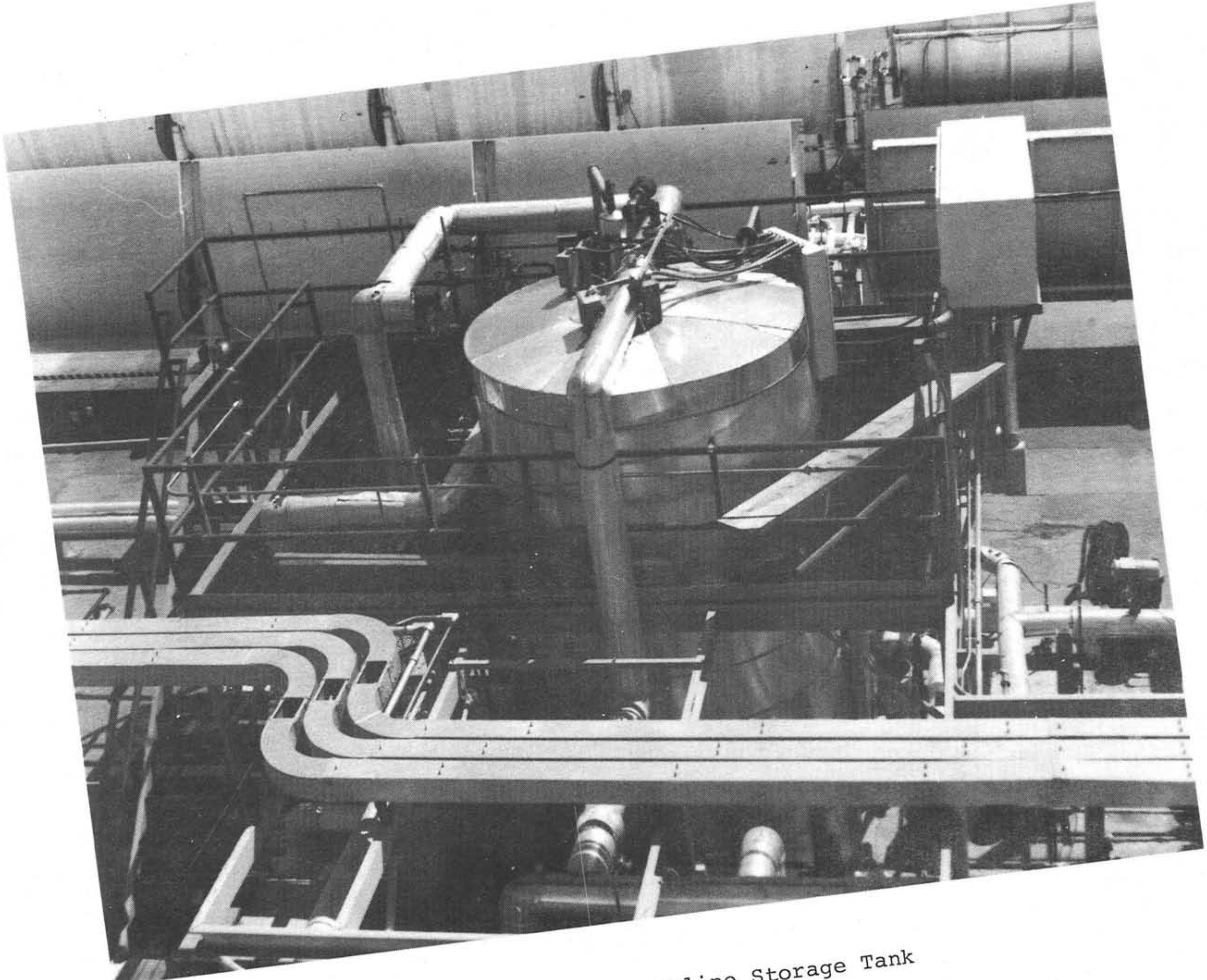

Figure 10. Thermocline Storage Tank

XV. SHENANDOAH* PROTOTYPE DISH EVALUATION PROGRAM -- J. Zimmerman, (505) 844-3338

OBJECTIVES

a. To install four prototype dishes which are mounted, interconnected, and controlled as designed for Shenandoah.
b. To evaluate dish components, performance, control technique, and interaction preliminary to design freeze.
c. To continue program by evaluating all dish, control, etc., modifications as they occur, including the first "tool-made sample."

STATUS AS OF 1 JULY 1980

1. The four prototype dishes were installed in summer 1979.
2. First prototype model has been fully evaluated, resulting in the following typical modifications.
    - Dish spacing in field.
    - Reflective surface (RTV 670 to FEK 244).
    - Collector control unit relay and circuit.
    - Receiver aperture plate, optical sensors, and coil.
    - Collector control program.
3. Test setup for evaluation of "single pass" coil under way.

FUTURE ACTIVITIES

- Evaluate "single pass" coil, including performance, efficiency, etc.
- Install and test "tool-made" sample.
- Issue final test report.
- Support future operation/maintenance problems experienced at Shenandoah.

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*Shenandoah is a large-scale experiment program to construct and operate a solar total energy plant for a 2400-m^2 knitwear apparel factory.

REFERENCES

1. Shenandoah Final Report for 1 October 1977 through 31 July 1978, ALD/3985-1.

2. Shenandoah Operating Plan, Document No. 78SDS4235, December 1979.

3. Final Report on Test of STEP, Shenandoah Parabolic Dish Solar Collector Quadrant Facility, December 1979.

4. Shenandoah Final Design Report, Document No. 78SDS4234, January 1980.

5. Figure 11. Shenandoah Dishes Mounted at MSSTF.

Figure 11. Shenandoah Dishes Mounted at MSSTF

XVI. CUSTOM ENGINEERING TROUGH PROGRAM -- J. Zimmerman (505) 844-3338

OBJECTIVE

To contract the design, fabrication, and installation of 1000-ft^2 fiberglass/honeycomb troughs at the MSSTF. The fiberglass/honeycomb structure was selected for its stability in environmental testing. Once installed, SNLA will perform a long-term evaluation program and compare results to first generation troughs.

STATUS AS OF 1 JULY 1980

1. Troughs have been designed, fabricated, and installed at the MSSTF by Custom Engineering, Denver, Colorado.
2. Trough evaluation is under way, using two receiver designs (see Long-Term Receiver Evaluation):
   - 1-5/8-inch OD absorber tube with passively evacuated annulus.
   - 1-3/8-inch OD absorber tube similar to that proposed for the performance prototype troughs.

FUTURE ACTIVITIES

- Characterization of CE trough simultaneously with performing long-term receiver tests and glass cleaning tests.
- Observation of long-term performance and structural/material stability.

REFERENCES

1. Custom Engineering Final Report (to be published).

2. Figure 12. Custom Engineering Troughs.

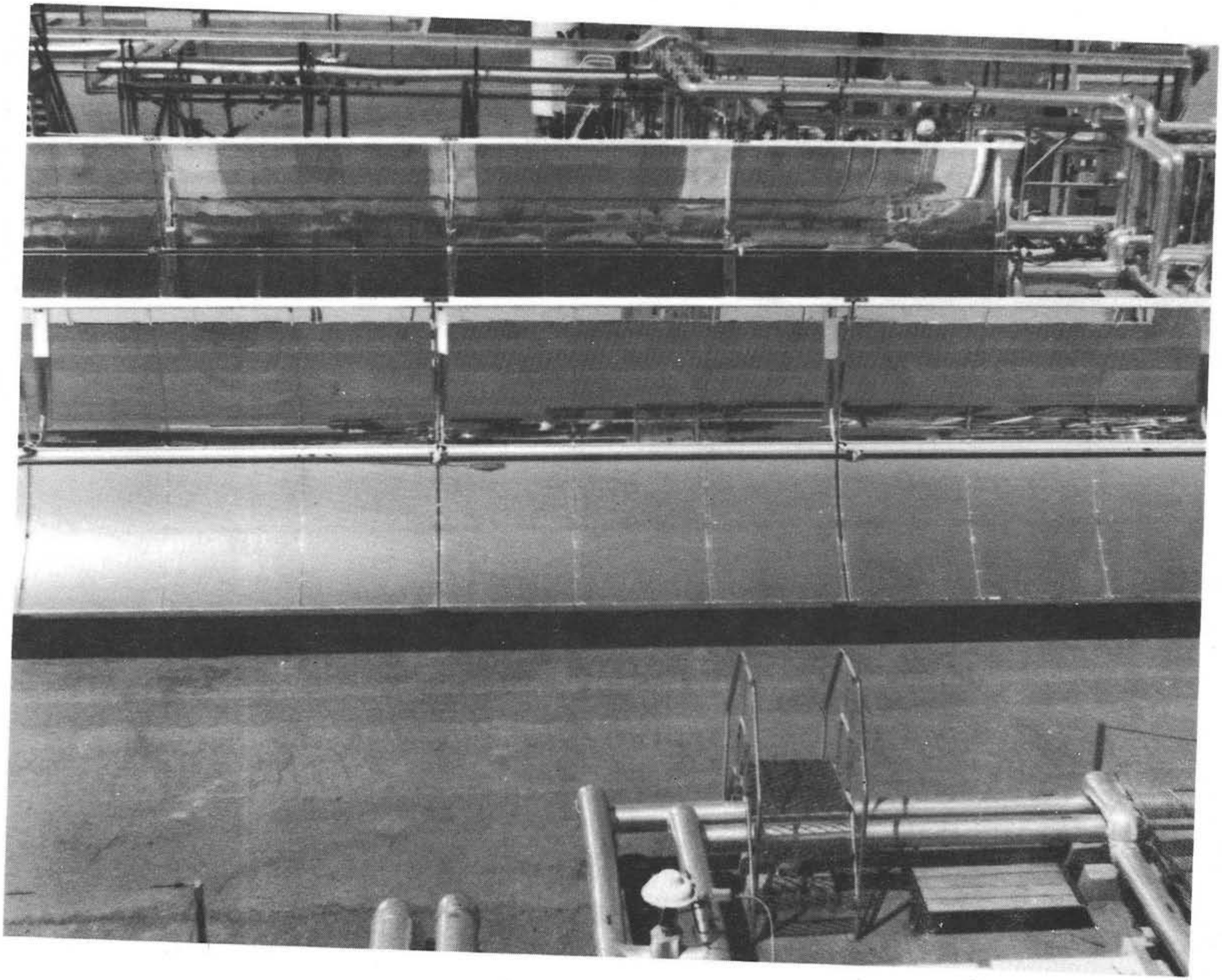

Figure 12. Custom Engineering Troughs

XVII. RAYTHEON DISH PROGRAM -- L. Torkelson (505) 846-0027

OBJECTIVES

To fabricate, install, evaluate, and demonstrate the Raytheon dish which was selected in February 1975 as a promising candidate for midtemperature solar applications.

STATUS AS OF 1 JULY 1980

1. Raytheon test program was completed 24 June 1980. Test results include
   - Dish noontime efficiency throughout calendar year.
   - Heat loss data.
   - All-day performance at spring equinox and summer solstice.
2. Plans for disassembly and transfer to 5 MW_t CRTF are under way. Will be used as high-flux concentrator for R&D on flux gages.
3. Final report will be issued in fall 1980.

FUTURE ACTIVITIES

- Install reflective structure (with mirrors) at 5 MW_t Central Receiver Test Facility (SNLA).
- Install the two-axis tracking pedestal at the SNLA photovoltaic test facility (used as universal tracking mount).

REFERENCES

1. Solar Collector Subsystem Preliminary Design Program Final Report, SAND78-7034 (Albuquerque: Sandia National Laboratories, May 1977).
2. Solar Collector Design and Fabrication Program Final Report, SAND78-7035 (Albuquerque: Sandia National Laboratories, May 1978).
3. Figure 13. Raytheon Dish.

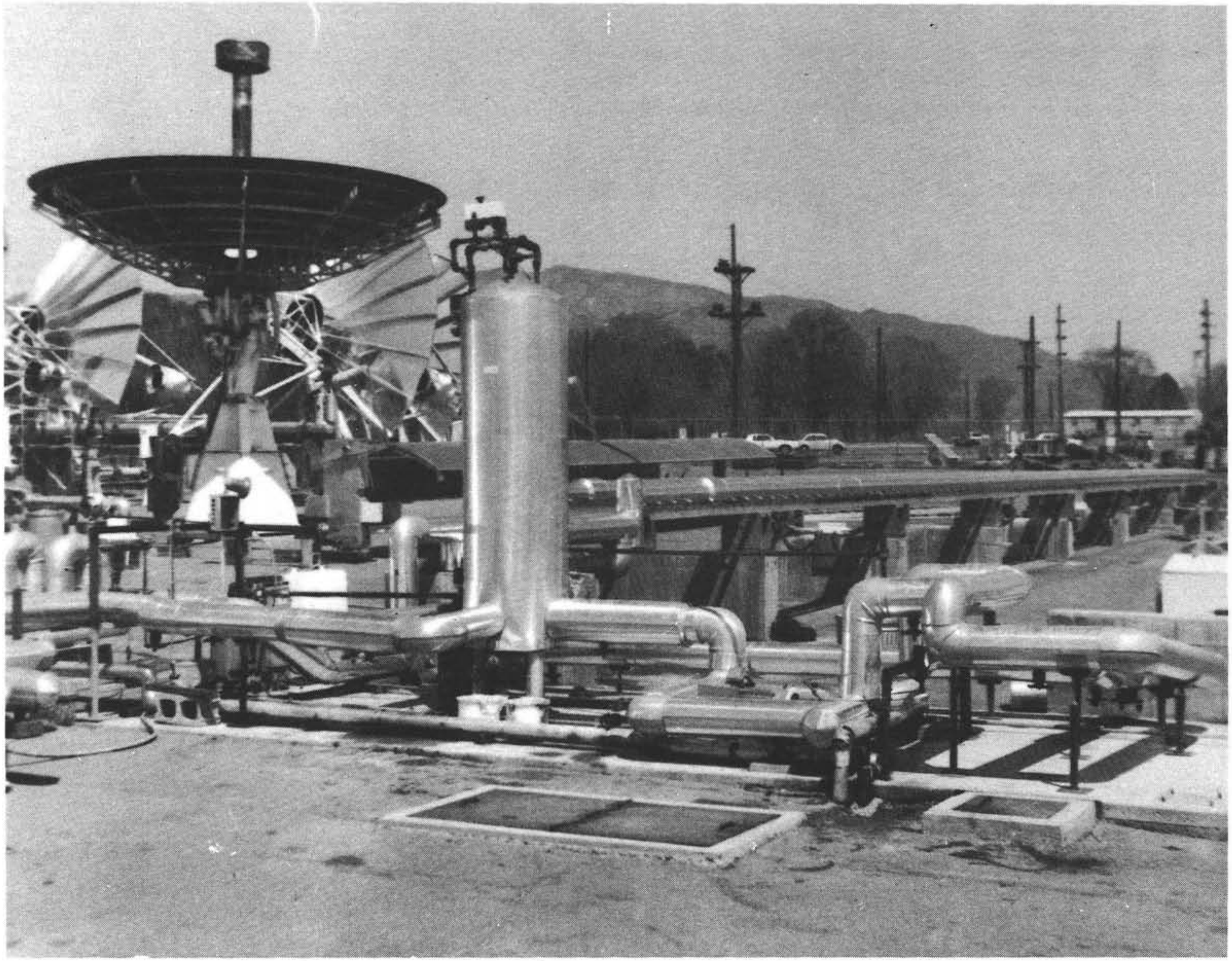

Figure 13. Raytheon Dish

XVIII. FOUNDATION TESTS -- E. Rush (505) 844-5579

OBJECTIVE

To determine overturning moment and lift force properties of various foundation designs.

STATUS AS OF 1 JULY 1980

1. Foundation test series has been completed on five foundation designs with a matrix of 12- and 18-inch diameter and 5- to 7-1/2-foot depth.
2. Comparison of results in item 1 was made with analytical data.

FUTURE ACTIVITIES

- Continue to test new foundation designs as they are proposed for sites and collectors.

REFERENCES

1. H. Auld, Study of Low Cost Foundation/Anchor Designs for Single Axis Tracking Solar Collector System, SAND78-7048 (Albuquerque: Sandia National Laboratories, January 1979).

2. H. Auld, Study of Foundation Designs for Single Axis Tracking Solar Collector Systems under Reduced Loading Conditions, SAND79-7016 (Albuquerque: Sandia National Laboratories, May 1979).

3. H. Auld, Analysis of Field Test Results for Single Axis Tracking Solar Collector Foundations, SAND79-7023 (Albuquerque: Sandia National Laboratories, July 1979).

4. H. Auld, Design of Field Test and Analysis of Experimental Results for LSE 7 Meter Collector Foundations, Shenandoah, Georgia, SAND79-7075 (Albuquerque: Sandia National Laboratories, December 1979).

XIX. HEAT TRANSFER OIL AGING PROGRAM -- R. McVeety (505) 844-6086

OBJECTIVE

To obtain long-term aging characteristics of heat transfer oil being used in the various field experiments. Oil characteristics include density, viscosity, specific heat, etc.

STATUS AS OF 1 JULY 1980

1. MSSTF oil samples tested and reported in July 1979.
2. Coolidge, Willard, MSSTF oil samples tested and reported in February 1980.

FUTURE ACTIVITIES

- Coolidge, Willard, MSSTF samples taken in July 1980.
- Continue at 6-month intervals.

REFERENCES

1. Monsanto letter reports to R. McVeety, SNLA, July 1979 and February 1980.
2. W. McCulloch, Heat Transfer Fluid Experiences at the MSSTF, SAND79-1802 (Albuquerque: Sandia National Laboratories, January 1980).

XX. GLASS-REINFORCED CONCRETE STUDY -- R. Lundgren (505) 844-3338

OBJECTIVES

Through contract with Stanford Research Institute,

a. To perform literature research into the properties of glass reinforced concrete and determine its potential for use as collector structural material.

b. To determine physical properties, glass compatibility, etc., using small glass-reinforced concrete samples.

c. Depending upon initial test results, to design and build collector trough sections for evaluation.

STATUS AS OF 1 JULY 1980

1. Contract has been placed with SRI.
2. Literature research has been completed.
3. Test samples are under investigation.

FUTURE ACTIVITIES

- Continue working with test samples.
- Review test results and make decision as to whether to continue program.

REFERENCES

1. American Concrete Institute, "Fiber Reinforced Concrete," SP44, December 1979.

2. MB Associates, "Low Cost Photovoltaic Concentrator Array," final report, MB-R-79/36, March 1980.

3. Aerospace Corporation, Evaluation of Line Focus Solar Central Power Systems, vol I and II, March 1980.

XXI. Large Aperture Parabolic Trough -- J. Zimmerman (505) 844-3338

OBJECTIVES

a. To purchase four T-2100* concentrating parabolic trough solar collectors from Solar Kinetics, Inc. (SKI).

b. To install, characterize, and perform long-term performance tests on T-2100.

STATUS AS OF 1 JULY 1980

1. Contract has been placed with SKI.
2. Site design has begun at MSSTF.

FUTURE ACTIVITIES

- Design to be initiated by SKI.
- SKI/SNLA to perform basic calculations.
- Design review.
- SNLA approval to proceed with fabrication.
- Installation and testing.

REFERENCE

1. Aerospace Corporation, Evaluation of Line Focus Solar Central Power Systems, vol I and II, March 1980.

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*A single T-2100 parabolic trough concentrating collector with the approximate dimensions of 21-foot aperture width and 20-foot length (approximate aperture area of 420 ft^2). The solar collector includes the related drive gear trackers, support pylons, receivers, and hoses.

XXII. SOLAR INTENSITY PROFILE GAGE* -- J. Zimmerman (505) 844-3338

OBJECTIVES

Through contract with BDM, Albuquerque, New Mexico,

a. To develop an Intensity Profile Gage. This will require instrument performance specifications, design, procurement, fabrication, and calibration of the instrumentation. The first application will be to produce a solar intensity profile of a T-700 collector without the receiver tube in place.

b. To determine if the SIPG can be applied to: (1) a parabolic trough with the tube in place, (2) plane surfaces for linear concentrators, e.g., photovoltaic concentrators, and (3) a fresnel lens.

STATUS AS OF 1 JULY 1980

1. Contract has been placed with BDM.

FUTURE ACTIVITIES

- Design of flux gage.
- Design review.
- Procurement, fabrication, and calibration.

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*A device that will attach to a parabolic trough and measure the solar intensity near the location of the receiver tube. The receiver tube may or may not be in place.

XXIII. D-SHAPED RECEIVER TUBE* AND RECEIVER TUBE SUBASSEMBLY** (RTS)-- J. Zimmerman (505) 844-3338

OBJECTIVES

a. To characterize an SKI T-700 solar collector using a laser technique and a flux profile measurement.

b. To provide detailed trade-offs as a function of temperature and design an optimum RTS as a function of temperature for the T-700 collector (using a D-shaped receiver tube).

c. To build an optimized RTS for the T-700.

d. To characterize the optimized RTS and compare with the circular cross section baseline RTS.

STATUS AS OF 1 JULY 1980

1. Contract has been placed with BDM.

FUTURE ACTIVITIES

- The future of this program is dependent upon results from Solar Intensity Profile Gage program with BDM.

REFERENCE

1. Aerospace Corporation, Evaluation of Line Focus Solar Central Power Systems, vol I & II, March 1980.

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*Instead of the normal circular cross section receiver tube, a D-shaped tube would be flattened to give a D-shaped cross section with the flat away from the reflector surface of the solar collector to optimally decrease the thermal loss.

**The fluid loop where the reflected solar energy is intercepted and the thermal energy is transferred to the heat transfer fluid. The RTS will also include a transparent envelope to decrease the thermal losses and seal the absorber tube from the environment, fittings to connect one RTS to another or to flexible hose at the end of a string of parabolic troughs.

XXIV. MULTITANK STORAGE TESTS -- T. Harrison (505) 844-6394

OBJECTIVE

To install three storage tanks (3400 gallons each) for MSSTF test support and analysis which includes

- To measure and to evaluate thermal losses.
- To determine temperature distribution through the tanks during periods of heat storage.
- To develop a control strategy.
- To investigate the cost of multiple tank storage.

STATUS AS OF 1 JULY 1980

1. Multitank system has been fully characterized.
2. Control strategies have been investigated.
3. Cost analysis has been completed.

FUTURE ACTIVITIES

- Support MSSTF testing.
- Investigate new control strategies when they are developed.

REFERENCES

1. Figure 14. Multitank System.
2. Randall, Summary Report: Multiple-Tank High-Temperature Storage Subsystem, SAND79-2056 (Albuquerque: Sandia National Laboratories, April 1980).
3. Harrison et al, Solar Total Energy Test Facility Project Test Results: High-Temperature Thermocline Storage Subsystem, SAND77-1528 (Albuquerque: Sandia National Laboratories, April 1978).
4. Harrison and Randall, Thermal Storage Experience at the MSSTF and Plans for the Future, NASA Conference Publication 2125, December 1979.

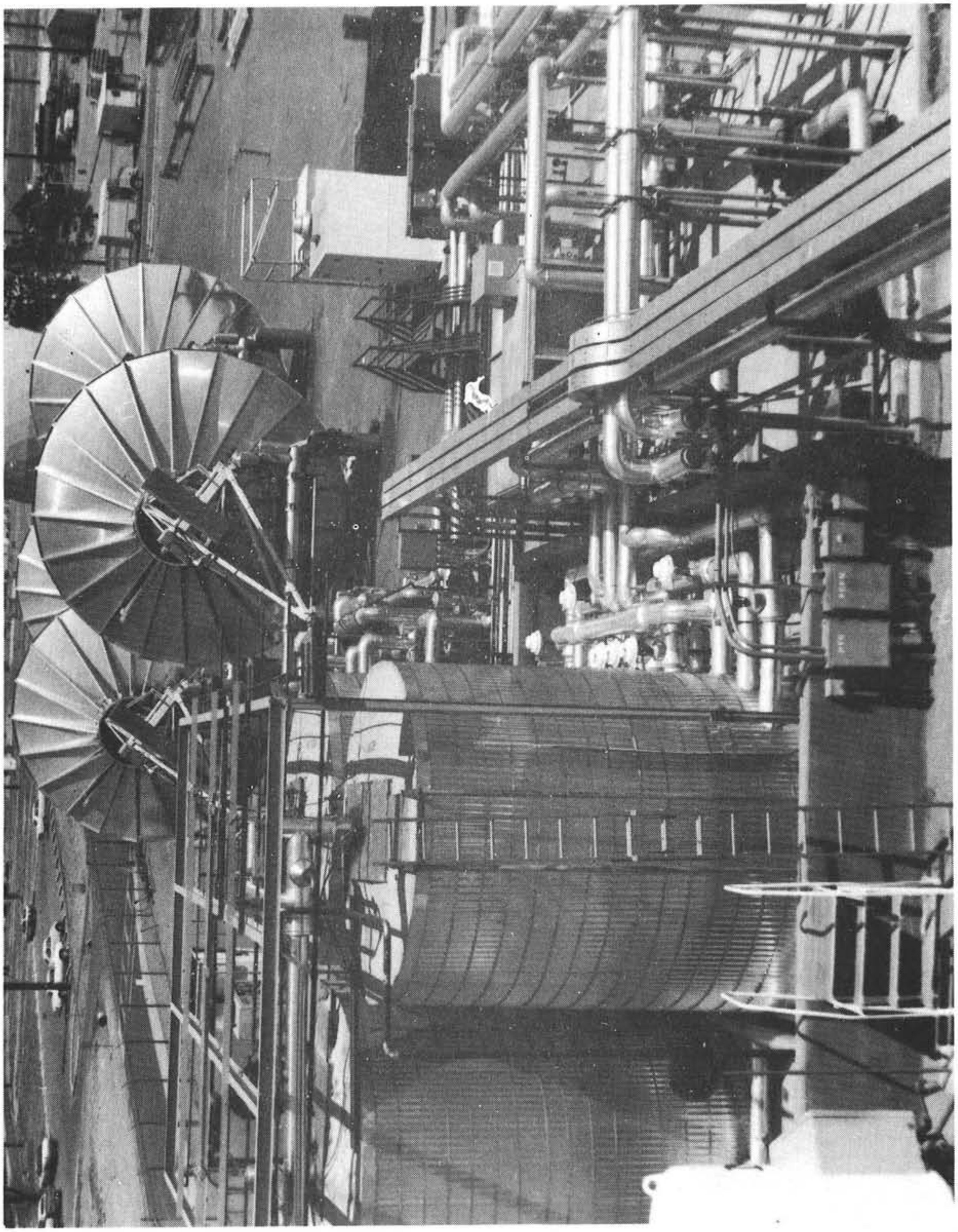

Figure 14. Multitank System

XXV. ENERGY CONVERSION SYSTEM -- J. Abbin (505) 844-8590

OBJECTIVE

To install the Energy Conversion System (ECS) at rating of 32 kW_e.

- To determine operational characteristics.
- To determine suitability of ECS as part of a solar total energy system.
- To use as integral part of other MSSTF tests as required.

STATUS AS OF 1 JULY 1980

1. ECS system has been fully characterized.
2. Feasibility of using as integral part of total energy system has been proven.
3. ECS is on standby for test support at MSSTF.

FUTURE ACTIVITIES

- Use as required.

REFERENCES

1. Figure 15. Energy Conversion System.
2. Abbin, Solar Total Energy Test Facility Project Test Summary Report: Rankine Cycle Energy Conversion System, SAND78-0396 (Albuquerque: Sandia National Laboratories, April 1978).

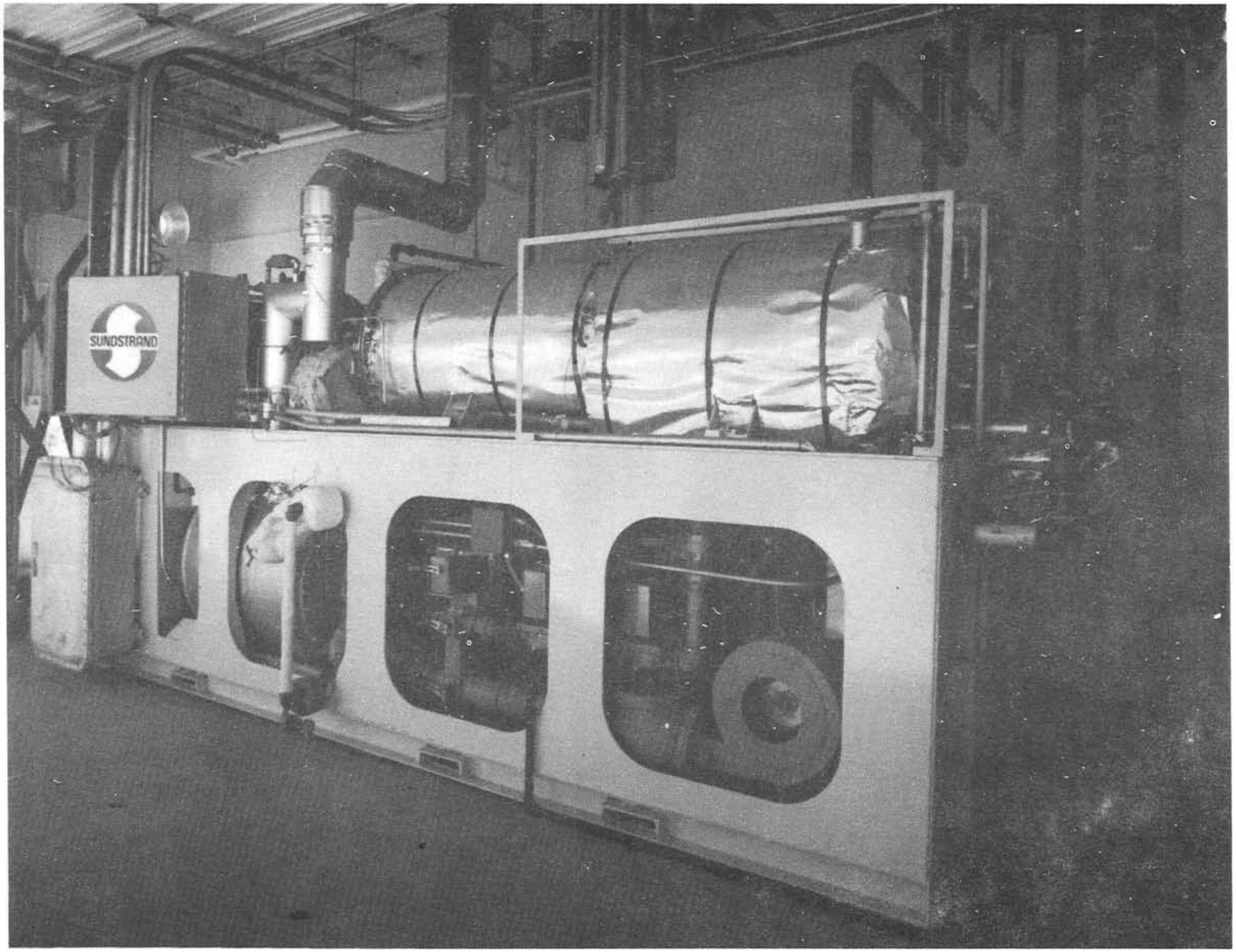

Figure 15. Energy Conversion System

XXVI-A. COLLECTOR MODULE TEST FACILITY: POWER REQUIREMENTS -- R. Workhoven (505) 844-5427

OBJECTIVE

To measure power requirements of tracking system/drive system.

TEST RESULTS

Daily Power Consumption

- Del: 40 linear feet, 8 modules
- Acurex: 40 linear feet, 4 modules
- T-700: 20 linear feet, 1 module

FUTURE ACTIVITIES

- Measure Power Consumption

  Suntec: 20 linear feet, 1 module
  EPT #2: 40 linear feet, 2 modules
  Other

XXVI-B. COLLECTOR MODULE TEST FACILITY: COLLECTOR COMPONENT/SUB-SYSTEM/SYSTEM -- R. Workhoven (505) 844-5427

OBJECTIVE

To support collector development program.

TEST RESULTS (Data available in Figure 17)

- Engineering Prototype No. 1 (1-1/4-inch receiver)
- Engineering Prototype No. 2 (EPT No. 1 with 1-inch receiver)

FUTURE ACTIVITIES

- Support by testing new designs, modifications, etc.

REFERENCES

1. Figure 16. Engineering Prototype Trough.
2. Figure 17. Performance of EPT No. 2.

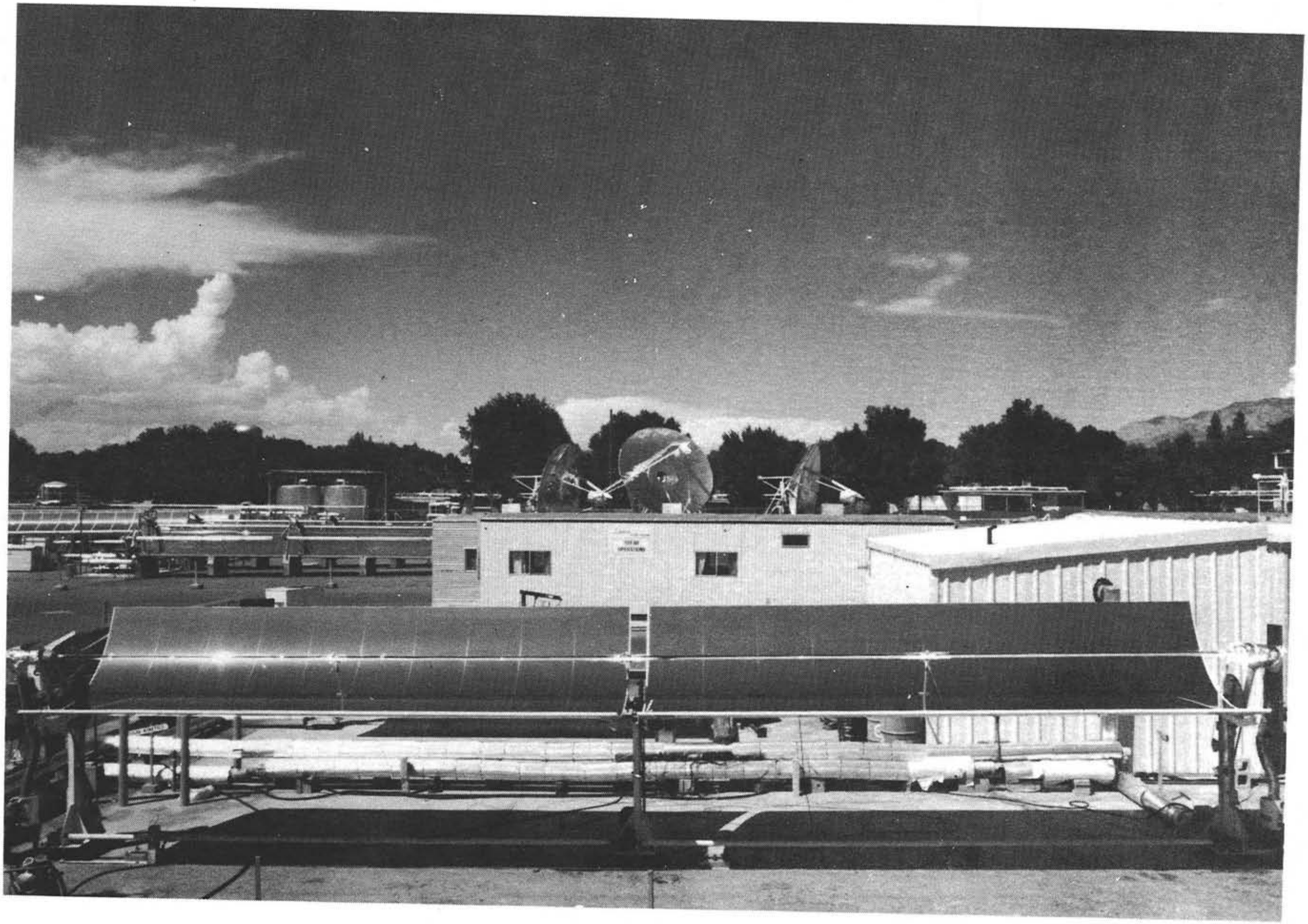

Figure 16. Engineering Prototype Trough

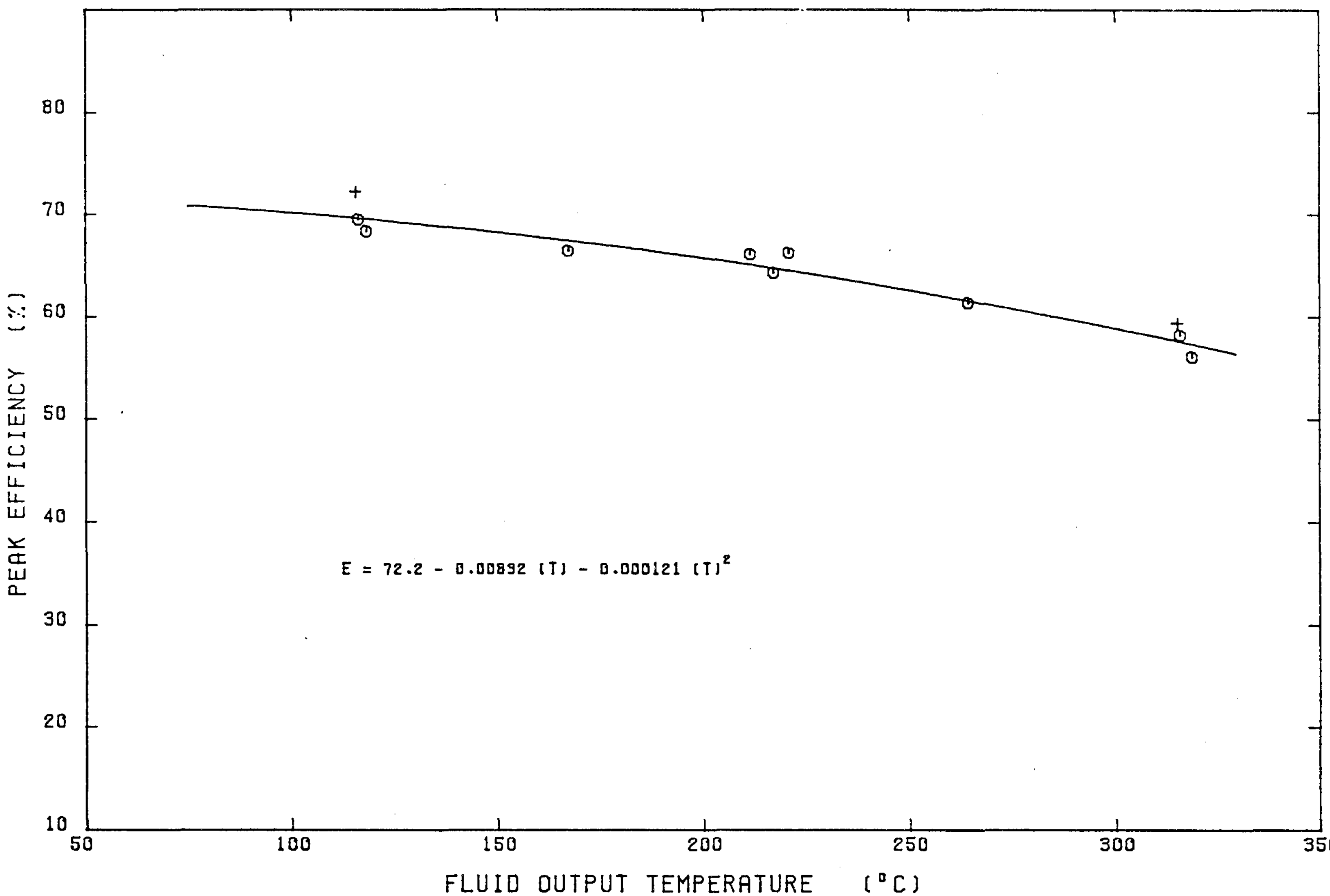

Figure 17. Performance of EPT No. 2

XXVI-C. COLLECTOR MODULE TEST FACILITY: COMMERCIAL COLLECTOR EVALUATION (Compound Parabolic Collectors*) -- R. Workhoven (505) 844-5427

OBJECTIVE

To characterize commercial compound parabolic collectors (CPC).

FY80 TEST RESULTS (Data available)

- GE TC-300 (April 1980)

FUTURE ACTIVITIES

- GE TC-300 completion.
- Chamberlain 3X Collector evaluation.

REFERENCES

1. Figure 18. TC-300 Test Setup.
2. Figure 19. Chamberlain 3X Collector.

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*Compound Parabolic Collector (CPC) is a nontrac ing line focus concentrating collector. Manual adjustment of the tilt angle is normally made as a function of time of year.

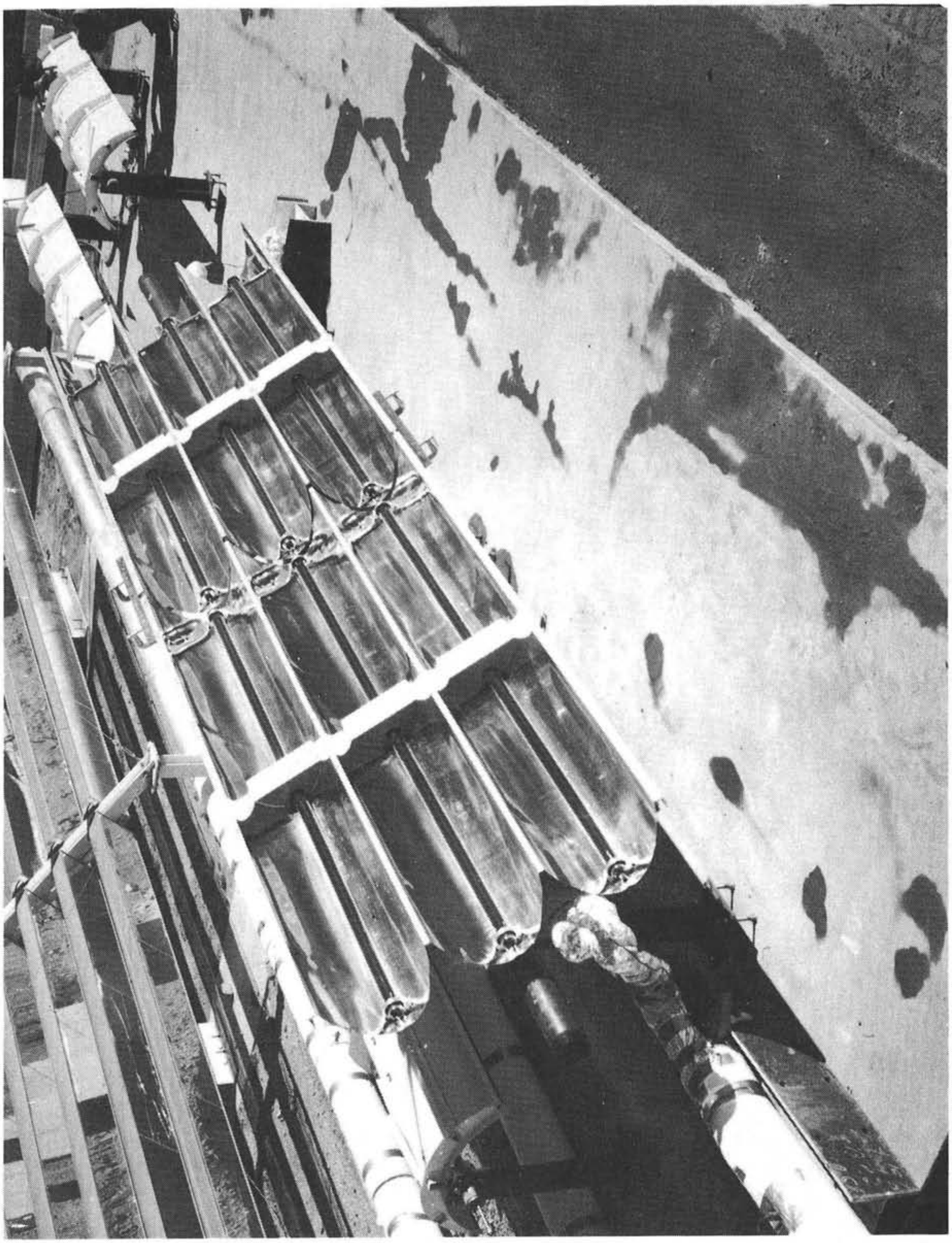

Figure 18. TC-300 Test Setup

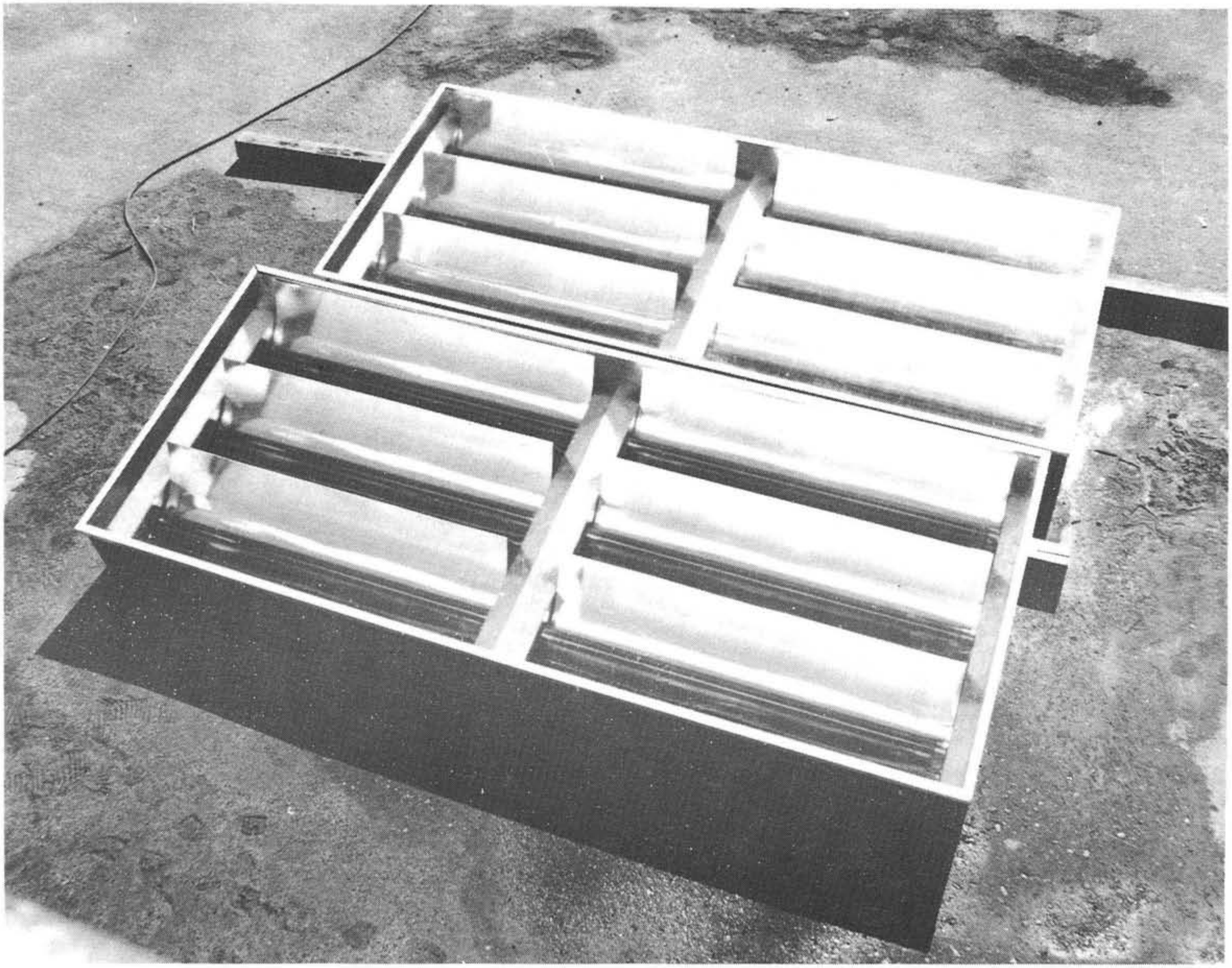

Figure 19. Chamberlain 3X Collector

XXVI-D. COLLECTOR MODULE TEST FACILITY: COMMERCIAL COLLECTOR EVALUATION OF PARABOLIC TROUGHS -- R. Workhoven (505) 844-5427

OBJECTIVE

To characterize commercial parabolic troughs.

TEST RESULTS FROM CURRENT COMMERCIAL COLLECTOR DESIGNS (Data available similar to Figure 21)

1. East-West Axis.
   - Acurex trough with Coilzak (March 1979)
   - Acurex trough with Glaverbel glass (October 1979)
   - SKI T-700 with FEK (February 1980) (Figure 22 with glass)
   - Suntec with glass (February 1980) (Figure 23)
2. North-South Axis.
   - Acurex with Coilzak (April 1979)
   - Acurex with Glaverbel glass (March 1980)
   - Acurex with FEK (April 1980) (Figure 24)

FUTURE ACTIVITIES

- Acurex with FEK (East-West)
- T-700 with FEK on turntable
- T-700 with glass on turntable
- Polisolar

REFERENCES

1. Figures 20, 21, and 22. Collectors under Test Pictures.
2. Dudley and Workhoven, Summary Report CMTF Test Results, SAND80-0846 (Albuquerque: Sandia National Laboratories, April 1980).
3. Dudley and Workhoven, Performance Testing of the Acurex Solar Collector Model 3001-03, SAND80-0872 (Albuquerque: Sandia National Laboratories, March 1980).

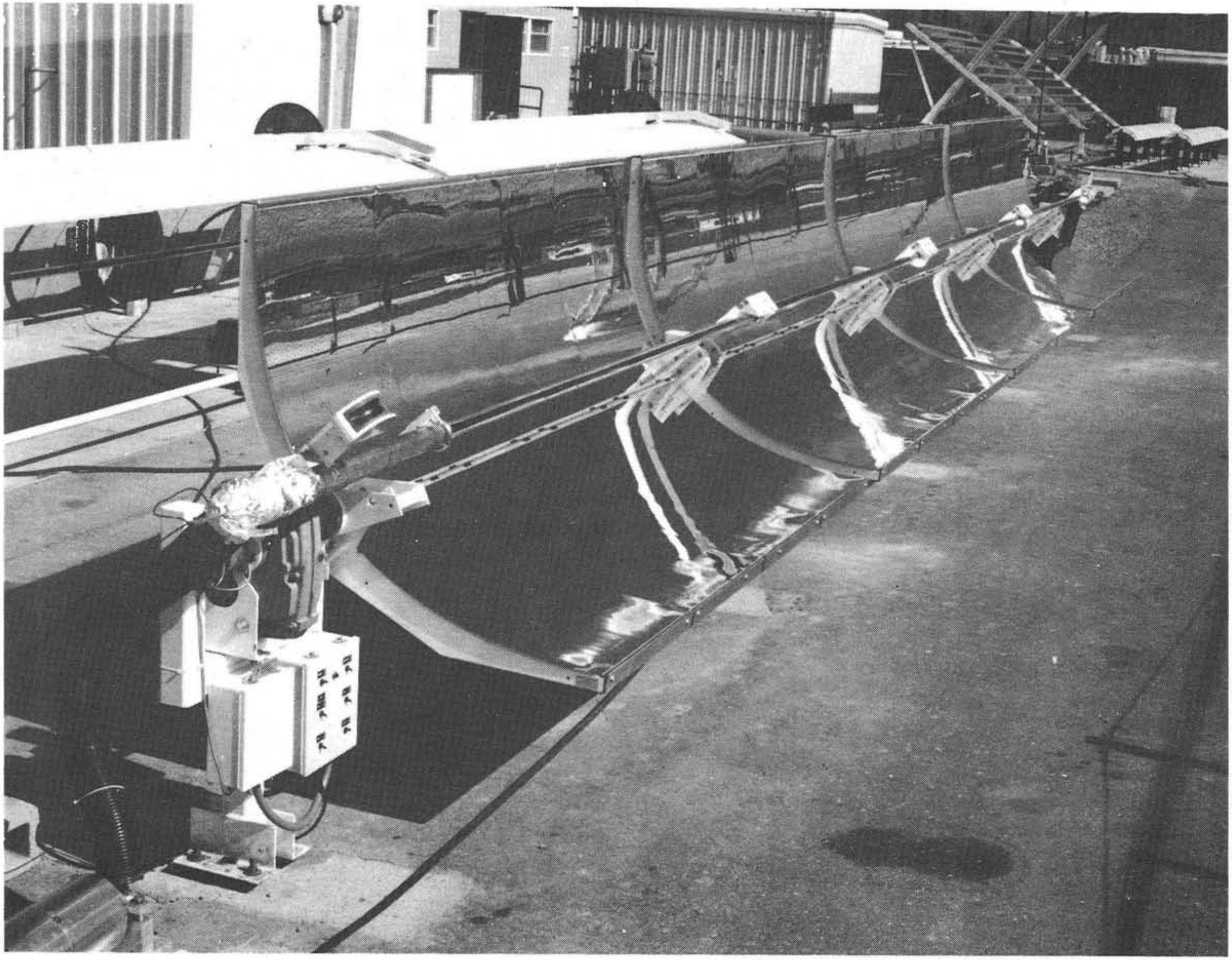

Figure 20. Acurex Collector under Test

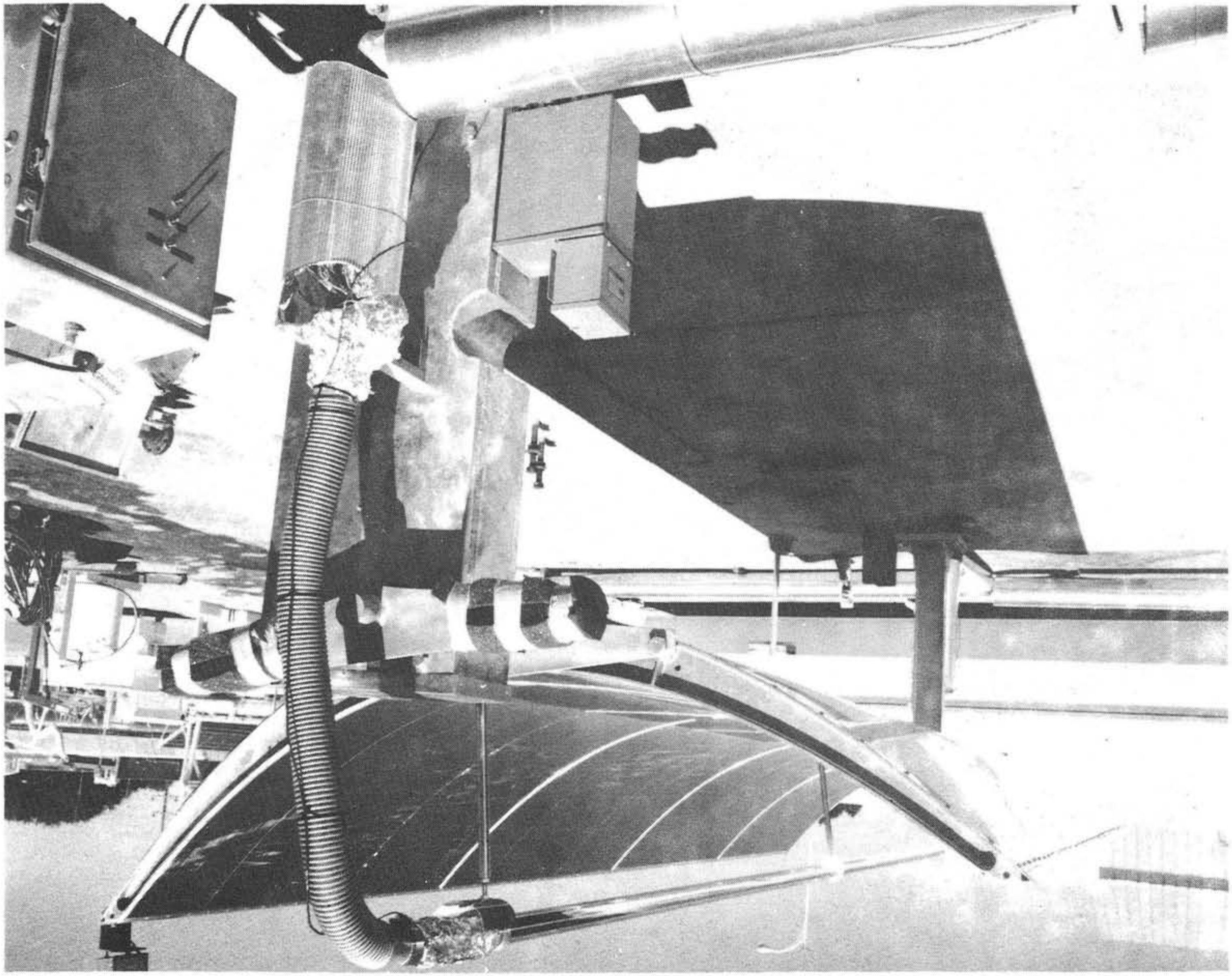

Figure 21. T-700 Collector under Test

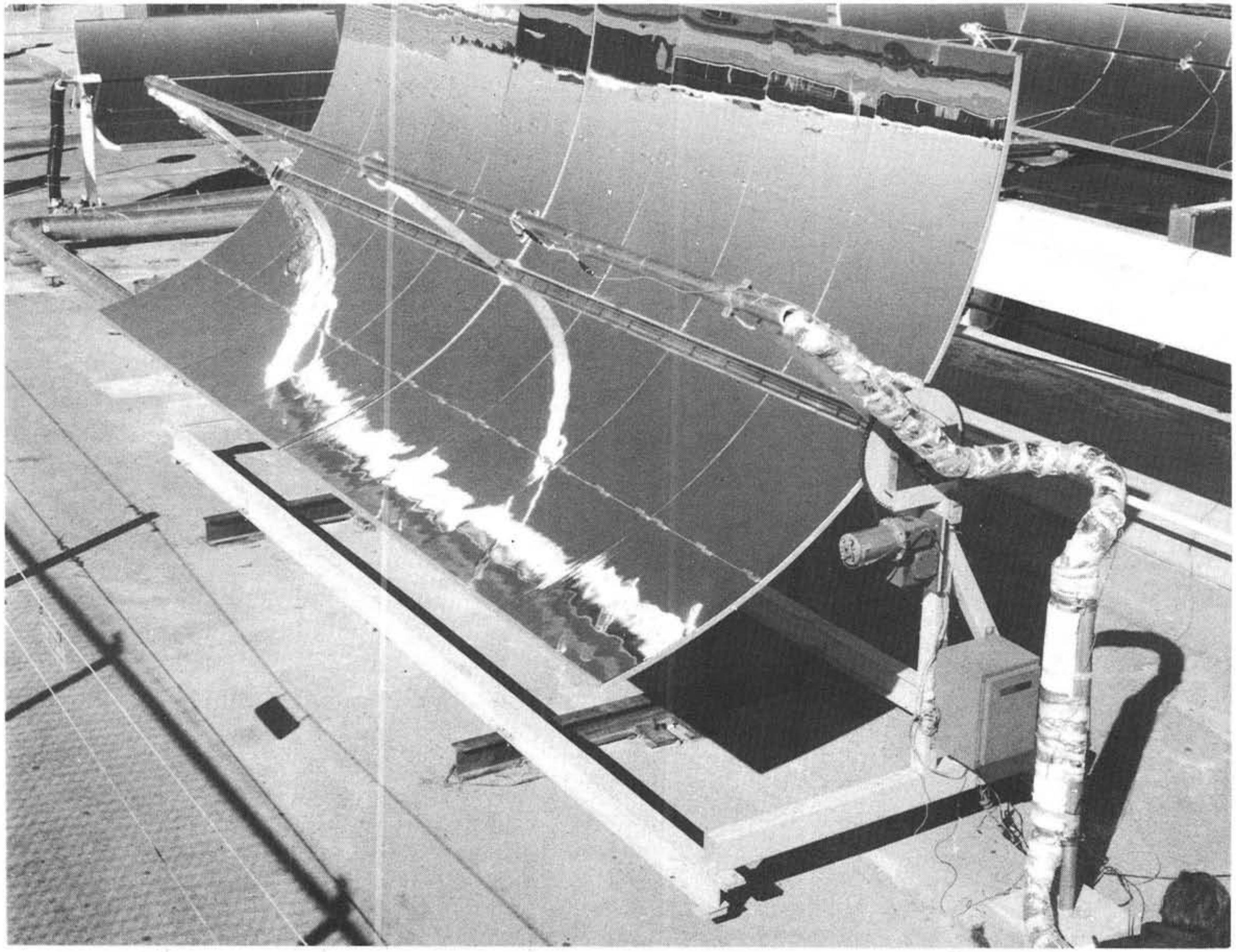

Figure 22. Suntec Collector under Test

XXVI-E. COLLECTOR MODULE TEST FACILITY: TRACKER EVALUATION -- R. Workhoven (505) 844-5427

OBJECTIVE

Tracker development and evaluation.

TEST RESULTS (Data available)

1. Shadow band trackers.
   - Advanced shadow band on Acurex with Coilzak
   - Acurex shadow band on Acurex Glass and FEK
   - Delevan shadow band on T-700
2. Honeywell flux sensor on T-700 and Suntec.
3. Wound wire flex sensor on Engineering Prototype Trough.

FUTURE ACTIVITIES

- Wound wire flux sensor modifications and additional testing
- Optical fiber flux sensor testing

XXVI-F. COLLECTOR MODULE TEST FACILITY: RECEIVER EVALUATION -- R. Workhoven (505) 844-5427

OBJECTIVE

Receiver development and evaluation.

TEST RESULTS (Data available)

- 1-inch versus 1-1/4-inch receiver tubes on Engineering Prototype
- Olympic plating versus Highland plating on T-700
- Suntec receiver tube (1-5/8-inches) with and without glass cover

FUTURE ACTIVITIES

- Suntec with and without back reflector on receiver

XXVI-G. COLLECTOR MODULE TEST FACILITY: COLLECTOR TURNTABLE -- R. Workhoven (505) 844-5427

OBJECTIVE

Turntable checkout and test program.

STATUS AS OF 1 JULY 1980

1. Turntable designed and built by Custom Engineering, Denver.
2. Turntable installed, corrected, and checked out by SNLA.
3. Turntable readied for testing by SNLA.

FUTURE ACTIVITIES

- Evaluate T-700 with FEK and glass.
- Perform studies on T-700 performance versus incident angle.
- Perform studies on T-700 performance versus solar intensity.
- Conduct majority of collector tests.

REFERENCE

1. Figure 23. Collector Turntable.

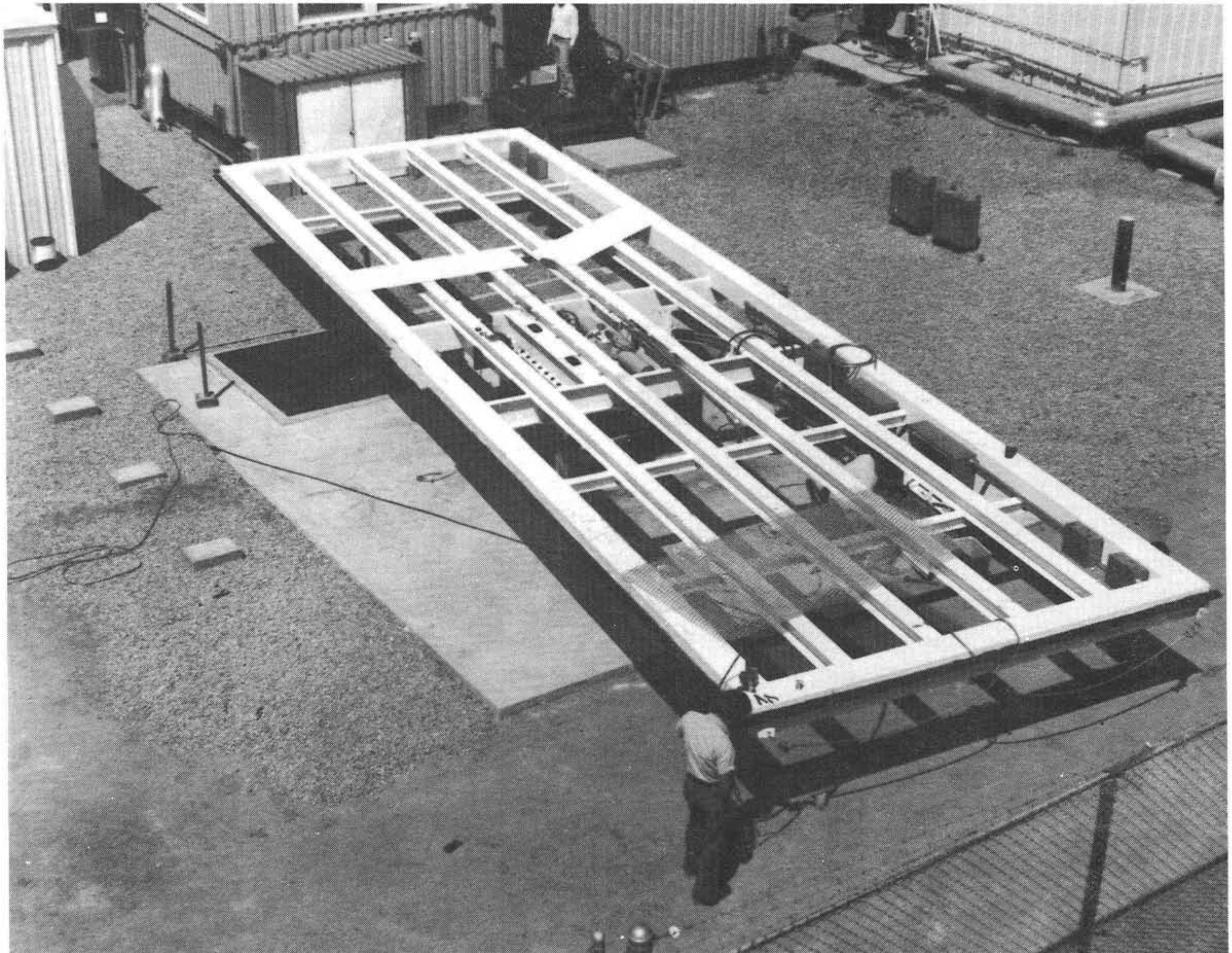

Figure 23. Collector Turntable

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