NASA CR-161,825

NASA-CR-161825
19810021981

DOE/NASA CONTRACTOR REPORT

DOE/NASA CR- 161825

# DESIGN DATA PACKAGE AND OPERATING PROCEDURES FOR MSFC SOLAR SIMULATOR TEST FACILITY

Prepared by

WYLE Laboratories
Solar Energy Systems Division
Huntsville, Alabama 35805

Under Contract DEN-000006 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



U.S. Department of Energy



Solar Energy

BEST

AVAILABLE

COPY

# TABLE OF CONTENTS

# LIST OF FIGURES

## 1.0 INTRODUCTION

As part of the George C. Marshall Space Flight Center (MSFC) role in support of the Department of Energy (DOE) program for "Solar Heating and Cooling Development in support of the Demonstration Program," a solar simulation test facility was constructed to evaluate solar collector performance under simulated outdoor operating conditions. MSFC continues to manage and operate this test facility. The primary goal of the facility is to evaluate the performance capability and "worst case" failure modes of collectors, which utilize either air or liquid transport media.

The stimuli for this facility are the time and labor savings derived by not being subject to the capricious nature of outdoor weather conditions, and the more critical factor of achieving complete repeatability from test to test. For example, the solar flux intensity can be set at constant levels ranging from 395 $W/m^2$ (125 $Btu/hr\text{-}ft^2$) up to 1120 $W/m^2$ (355 $Btu/hr\text{-}ft^2$); the wind speed can be maintained at velocities ranging from 1.3 to 5.8 m/s (3 to 13 mph); the collector fluid inlet temperature can be maintained at levels ranging from ambient temperature to 100$^oC$ (212$^oF$) or higher depending on fluid properties and system pessurization with fluctuations limited to $\pm$ 0.1$^oC$ ($\pm$ .18$^oF$) for extended periods of time. Control of the above parameters provides excellent repeatability from test to test which can never be achieved when testing out doors.

Environmental parameters the facility can simulate include sunfall conditions such as solar radiation intensity, solar spectrum, collimation, and uniformity, as well as solar attitude. Prevailing wind conditions of velocity and direction can also be simulated. The facility is capable of reproducing solar system conditions imposed on the collector, including transport media type and flowrate, collector fluid inlet temperature, and geometric factors of collector tilt and azimuth angles.

Sun simulation is achieved by 405 tungsten-halogen lamps which provide a source of energy near the solar spectrum at air mass 2. Each lamp is paired with a Fresnel lens for energy collimation. This combination forms a 27 x 15 illumination array. The lamp array, which is mounted with its long axis tilted up, is attached to an apparatus capable of being tilted around a horizontal axis (Figure 1 and drawing FAC-AE-4619-M2). The array can irradiate a 1.2 x 2.4 m (4' x 8') planar surface area. Collector orientation and thermal/fluid simulations are provided by a tilt table arrangement in conjunction with either an air or a liquid thermal/fluid loop. Wind velocity and direction on the collector are provided by two portable floor fans. These elements are all housed in a thermostatically controlled high bay building within the MSFC test complex.

Typically, testing in the simulator is performed to acquire collector efficiency data, the collector time constant, incident angle modifier data, and stagnation temperature values. The techniques utilized to make these evaluations follow in general the guidelines given in ASHARAE Standard 93-77, "Methods of Testing to Determine the Thermal Performance of Solar Collectors."

## 1.0 INTRODUCTION (Continued)

In reference 4.1 comparison of efficiency data generated in a natural outdoor environment to those generated in the simulator are presented. These comparisons are made for a double covered, selectively coated liquid flat plate collector and single covered, non-selectively coated air collector. The comparisons indicate outdoor flat plate collector efficiency data can be reproduced in the simulator to within 6 percent of the outdoor measurement.

Similar comparison of outdoor performance for a vacuum tube collector is provided in reference 4.2. Again, the indoor/outdoor correllation is excellent for both thermal efficiency and incident angle modifier data.

## 2.0 FACILITY DESCRIPTION

The facility includes the capability to simulate sunlight on the collector surface as its primary feature. However, it also provides a capability to simulate other conditions imposed by the solar system (i.e., storage and heating and/or cooling subsystems inputs), as well as natural environment conditions important to collector performance such as wind simulation and solar attitude. These simulations are accomplished by the major elements of the facility, which are the sun simulator, the solar system or load simulator, and the basic facility (Figure 1). A detailed description of each of the elements is given in the following paragraphs.

### 2.1 Sun Simulator Description

The key element of this facility is the sun simulator. This includes the lamp housing, lens housing, lamp/lens cooling equipment, and control equipment. Descriptions of these items follow.

#### 2.1.1 Lamps

The simulator uses 405 GE Model ENH quartzline lamps to produce the solar intensity and radiation spectrum. These lamps are rated at 250W at 120V. They use a tungsten filament with an equivalent source temperature at 1843$^{\circ}$C (3350$^{\circ}$F). The filament is housed in a quartz bulb filled with halogen gas which produces an energy spectrum similar to that of the sun at air mass 2 (see reference 4.1). The bulb is attached to a diachroic-coated glass reflector. This ellipsoidal reflector is mounted to the base of the bulb to limit the direction of light from the bulb. It also serves to limit infrared emission due to the selective nature of the reflector reflectivity.

Early lamps had stippled reflectors, while later versions use a faceted surface texture (Figure 2).

#### 2.1.2 Fresnel Lenses

Each lamp is mounted in a housing immediately opposite the lens housing. Each lens/lamp combination is mounted so that it has optically coincident axes (Figure 3). Lenses are mounted with the refracting grooved

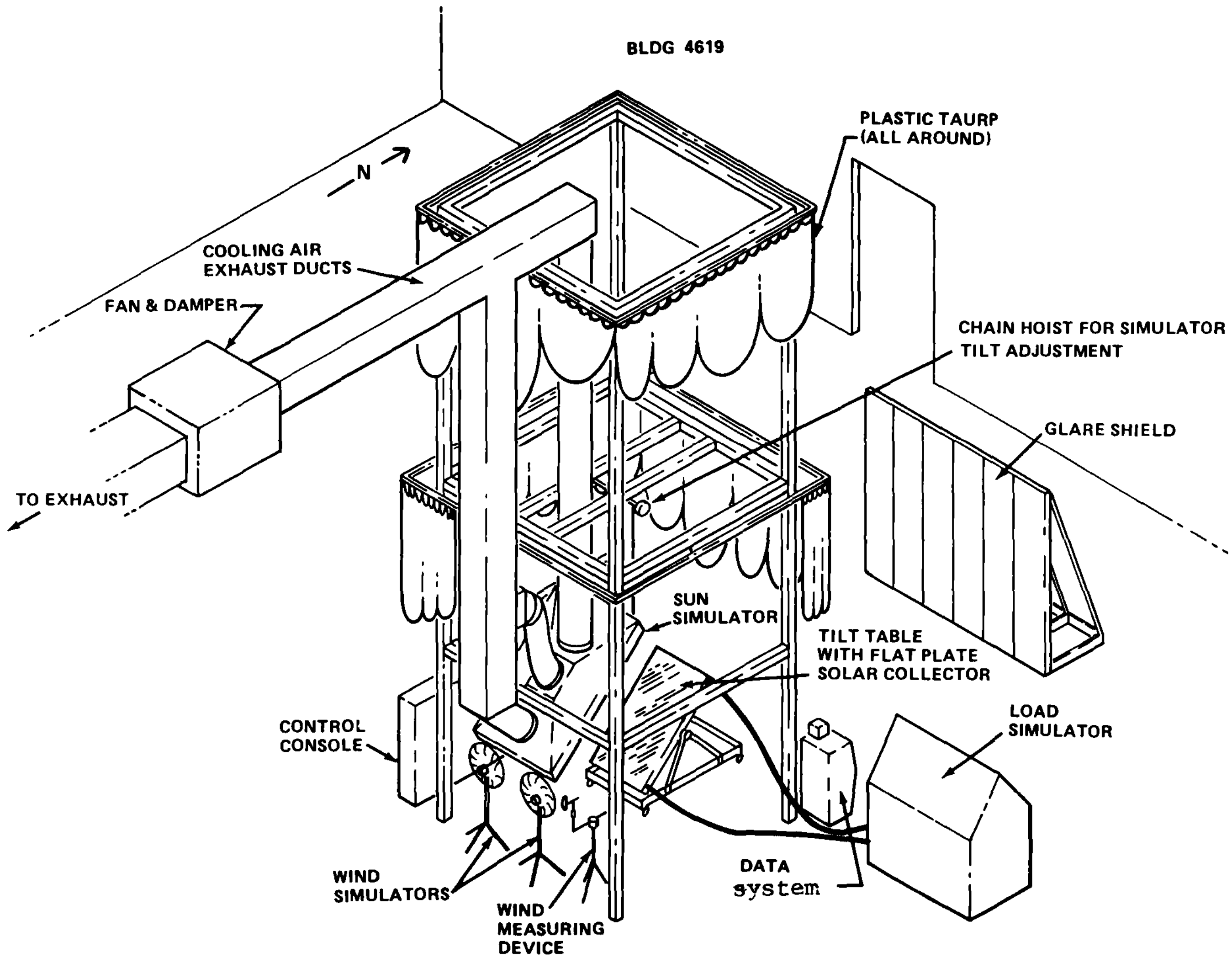



Figure 1. Test facility arrangement.

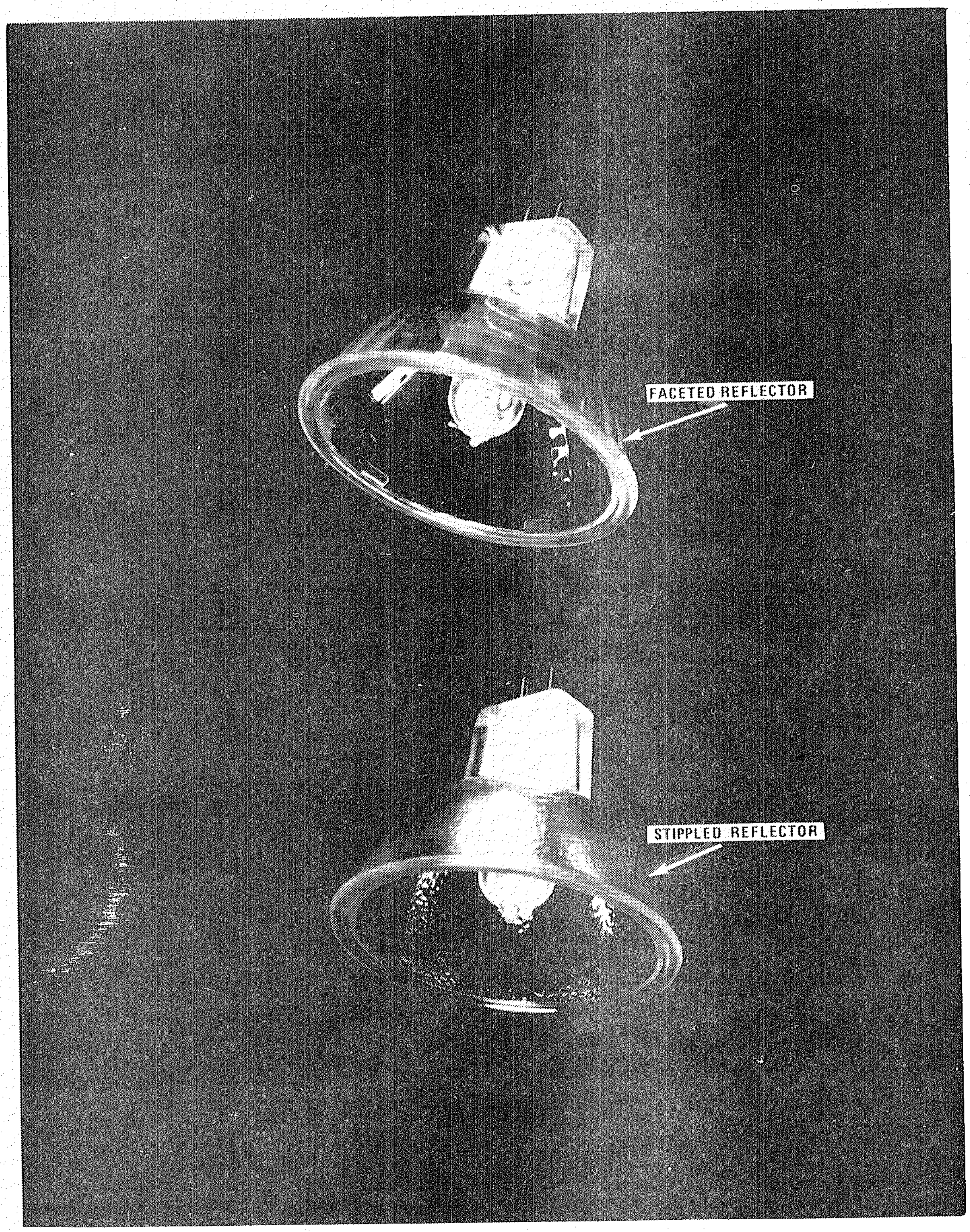



Figure 2. Tungsten-halogen lamps.

2.0 FACILITY DESCRIPTION (Continued)

2.1 Sun Simulator Description (Continued)

2.1.2 Fresnel Lenses (Continued)

surface facing the lamps. Spacing between corresponding lens/lamp pairs is 17.78 cm (7 inches). This spacing fixes the image created by the lamp 2.54 cm (1 inch) in front of the lamp reflector face and at the lens focal point. The 405 lens array is arranged in a 27 x 15 array (Figure 4).

Focusing of energy through the lens is achieved by multiple circular line grooves cut into the plastic with a groove density of 125 lines per inch. These grooves refract light rays from the lamps so that the focus of energy occurs at a point 15.24 cm (6 inches) from the lens. The spectra transmittance of the lens is shown in Figure 5.

Lenses are made of 0.6 mm (0.1625 in.) thick acrylic. Circular stock is cut to a hexagonal shape 12.7 cm (5 inches) accross flats. Semi-circular notches are cur in opposite flats to allow mounting (Figure 6). The lenses are secured to the lens housing by lightly torquing the mounting bolts. The lens housing is hinged to allow access to the lamps (Figure 7). Replacement lenses can be obtained from the Lectric Lite Company of Fort Worth, Texas.

2.1.3 Lamp/Lens Cooling

Cooling is provided the lamps and lenses by ingesting room air through eight household type fiberglass filters. The air then passes between the lenses and the lamps and through orifices in the lamp housing located adjacent to each lamp. Deflectors at the outlet of these orifices direct cooling air accross the lamp base and into a tapered plenum immediately behind the lamp housing, The heated air is mixed in the plenum and drawn off through a 63.5 cm (25 inches) diameter duct. From the duct, the warm air may be either exhausted outside during the warm summer months or returned to the high bay building for heating purposes in the winter months (Figure 8).

A variable position damper, located in the exhaust duct upstream of the fan, is used to control the cooling air flowrate, The damper position is manually set at the control console to maintain the lamp base temperature at or near an average of 288$^{\circ}$C (550$^{\circ}$F). A 283 $m^3$/min. (10,000 cfm) constant speed fan supplies air flow for this system. Opening and closing of the damper changes the flow resistance to allow the flowrate to be adjustable from a low of 125 $m^3$/min (4400 cfm) to a high of 311 $m^3$/min (11,000 cfm). See drawing E-SKM-815 for details.

2.1.4 Controls

Lamp voltage control (and flux intensity) and cooling flowrate is provided through a control panel located immediately adjacent to the simulator (Figure 9). Simulator flux intensity control is manual, utilizing a 150 kVA Research Incorporated voltage controller. The device is a three-phase 208 V SCR voltage controller shown on drawing FAC-AE-4619-E-1, modified by manufacturer's part #D477035 and D-46996E. Lamps are connected

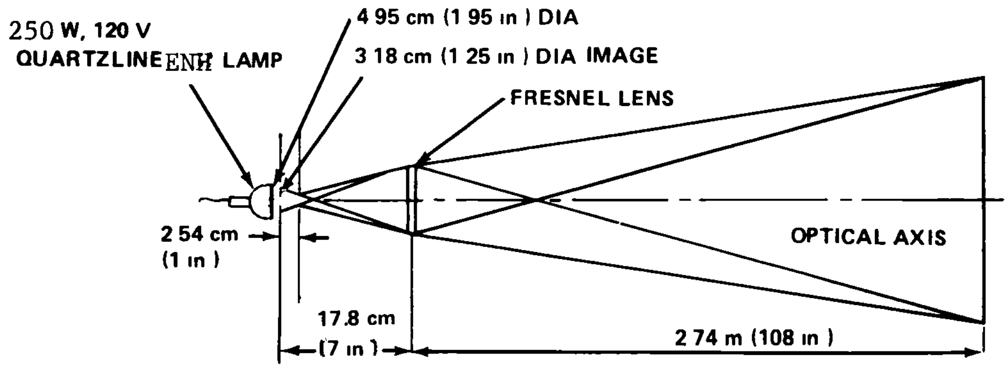



Figure 3. Optical layout of single lens/lamp combination.

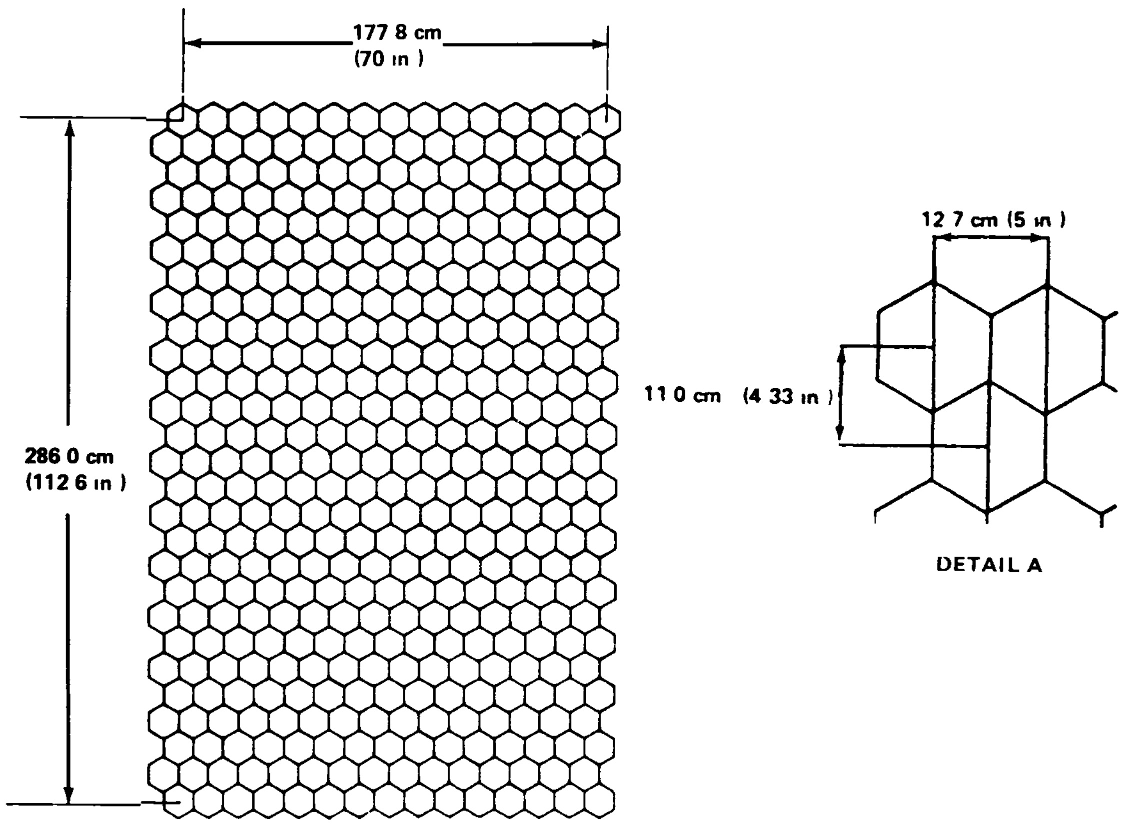



Figure 4. Lamp/lens illumination array.

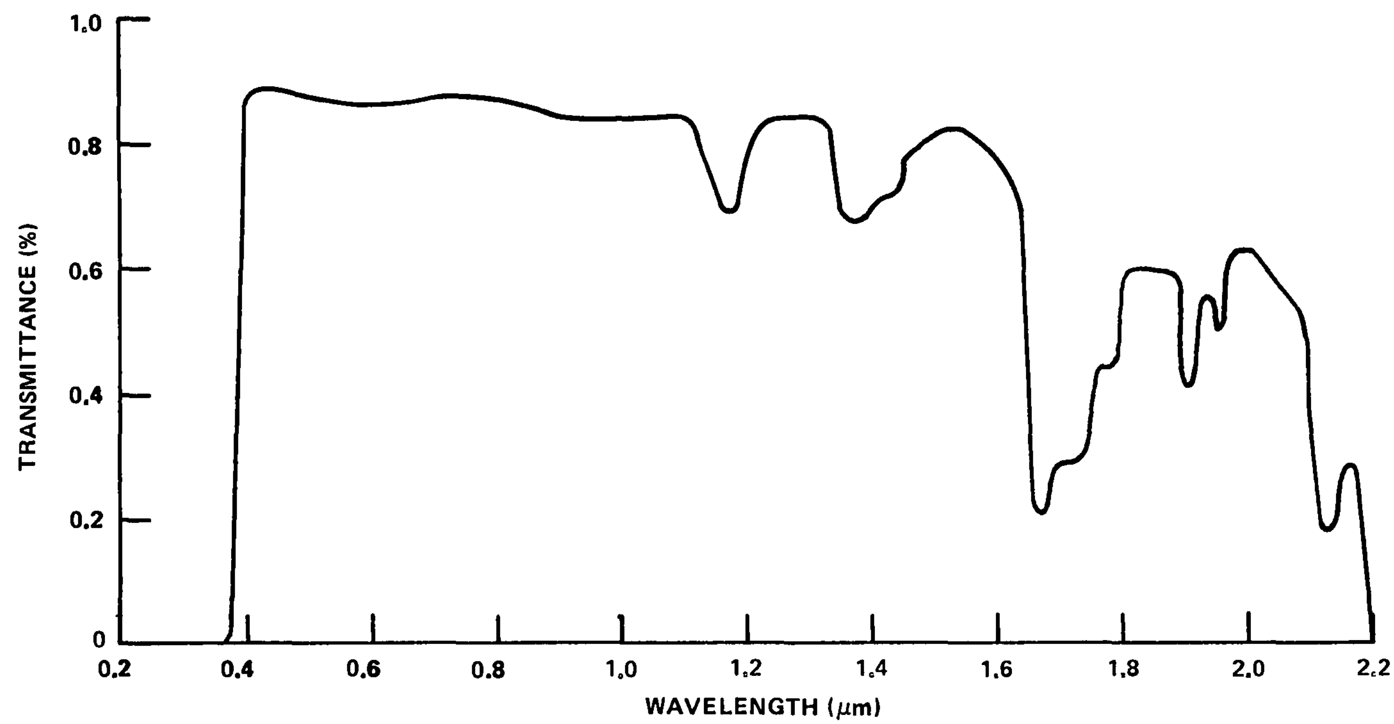



Figure 5. Transmittance of lens.

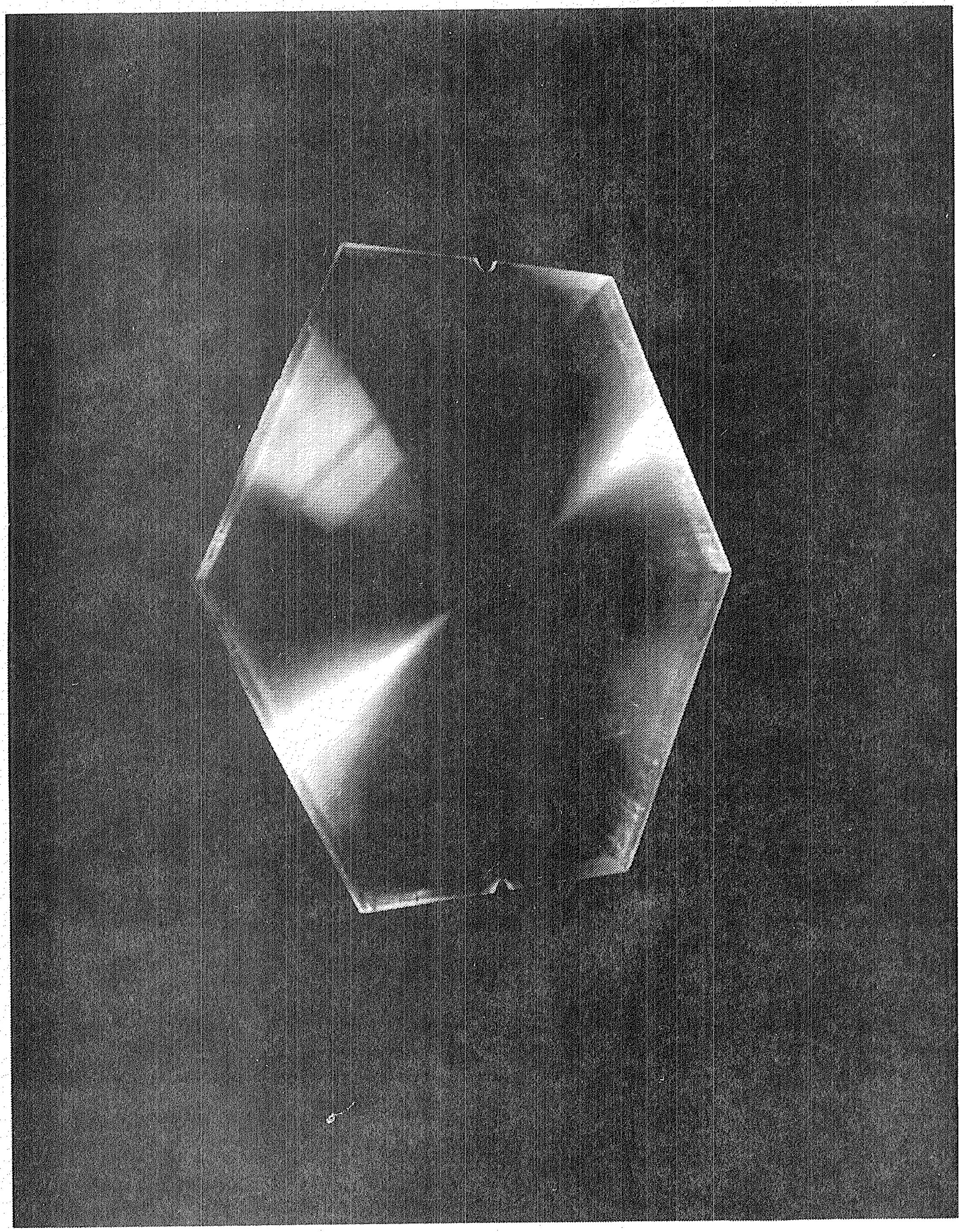


Figure 6. Fresnel Lens

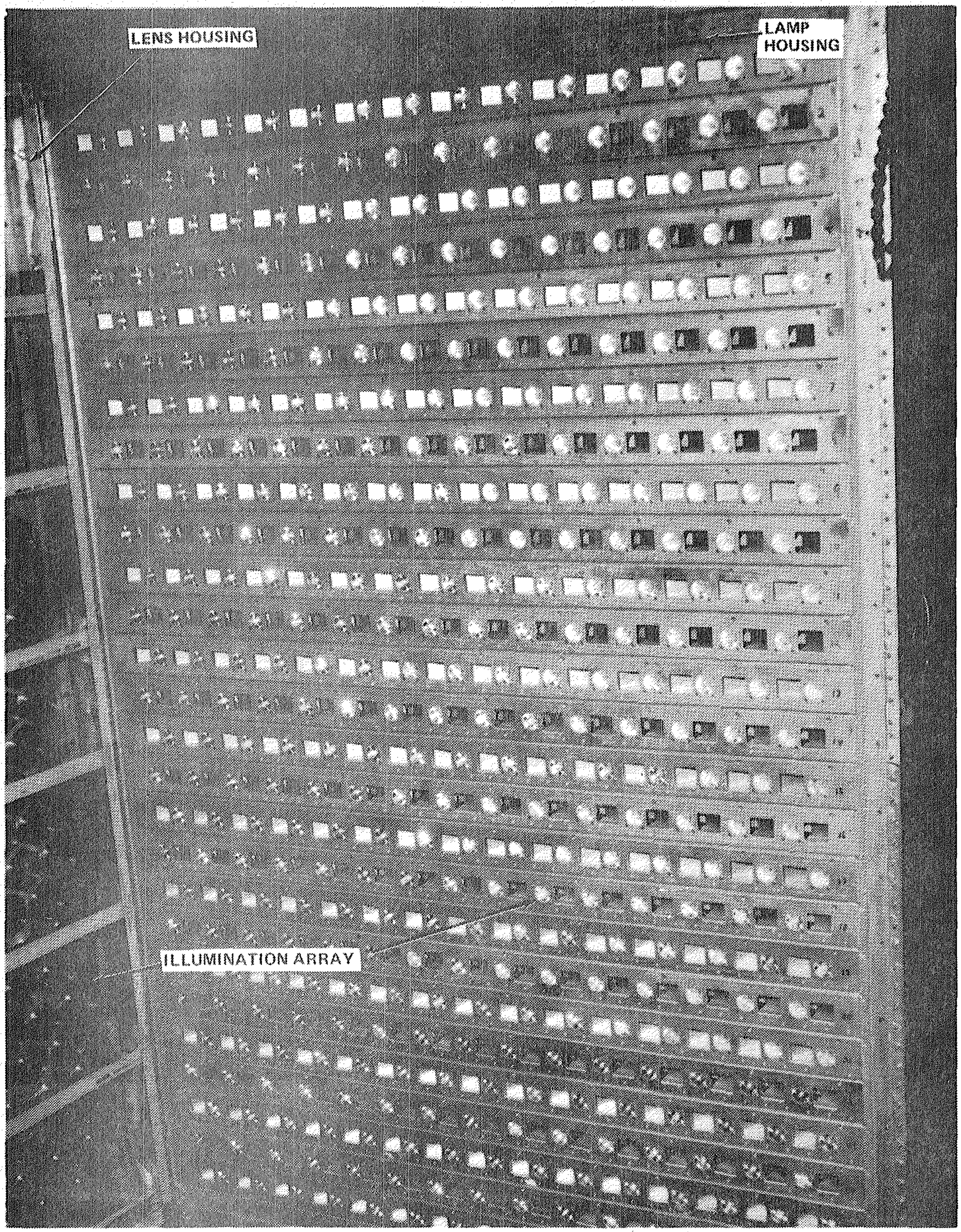



Figure 7. View of exposed lamp housing.

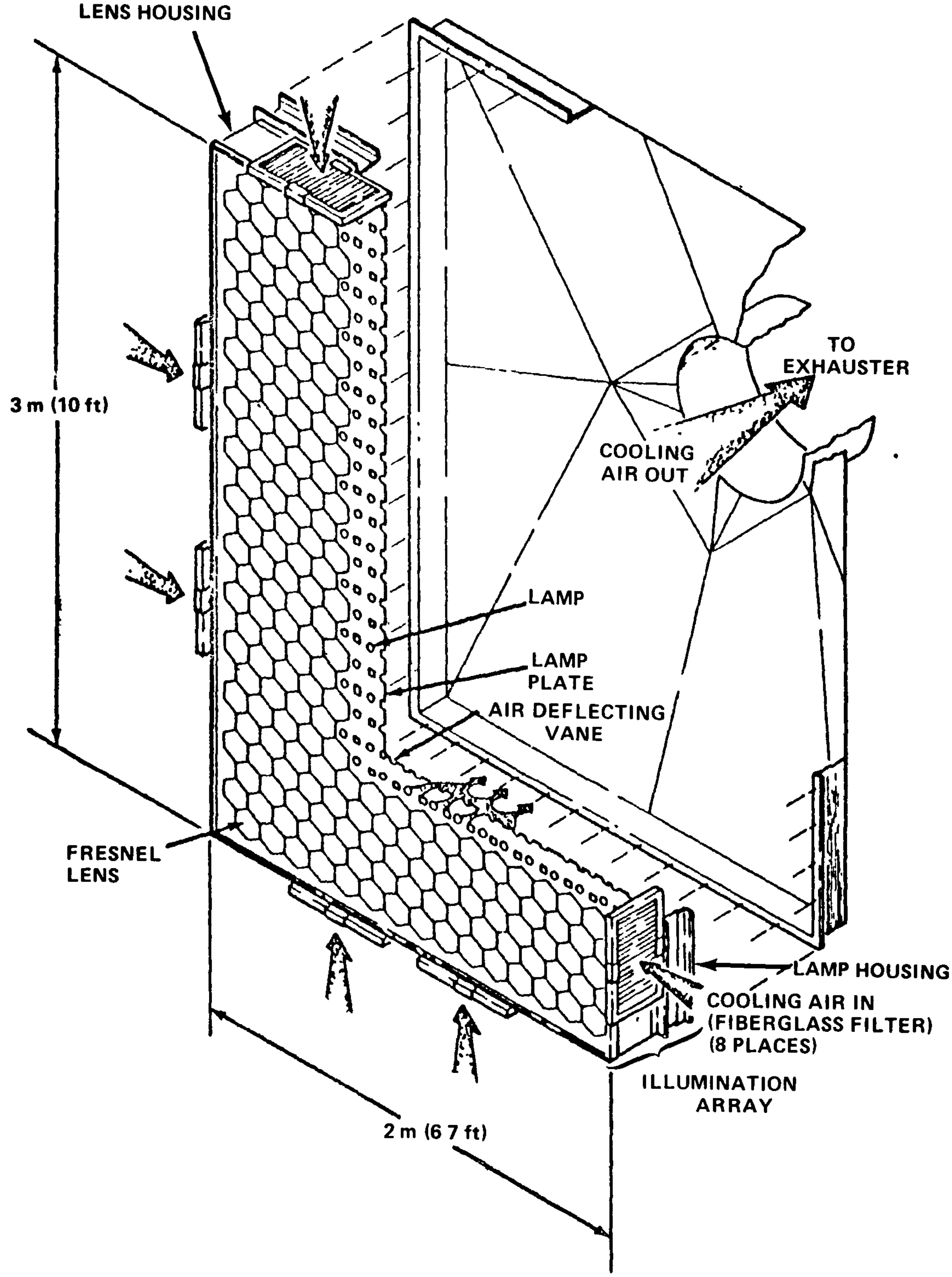



Figure 8. Lamp/ lens cooling system flow arrangement.

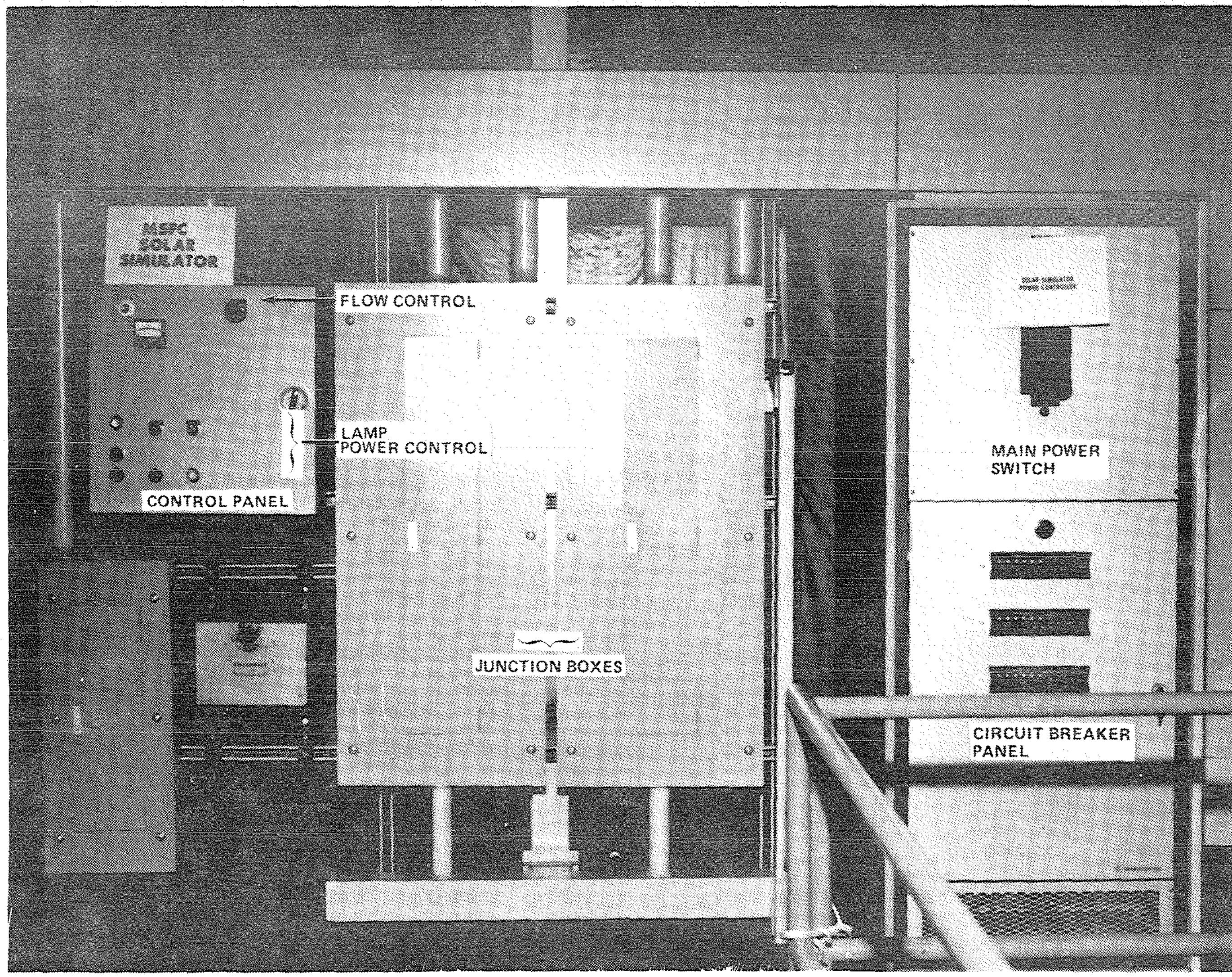



Figure 9. Control Console

2.0 FACILITY DESCRIPTION (Continued)

2.1 Sun Simulation Description (Continued)

2.1.4 Controls (Continued)

selectively to each of the three voltage phases by zones so that each quadrant of the sun simulator is on opposite voltage phases. Figure 10 shows the lamp electical phase arrangement as well as the lamp/lens number scheme. Selective location of lamps within phases is used in an attempt to smooth non-uniformities in flux intensity resulting from voltage disparities between phases.

## 2.2 Solar System Simulator Description

This simulation element includes the collector orientation positioning and solar system boundary condition simulation by the fluid loops, including transport media flowrate and temperature.

### 2.2.1 Orientation Simulation

Simulation of orientation is provided by a variable attitude tilt table to which the collector test item is mounted. The table provides a kinematic capability to set varying collector tilt angles and azimuth angles. Sun azimuth and control of incidence angle positions may be simulated using the tilt table along with an azimuth adjustment structure. The tilt table is capable of continuous adjustment of tilt angles from 0 to 72 degrees from the horizontal. Azimuth adjustments from 0 to 60 degrees can be achieved either by rotating the entire tilt table or by use of a special azimuth adjustment structure mounted on the tilt table.

The table surface is 2.4 x 1.5 cm (8 x 5 ft) in plan form. It consists of a 6061 aluminum angle structure to which a 142 by 244 cm (56 x 96 in.) sheet of 1.9 cm (0.75 in.) varnished plywood is bolted to form the collector mounting pad (Figures 11a and 11b).

### 2.2.2 Fluid/Thermal Loop Simulation

Fluid/thermal simulation is provided by an open-air loop (Figure 12). In this loop the transport media flowrate can be varied from 0 to 4.5 STD $m^3$/min. (0 to 160 STD cfm). Control with $\pm$ 2% of the desired flowrate, at steady state, can be achieved. Collector inlet air temperature can be varied from near ambient to 93°C (200°F) and controlled to within $\pm$ 0.6°C ($\pm$ 1°F).

The air load simulator is an open-flow loop drawing room air in and supplying it to the collector. The basic hardware in this loop consists of:

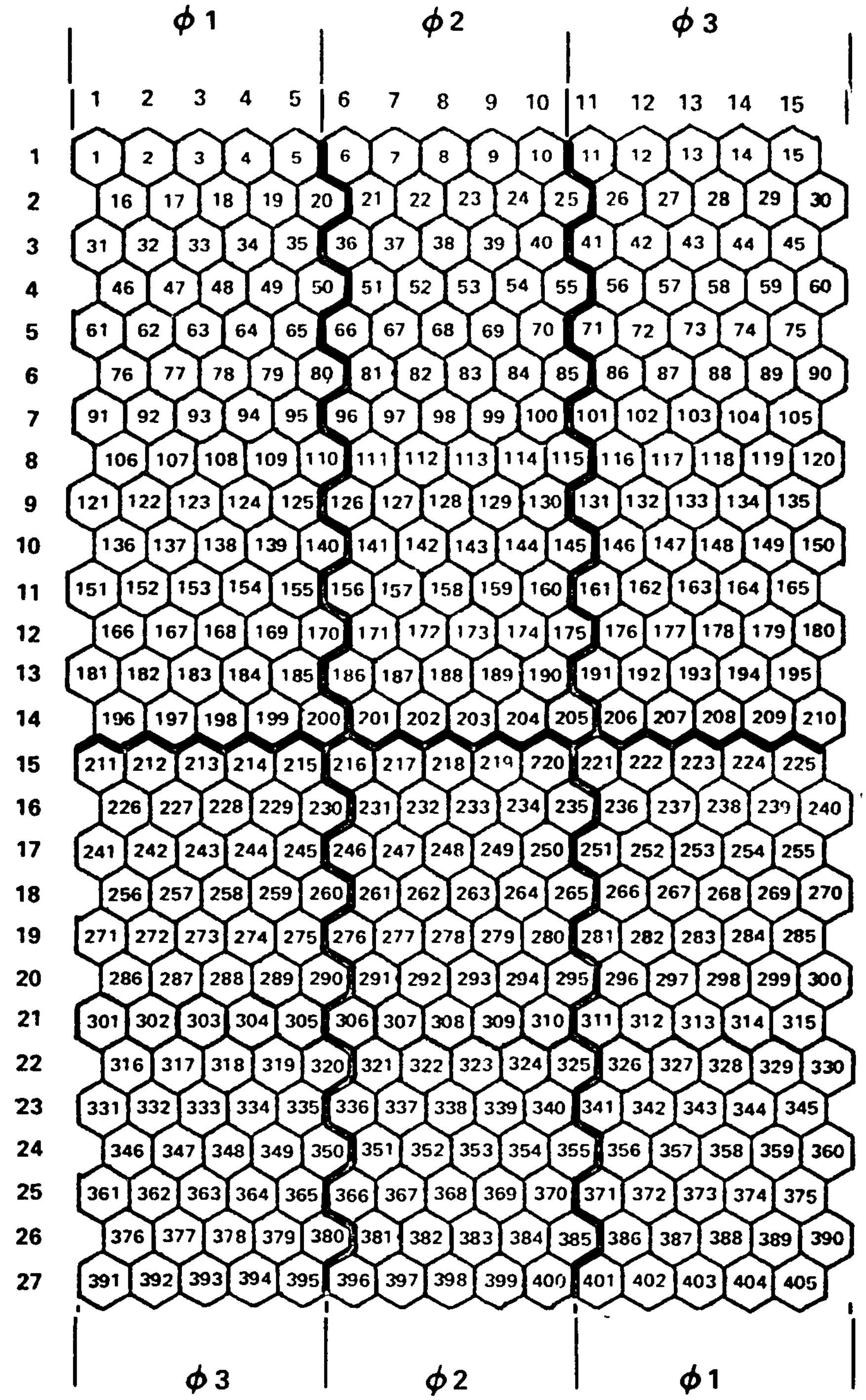
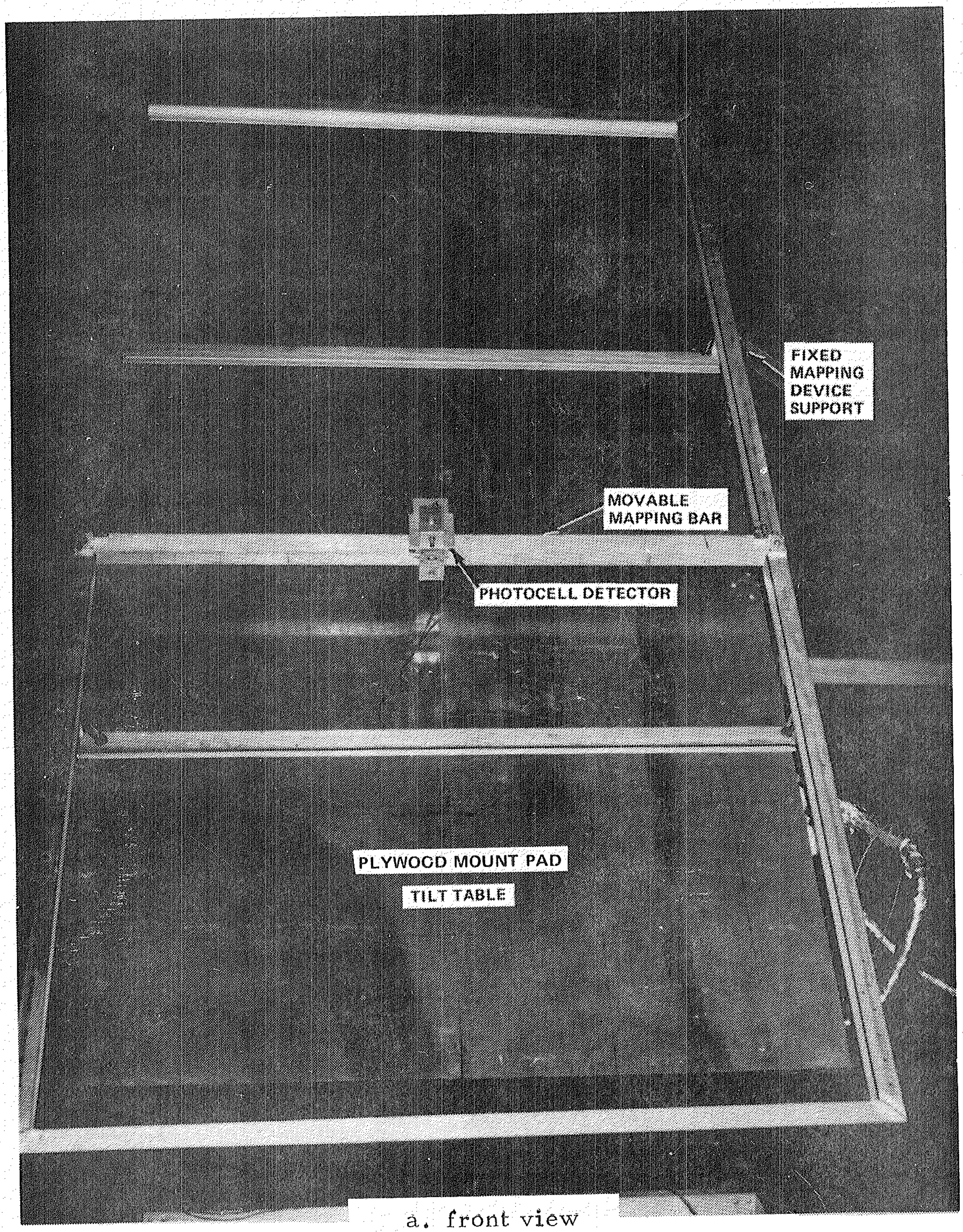
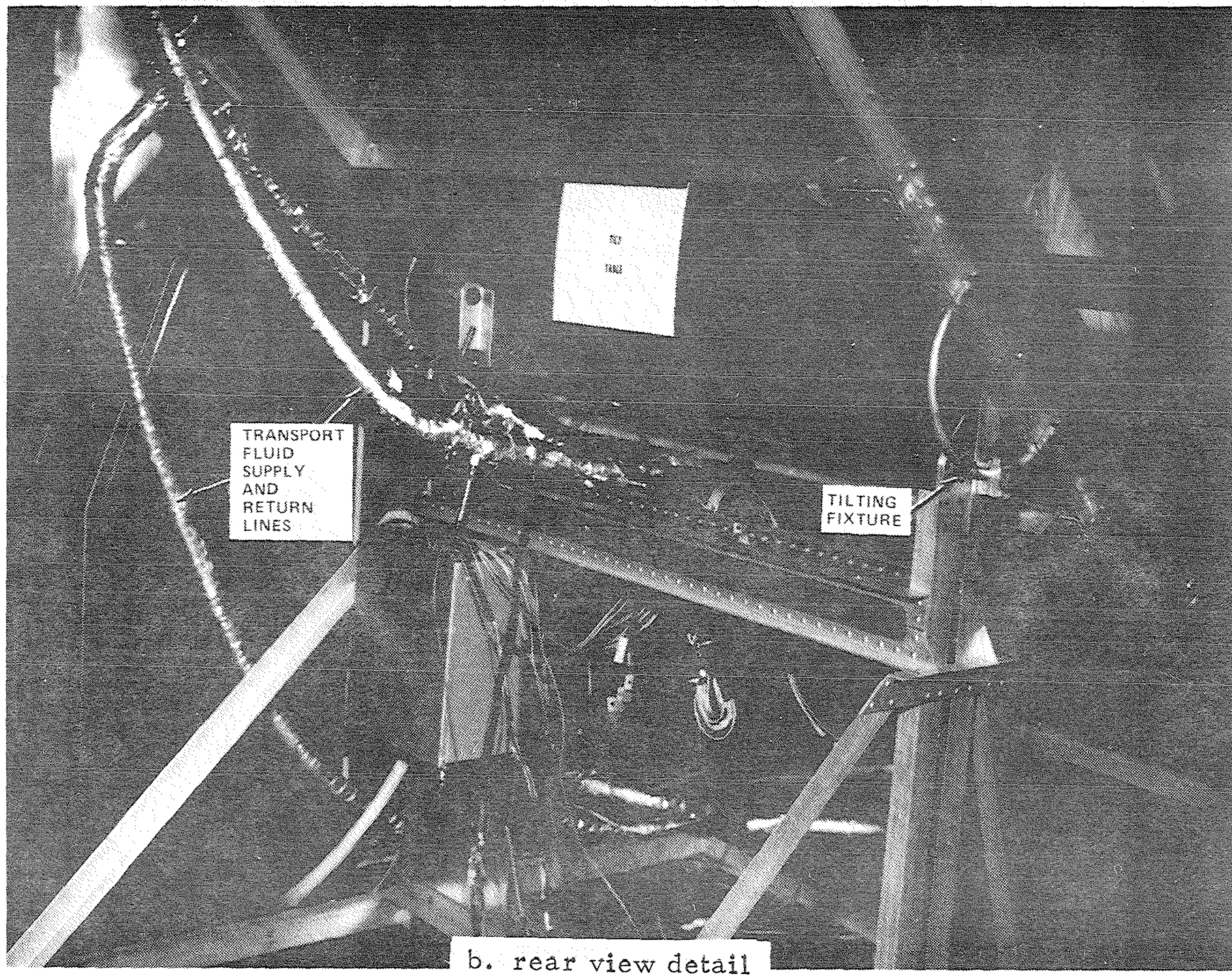


Figure 10. Grid network and electrical arrangement.



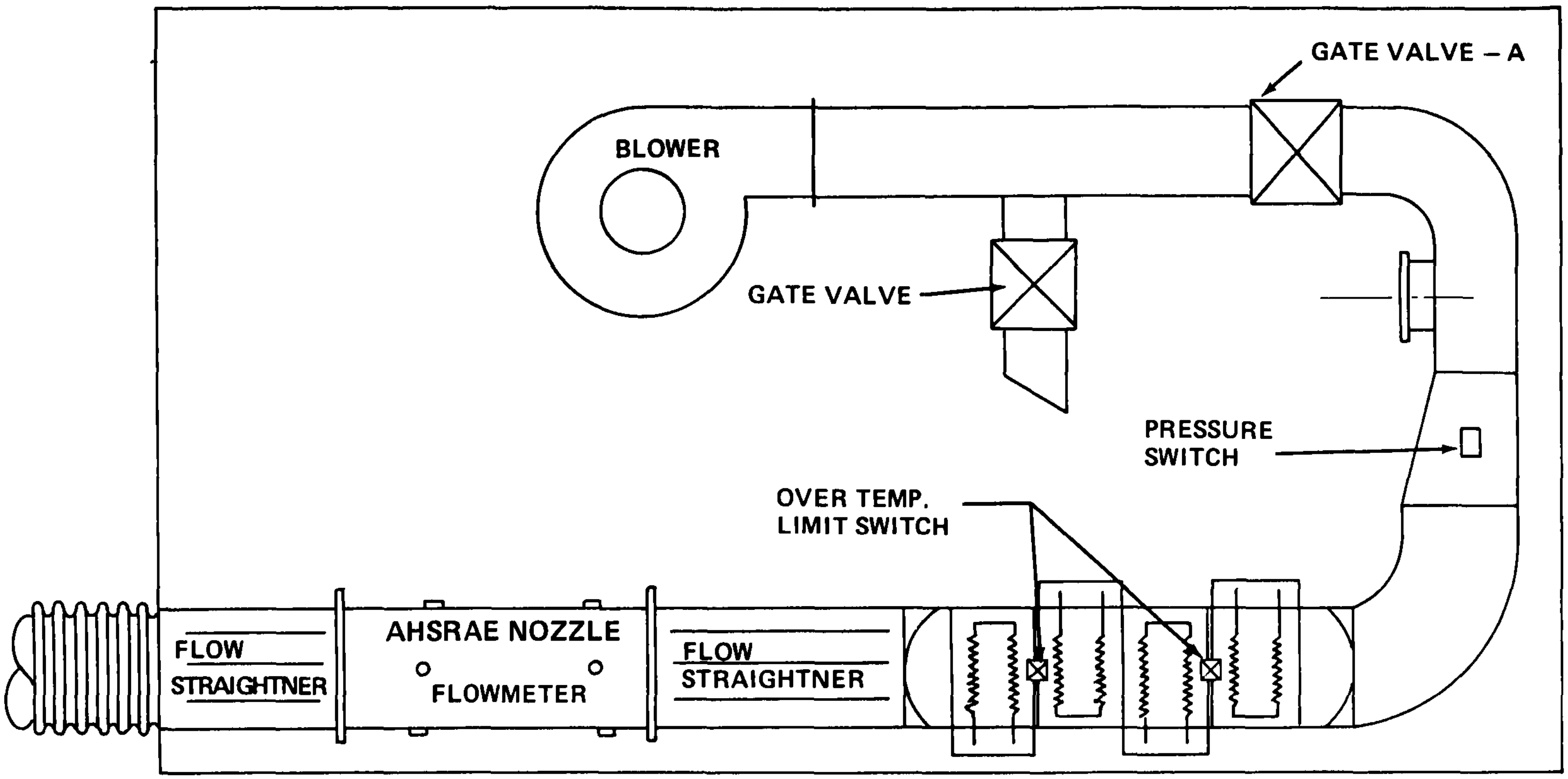

a. front view

Figure 11. Tilt table with mapping rig.




b. rear view detail

Figure 11. (Concluded).




4 HEATING ELEMENTS @ 3.75 kW 208 V

Figure 12. Air loop thermal simulator schematic.

2.0 FACILITY DESCRIPTION (Continued)

2.2 Solar System Simulator Description (Continued)

2.2.2 Fluid/Thermal Loop Simulation (Continued)

1. A 1½ hp 115 blower/motor combination.

2. A 230V proportional heater controller.

3. Four 3.75 kW strip heaters.

4. ASHRAE standard nozzel and test section.

5. Two 20.34 cm (8 in.) gate valves.

Figure 13 depicts the arrangement of air loop hardware.

The liquid loop normally utilizes a 50% by volume (52.7% by weight) ethylene glycol (Prestone II)/water mixture with corrosion inhibitor. For this fluid, flowrates may be varied from 0.02 to 0.25 $m^3/h$ (6 to 67 gal/h) with ± 2% control of the flowrate at steady state. Inlet temperature control of 0.6°C (± 1°F) can be achieved for these flowrates over a range of ambient to 104°C (220°F) with the water/glycol mixture. Energy collection rates of up to 2632 w (9000 BTU/H) can be accepted while meeting these conditions. These conditions can be met while encountering fluid resistances up to 138,000 $N/m^2$ (20 psig). Most of the transport media used in solar systems may be used in this fluid loop with corresponding alterations in the thermal/fluid loop simulation capability. Hardware in the liquid loop includes:

1. A 110V, 1/3 hp fluid pump.

2. A 230V proportional heater power controller.

3. A 230V, 18 kW submersion heater.

4. A shell type single pass liquid/liquid heat exchanger.

5. A fluid reservoir.

6. A rotometer visual flowmeter.

7. A valve controller.

8. Miscellaneous hand valves.

Figure 14 is a shematic of the loop arrangement. Figure 15 is a photograph depicting the layout of hardware in the liquid loop.

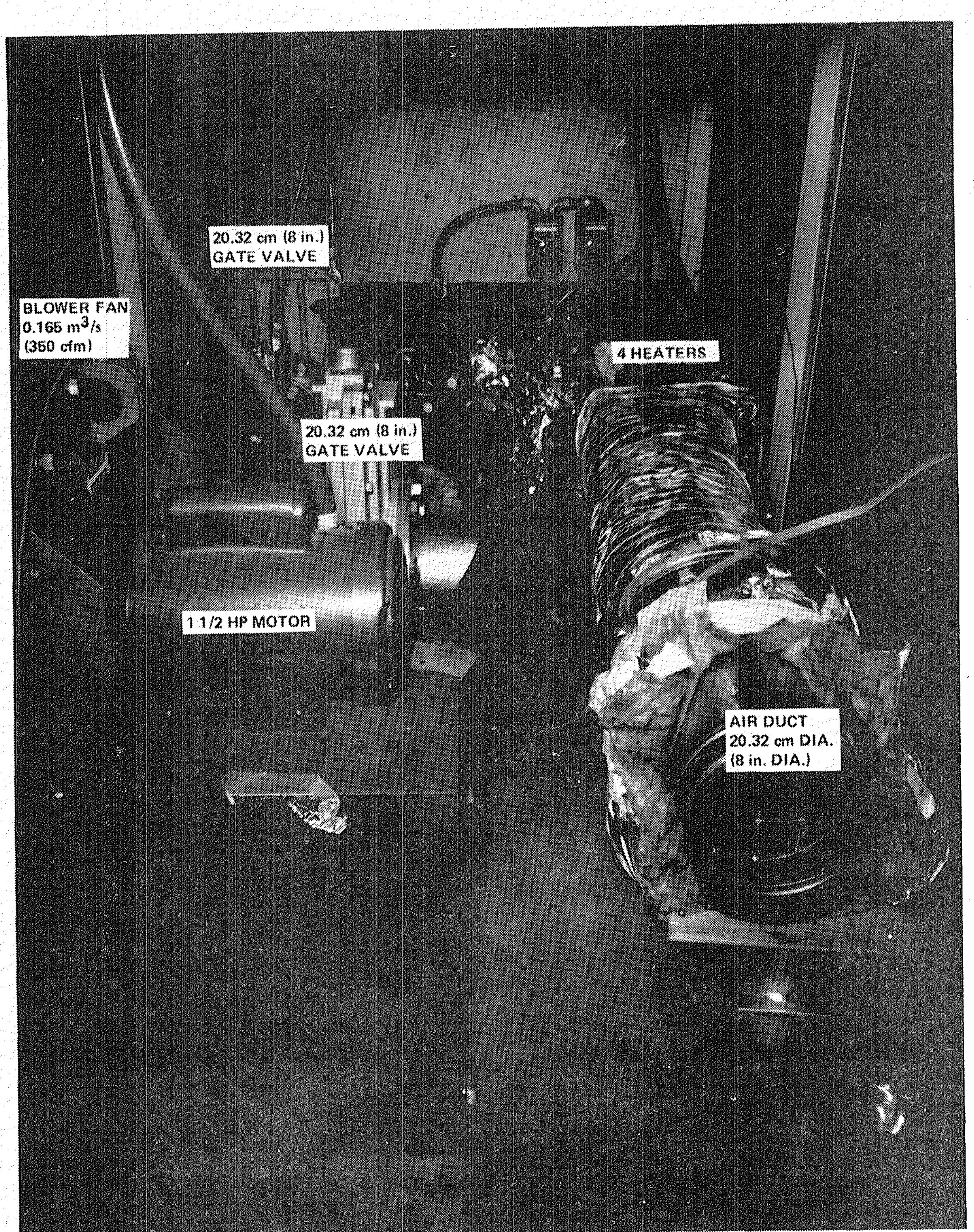



Figure 13. Air loop simulator arrangement.

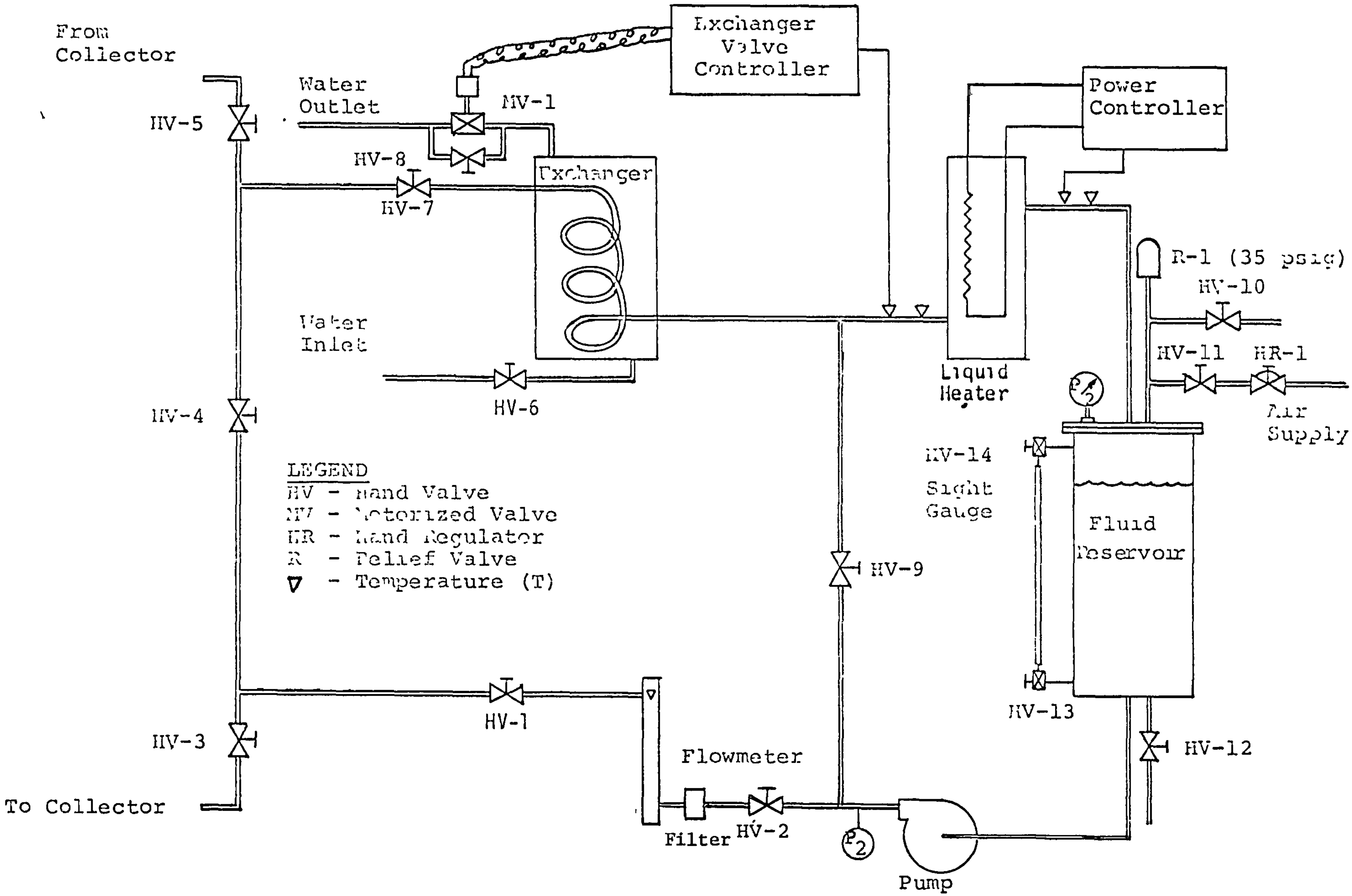



FIGURE 14. SOLAR COLLECTOR LIQUID TEST SET UP

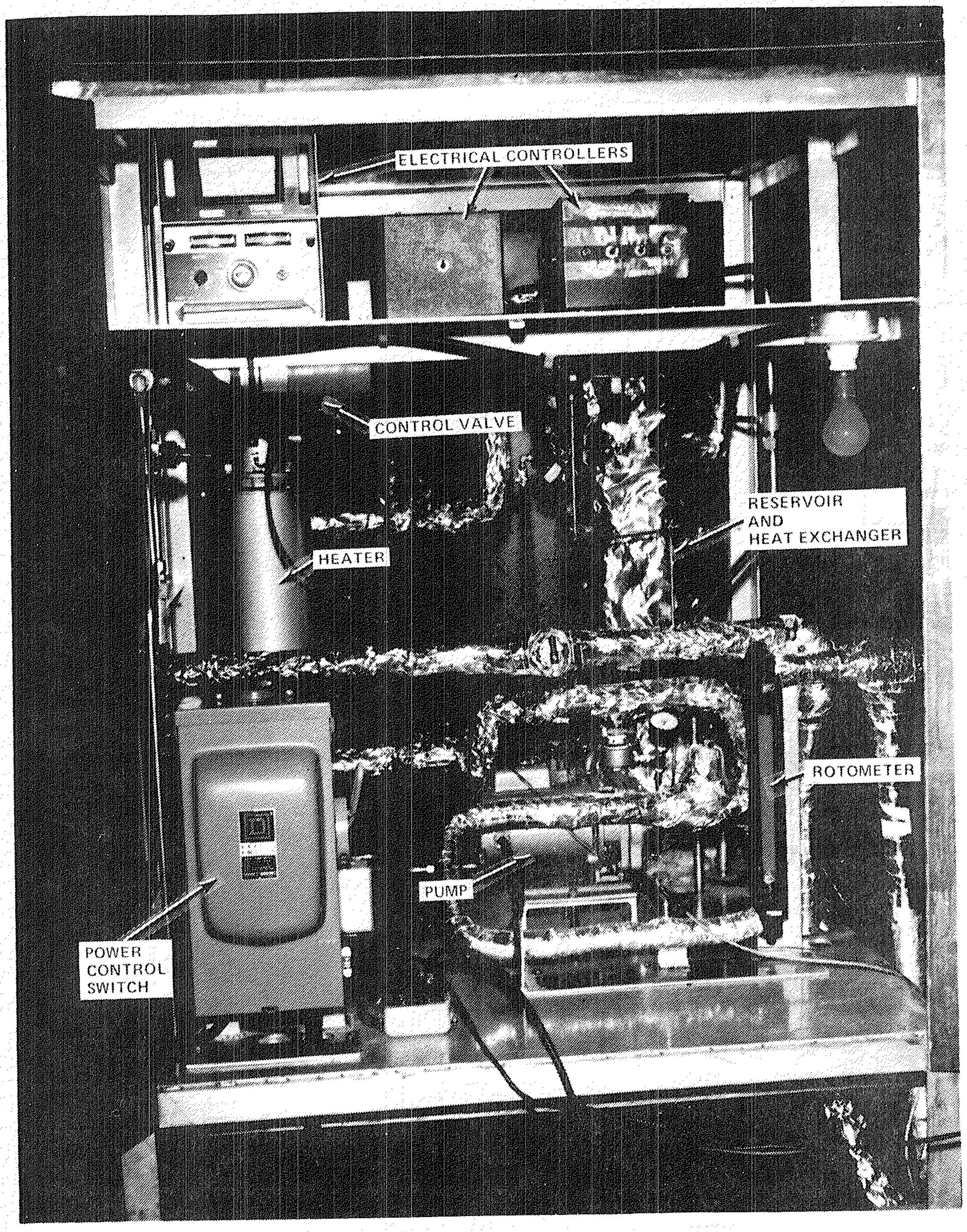



Figure 15. Liquid loop Simulator arrangement.

2.0 FACILITY DESCRIPTION (Continued)

## 2.3 Basic Facility

In addition to the previously discussed simulation capabilities of solar flux and attitude and fluid loop simulation, the basic facility also provides both external wind and sun positional simulation capabilities. The sun altitude position simulation is provided by the design of the floating illumination array mount. This floating arrangement allows varying the housing angle from horizontal to 72 degrees above the horizontal. Control of this simulated solar altitude is achieved by manually adjusting a chain hoist attached to the illumination array. Since the flexible cooling air exhaust duct connected to the array has a limited travel, alternate duct position connections are proveded. Three position connections are available to accomodate low, mid, and high solar altitude positions (Figure 16).

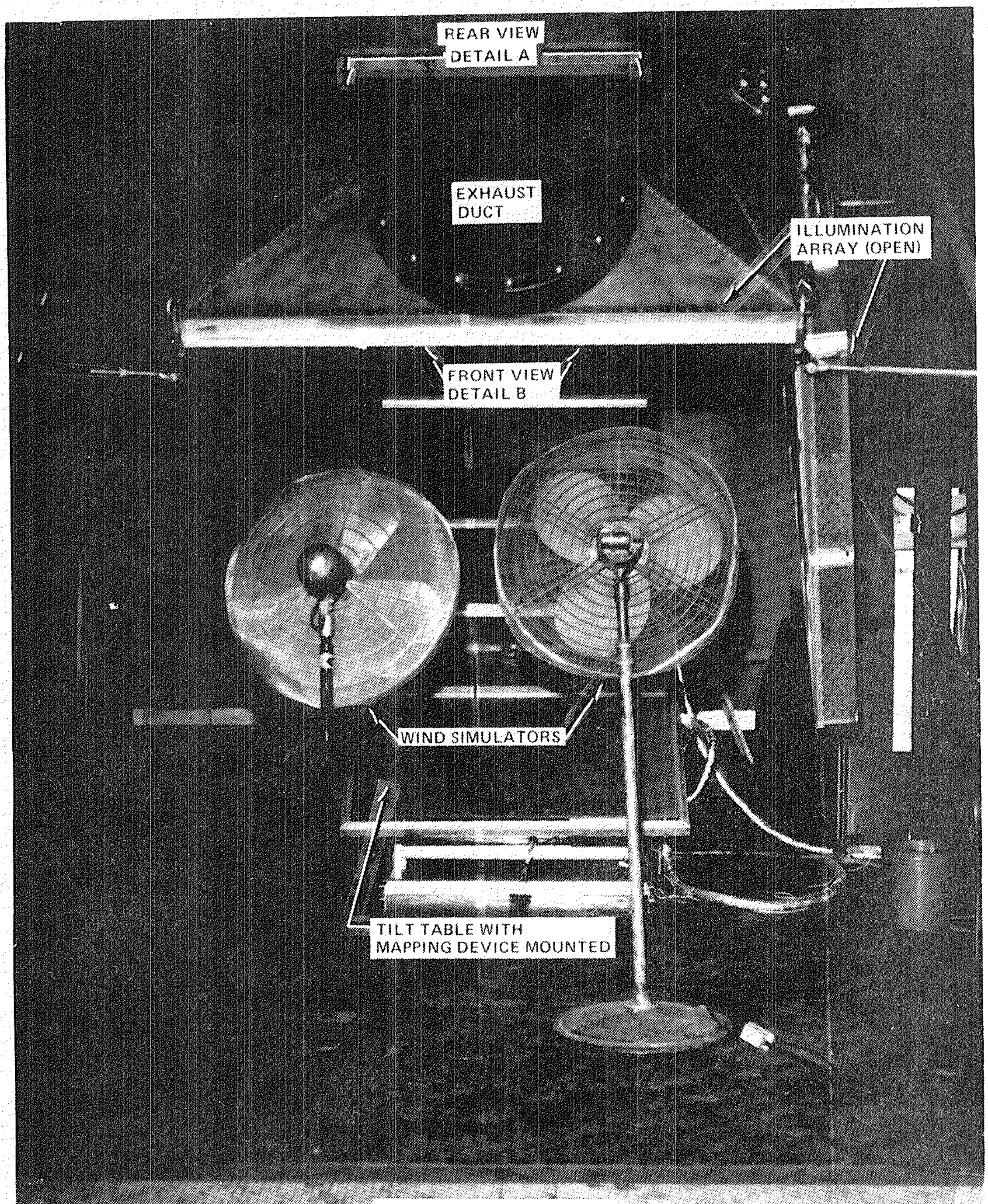
Wind simulation is provided by two fans. The two 1/4 hp, 76 cm (30 in.) diameter blade fans are mounted 182 cm high. The fans are three-bladed with a 1140 to 860 rpm range. Velocities from 1.3 to 5.8 m/s (3 to 13 mph) can be achieved with the fans by selecting different fan speeds. Two fans are used to achieve better velocity uniformity across the test plane. Wind is normally directed into the collectors from the south, but mobility of the fan allows direction simulation from any angle.

All elements of the simulator, with the exception of the control console (Figure 17), are housed in a mild steel structure surplused from a previous test program. The structure is 8.5 m (28 feet) in height, with a 4.3 m (14 feet) square plan form. The frame structure is covered on all sides except the north side with a blue plastic tarpaulin. A mobile glare shield (Figure 1) is situated behind this open side and in front of a visitor viewing area to protect the eyes of passersby and limit spurious radiant energy inputs from other sources to the test item. This shield is constructed from angle iron structure and covered with the same tarpaulin material.

The entire simulator structure is housed in Building 4619. The simulator is located in the west end of the high bay portion of the building. This building is located near the corner of Rideout and Fowler Roads of MSFC (Figure 18).

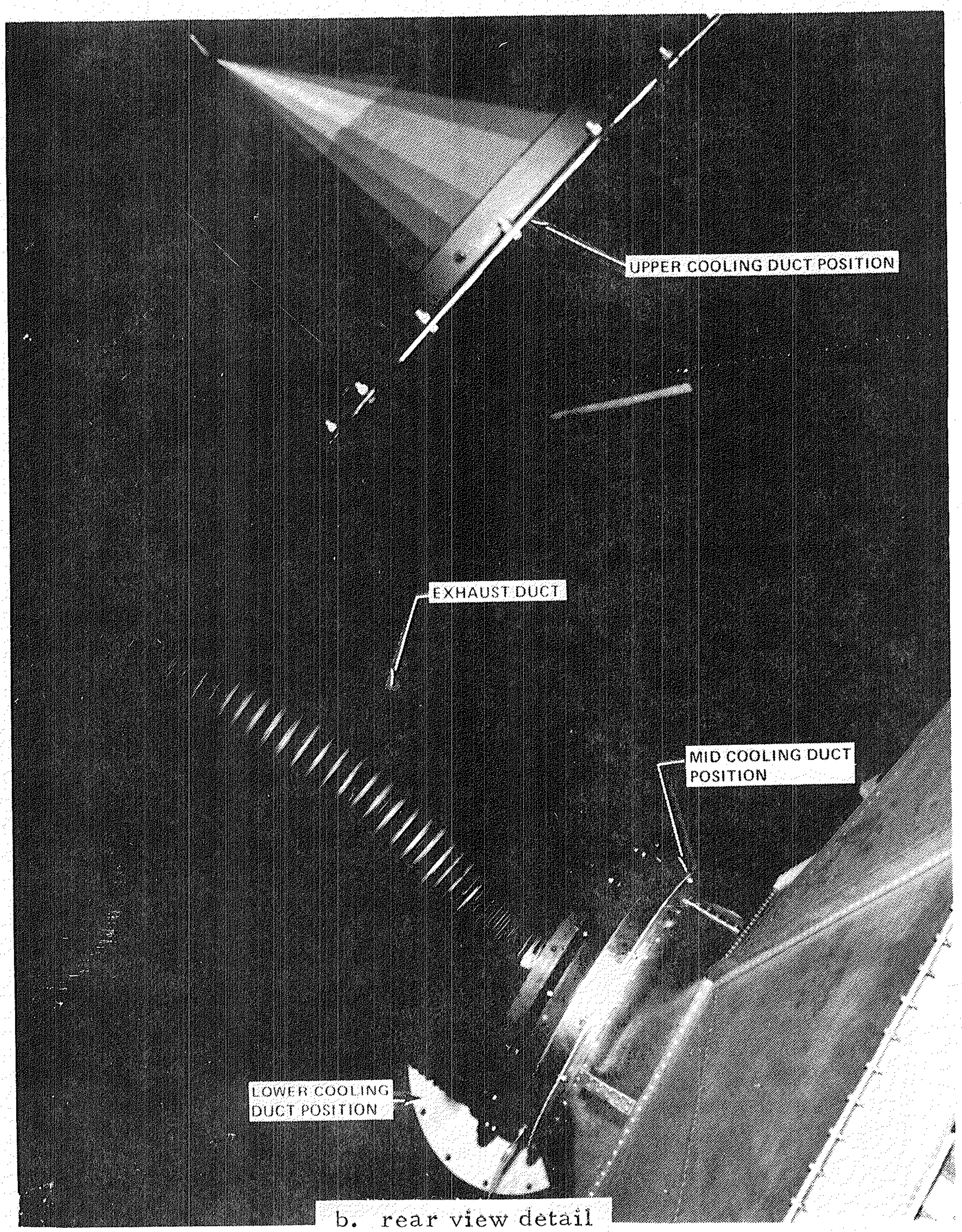
## 2.4 Instrumentation

The instrumentation/data acquisition system available(modified LSI11-2 computer with twelve bit analog to digital resolution)has a capability of 256 channels of analog or digital data. Instrumentation for collector test items includes absolute and differential temperature measurements, flowrate measurements, absolute and differential pressure measurements, wind velocity, as well as total solar radiation measurements (diffuse and direct radiation measurements are not normally recorded but may be acquired for special tests). These measurements use a number of different type sensors



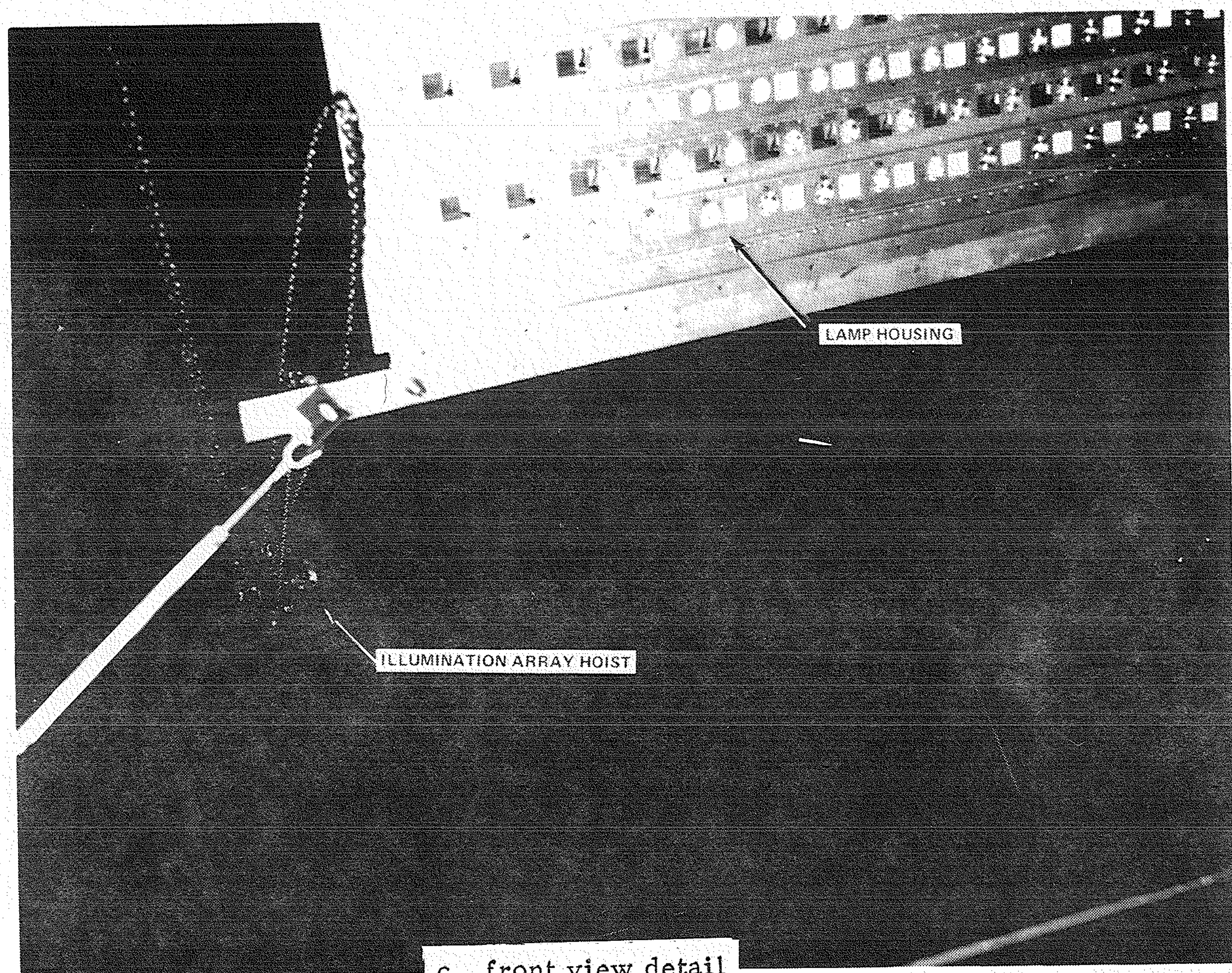
a. overview

Figure 16. Basic Facility.



b. rear view detail

Figure 16. (Continued).




c. front view detail

Figure 16. (Concluded)

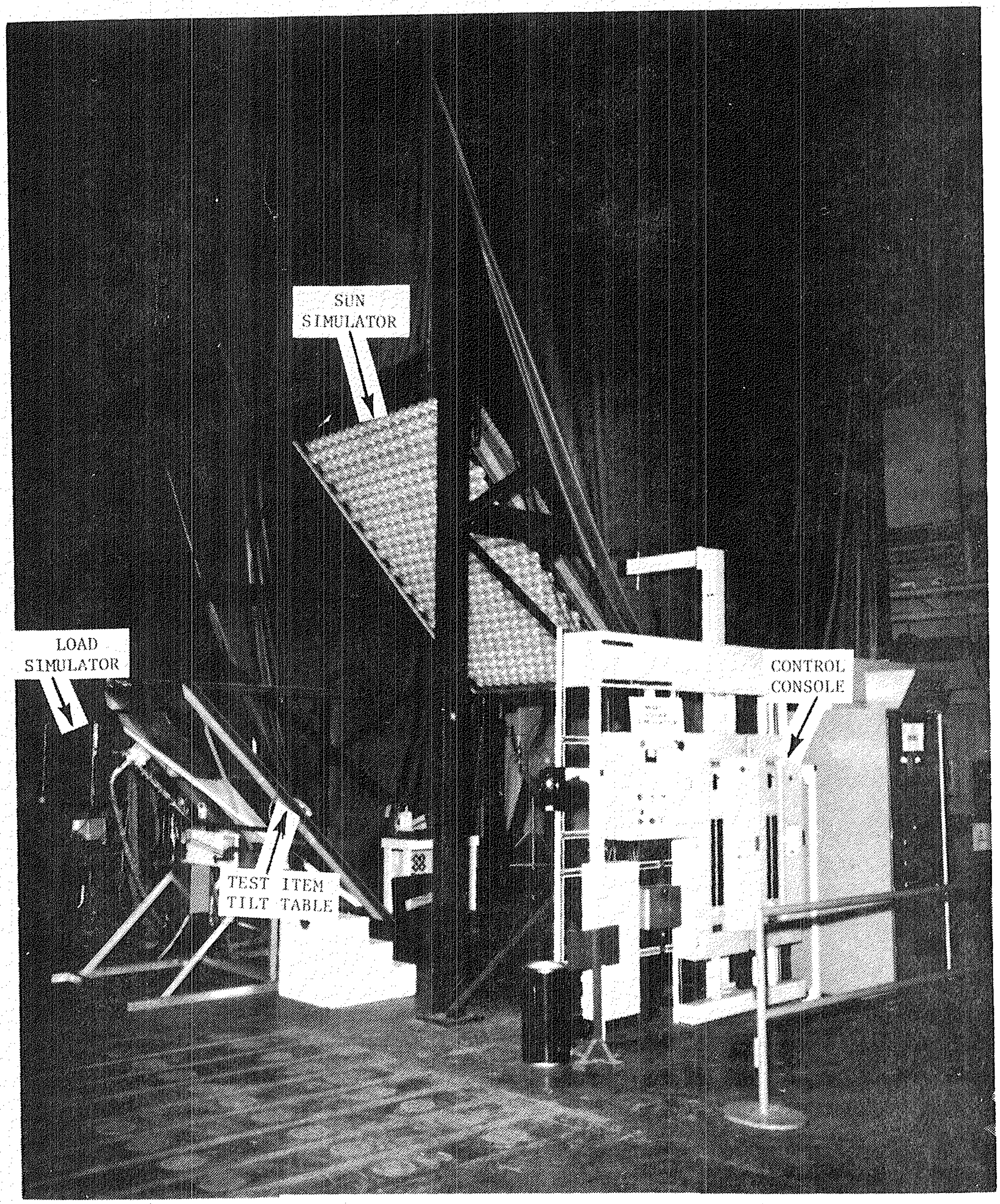



Figure 17. Overall view of simulator.

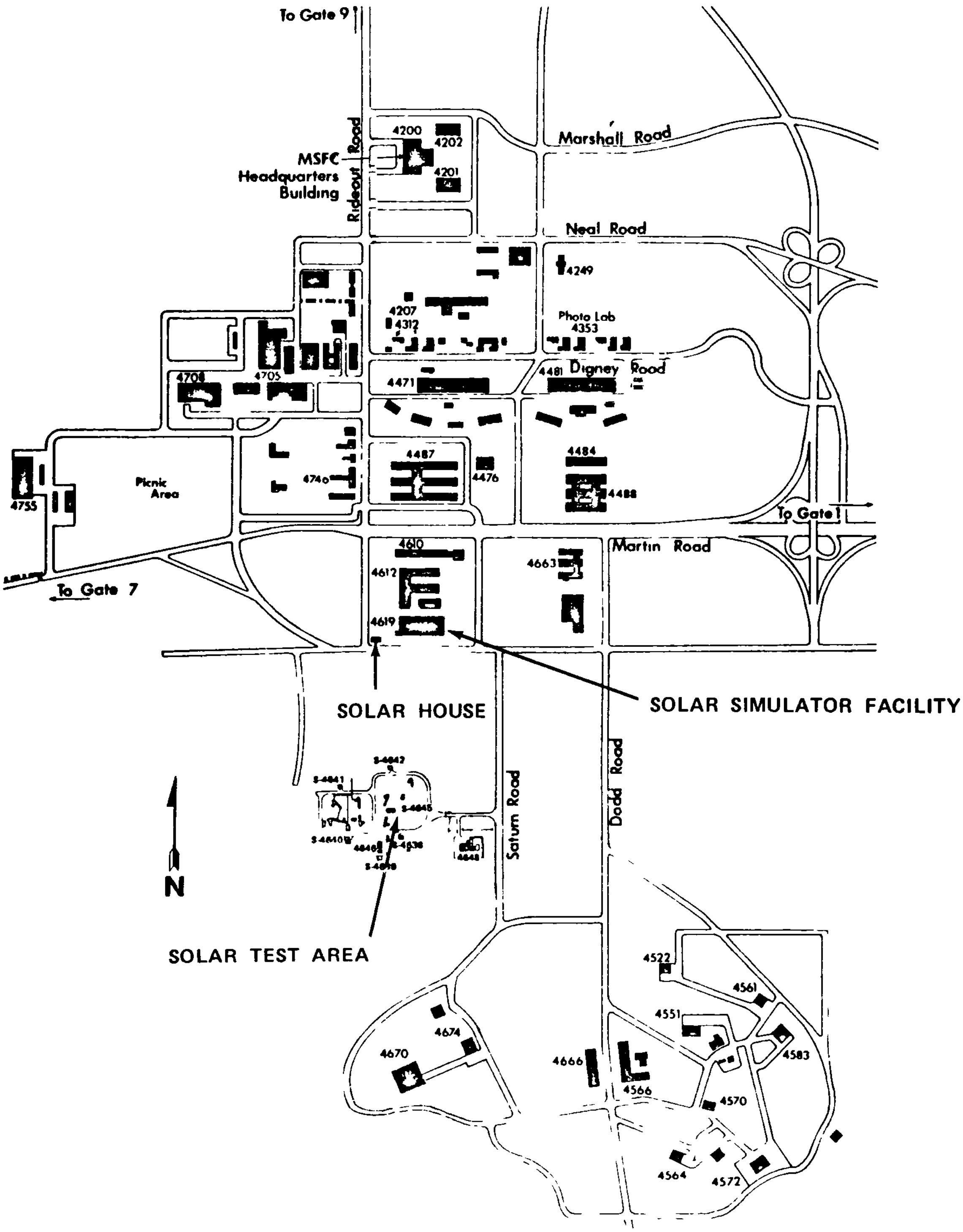



Figure 18. MSFC layout.

## 2.4 Instrumentation (Continued)

depending on media, measurement type, and location of measurement. Table II details these measurements along with type and estimated accuracy of sensors. Overall measurement accuracies and minimum unit readout capabilities are given in Table I.

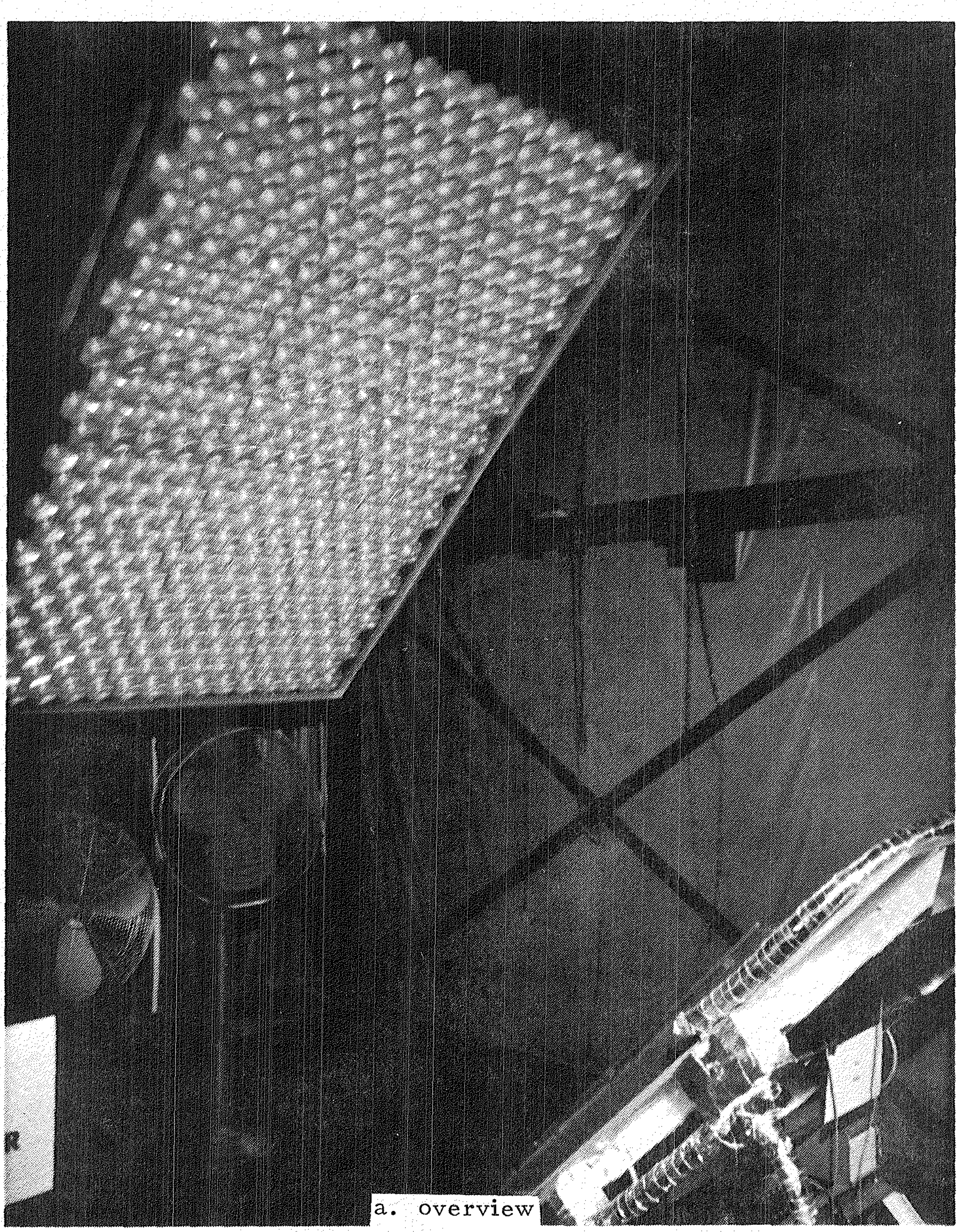
Facility peculiar instrumentation includes nine surface mounted thermocouples on simulator lenses, a cooling air outlet temperature, six lamp bulb base temperature measurements, and the lamp array voltage output. Figure 19 depicts illumination array with details of lamp and lens instrumentation locations. A list of typical collector performance measurements are listed by name in Table II.

In addition to data recordings, before each test observations are made concerning each collector. These observation data include spectral property measurements, which in some cases cannot be made because of the adverse effect of collector disassembly in its subsequent testing or further use. For those collectors for which measurements can be made, five points on the cover and absorber (one in each corner and one in the center) are used to acquire the average readings.

## 2.5 Listing of Solar System Simulator Detailed Drawings

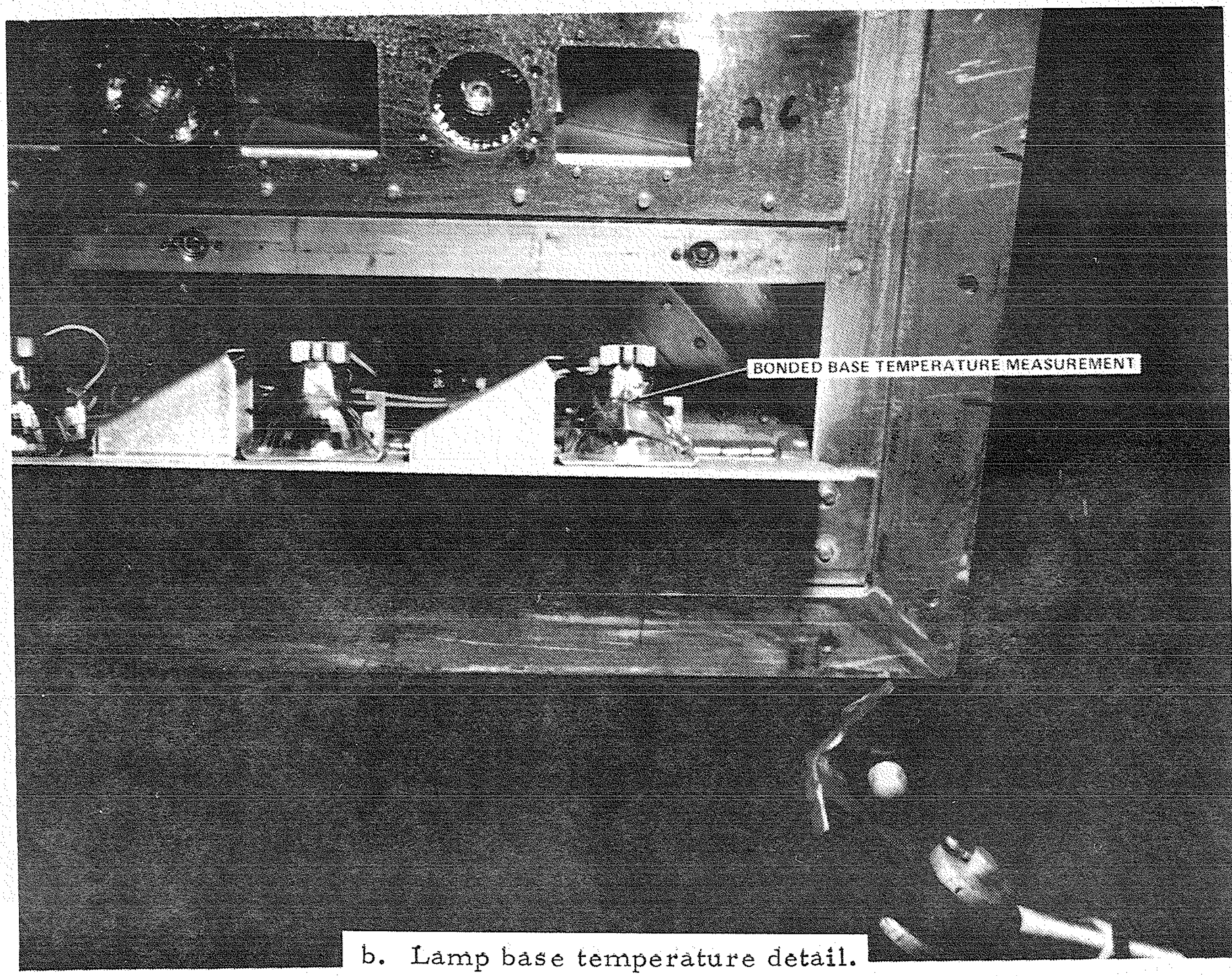
Working drawings of the Solar Simulator were created by Management Services, Incorporated under NASA AE Contract Number NAS8-21769. A list of these drawings follows.

| Drawing Number | Description |
|---|---|
| FAC-AE-4619-E-1 | Solar Simulator Lamp Array and Equipment Power Plan |
| FAC-AE-4619-E-2 | Solar Simulator Lamp Array and Equipment Wiring Lists and Selections |
| FAC-AE-4619-M1 | Solar Simulator Lamp Array and Equipment Plan and Sections |
| FAC-AE-4619-M2 | Solar Simulator Lamp Array and Equipment Plan, Sections, and Isomectric |
| FAC-AE-4619-M3 | Cables Installation For Solar Simulator Plan Elevation |
| FAC-AE-4619-S1 | Solar Simulator Lamp Array and Equipment Structural and Architectural |
| FAC-AE-4619-S2 | Solar Simulator Lamp Array and Equipment Structural Sections and Details |
| FAC-AE-4619-S3 | Solar Simulator Lamp Array and Equipment Structural Sections and Details |



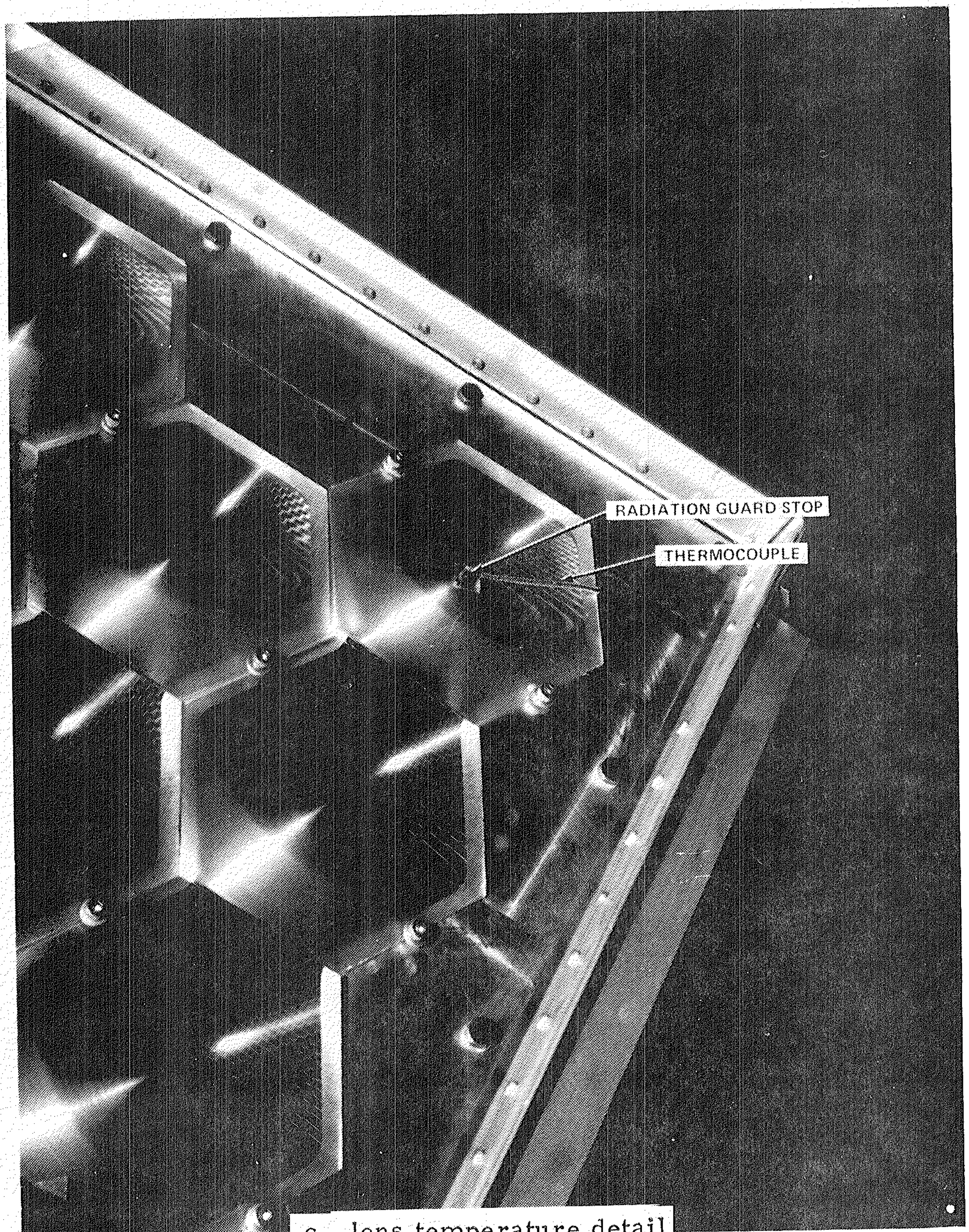
a. overview

Figure 19. Simulator test arrangement.




b. Lamp base temperature detail.

Figure 19. (Continued).



c. lens temperature detail

Figure 19. (Concluded).

## 2.0 FACILITY DESCRIPTION (Continued)

### 2.5 Listing of Solar System Simulator Detailed Drawings (Continued)

Additional MSFC Solar Simulator Drawings are listed below:

| Drawing Number | Description |
|---|---|
| EC 12 SK751 | Solar Simulator Wiring |
| 20 M 33640 | Lens Mounting Plate, Solar Simulator (one sheet) |
| 20 M 33641 | Lamp Assembly, Sun Simulator (two sheets) |
| 20 M 33643 | Support, Lens Mounting Plate, Sun Simulator, (two sheets) |
| 20 M 33644 | Frame, Lamp Assembly, Sun Simulator, (one sheet) |
| 20 M 33645 | Hood Assembly, Sun Simulator, (two sheets) |
| 20 M 33646 | Solar Simulator Assembly (two sheets) |

Detailed Solar Simulator drawings are in Appendix B.

3.0 OPERATING PROCEDURES

3.1 General Prerequisites

3.1.1 Prior to operating the Solar Simulator Test Facility, authorization shall be obtained from the responsible Test Facility Manager.

3.1.2 Prior to applying power to the solar simulator, the sun screen must be positioned between the solar simulator and the visitors' booth located on the north side of the bay area of Building 4619.

3.1.3 Prior to operating the facility for the purpose of testing, verify that all instrumentation and equipment to be used for the test have a current calibration label and that the calibration period will not expire before the expected conclusion of the test.

3.2 Applicable Documents

| | | |
|---|---|---|
| 3.2.1 | OSHA 22066 | General Industry Safety and Health Regulations |
| 3.2.2 | MM 1700.4 | Safety and Environmental Health Standards |
| 3.2.3 | MM 8800.1 | Environmental Quality Manual |
| 3.2.4 | MMI 1700.11 | Protection of Personnel and Property |
| 3.2.5 | NMI 1711.2 | Reporting, Investigation, and Action on Mishaps Involving MSFC Employees, Resources and Property |
| 3.2.6 | MMI 5300.4 | Metrology and Calibration |
| 3.2.7 | MSFC STD 146 | Color Coding |
| 3.2.8 | SHC 2008 | Master Test Plan for the Solar Heating and Cooling Project |
| 3.2.9 | SHC 3006 | Composite Solar Simulator Requirements Solar Heating and Cooling Development Program |
| 3.2.10 | SHC 3007 | Instrument Program and Components List (IP&CL) for the MSFC Solar Energy Test Facility |
| 3.2.11 | NBS TN-899 | Developement of Proposed Standards for Testing Solar Collectors and Thermal Storage Devices |

3.0 OPERATING PROCEDURES (Continued)

3.3 Safety

Primary responsibility for compliance with all safety regulations/ precautions applicable to the operation of this facility is vested in facility supervisors. This does not relieve the simulator operator from responsibility for safety during simulator operation.

3.4 Emergency Telephone Numbers

| | |
|---|---|
| Medical Center | 453-2390 |
| Fire | 117 |
| Ambulance | 112 |

3.5 Solar Simulator System Setup (Test Table Tilt Angle Equals the Tilt Angle of the Lamp Array)

The following is the procedure to be used for determining the system setup parameters to be used for collector testing. Figure 3-1 shows the simulator testing setup and defines the symbols used.

3.5.1 A test flux level will be specified in the test requirements. Before the test specimen is mounted on the test table, a field map will be required to determine if the simulator power controller is set to produce the proper flux level. This procedure is described in Section 3.6 and will have to be performed iteratively until the required flux level is obtained.

3.5.2 Mount the test specimen centered on the test table.

3.5.3 Measure the distance from the top of the test table to the top surface of the collector. Record this distance ($d_c$).

3.5.4 Using the following formulae, compute $h_{test}$ and $L_{test}$.

$$h_s = (d_{test} + d_c + d_t)\ (\cos\theta)$$

$$L_{test} = (d_{test} + d_c + d_t)\ (\sin\theta)$$

$$h_{test} = h_s + h_{table}$$

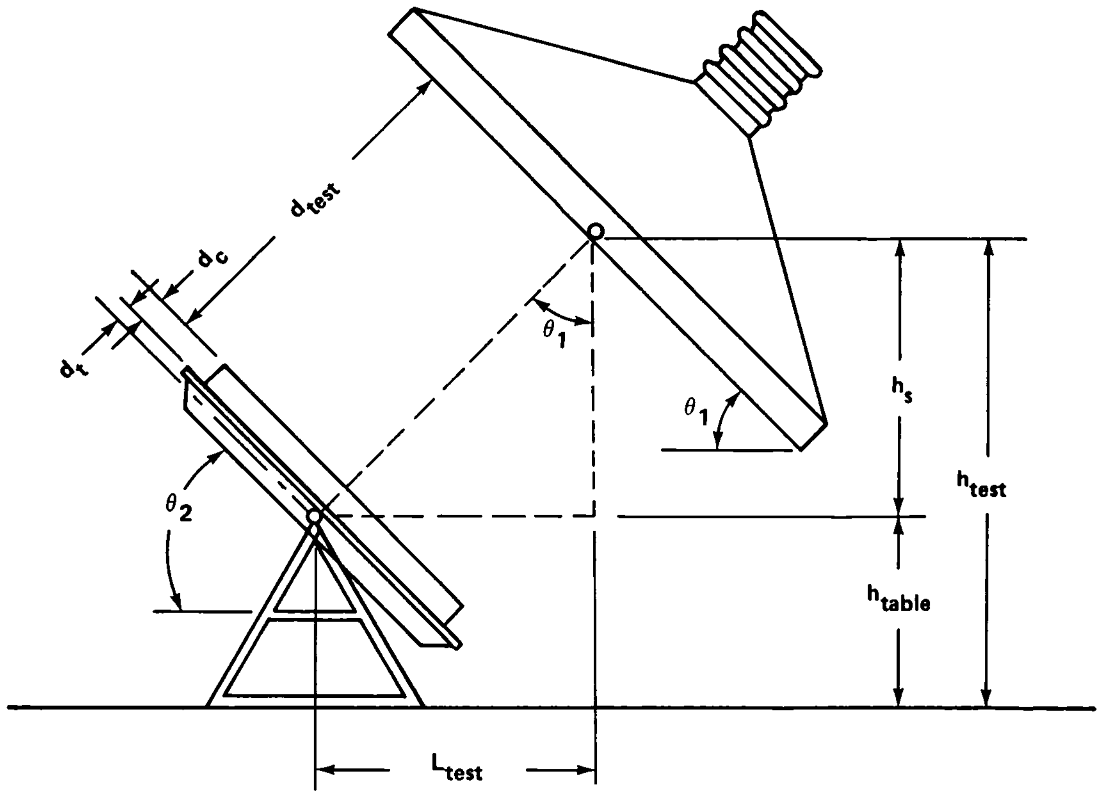
where:

$d_{test}$ = 9 ft.

$d_t$ = 1.5 in.

$h_{table}$ = 4 ft. 1 in.

$\theta$ = Tilt angle




| | | |
|---|---|---|
| $d_t$ | = | DISTANCE FROM TABLE PIVOT POINT TO TABLE SURFACE 0.04 m (1.5 in ) |
| $d_c$ | = | DISTANCE FROM BACK SURFACE OF COLLECTOR TO ITS TOP SURFACE |
| $d_{test}$ | = | DISTANCE FROM SIMULATOR LENS PLANE TO THE COLLECTOR TOP SURFACE 2 8 m (9 ft) |
| $\theta_1$ | = | SIMULATOR TILT ANGLE |
| $\theta_2$ | = | TABLE TILT ANGLE |
| $h_{table}$ | = | VERTICAL DISTANCE FROM FLOOR TO TABLE PIVOT POINT 1 2 m (49 in.) |
| $h_s$ | = | VERTICAL DISTANCE FROM TABLE PIVOT POINT TO THE CENTER POINT OF THE LENS PLANE |
| $h_{test}$ | = | VERTICAL DISTANCE FROM FLOOR TO THE CENTER POINT OF THE LENS PLANE |
| $L_{test}$ | = | HORIZONTAL DISTANCE FROM THE CENTER POINT OF THE LENS PLANE TO THE TABLE PIVOT POINT |

Figure 3-1. Solar simulator setup.

3.0 OPERATING PROCEDURES (Continued)

3.5 Solar Simulator System Setup (Continued)

3.5.5 Using the chain hoist located at the right side of the simulator lamp array, adjust the array to the required tilt angle and the height ($h_{test}$) as measured from the binding posts located on either side of the center of the lamp array.

3.5.6 Attach a plumb bob to each binding post mentioned in Step 3.5.5, and place a mark on the floor directly under each.

3.5.7 Draw a chalk line connecting the two points and bisect the chalk line.

3.5.8 Construct a line perpendicular to the line drawn in Step 3.5.7 and passing through its center. This line should extend at least a distance ($l_{test}$) in a northerly direction.

3.5.9 Measure off a distance equal to $l_{test}$ from the base line in Step 3.5.5 along the line drawn in Step 3.5.8, and mark this point.

3.5.10 Center the test table (left to right) over the line drawn in Step 3.5.8 and located so that the pivot point of the table is directly over the mark made in Step 3.5.9.

3.5.11 Set the test table tilt angle to the angle required for testing. The flow systems should now be set up, all instrumentation should be hooked up, and the system should be ready for testing.

3.6 Field Mapping

A field map should be taken prior to any series of tests and after any test during which a significant number of lamps have been burned out.

3.6.1 The simulator lamp array should be set up as described in Step 3.5.4 through Step 3.5.11, using 9-3/8 in. for $d_c$ in the equations listed in Step 3.5.4.

3.6.2 Set the lamp power to give approximately 300 BTU/Hr·Ft$^2$.

3.6.3 Use the pyranometer to take readings at intersections of a one foot grid on the table, a total of 32 readings.

3.6.4 If maximum or minimum readings vary by more than plus or minus 10% of the average, exchange one-half of the bulbs from high intensity areas and low intensity areas.

3.6.5 Repeat Step 3.6.3 and 3.6.4 until all readings are within 10% of the average.

3.6.6 An alternate mapping scheme using scanner is described in Appendix A.

3.0 OPERATING PROCEDURES (Continued)

3.7 Start Up Procedure

3.7.1 Arrange with Data Collection Group to monitor simulator operation.

3.7.2 INSURE THAT SCREEN IS BETWEEN SIMULATOR AND THE VISITORS' BOOTH.

3.8 Simulator Power Up Procedure

3.8.1 Open cooling water hand valve on the power controller console (A on Figure 3-2).

3.8.2 Close main supply breaker (480 volts) located on power duct above the door to Room 158A, Building 4619.

3.8.3 Close main circuit breaker on Panel AA-3.

3.8.4 Close control circuit breaker (No. 2) on Panel AA-3.

3.8.5 Close exhaust fan circuit breaker (No. 18) on Panel AA-3.

3.8.6 Check over-temperature meter relay for a setting of 200°F (B on Figure 3-2).

3.8.7 Set air flow damper to maximum open position (C on Figure 3-2).

3.8.8 Start exhaust fan using start button on fan control panel (D on Figure 3-2).

3.8.9 Set level potentiometer on power controller console to "0" (E on Figure 3-2).

3.8.10 Close main circuit breaker on power controller console (F on Figure 3-2).

3.8.11 Check Panel AA-1 and Panel AA-2 to insure that all lamp circuit breakers required for simulator operation are turned on (See Figure 3-3).

3.8.12 Close main circuit breaker on Panel AA-1.

3.8.13 Close main circuit breaker on Panel AA-2.

3.8.14 Gradually increase level potentiometer on power controller to desired operating point (See Figure 3-4).

3.8.15 Adjust air flow damper to obtain the prescribed operating temperature as monitored on the computer.

3.9 Simulator Power-Down Procedure

3.9.1 Set level potentiometer on power controller to "0".

3.9.2 Open main circuit breaker on Panel AA-1.

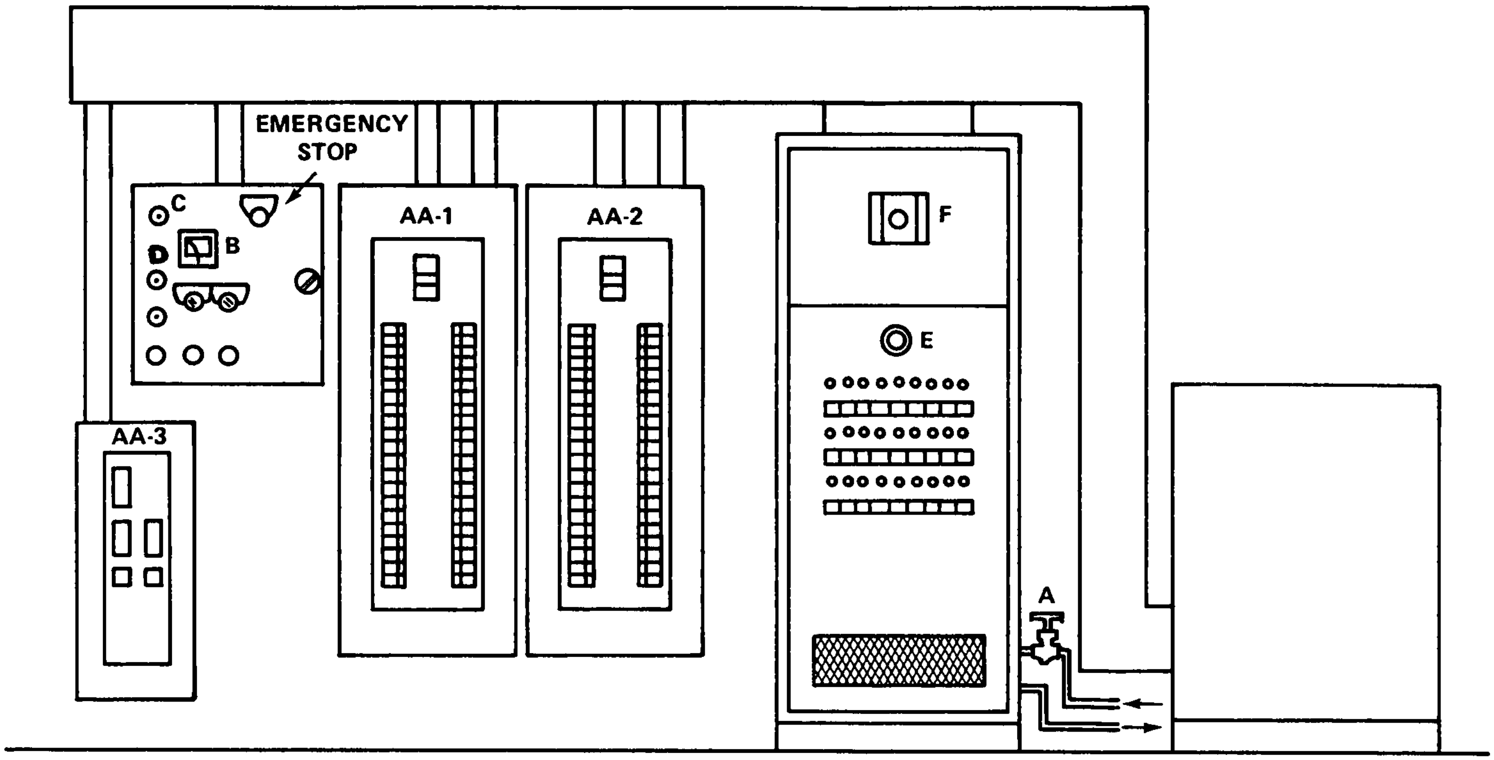



Figure 3-2. Solar simulator controls.

| Row | Columns 1-5 | Columns 6-10 | Columns 11-15 |
|---|---|---|---|
| **BREAKER BOX AA-1** | | | |
| 1 | 40 | 41 | 42 |
| 2 | 37 | 38 | 39 |
| 3 | 34 | 35 | 36 |
| 4 | 31 | 32 | 33 |
| 5 | 28 | 29 | 30 |
| 6 | 25 | 26 | 27 |
| 7 | 22 | 23 | 24 |
| 8 | 19 | 20 | 21 |
| 9 | 16 | 17 | 18 |
| 10 | 13 | 14 | 15 |
| 11 | 10 | 11 | 12 |
| 12 | 7 | 8 | 9 |
| 13 | 4 | 5 | 6 |
| 14 | 1 | 2 | 3 |
| **BREAKER BOX AA-2** | | | |
| 15 | 1 | 2 | 3 |
| 16 | 4 | 5 | 6 |
| 17 | 7 | 8 | 9 |
| 18 | 10 | 11 | 12 |
| 19 | 13 | 14 | 15 |
| 20 | 16 | 17 | 18 |
| 21 | 19 | 20 | 21 |
| 22 | 22 | 23 | 24 |
| 23 | 25 | 26 | 27 |
| 24 | 28 | 29 | 30 |
| 25 | 31 | 32 | 33 |
| 26 | 34 | 35 | 36 |
| 27 | 37 | 38 | 39 |

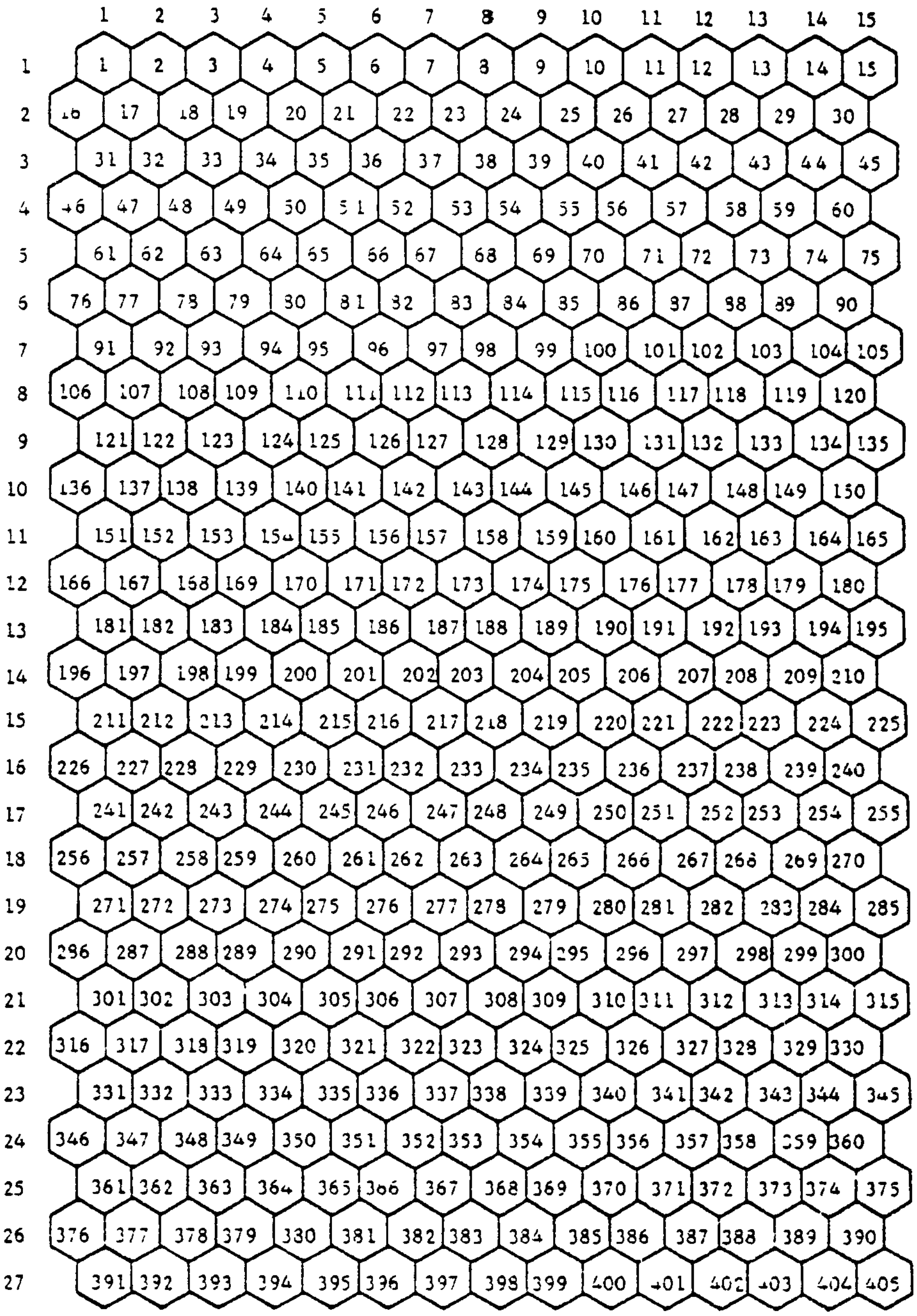



FIGURE 3-3 LAMP LOCATIONS AND CIRCUIT BREAKER ASSIGNMENT

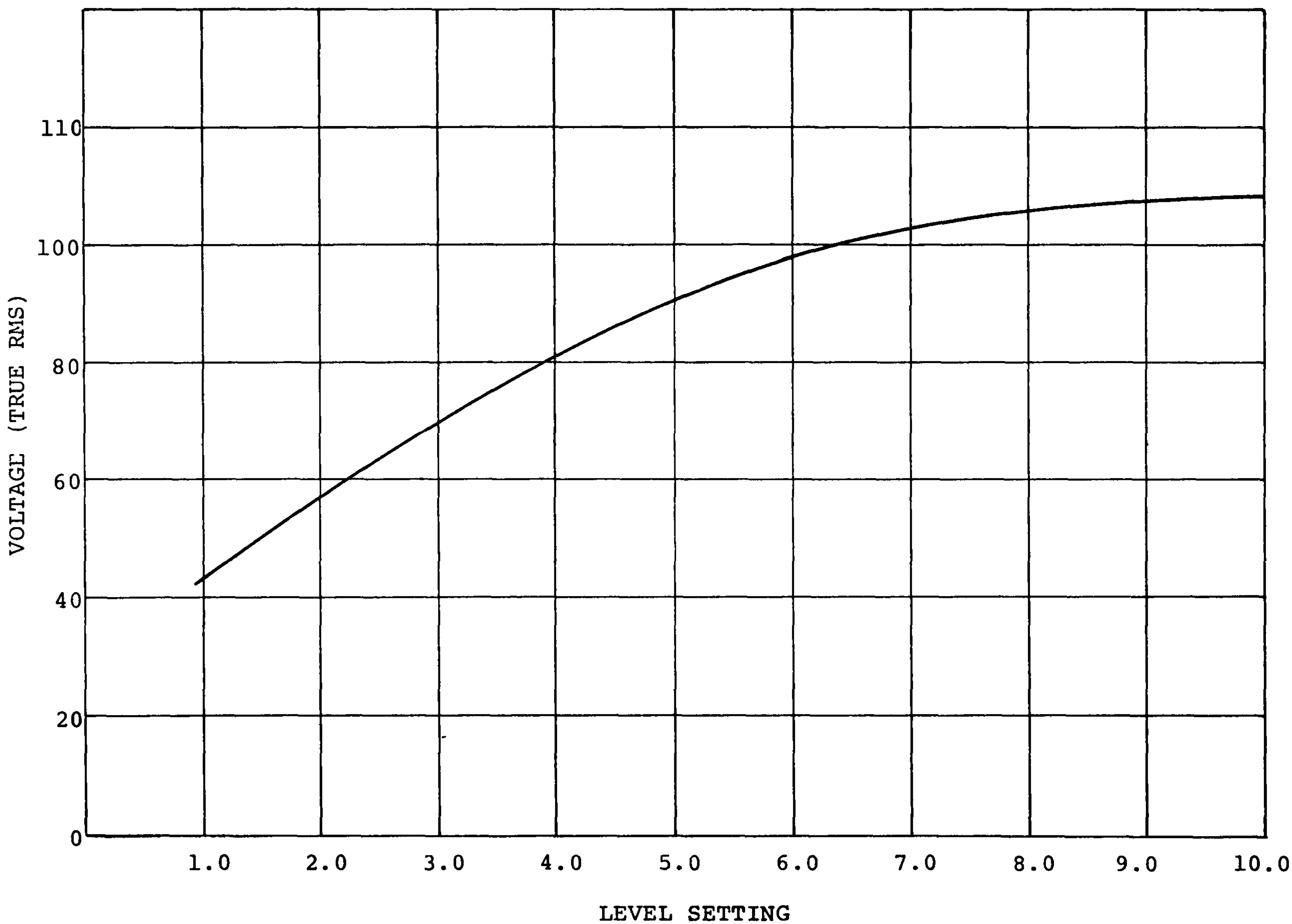



FIGURE 3-4 POWER LEVEL CONTROL SETTING VERSUS OUTPUT VOLTAGE

3.0 OPERATING PROCEDURES (Continued)

3.9 Simulator Power-Down Procedure (Continued)

3.9.3 Open main circuit breaker on Panel AA-2.

3.9.4 Open main circuit breaker on power controller console.

3.9.5 Set air flow damper to maximum open position.

3.9.6 When lamp base temperature is below 100$^{o}$F, as observed on computer, stop exhaust fan using stop button on fan control panel (G on Figure 3-2).

3.9.7 Open exhaust fan circuit breaker (No. 18) on Panel AA-3.

3.9.8 Open control circuit breaker (No. 2) on Panel AA-3.

3.9.9 Open main circuit breaker on Panel AA-3.

3.9.10 Open main supply breaker (480 volts) located on power duct above the door of Room 158A, Building 4619.

3.9.11 Close cooling water hand valve on the power controller console.

3.10 Shut-Down Procedure

3.10.1 Notify Data Collection Group that simulator operation has been completed.

3.11 Air Loop Operating Procedure (Refer to Figure 12 and Figure 13)

3.11.1 Prior to operating the air loop assure that:

1. The air inlet to the blower is open.
2. The air heater is OFF.
3. The air blower is OFF.
4. The gate valve nearest the blower is open.
5. Gate valve A is closed.

3.11.2 Turn the main power switch ON.

3.11.3 Turn the blower ON.

3.11.4 Slowly open gate valve A until the system air flow rate, as measured by the Hastings Air Meter, approximates the air flow desired for the test.

3.11.5 Set power controller to proper set point for desired temperature.

3.11.6 Turn heaters ON.

3.0 OPERATING PROCEDURES (Continued)

3.11 Air Loop Operating Procedure (Continued)

3.11.7 Adjust heater controller as necessary to obtain desired collector inlet temperature.

3.11.8 Adjust gate valve A as necessary to obtain proper flow test parameter.

3.11.9 Allow collector air inlet temperature and flow rate to stabalize. Note: Once the system is stable; ie., test parameters solar flux, flowrate, and collector inlet temperature have not varied significantly for 15 minutes and are at the values required for a particular test, test data recording should begin. Solar flux should not vary more than $\pm$ 9 w/m$^2$ ($\pm$ 3 BTU·Hr/Ft$^2$) over the test period. The air flow rate should not vary more than $\pm$ 1% over the test period. Similarly the inlet air temperature should not fluctuate beyond $\pm$ 0.5°C ($\pm$ 0.9°F) during the test. Test data should be recorded continually for a minimum of 15 minutes or twice the collector time constant, whichever is greater, when testing for collector thermal efficiency.

3.11.10 After testing is completed:

1. Turn OFF the heater power.
2. Turn OFF the blower.
3. Close gate valve A.
4. Turn OFF the main power switch.

3.12 Liquid Loop Operating Procedure (Refer to Figure 14 and Figure 15)

3.12.1 Prior to operating the liquid loop assure that:

1. Liquid reservoir is at least 75% full.
2. Liquid pump is OFF.
3. Liquid heater is OFF.
4. Hand valves HV-2, HV-3, HV-5, HV-6, HV-7, HV-9 and HV-10 are OPEN.
5. Hand valves HV1, HV-4, HV-8, HV-11, HV-12, HV-13 and HV-14 are CLOSED.

3.12.2 Turn main power switch ON.

3.12.3 Turn liquid pump ON.

3.12.4 Set power controller to proper set point for desired temperature.

3.12.5 Turn heater ON.

3.0 OPERATING PROCEDURES (Continued)

3.12 Liquid Loop Operating Procedure (Continued)

3.12.6 Turn exchanger controller switch to manual and set control to -15°C (5°F) below desired operating temperature.

3.12.7 Using exchanger controller manual switch, position valve slider to mid-range.

3.12.8 OPEN HV-8.

3.12.9 Slowly OPEN HV-1.

CAUTION: A surge of liquid could cause damage to collectors.

3.12.10 Adjust HV-1 to obtain .0315 x/s (0.5 GPM) as indicated on the minimum reading flowrator. Maintain this setting until system is clear of air.

NOTE: If system is being used with Solar Simulator, power up simulator before proceeding to next step.

3.12.11 After system is clear of air, adjust HV-8 as necessary to obtain a temperature of approximately -15°C (5°F) below desired collector inlet temperature.

3.12.12 Adjust heater controller as necessary to obtain desired collector inlet temperature.

3.12.13 Allow collector liquid inlet temperature to stabalize at proper temperature test parameter.

3.12.14 CLOSE HV-9.

3.12.15 Adjust HV-1 as necessary to obtain proper flow test parameter.

3.12.16 Turn exchanger controller switch to AUTO.

NOTE: Once the system is stable; i.e., test parameters solar flux, flowrate, and inlet temperatures have not varied significantly for 15 minutes and are at the values required for a particular test, test data recording should begin. Solar flux should not vary more than $\pm$ 9 w/m$^2$ ($\pm$ 3 BTU·Hr/Ft$^2$) over the test period. The liquid flowrate should not vary more than $\pm$ 1% over the test period. Similarly, the inlet fluid temperature should not fluctuate beyond $\pm$ 0.5°C ($\pm$ 0.9°F) during the test. Test data should be recorded continually for 15 minutes or twice the collector time constant, whichever is greater, when testing for collector thermal efficiency.

3.0 OPERATING PROCEDURES (Continued)

3.12 Liquid Loop Operating Procedure (Continued)

3.12.17 After testing is completed:

1. Turn OFF the heater power.
2. Turn the exchanger controller switch to MANUAL.
3. OPEN HV-4, and HV-8.
4. CLOSE HV-3 and allow system to flow until liquid temperature is below 150°F.
5. Turn OFF liquid pump.
6. Turn OFF main power switch.
7. CLOSE HV-6.

## 4.0 REFERENCES


| | | |
|---|---|---|
| 4.1 | DOE/NASA TM 78165 | Use of the Marshall Space Flight Center Solar Simulator in Collector Performance Evaluation. |
| 4.2 | DOE/NASA CR 161421 | Comparison of Indoor-Outdoor Thermal Performance for the Sunpak Evacuated Tube Liquid Collector. |
| 4.3 | ASHRAE 93-77 | Methods of Testing to Determine the Thermal Performance of Solar Collectors. |

TABLE I. MEASUREMENT ACCURACY

| Type | Media | Accuracy | Minimum Readout |
|---|---|---|---|
| Thermocouple | Liquid | ±0.5°C (±0.9°F) | ±0.06°C (±0.1°F) |
| Thermopile | Air | ±0.06°C (±0.1°F) | ±0.4°C (±0.7°F) |
| Resistance Thermometer | (Liquid and Air) | ±0.3°C (±0.5°F) | ±0.006°C (±0.01°F) |
| Solar Flux | N/A | ±3% | |
| Flowrate | Liquid<br>Air | ±1% of FS (1.2 gpm) ($0.08\ m^3/s$)<br>±2% of FS (210 cfm) ($0.1\ m^3/s$) | ±0.00001 kg/s (±0.1 lb/h) |
| Wind Velocity | Air | ±3% FS (30 mph) (13 m/s) | N/A |
| Voltage | N/A | ±0.5% FS (0-500 V) | N/A |

TABLE II. COLLECTOR PERFORMANCE MEASUREMENTS

| Function |
|---|
| Absorber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Abosrber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Abosrber Surface Temperature, °C (°F) |
| Convector Tube Surface Temperature, °C (°F) |
| Convector Tube Surface Temperature, °C (°F) |
| Convector Tube Surface Temperature, °C (°F) |
| Convector Tube Surface Temperature, °C (°F) |
| Convector Tube Surface Temperature, °C (°F) |
| Convector Tube Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C °F |
| Absorber Surface Temperature, °C (°F) |
| Convector Tube Surface Temperature, °C (°F) |
| Convector Tube Surface Temperature, °C (°F) |
| Absorber Surface Temperature, °C (°F) |
| Ambient Temperature, °C (°F) |
| Insolation Rate, W/m$^2$ (Btu/ft$^2$-h) |
| Flowrate, kg/s (lb/h) |
| Collector Inlet Temperature, °C (°F) |
| Collector Outlet Temperature, °C (°F) |

# APPENDIX A

## PROCEDURE FOR FIELD MAPPING USING SCANNER

APPENDIX A

PROCEDURE FOR FIELD MAPPING USING SCANNER

1.1 Field Mapping Subsystem

The solar simulator field mapping subsystem consists of:

o A support frame which mounts on the test table. (Figure A-1).

o A lateral scanner bar which supports the detector carriage and may be moved to set vertical positions over the test table.

o A photo transistor detector and amplifier. (Figure A-2).

o A detector carriage which is driven by a servo motor and scans from left to right or right to left. (Figure A-3).

o Power supplies for the detector amplifier and servo motors.

o Strip chart recorder.

o Console (Figure A-4).

1.2 Field Mapping

A field map should be taken prior to any series of tests and after any test during which a significant number of lamps have burned out.

1.2.1 The simulator lamp array should be set up as described in steps 3.5.4 through 3.5.11 using 9-3/8 inches for $d_c$ in the equations listed in step 3.5.4.

1.2.2 Mount the mapping frame on the test table. A pair of mounting holes in the frame should be aligned over the horizontal centerline of the table.

1.2.3 Mount the scanner bar in the holes in the frame over the horizontal centerline of the table. These holes will now be the zero (0) reference point for vertical scans.

1.2.4 Connect the cable assembly from the scanner console to the detector carriage (Figure A-4).

1.2.5 Power up the 15 volt power supplies in the scanner console and adjust both supplies to read 15 volts.

1.2.6 Turn on the 400 cycle supply in Building 4619.

1.2.7 Turn on the power to the chart recorder, turn off the chart drive mechanism, and raise the pen.

1.2.8 Turn on the simulator in accordance with startup procedure (3.7). Allow the simulator to reach its operating temperature.

1.2.9 Move the detector carriage to the center of the scanner bar. Insure that the three-position scanner switch is in its center position.

1.2.10 Cover the detector and zero the galvanometer using the bias control. Zero the chart recorder.

1.2.11 Uncover the detector and adjust the gain control until the chart recorder pen is at about 80% of full scale. Repeat step 1.2.10 to check for zero.

1.2.12 Repeat steps 1.2.10 and 1.2.11 until the recorder reads zero when the detector is covered and approximately 80% when uncovered. Record this level on the chart recorder by lowering the pen and running the chart drive for a short time.

1.2.13 Switch the scanner switch to the L R position. The carriage should move to the right reference side of the table (that is the right side of the table when looking at the simulator). The carriage should stop at the end of the carriage and the red indicator lamp should light.

1.2.14 Place the pyranometer on the carriage bar over the center of the table and take two readings from the computer printout of the flux level. Write these flux level readings on the chart recorder paper next to the mark recorded in Step 1.2.12.

1.2.15 Set the scanner switch to the R L position, start the chart recorder and lower the pen. Press the button next to the read indicator lamp until the lamp goes out. The carriage will now scan from right to left and stop on the left hand side of the table lighting the read indicator. Stop the chart recorder, raise the pen, and mark the vertical position (in this case, "0") and R L on the chart recorder paper to indicate a right to left scan.

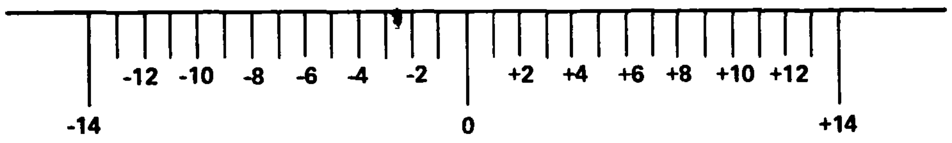
1.2.16 Set the scanner switch to the L R position, start the chart recorder and lower the pen. Press the button next to the red indicator lamp until the lamp goes out. The carriage will scan from left to right and stop on the right hand side of the table, lighting the red indicator. Stop the chart recorder, raise the pen and mark the vertical position and L R on the chart recorder paper.

1.2.17 Move the scanner bar down six (6) inches and repeat steps 1.2.15 and 1.2.16, marking the chart with -6". Continue this process moving the bar 6 inches at a time and repeating steps 1.2.15 and 1.2.16 until -48" is scanned.

1.2.18 Now move the bar back to the zero point and repeat steps 1.2.15 and 1.2.16. Repeat step 1.2.17 only in a positive direction (up the table).

1.2.19 Review the chart recorder data to insure that the L  R chart is a mirror image of the R  L data. If it is not, or if the two "0" maps do not agree, check the mapping system and the simulatro. Then remap the field. If it is, proceed with the data analysis.

1.2.20 Using the right to left scans and a scale similar to the one below, read off the chart recorder amplitude at the points indicated on the scale.




1.2.21 Record the reading in tabular form from the +48" through "0" to the -48" scan and forward this data along with the level measured in step 1.2.12 and the flux level measured in step 1.2.14 for analysis.

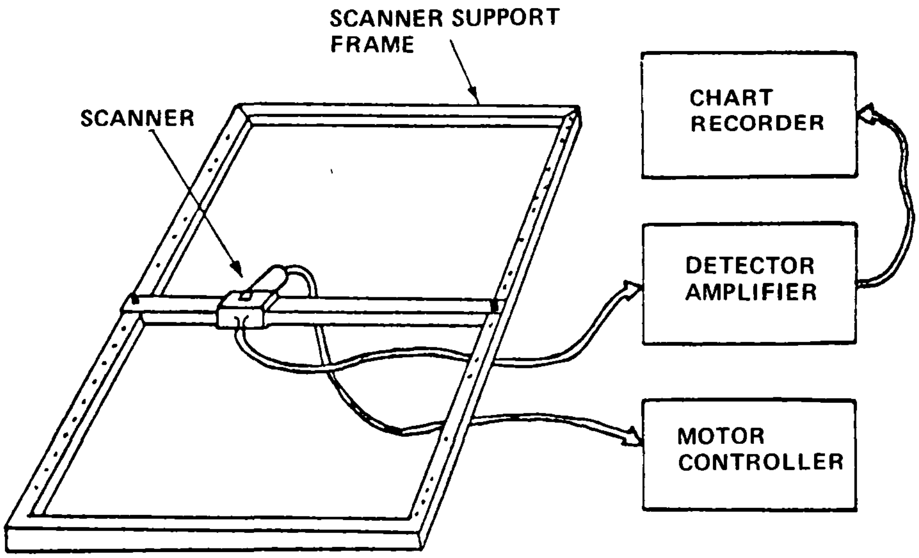



Figure A-1.Uniformity measurement apparatus.

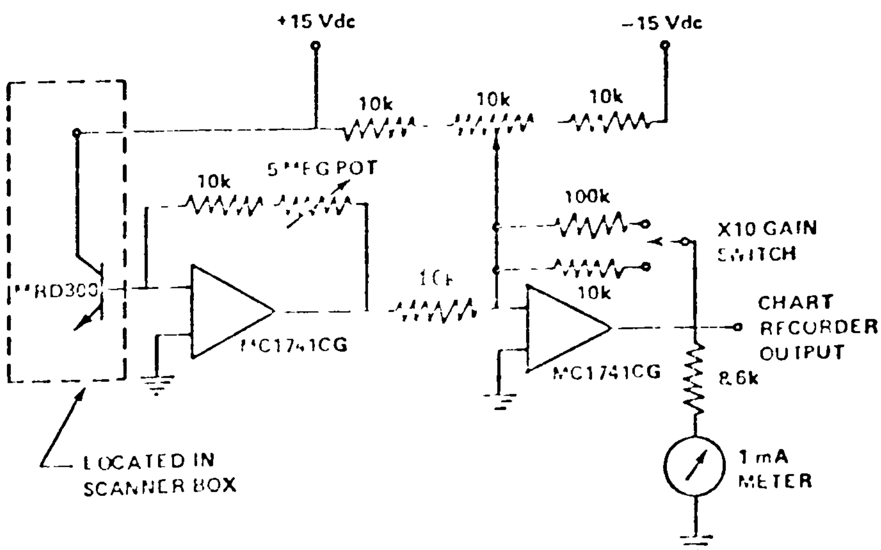



Figure A-2.Detector circuit.

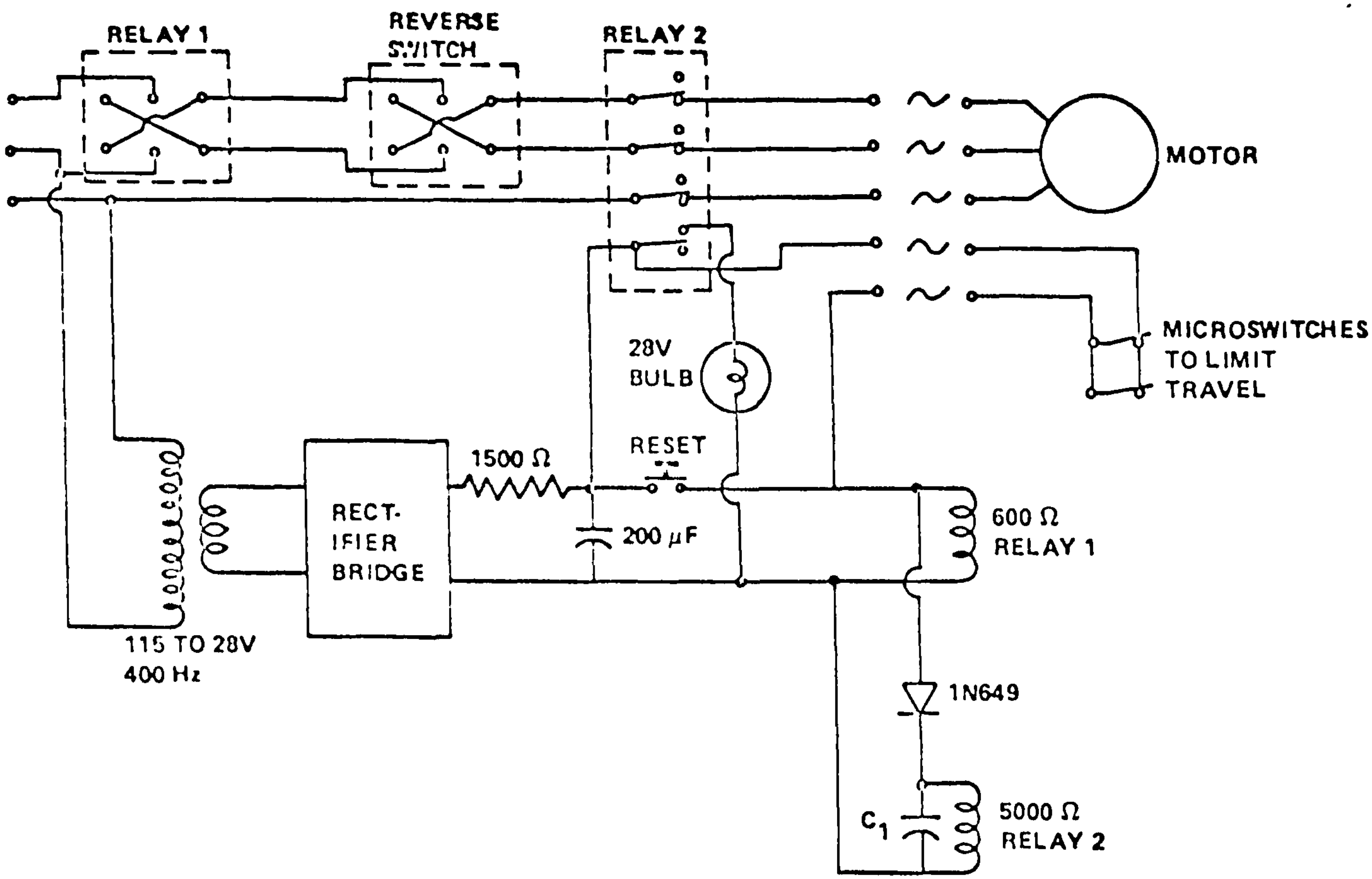
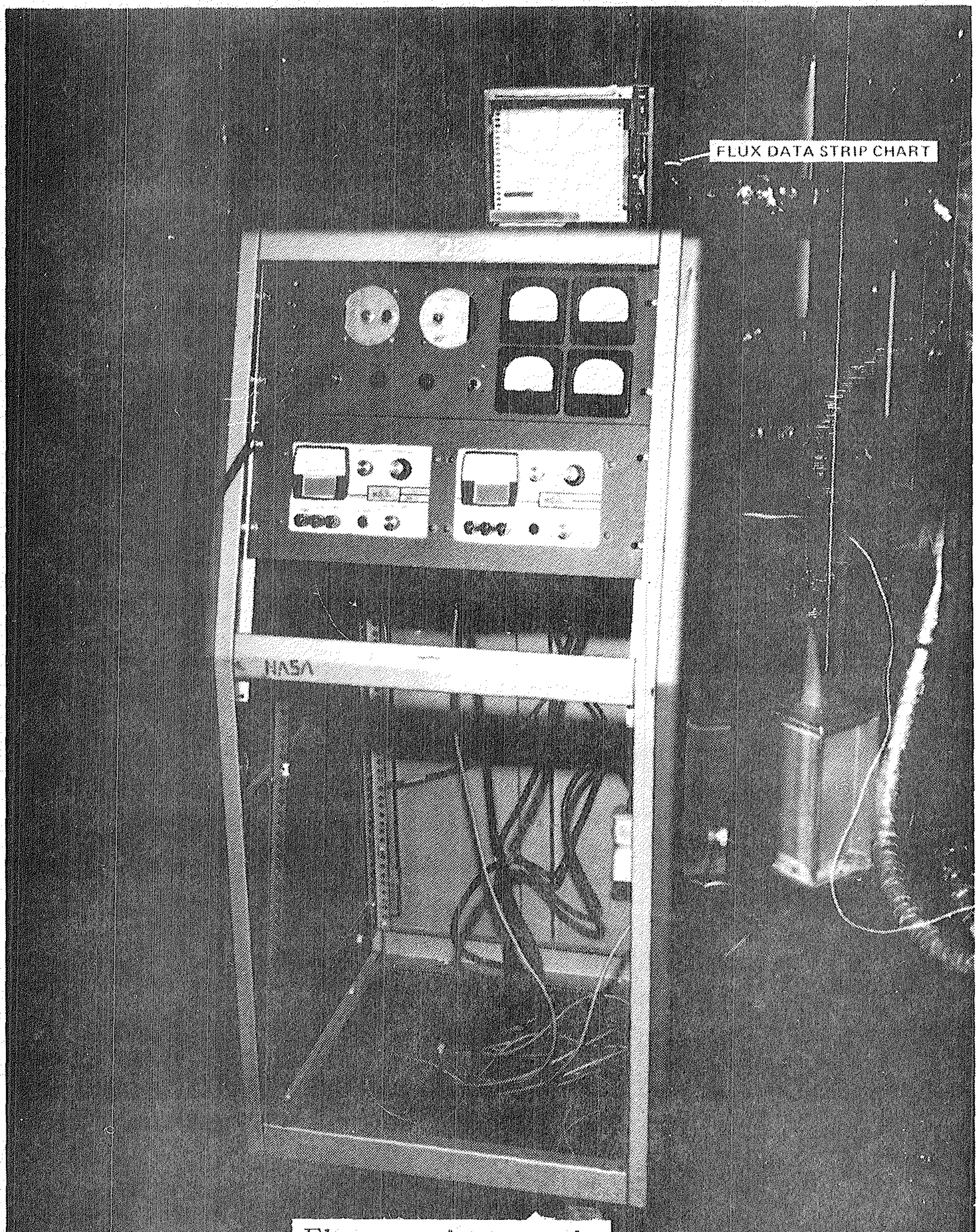



Figure A-3Scan motor control circuit.




Flux mapping console

Figure A-4.

APPENDIX B

DETAILED DRAWINGS

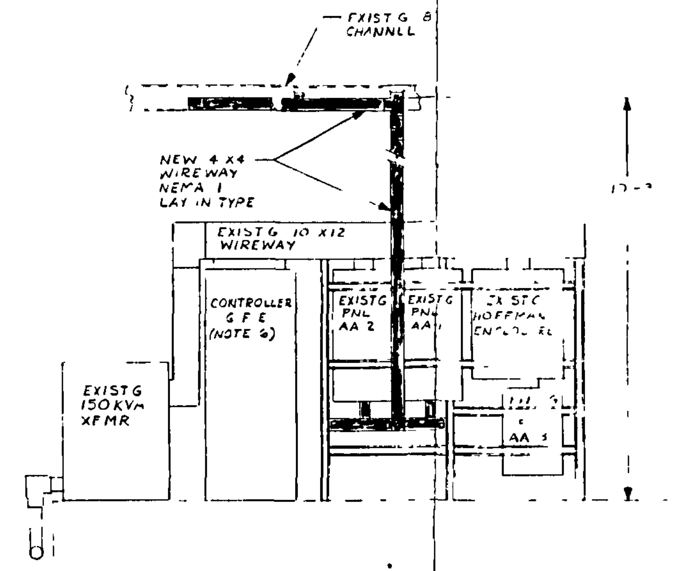
# SOLAR SIMULATOR WIRING LISTS

| PANEL "AA-1" CKT BKR NO | PLUG NO | PIN NO | REMARKS |
|---|---|---|---|
| 1 | 1 | A | |
| NEUTRAL (N) | 1 | B | |
| 2 | 1 | C | |
| N | 1 | D | |
| 3 | 1 | E | |
| N | 1 | F | CABLE #1 |
| 4 | 1 | G | |
| N | 1 | H | |
| 5 | 1 | J | |
| N | 1 | K | |
| 6 | 1 | L | |
| N | 1 | M | |
| 7 | 2 | A | |
| N | 2 | B | |
| 8 | 2 | C | |
| N | 2 | D | |
| 9 | 2 | E | |
| N | 2 | F | CABLE #2 |
| 10 | 2 | G | |
| N | 2 | H | |
| 11 | 2 | J | |
| N | 2 | K | |
| 12 | 2 | L | |
| N | 2 | M | |
| 13 | 3 | A | |
| N | 3 | B | |
| 14 | 3 | C | |
| N | 3 | D | |
| 15 | 3 | E | |
| N | 3 | F | CABLE #3 |
| 16 | 3 | G | |
| N | 3 | H | |
| 17 | 3 | J | |
| N | 3 | K | |
| 18 | 3 | L | |
| N | 3 | M | |
| 19 | 4 | A | |
| N | 4 | B | |
| 20 | 4 | C | |
| N | 4 | D | |
| 21 | 4 | E | |
| N | 4 | F | CABLE #4 |
| 22 | 4 | G | |
| N | 4 | H | |
| 23 | 4 | J | |
| N | 4 | K | |
| 24 | 4 | L | |
| N | 4 | M | |
| 25 | 5 | A | |
| N | 5 | B | |
| 26 | 5 | C | |
| N | 5 | D | |
| 27 | 5 | E | |
| N | 5 | F | CABLE #5 |
| 28 | 5 | G | |
| N | 5 | H | |
| 29 | 5 | J | |
| N | 5 | K | |
| 30 | 5 | L | |
| N | 5 | M | |
| 31 | 6 | A | |
| N | 6 | B | |
| 32 | 6 | C | |
| N | 6 | D | |
| 33 | 6 | E | |
| N | 6 | F | CABLE #6 |
| 34 | 6 | G | |
| N | 6 | H | |
| 35 | 6 | J | |
| N | 6 | K | |
| 36 | 6 | L | |
| N | 6 | M | |
| 37 | 7 | A | |
| N | 7 | B | |
| 38 | 7 | C | |
| N | 7 | D | |
| 39 | 7 | E | |
| N | 7 | F | CABLE #7 |
| 40 | 7 | G | |
| N | 7 | H | |
| 41 | 7 | J | |
| N | 7 | K | |
| 42 | 7 | L | |
| N | 7 | M | |

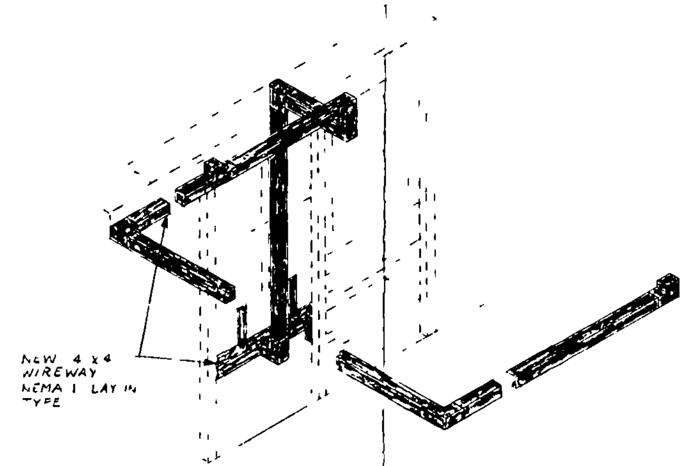
| PANEL 'AA 2 CKT BKR NO | PLUG NO. | PIN NO. | REMARKS |
|---|---|---|---|
| 1 | 8 | A | |
| NEUTRAL (N) | 8 | B | |
| 2 | 8 | C | |
| N | 8 | D | |
| 3 | 8 | E | |
| N | 8 | F | CABLE #8 |
| 4 | 8 | G | |
| N | 8 | H | |
| 5 | 8 | J | |
| N | 8 | K | |
| 6 | 8 | L | |
| N | 8 | M | |
| 7 | 9 | A | |
| N | 9 | B | |
| 8 | 9 | C | |
| N | 9 | D | |
| 9 | 9 | E | |
| N | 9 | F | CABLE #9 |
| 10 | 9 | G | |
| N | 9 | H | |
| 11 | 9 | J | |
| N | 9 | K | |
| 12 | 9 | L | |
| N | 9 | M | |
| 13 | 10 | A | |
| N | 10 | B | |
| 14 | 10 | C | |
| N | 10 | D | |
| 15 | 10 | E | |
| N | 10 | F | CABLE #10 |
| 16 | 10 | G | |
| N | 10 | H | |
| 17 | 10 | J | |
| N | 10 | K | |
| 18 | 10 | L | |
| N | 10 | M | |
| 19 | 11 | A | |
| N | 11 | B | |
| 20 | 11 | C | |
| N | 11 | D | |
| 21 | 11 | E | |
| N | 11 | F | CABLE #11 |
| 22 | 11 | G | |
| N | 11 | H | |
| 23 | 11 | J | |
| N | 11 | K | |
| 24 | 11 | L | |
| N | 11 | M | |
| 25 | 12 | A | |
| N | 12 | B | |
| 26 | 12 | C | |
| N | 12 | D | |
| 27 | 12 | E | |
| N | 12 | F | CABLE #12 |
| 28 | 12 | G | |
| N | 12 | H | |
| 29 | 12 | J | |
| N | 12 | K | |
| 30 | 12 | L | |
| N | 12 | M | |
| 31 | 13 | A | |
| N | 13 | B | |
| 32 | 13 | C | |
| N | 13 | D | |
| 33 | 13 | E | |
| N | 13 | F | CABLE #13 |
| 34 | 13 | G | |
| N | 13 | H | |
| 35 | 13 | J | |
| N | 13 | K | |
| 36 | 13 | L | |
| N | 13 | M | |
| 37 | 14 | A | |
| N | 14 | B | |
| 38 | 14 | C | |
| N | 14 | D | |
| 39 | 14 | E | |
| N | 14 | F | CABLE #14 |
| 40 | 14 | G | |
| N | 14 | H | |
| 41 | 14 | J | SPARE |
| N | 14 | K | SPARE |
| 42 | 14 | L | SPARE |
| N | 14 | M | SPARE |

## CONTROL CABLES TO ARRAY

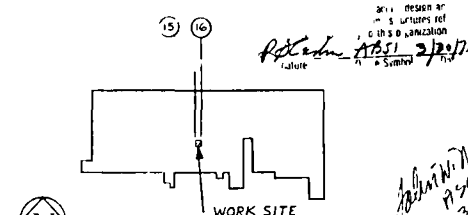
| FUNCTION | FROM | TO | REMARKS | |
|---|---|---|---|---|
| EQUIP GND (GREEN) | PNL AA 2 | FRAME OF ARRAY | * DIRECT CONN | |
| AIR FLOW SWITCH | HOFFMAN ENCLOSURE | AIR FLOW SW ON DUCT ABOVE ARRAY | * DIRECT CONN | |
| AIR FLOW SWITCH | HOFFMAN ENCLOSURE | AIR FLOW SW ON DUCT ABOVE ARRAY | * DIRECT CONN | CABLE #15 |
| SPARE | HOFFMAN ENCLOSURE | STRAP TOGETHER WITH CONDUCTORS TO AIR FLOW SW | | |
| SPARE | | | | |




SECTION B-B
N T S




ISOMETRIC VIEW OF WIREWAY
N T S




KEY PLAN-4619
N T S

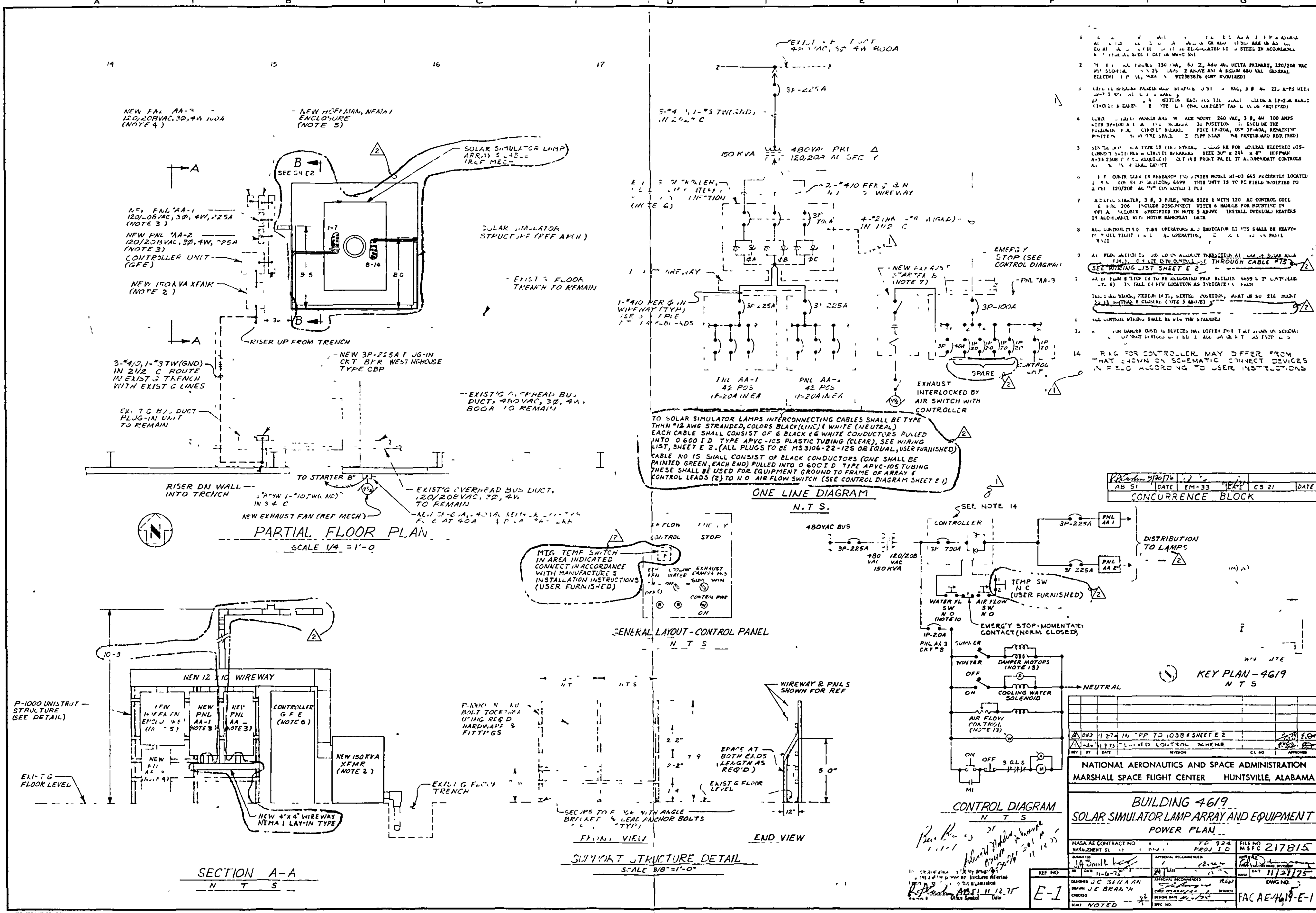
| REV | BY | DATE | REVISION | CI NO. | APPROVED |
|---|---|---|---|---|---|

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA

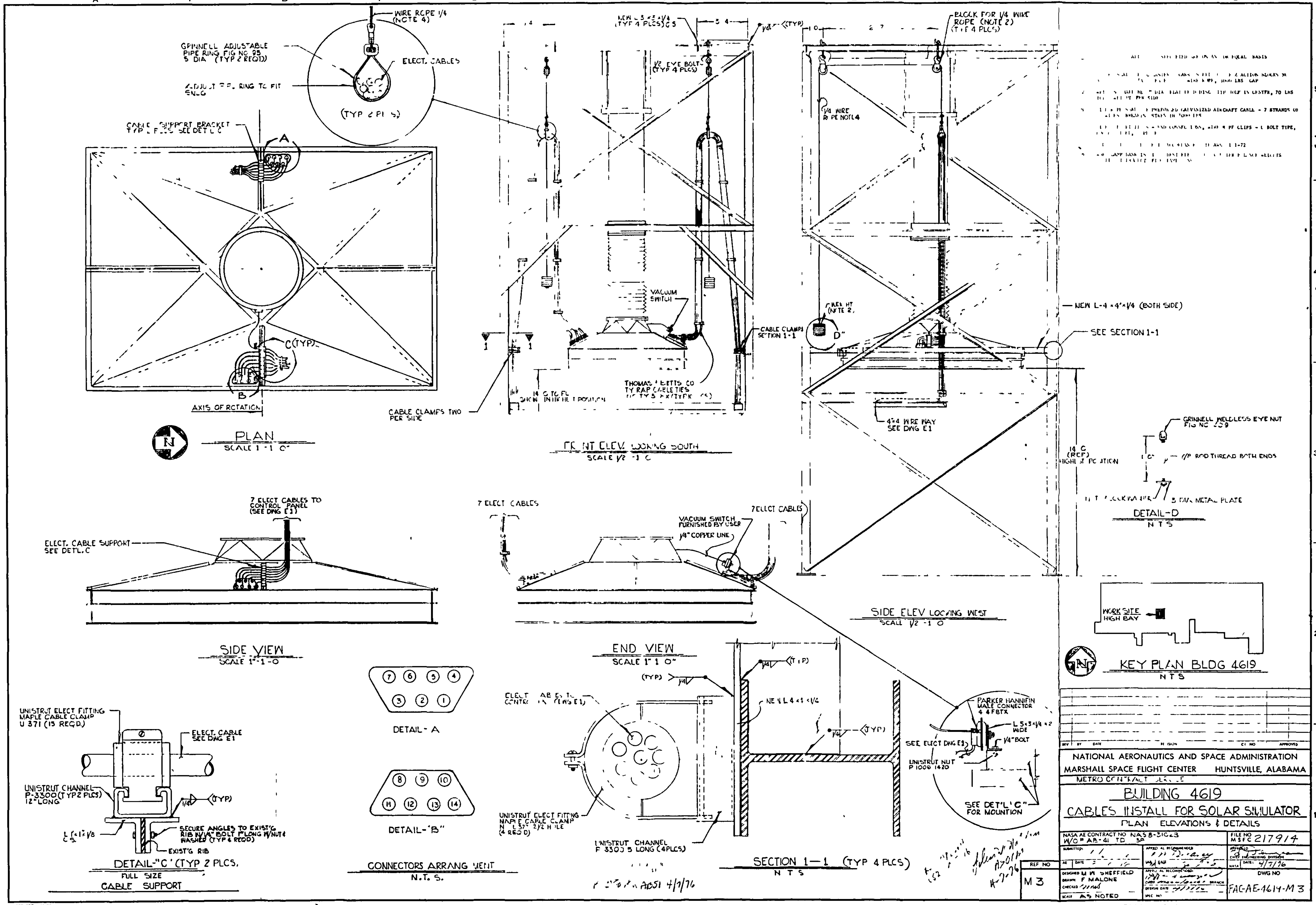
BUILDING 4619
SOLAR SIMULATOR LAMP APPAY AND EQUIPMENT
WIRING LISTS & SECTIONS

NASA AE CONTRACT NO TD-
FILE NO MSFC 217913
SUBMITTED
APPROVAL RECOMMENDED
APPROVED CHIEF ENGINEERING DIVISION
NASA DATE 4/2/76
REF NO E-2
DESIGNED J C SPILMAN
DRAWN O H FORD
CHECKED
SCALE NOTED
DESIGN DATE
SPEC NO
DWG NO FAC-AE-4619-E2

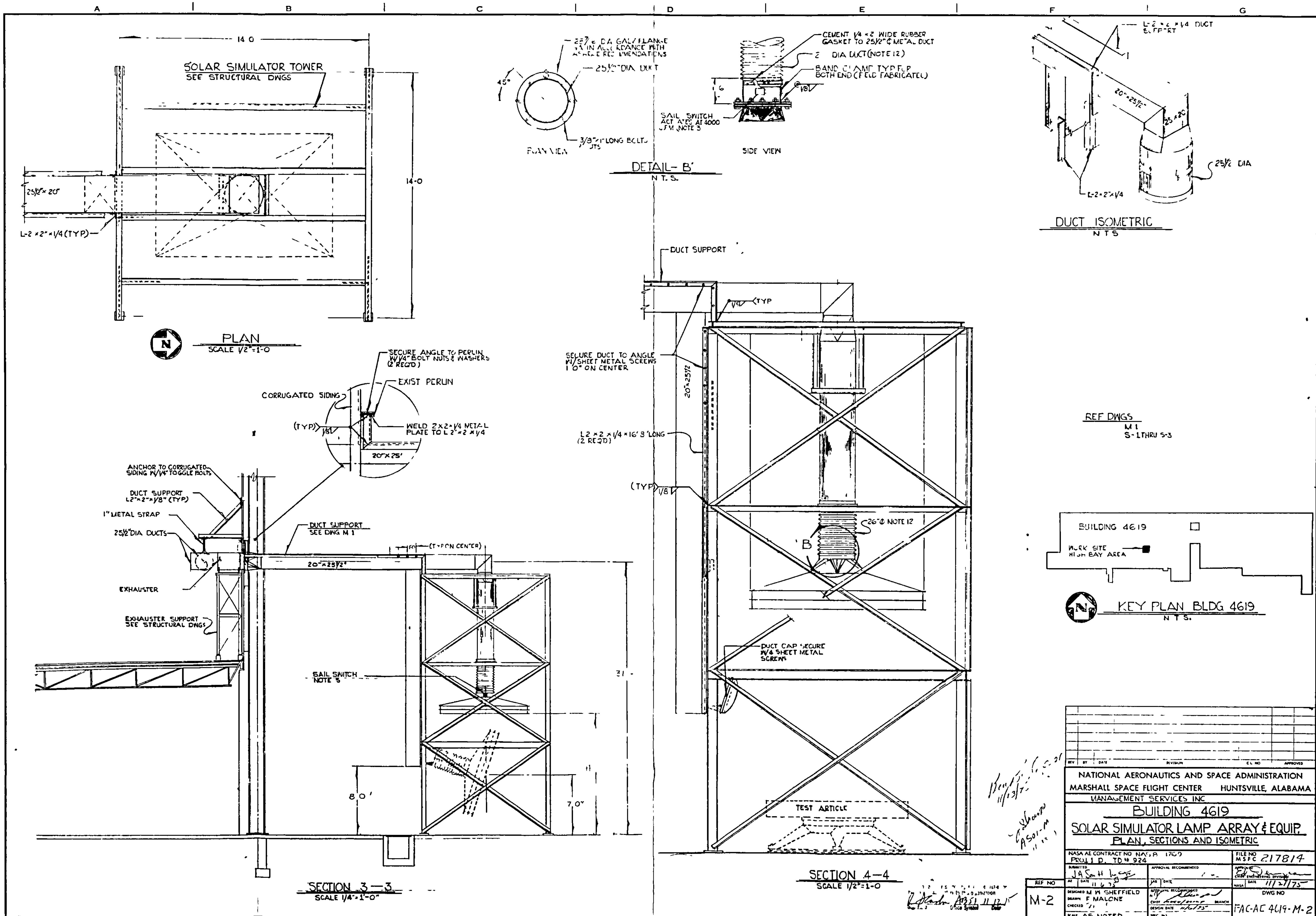
M S I. DWG E-SKE-425



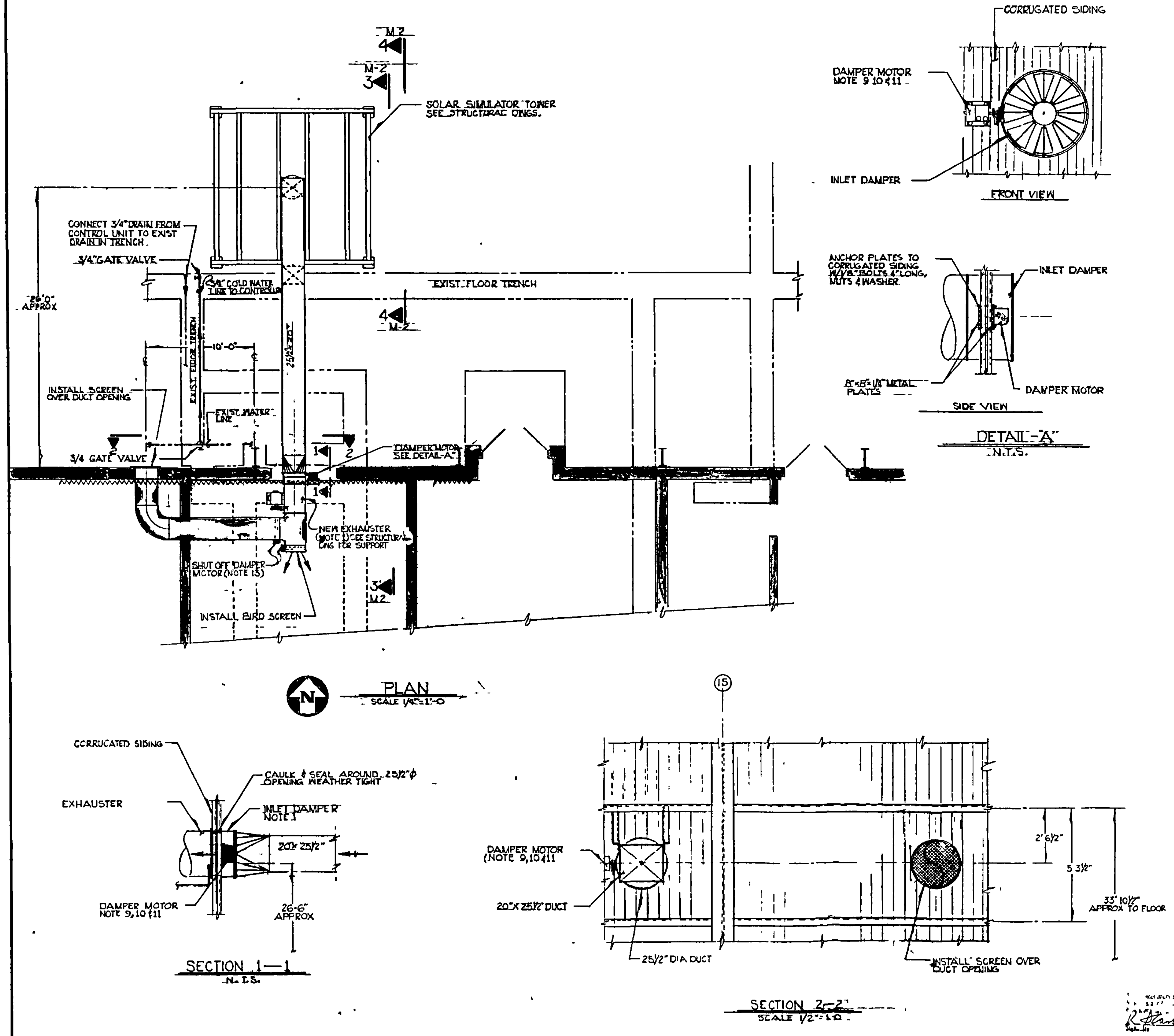

M S I DWG E-SKE-397

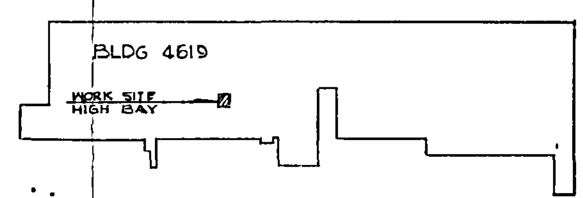



M C S DWG E-SKM-2000



M.S.I DWG. E-SKM-816




KEY PLAN BLDG. 4619
N T S

NOTES. ALL ITEMS SPECIFIED ARE ON AN "OR EQUAL" BASIS

1. EXHAUSTER SHALL BE AEROVENT TYPE W, BELT DRIVEN, SIZE 25", CAT. NO. W25BB, 7 1/2 HP MOTOR, 3 PHASE, 60 CYCLE, 208/440 AC, CAP. 11,750 CFM @ 1/2" S.P.

ACCESSORIES.

A. INLET DAMPER-AIR VOLUME CONTROL, SIZE 25.
B. SUPPORT LEGS, SIZE 25.
C MOTOR COVER

2. DUCTWORK SHALL BE FABRICATED FROM GALVANIZED SHEET STEEL, GAUGE IN ACCORDANCE WITH ASHRAE RECOMMENDATIONS.

3. SAIL SWITCH SHALL BE JOHNSON S-772B AIR FLOW SWITCH 208/440 VOLTAGE, SPST, NORMALLY OPEN

4. WELDING SHALL CONFORM TO AWS D.10.

5. STRUCTURAL STEEL SHALL BE ASTM A-36.

6. CLEANING - PIPING SHALL BE FLUSHED UNTIL FREE OF DIRT AND SCALE. PIPING SHALL THEN BE FILLED WITH A SOLUTION OF CHLORINE IN WATER (50 PPM BY WEIGHT) AND LEFT STANDING FOR 24 HOURS. FLUSH WITH POTABLE WATER UNTIL CHLORINE CONCENTRATION IS 10 PPM OR LESS.

7. TESTING - HYDROSTATICALLY TEST PIPING AS FOLLOWS:

WATER SUPPLY LINES & DRAIN LINES - 100 PSIG
HOLD PRESSURE FOR ONE HOUR WITHOUT LEAKS.

8. IDENTIFICATION - IDENTIFY ALL LINES AS PER MSFC-STD-166.

9. OPERATOR, VOLUME DAMPER - LOW VOLTAGE MOTOR (24 VAC), PROPORTIONING WITH FEED BACK POTENTIOMETER. POSITIONS DAMPER PROPORTIONALLY ACCORDING TO CONTROLLER (MANUAL POTENTIOMETER) SETTING HAS BALANCING RELAY FIXED 90° OR 160° STROKE WITH 15 OR 30 SECOND TIMING, HONEYWELL M944A. OR APPROVED EQUAL

10. LOW VOLTAGE TRANSFORMER FOR ABOVE OPERATOR 120/208/240 VAC, 60 CYCLE, SINGLE PHASE TO 24 VAC TRANSFORMER TO MOUNT ON OPERATOR LISTED IN ITEM 9. COVER TO ENCLOSE TRANSFORMER AND OPERATOR INCLUDED, HONEYWELL 150810B, OR APPROVED EQUAL

11. OPERATOR CONTROLLER - MANUAL POTENTIOMETER WITH NAME PLATE, DIAL PLATE, AND ADJUSTMENT KNOB ASSEMBLY SUITABLE FOR PANEL MOUNTING, HONEYWELL 112804FD. OR APPROVED EQUAL

12 FLEXIBLE DUCT, 26 DIAMETER, FLEXAUST COMPANY, TYPE CWC, 15 FT. STD. LENGTHS OR APPROVED EQUAL

13 MOTOR OPERATORS FOR OUTSIDE AND INSIDE AIR SHUTOFF DAMPERS SHALL HAVE THE FOLLOWING REQUIREMENTS 75 IN-LBS TORQUE AT MAX LOAD, 150 IN-LBS BREAK-AWAY TORQUE, TWO POSITION MOTOR OPERATION, 30 SEC TIME WITH 90° STROKE, 120 VOLT A C HONEYWELL NO M644-1007 ONE REQUIRED DIRECT ACTING AND ONE REVERSE ACTING

| REV | EM 35 | DATE | PB 51 | DATE | CS 21 | DATE |
|---|---|---|---|---|---|---|

CONCURRENCE

| REV | BY | DATE | REVISION | CL NO. | APPROVED |
|---|---|---|---|---|---|
| 1 | MCS | 7-6-76 | CHANGED DAMPER MOTOR | TD 99 | |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
MANAGEMENT SERVICES INC

BUILDING 4619
SOLAR SIMULATOR LAMP ARRAY & EQUIP
PLAN & SECTIONS

NASA AE CONTRACT NO NAS8 21769
PROJ 1D T.D. NO. 924
FILE NO MSFC 217813

SUBMITTED: J A Smith
AE DATE 11 6 75
APPROVAL RECOMMENDED:
APPROVED: CHIEF ENGINEERING DIVISION
NASA DATE 11/21/75

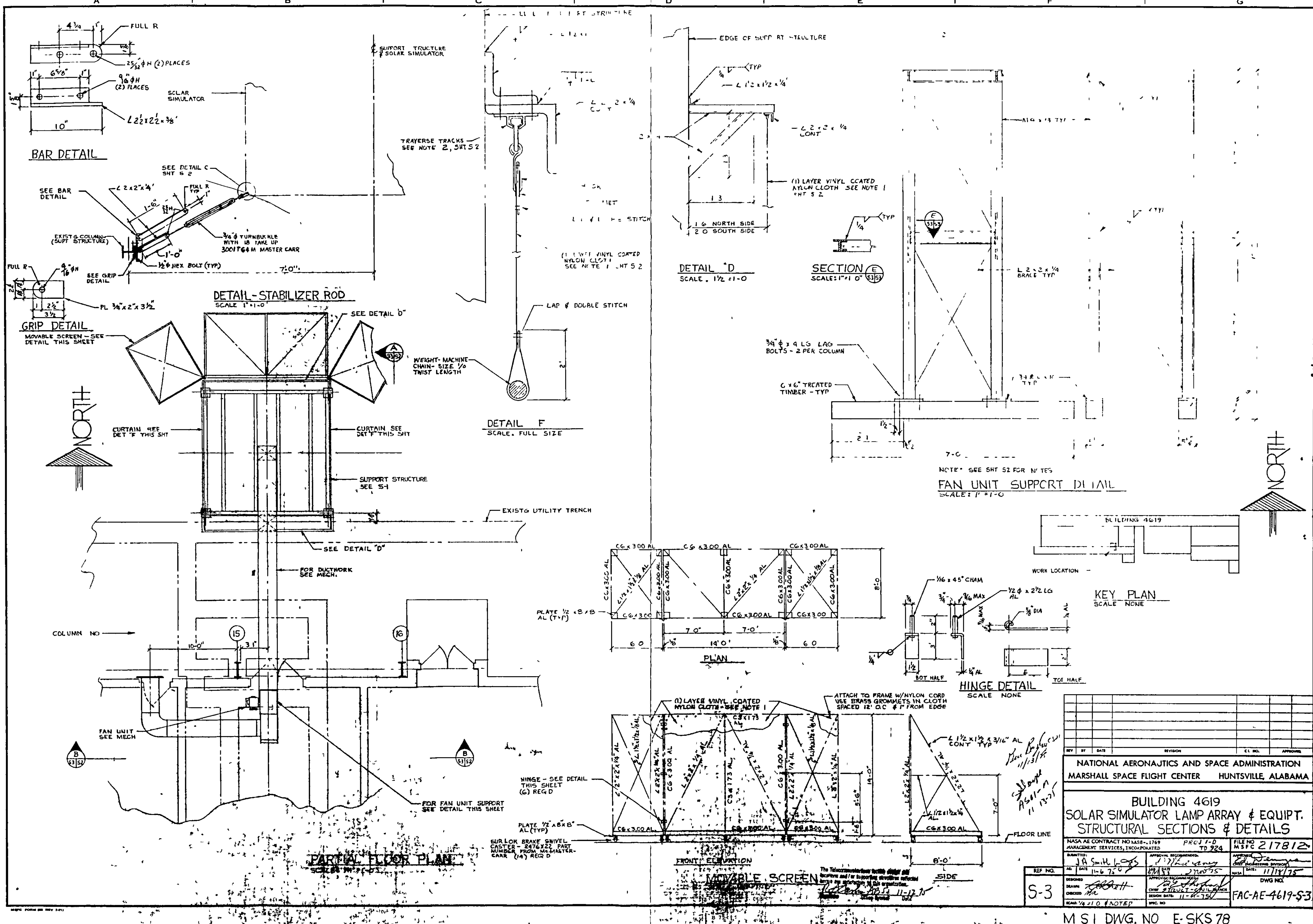
REF NO. M-1

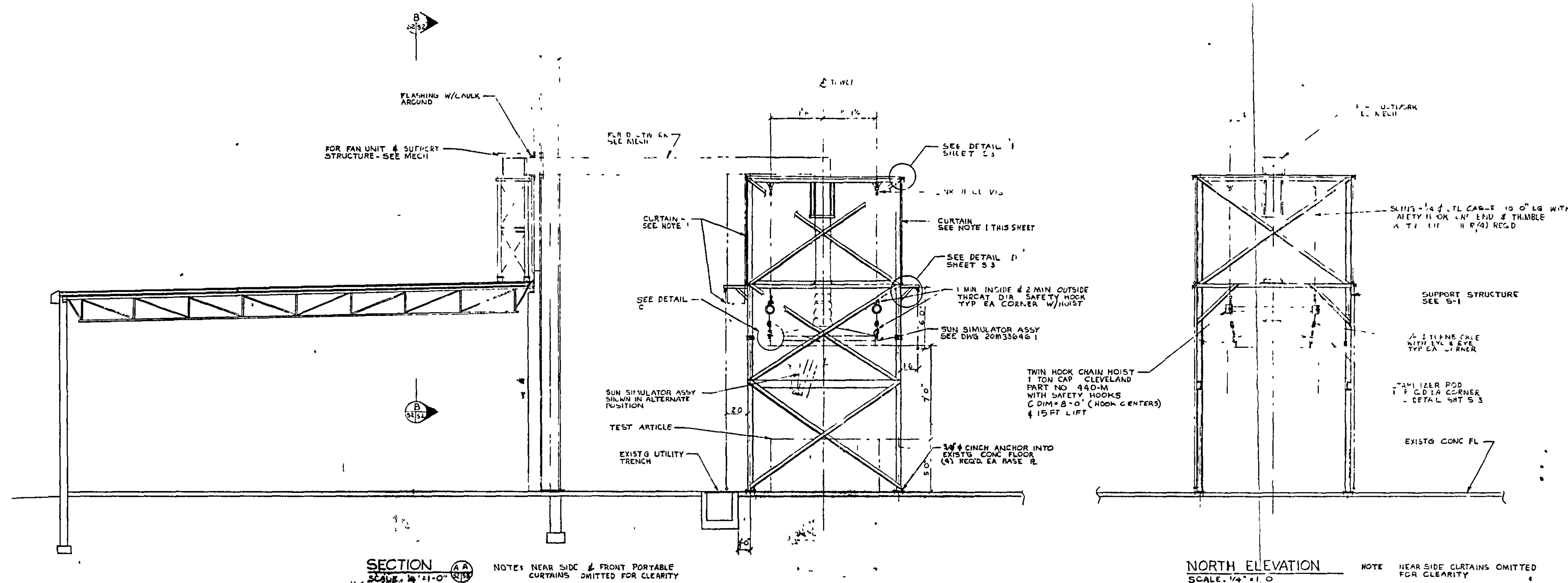
DESIGNED M. W. SHEFFIELD
DRAWN F MALONE
CHECKED
SCALE AS NOTED
APPROVAL RECOMMENDED: CHIEF BRANCH
DESIGN DATE 11/6/75
SPEC. NO

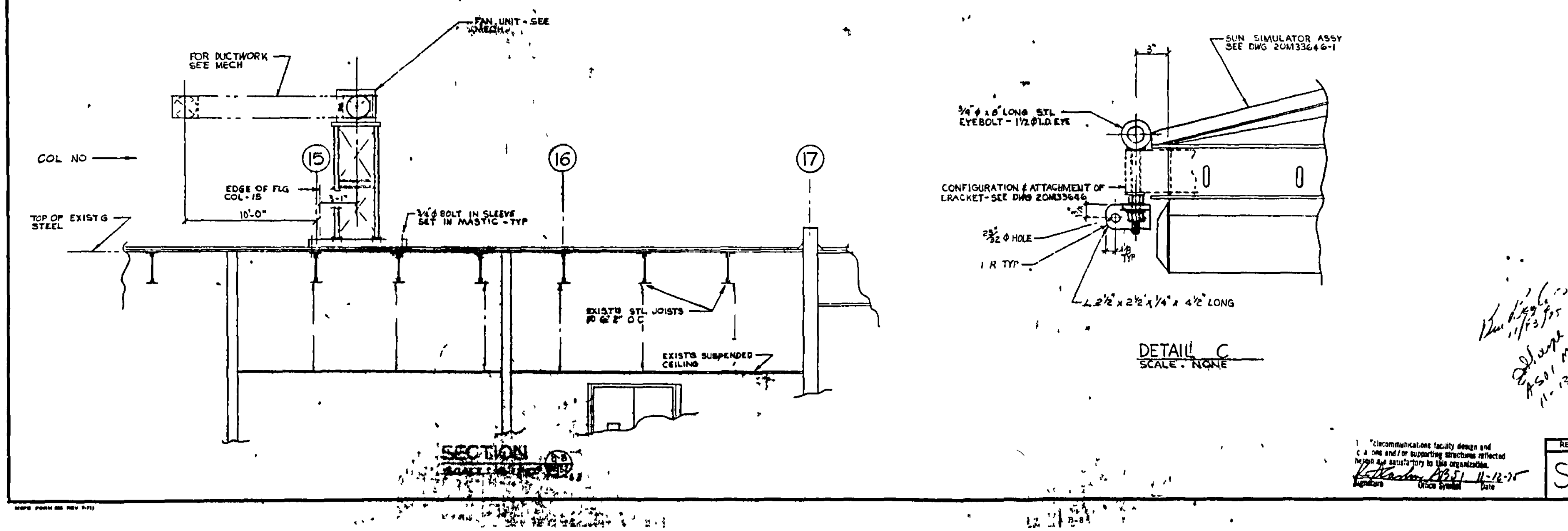
DWG NO. FAC-AE-4619-M-1

AB51 11/12/75
Office Symbol Date

M S.I DWG. E SKM-815


BAR DETAIL
FULL R
25/32 ϕH (2) PLACES
9/16 ϕH (2) PLACES
L 2½x2½x3/8
SOLAR SIMULATOR
SEE DETAIL C SHT S 2
SEE BAR DETAIL
3/4ϕ TURNBUCKLE WITH 18 TAKE UP 3001 TG & M MASTER CARR
EXISTG COLUMN (SUPT STRUCTURE)
½ϕ HEX BOLT (TYP)
SEE GRIP DETAIL
PL 3/8x2x3½
GRIP DETAIL
DETAIL-STABILIZER ROD
SCALE 1"=1-0
TRAVERSE TRACKS SEE NOTE 2, SHT S 2
WEIGHT- MACHINE CHAIN- SIZE 1/0 TWIST LENGTH
LAP & DOUBLE STITCH
DETAIL F
SCALE. FULL SIZE
EDGE OF SUPPORT STRUCTURE
(1) LAYER VINYL COATED NYLON CLOTH SEE NOTE 1 SHT S 2
16 NORTH SIDE
20 SOUTH SIDE
DETAIL D
SCALE. 1½=1-0
SECTION E
SCALE: 1"=1 0"
3/4ϕ x 4 LG LAG BOLTS - 2 PER COLUMN
6x6" TREATED TIMBER - TYP
L 2x2x1/4 BRACE TYP
NOTE: SEE SHT S2 FOR NOTES
FAN UNIT SUPPORT DETAIL
SCALE: 1"=1-0
MOVABLE SCREEN - SEE DETAIL THIS SHEET
SEE DETAIL D
CURTAIN SEE DET F THIS SHT
SUPPORT STRUCTURE SEE S-1
EXISTG UTILITY TRENCH
FOR DUCTWORK SEE MECH.
NORTH
COLUMN NO
FAN UNIT SEE MECH
FOR FAN UNIT SUPPORT SEE DETAIL THIS SHEET
PARTIAL FLOOR PLAN
BUILDING 4619
WORK LOCATION
KEY PLAN
SCALE NONE
C6x3.00 AL
PLATE ½x8x8 AL (TYP)
PLAN
1/16x45° CHAM
½ϕ x 2½ LG AL
BOT HALF
TOP HALF
HINGE DETAIL
SCALE NONE
(1) LAYER VINYL COATED NYLON CLOTH - SEE NOTE 1
ATTACH TO FRAME W/NYLON CORD USE BRASS GROMMETS IN CLOTH SPACED 12" O.C. & 1" FROM EDGE
L 1½x1½x3/16" AL CONT TYP
HINGE - SEE DETAIL THIS SHEET (6) REQ D
PLATE ½"x8x8" AL (TYP)
SUR LOK BRAKE SWIVEL CASTER - 2476X22 PART NUMBER FROM MC MASTER-CARR (14) REQ D
FLOOR LINE
FRONT ELEVATION
SIDE
MOVABLE SCREEN
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
BUILDING 4619
SOLAR SIMULATOR LAMP ARRAY & EQUIPT.
STRUCTURAL SECTIONS & DETAILS
FILE NO MSFC 217812
S-3
FAC-AE-4619-S-3
M S I DWG. NO E-SKS 78




NOTES:

1. MATERIAL FOR CURTAIN TO BE:

   VINYL COATED NYLON, 18 OZ WEIGHT, SHADE 25102 PER FED-STD-595. MIL-SPEC C-43006 AS MANUFACTURED BY SUN CHEMICAL.

2. CURTAIN TRAVERSE TRACKS TO BE:

   KIRSCH NO 9045 TRACK WITH KIRSCH NO. 9685 MOLDED SLIDE & HOOK AS MANUFACTURED BY KIRSCH COMPANY, STURGIS, MICHIGAN 49091.

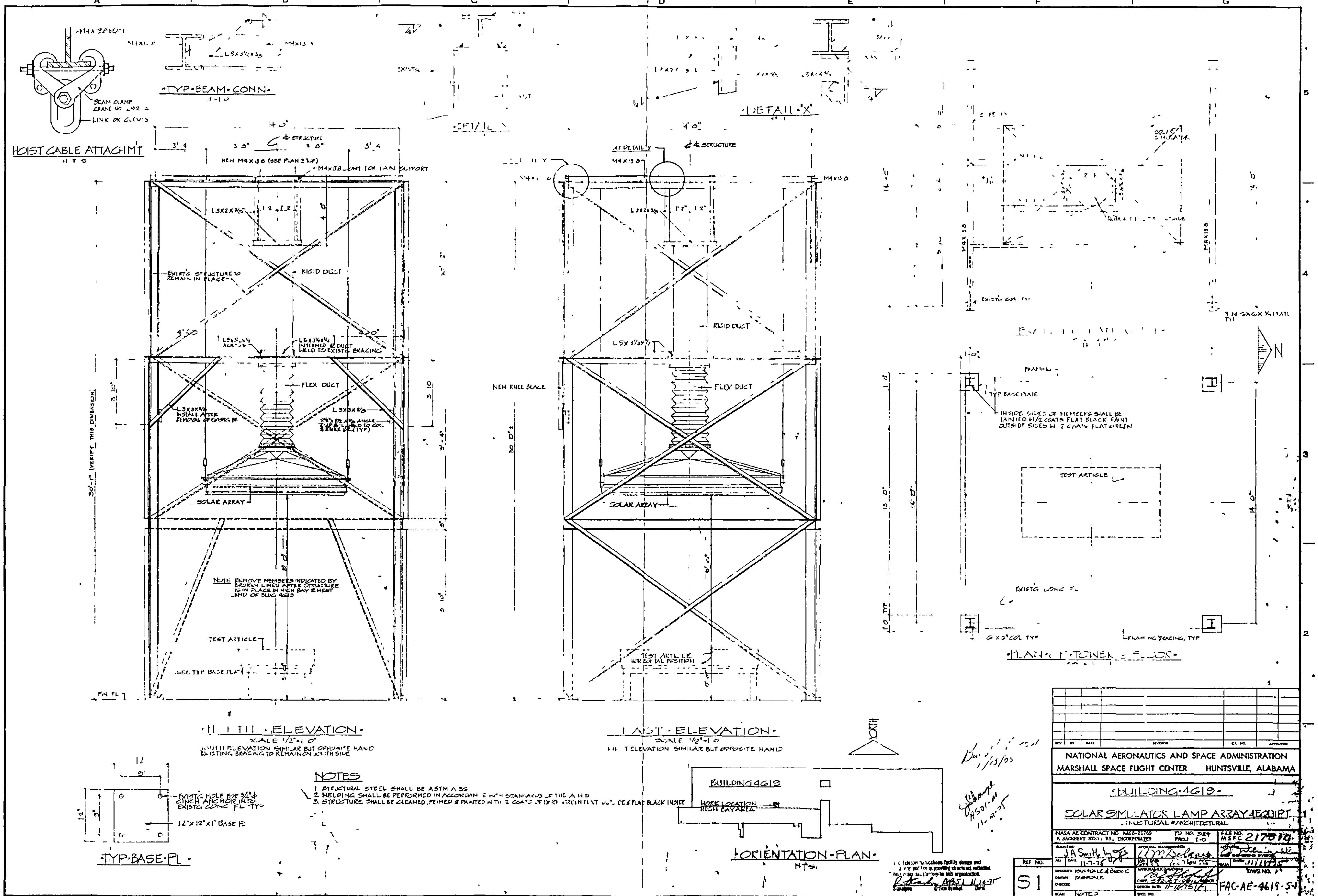
| REV | BY | DATE | REVISION | C.L. NO. | APPROVED |
|---|---|---|---|---|---|
| | | | | | |

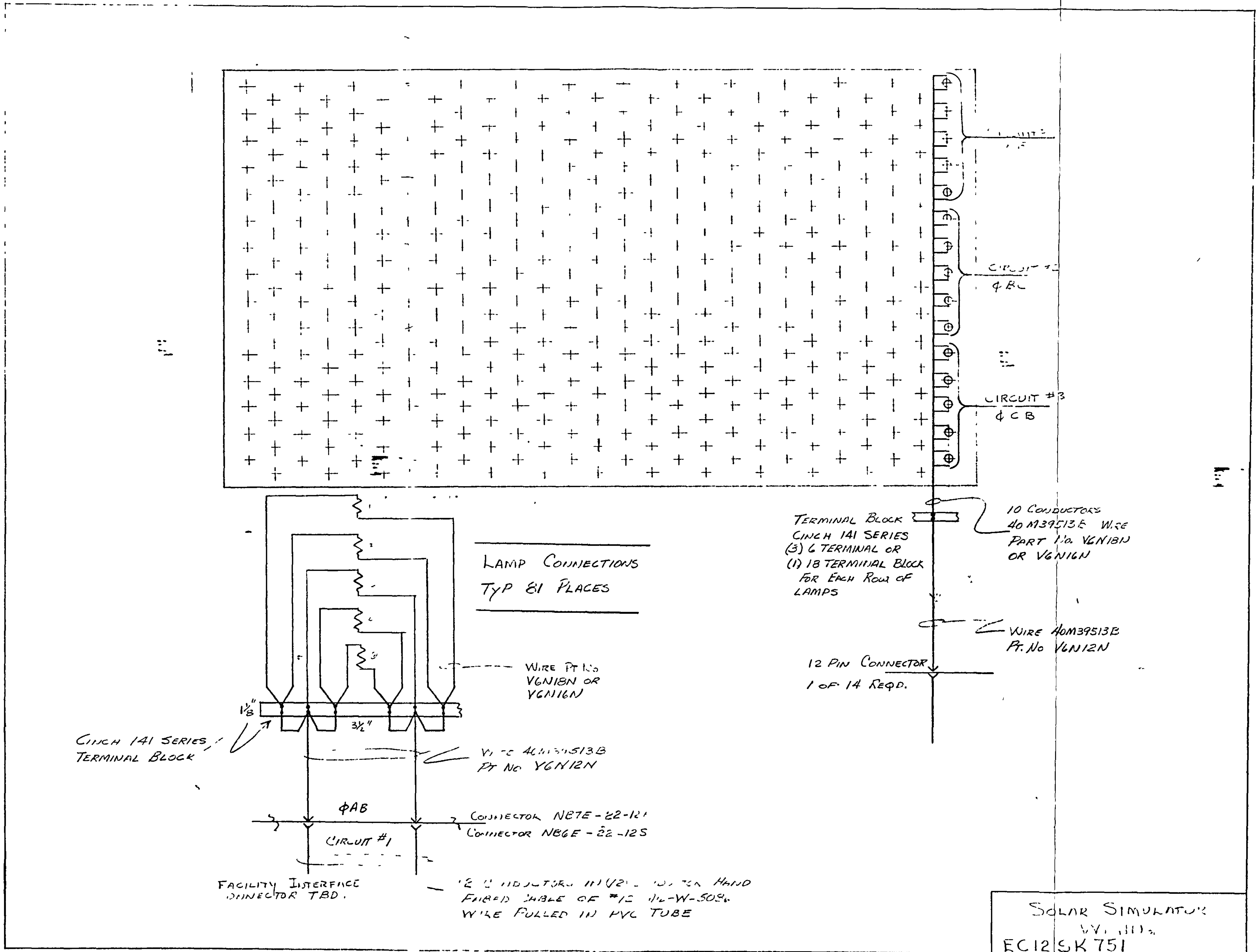
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA

BUILDING 4619
SOLAR SIMULATOR LAMP ARRAY & EQUIPT.
STRUCTURAL SECTIONS & DETAILS

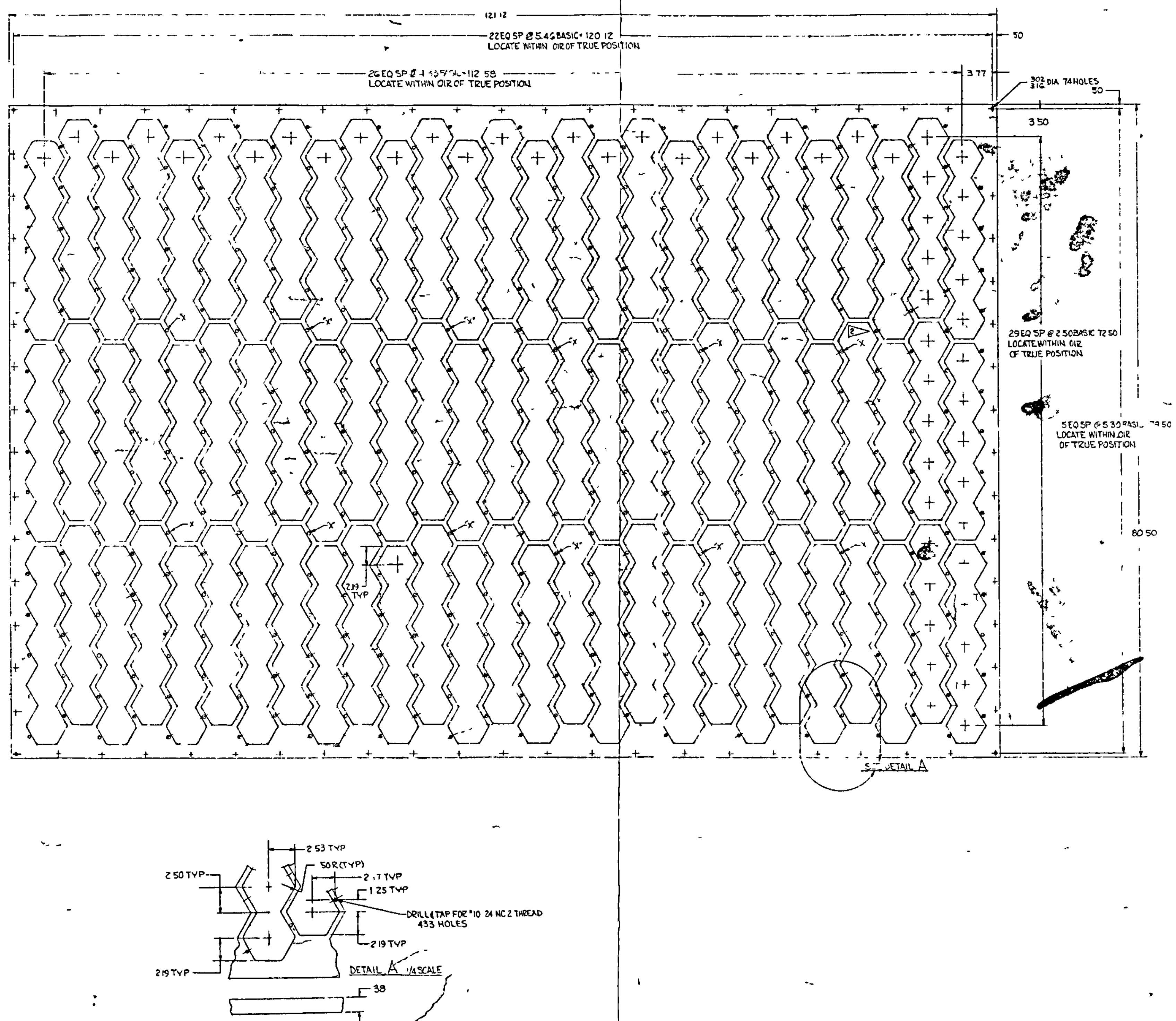
NASA AE CONTRACT NO. NAS8 21769 MANAGEMENT SERVICES INCORPORATED — PROJ 1-D TD 924
FILE NO. MSFC 217811
SUBMITTED: JA Smith
DATE 11-6-75
DESIGNED / DRAWN / CHECKED
SCALE AS NOTED
APPROVAL RECOMMENDED: CHIEF STRUCT-CIVIL BRANCH
DESIGN DATE 11-11-75
SPEC NO.
APPROVED: CHIEF ENGINEERING DIVISION
NASA DATE: 11/18/75
REF NO. S-2
DWG NO. FAC-AE-4619-S-2

M S.I DWG. NO · E-SKS-77


HOIST CABLE ATTACHM'T
N T S
BEAM CLAMP
LINK OR CLEVIS
TYP BEAM CONN
DETAIL "X"
¢ STRUCTURE
NEW M4X13.8 (SEE PLAN 3 UP)
M4X13.8 CONT FOR FAN SUPPORT
L3X2X3/8
EXIST'G STRUCTURE TO REMAIN IN PLACE
RIGID DUCT
L5X3 1/2X1/4 INTERMED ¢ DUCT HELD TO EXIST'G BRACING
FLEX DUCT
L3X3X3/8 INSTALL AFTER REMOVAL OF EXIST'G BR
L3X3X3/8
SOLAR ARRAY
NOTE REMOVE MEMBERS INDICATED BY BROKEN LINES AFTER STRUCTURE IS IN PLACE IN HIGH BAY & WEST END OF BLDG 4619
TEST ARTICLE
SEE TYP BASE PLATE
FIN FL
ELEVATION
SCALE 1/2"=1 0"
ELEVATION SIMILAR BUT OPPOSITE HAND
EXISTING BRACING TO REMAIN ON SOUTH SIDE
NEW KNEE BRACE
¢ DETAIL "X"
M4X13.8
¢ STRUCTURE
RIGID DUCT
L5X3 1/2X1/4
FLEX DUCT
SOLAR ARRAY
TEST ARTICLE HORIZONTAL POSITION
EAST ELEVATION
SCALE 1/2"=1 0
ELEVATION SIMILAR BUT OPPOSITE HAND
TYP BASE PLATE
INSIDE SIDES OF MEMBERS SHALL BE PAINTED W/2 COATS FLAT BLACK PAINT OUTSIDE SIDES W 2 COATS FLAT GREEN
TEST ARTICLE
EXIST'G LONG FL
FRAMING BRACING TYP
PLAN OF TOWER & FLOOR
N
12"X12"X1" BASE ℞
EXIST'G HOLE FOR 3/4" ϕ CINCH ANCHOR INTO EXIST'G CONC FL TYP
TYP BASE PL
NOTES
1 STRUCTURAL STEEL SHALL BE ASTM A 36
2 WELDING SHALL BE PERFORMED IN ACCORDANCE WITH STANDARDS OF THE A I S
3. STRUCTURE SHALL BE CLEANED, PRIMED & PAINTED WITH 2 COATS OF ... GREEN FLAT OUTSIDE & FLAT BLACK INSIDE
BUILDING 4619
WORK LOCATION HIGH BAY AREA
ORIENTATION PLAN
NTS
NORTH
REV | BY | DATE | REVISION | C.L. NO. | APPROVED
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA
BUILDING 4619
SOLAR SIMULATOR LAMP ARRAY EQUIPT
STRUCTURAL & ARCHITECTURAL
NASA AE CONTRACT NO NAS8-21769
MANAGEMENT SERVICES, INCORPORATED
TD NO 524
PROJ 1-D
FILE NO. MSFC 217810
SUBMITTED J A Smith
DATE 11-7-75
APPROVAL RECOMMENDED
APPROVED
CHIEF ENGINEERING DIVISION
DESIGNED RAGSDALE & BROCK
DRAWN RAGSDALE
CHECKED
SCALE NOTED
CHIEF, STRUCT-CIVIL BRANCH
DESIGN DATE 11-11-75
SPEC. NO.
REF NO.
S1
DWG NO.
FAC-AE-4619-S1
MSI DWG NO E-SKS-75



CIRCUIT #3
ϕCB
CIRCUIT #2
ϕBC
10 CONDUCTORS
40M39513E WIRE
PART No. V6N18N
OR V6N16N
TERMINAL BLOCK
CINCH 141 SERIES
(3) 6 TERMINAL OR
(1) 18 TERMINAL BLOCK
FOR EACH ROW OF
LAMPS
WIRE 40M39513B
PT. No V6N12N
12 PIN CONNECTOR
1 OF 14 REQD.
LAMP CONNECTIONS
TYP 81 PLACES
WIRE PT No
V6N18N OR
V6N16N
1⅛"
3½"
CINCH 141 SERIES
TERMINAL BLOCK
PT No Y6N12N
ϕAB
CONNECTOR NB7E-22-12
CONNECTOR NB6E-22-12S
CIRCUIT #1
FACILITY INTERFACE
CONNECTOR TBD.
WIRE PULLED IN PVC TUBE
SOLAR SIMULATOR
EC12 SK751



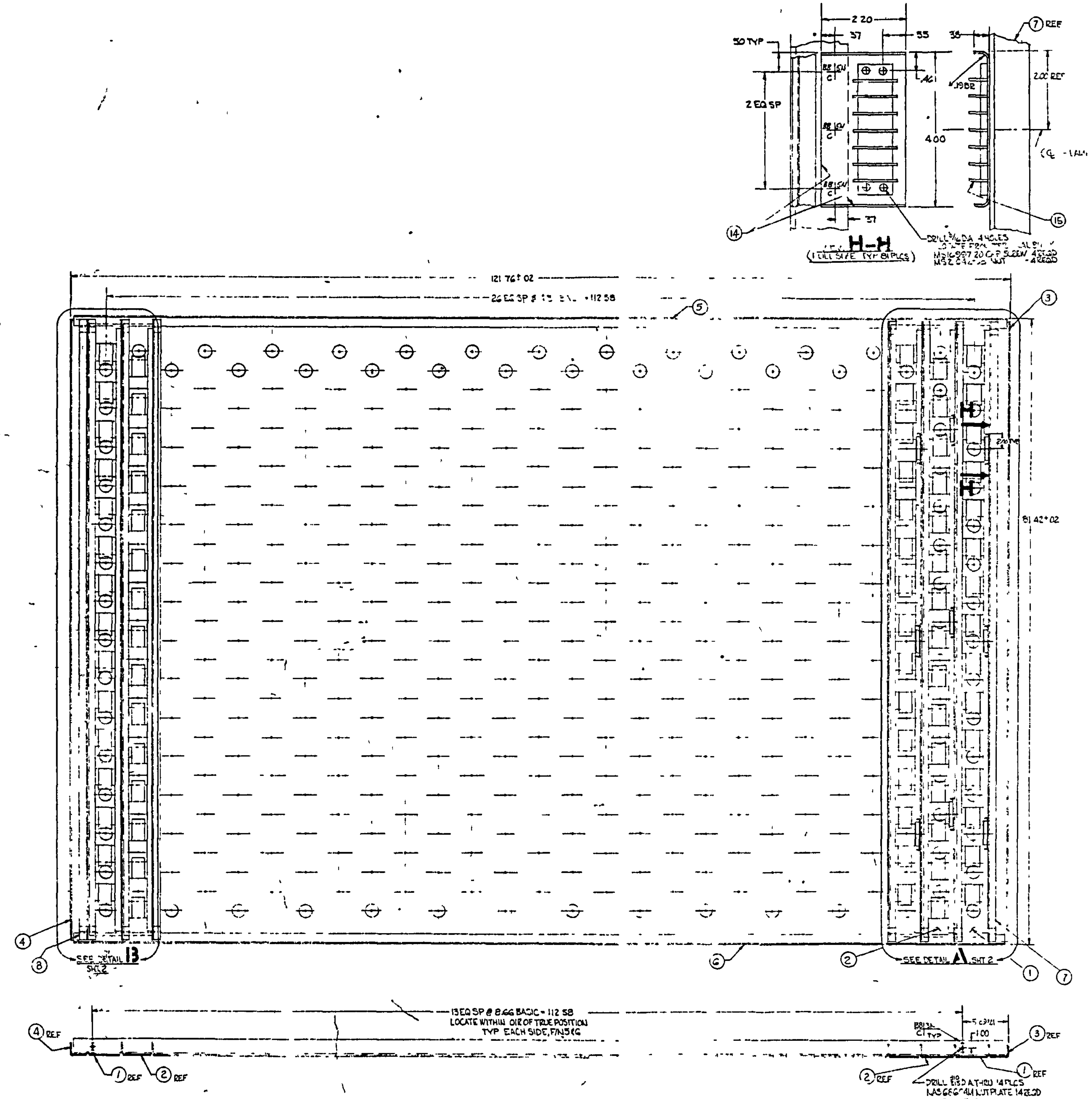

NOTES
1 REMOVE BURRS AND BREAK SHARP EDGES

| | |
|---|---|
| SEE ENGINEERING RECORDS | |
| UNLESS OTHERWISE SPECIFIED | DECIMALS .01 |
| MATERIAL | AL ALLOY PLATE 22 0 -87 |
| NEXT ASSY | USED ON |
| APPLICATION | |

LENS MOUNTING PLATE
SUN SIMULATOR

GEORGE C MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

REVISIONS




20M33641-1 ASSY SHOWN

## NOTES

1. REMOVE BURRS & BREAK ALL SHARP EDGES
2. HOLES TO MATCH HOLES IN ADJACENT PARTS ON ASSY
3. BJ•M...AD / BB•NS2...AD
4. FOR SYSTEM ... SEE ...

| F/N | QTY | PART NUMBER | DESCRIPTION | |
|---|---|---|---|---|
| | | MS... | NUT | |
| | | | CAP SCREW | |
| 5 | | | TERMINAL BLOCK | |
| 14 | 81 | | BRACKET | |
| 4 | 405 | | LAMP HOLDER | |
| | 25 | | NUT PLATE | |
| | 270 | | FASTENER | |
| 12 | | | DEFLECTOR | |
| | 27 | | | |
| | 14 | | | |
| 9 | 14 | -17 | | |
| 8 | 1 | -5 | TEE | |
| 7 | 27 | -13 | ANGLE | |
| 6 | 1 | -12 | ANGLE | |
| 5 | 1 | -11 | ANGLE | |
| 4 | 1 | -9 | ANGLE | |
| 3 | 1 | | | |
| 2 | 13 | -5 | LAMP PLATE | |
| 1 | 14 | -3 | LAMP PLATE | |
| | 1 | 20M33641-1 | | |
| | -1 | PART NUMBER | DESCRIPTION | |

LIST OF MATERIALS

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON | APPLICATION

UNLESS OTHERWISE SPECIFIED

MATERIAL

HEAT TREATMENT

FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING

SUBMITTED

APPROVED

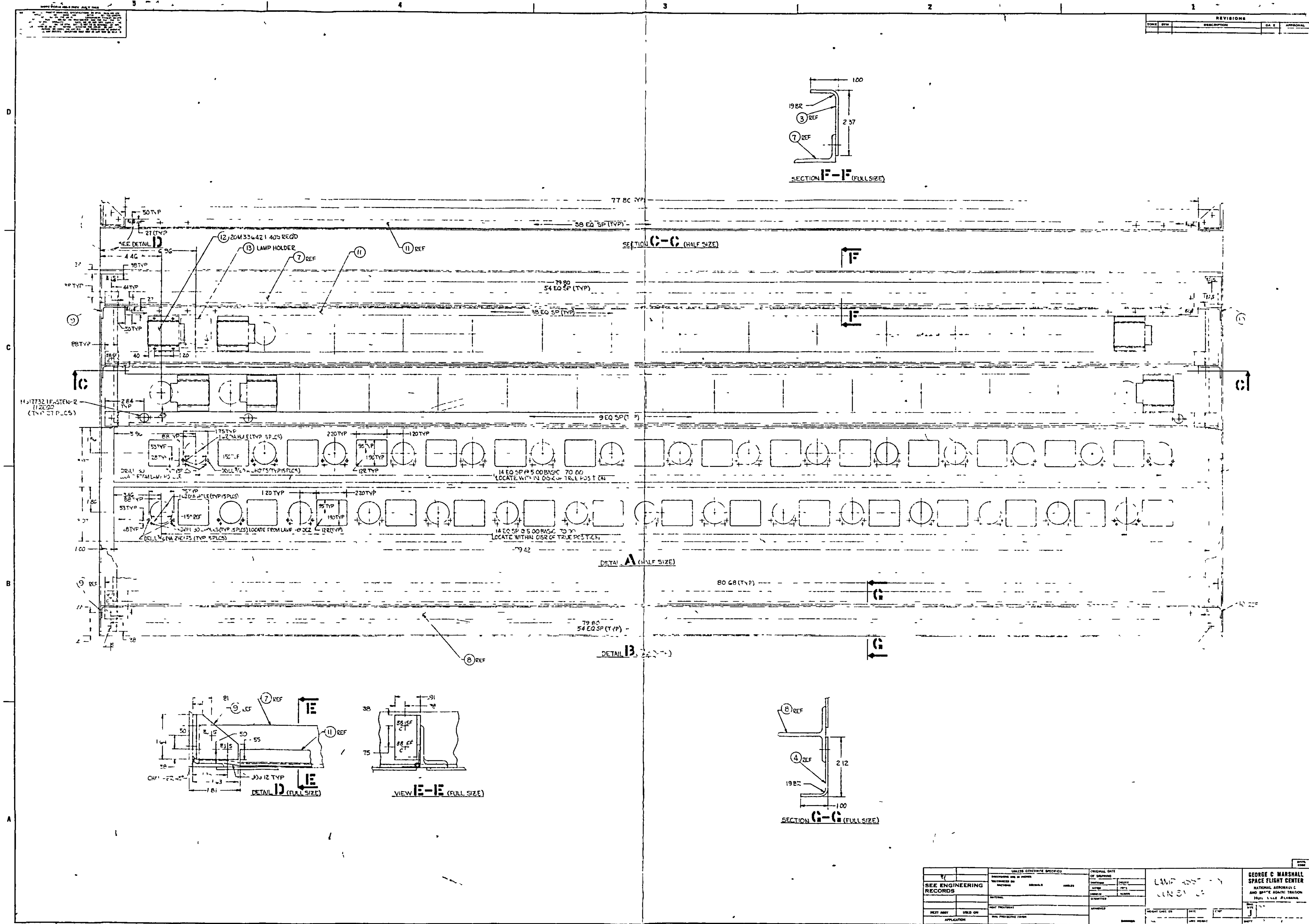
LAMP ASSEMBLY SUN SIMULATOR

GEORGE C MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

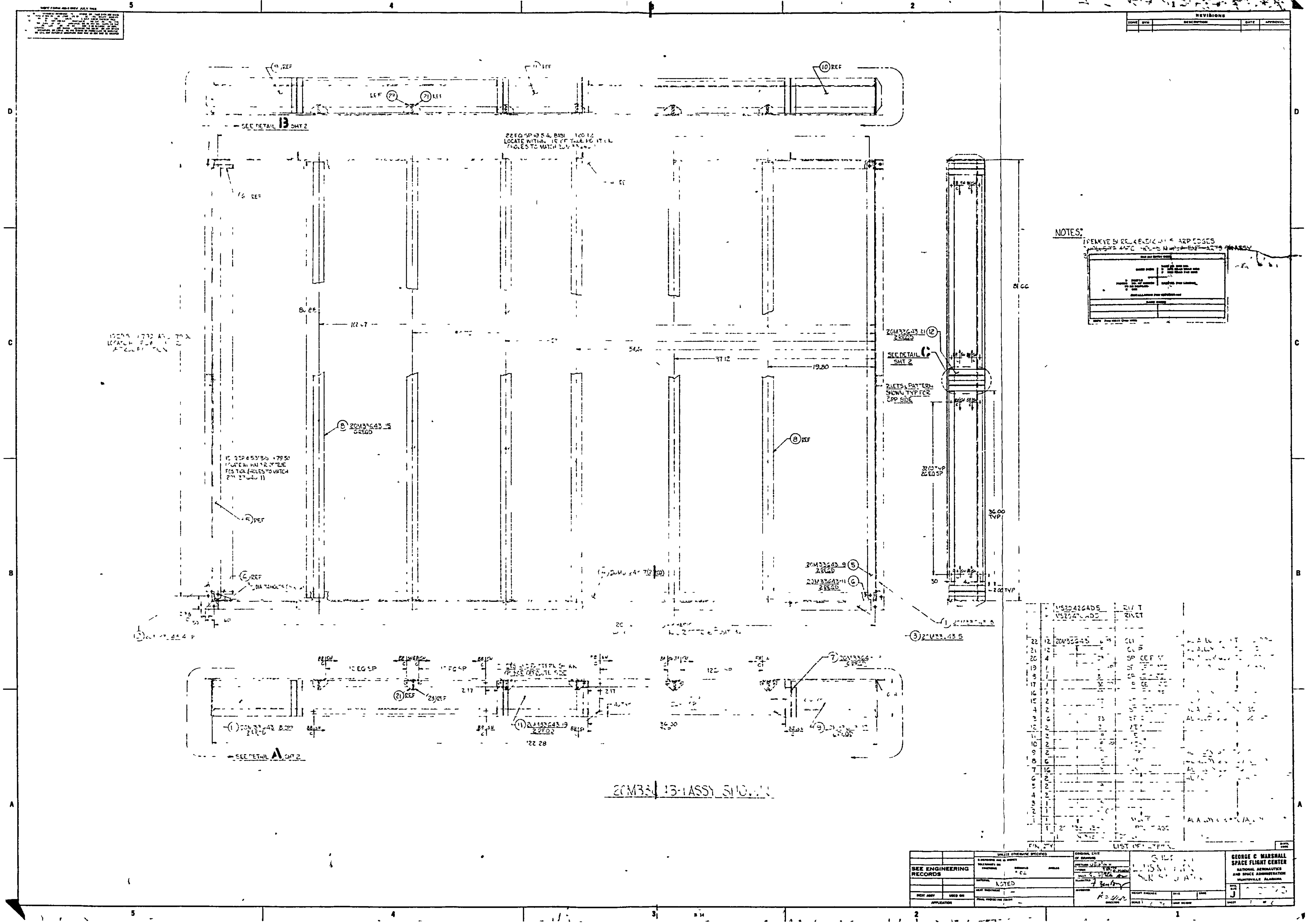
SIZE J

SHEET OF 2

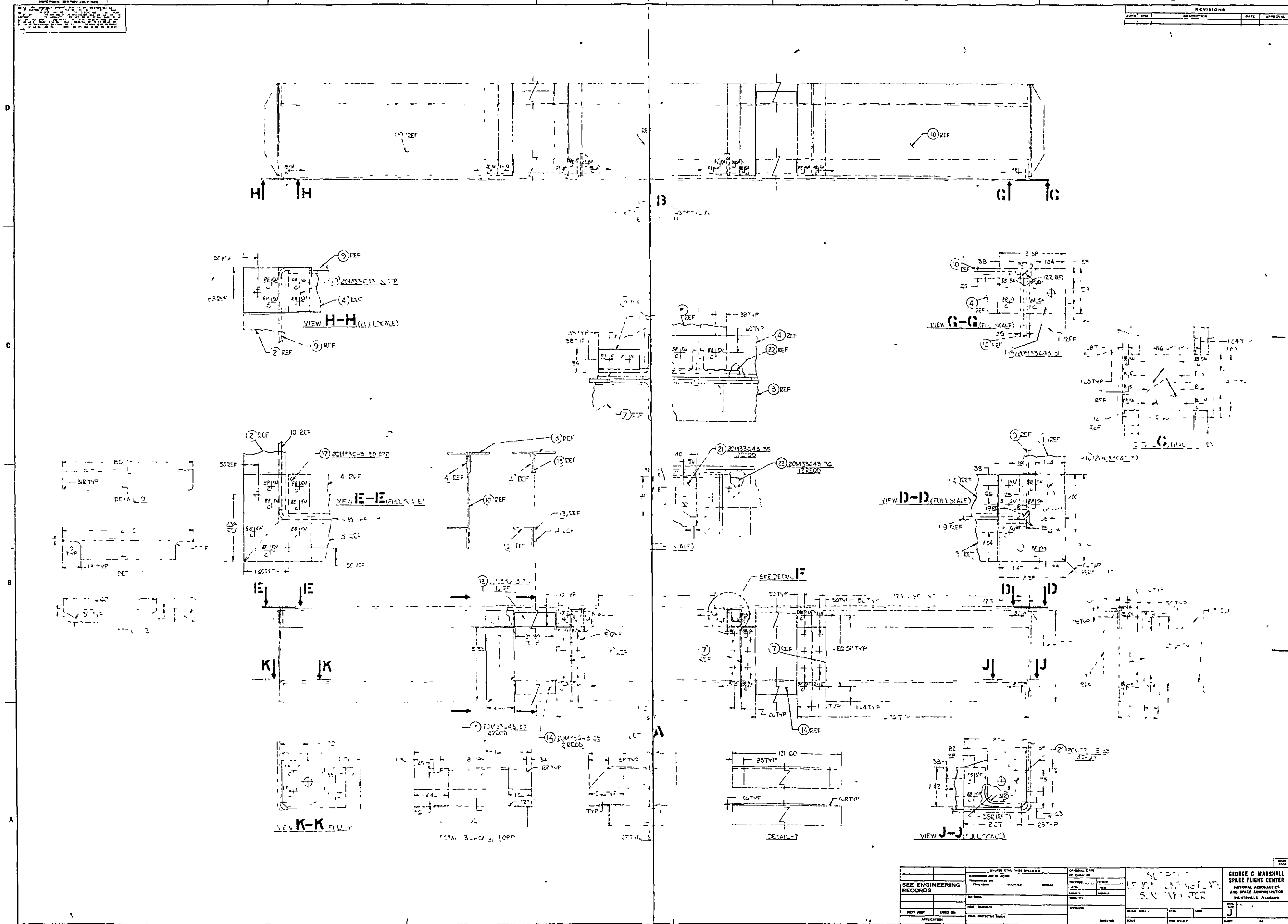
REVISIONS

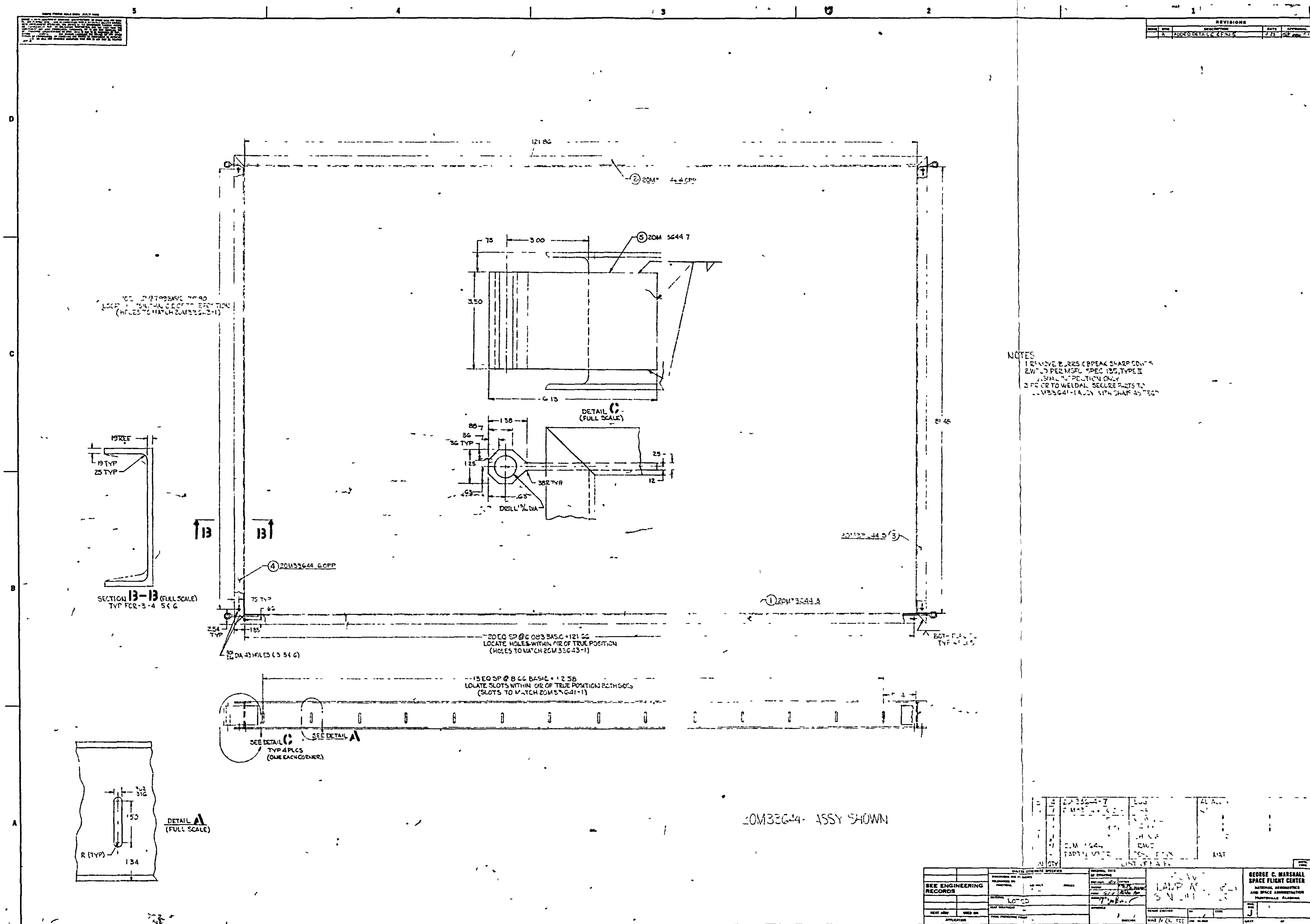


REVISIONS
SECTION F-F (FULL SIZE)
SECTION C-C (HALF SIZE)
77.80 (TYP)
38 EQ SP (TYP)
79.80
54 EQ SP (TYP)
SEE DETAIL D
(12) 20M33442 1 405 REQD
(13) LAMP HOLDER
(7) REF
(11) REF
9 EQ SP (TYP)
14 EQ SP @ 5.00 BASIC 70.00
LOCATE WITHIN .015R OF TRUE POSITION
DETAIL A (HALF SIZE)
80.68 (TYP)
(8) REF
DETAIL B
SECTION G-G (FULL SIZE)
DETAIL D (FULL SIZE)
VIEW E-E (FULL SIZE)
SEE ENGINEERING RECORDS
NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH
ORIGINAL DATE OF DRAWING
SUBMITTED
APPROVED
WEIGHT CALC ED
DATE
UNIT WEIGHT
GEORGE C MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SHEET

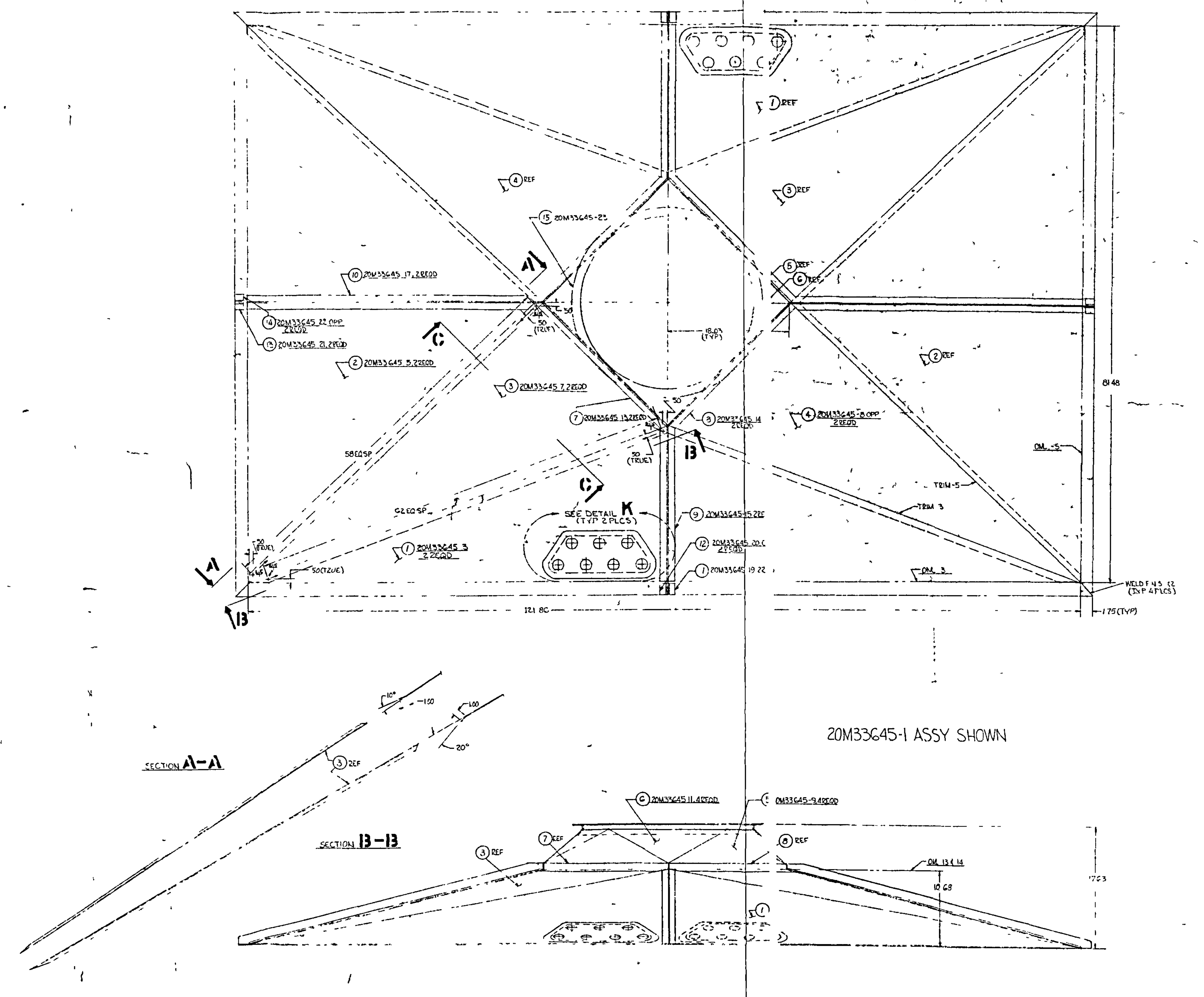


SEE DETAIL B SHT 2
SEE DETAIL C SHT 2
RIVETS & PATTERN SHOWN TYP FOR OPP SIDE
20M33643-15 6 REQD
8 REF
10 REF
19.80
37.12
54.4
36.00 TYP
32.00 TYP 2 EQ SP
81.66
NOTES:
SEE DETAIL A SHT 2
20M33643-9 2 REQD
20M33643-11 2 REQD
20M33643-19 2 REQD
LIST OF ITEMS
SEE ENGINEERING RECORDS
NOTED
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
REVISIONS


REVISIONS
VIEW H-H (FULL SCALE)
VIEW G-G (FULL SCALE)
VIEW E-E (FULL SCALE)
VIEW D-D (FULL SCALE)
VIEW K-K
VIEW J-J
SEE DETAIL F
DETAIL 7
SEE ENGINEERING RECORDS
GEORGE C MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA



REVISIONS
121.86
3.00
.75
3.50
6.13
DETAIL C
(FULL SCALE)
1.38
.88
.86
.36 TYP
1.25
.382 TYP
.63
.45
DRILL 13/64 DIA
.25
.12
81.48
19 REF
.19 TYP
.25 TYP
SECTION B-B (FULL SCALE)
B
75 TYP
.62
2.54 TYP
.185
20 EQ SP @ 6.083 BASIC = 121.66
LOCATE HOLES WITHIN DIA OF TRUE POSITION
(HOLES TO MATCH 20M33643-1)
13 EQ SP @ 8.66 BASIC = 112.58
LOCATE SLOTS WITHIN DIA OF TRUE POSITION BOTH SIDES
(SLOTS TO MATCH 20M33641-1)
SEE DETAIL C
TYP 4 PLCS
(ONE EACH CORNER)
SEE DETAIL A
.50
1.34
R (TYP)
DETAIL A
(FULL SCALE)
NOTES
2. WELD PER MSFC SPEC 135, TYPE II
SEE ENGINEERING RECORDS
UNLESS OTHERWISE SPECIFIED
MATERIAL
NOTED
NEXT ASSY
USED ON
APPLICATION
ORIGINAL DATE OF DRAWING
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE ALABAMA
J
QTY
MAT




NOTES:
1. REMOVE BURRS & BREAK SHARP EDGES
2. WELD PER MSFC-SPEC 135 TYPE II VISUAL INSPECTION ONLY
3. HOLES TO MATCH HOLES IN ADJACENT PARTS ON ASSY
4.

| | | | | |
|---|---|---|---|---|
| | 48 | [illegible] | RIVET | |
| | 24 | [illegible] | NUT PLATE | |
| | 24 | [illegible] | WASHER | |
| | 24 | AN173-5 | BOLT | |
| 15 | 2 | [illegible]645-25 | CONNECTOR PLATE | [illegible] |
| | | [illegible] | | |
| 1 | 1 | 20M33645 | [illegible] | [illegible] |
| [illegible] | 2 | 22 OPP | CLIP | [illegible] |
| [illegible] | 2 | 2 | CLIP | [illegible] |
| [illegible] | 2 | 21 OPP | CLIP | [illegible] |
| [illegible] | 2 | 19 | CLIP | [illegible] |
| [illegible] | 2 | 7 | TEE | [illegible] |
| 9 | 2 | 5 | TEE | [illegible] |
| 8 | 2 | 4 OPP | ANGLE | [illegible] |
| 7 | 2 | 13 | ANGLE | [illegible] |
| 6 | 4 | 1 | TRANSITION | [illegible] |
| 5 | 4 | 9 | SKIN | |
| 4 | 2 | 8 OPP | | |
| 3 | 2 | 7 | | |
| 2 | 2 | [illegible] | | |
| 1 | 2 | [illegible] | SKIN | AL ALLOY [illegible] |
| | | 20M33645 | HOOD ASSY | |
| | | PART NUMBER | DESCRIPTION | MATERIALS |
| FIND NO | QTY | | LIST OF MATERIALS | |

SEE ENGINEERING RECORDS

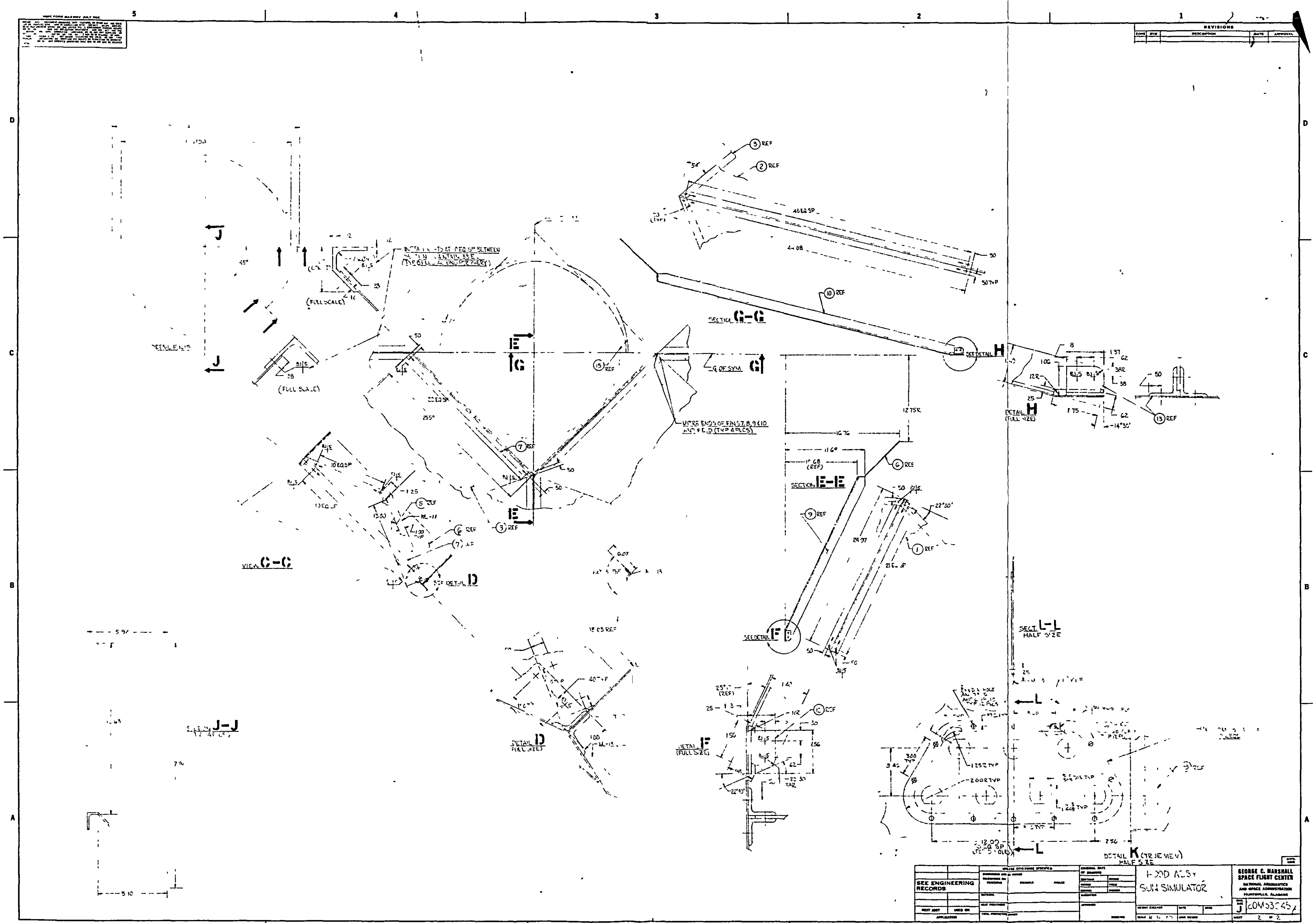
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON FRACTIONS / DECIMALS .02 / ANGLES 5

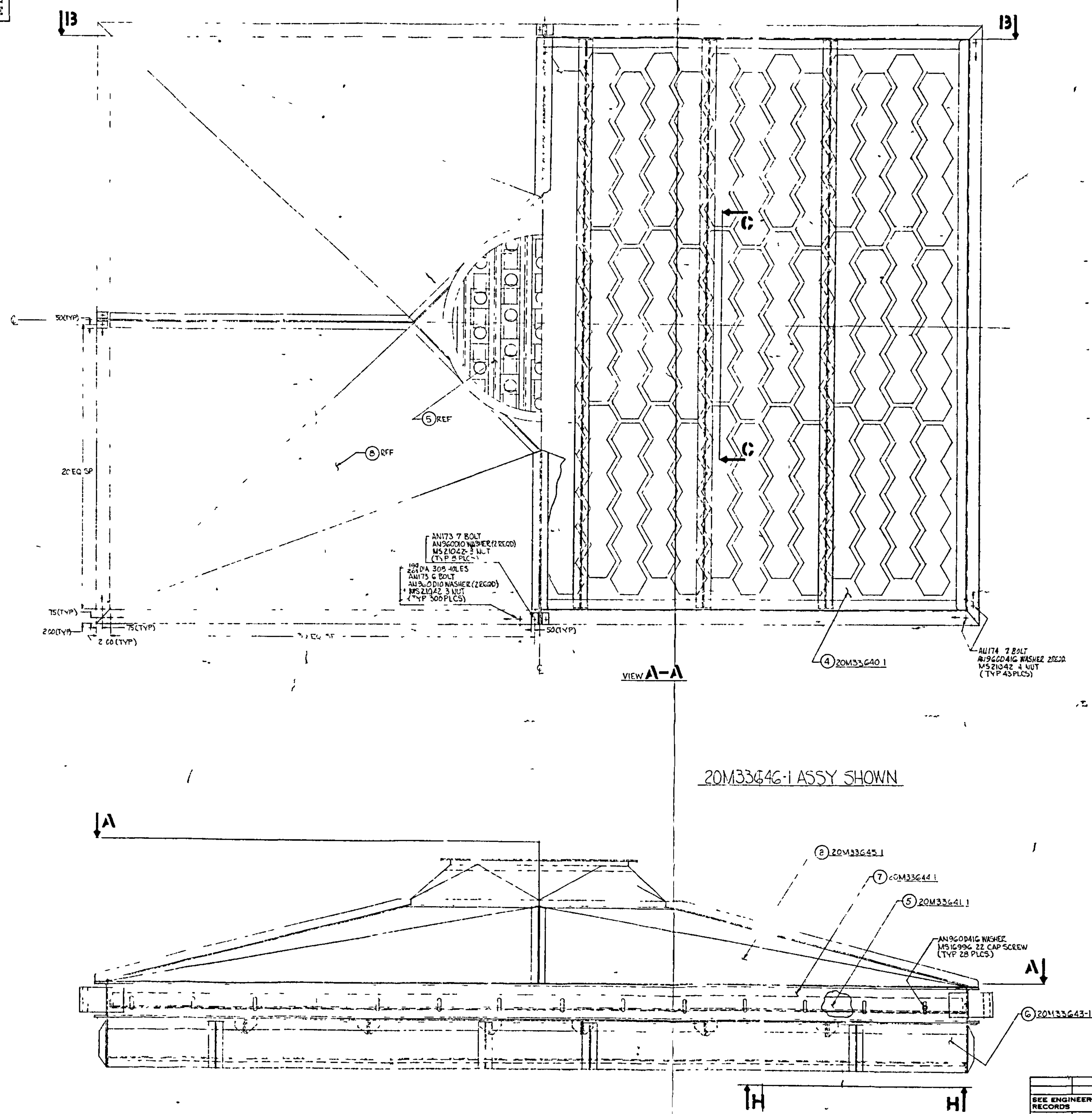
MATERIAL: NOTED
HEAT TREATMENT: NOTED

# HOOD ASSY
# SUN SIMULATOR

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

J 20M33645


REVISIONS
ZONE
SYM
DESCRIPTION
DATE
APPROVAL
SECTION G-G
SEE DETAIL H
DETAIL H (FULL SIZE)
SECTION E-E
SEE DETAIL F
DETAIL F (FULL SIZE)
DETAIL D (FULL SIZE)
SEE DETAIL D
VIEW C-C
SECT L-L HALF SIZE
DETAIL K (TRUE VIEW) HALF SIZE
SECTION J-J
℄ OF SYM
(FULL SCALE)
(FULL SCALE)
46 EQ SP
4-08
22 EQ SP
10 EQ SP
12.75R
16.76
11.68 (REF)
24.97
22°30'
14°30'
2.00R TYP
1.25R TYP
5.10
SEE ENGINEERING RECORDS
HOOD ASSY
SUN SIMULATOR
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
J
60M33C45
2 of 2




NOTES:

1 REMOVE BURRS & BREAK SHARP EDGES
2 HOLES TO MATCH HOLES IN ADJACENT PARTS ON ASSY
3 ALIGN 7 WITH CLEARANCE HOLES IN 20M33640-1 PRIOR TO INSTALLING

8J MS20470AD

| F/N | QTY | PART NUMBER | DESCRIPTION | MATERIALS |
|---|---|---|---|---|
| | 117 | MS21042 4 | NUT | |
| | 332 | MS21042-3 | NUT | |
| | 242 | AN960D416 | WASHER | |
| | 1061 | AN960D 0 | WASHER | |
| | 74 | AN174 10 | BOLT | |
| | 43 | AN174 7 | BOLT | |
| | 8 | AN173 7 | BOLT | |
| | 312 | AN173 6 | BOLT | |
| | 409 | MS16997 45 | CAP SCREW | |
| | 28 | MS16996 22 | CAP SCREW | |
| | | MS20470AD5 | RIVET | |
| 8 | 1 | 20M33645 1 | HOOD ASSY | |
| 7 | 1 | 20M33644 1 | LAMP ASSY FRAME | |
| 6 | 1 | 20M33643 1 | LENS PLATE SUPPORT | |
| 5 | 1 | 20M33641 1 | LAMP ASSY | |
| 4 | 1 | 20M33640 1 | LENS MOUNTING PLATE | |
| 3 | 12 | 20M33646 7 | SUPPORT LINK | BRASS BAR [illegible] 364 |
| 2 | 1 | 5 | HINGE | MAKE FROM MS200 8 |
| 1 | 2 | 3 | HINGE | MAKE FROM MS20[illegible] 8 |
| | | 20M33646 1 | SUN SIMULATOR ASSY | |

LIST OF MATERIALS

SEE ENGINEERING RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS - DECIMALS ±.02 ANGLES -

MATERIAL NOTED

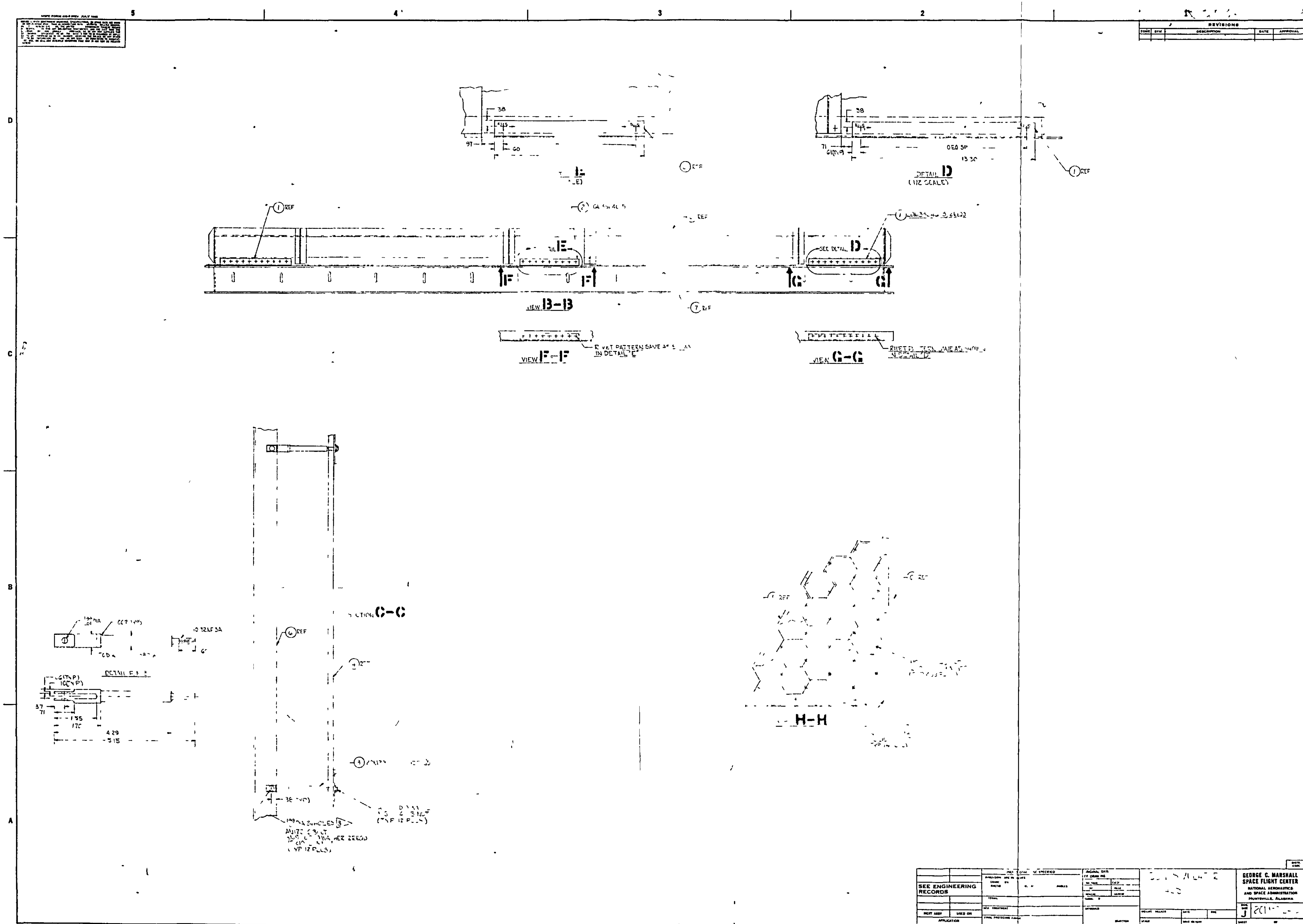
SUN SIMULATOR ASSY

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

J 20M33646

SCALE 1/5 & NOTED

SHEET 1 OF 2



REVISIONS
DETAIL D
(1/2 SCALE)
VIEW B-B
VIEW F-F
VIEW G-G
SECTION C-C
H-H
SEE ENGINEERING RECORDS
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

TECHNICAL REPORT STANDARD TITLE PAGE

| | | |
|---|---|---|
| 1 REPORT NO.<br>DOE/NASA CR-161825 | 2 GOVERNMENT ACCESSION NO. | 3 RECIPIENT'S CATALOG NO |

4 TITLE AND SUBTITLE
Design Data Package and Operating Procedures for MSFC Solar Simulator Test Facility

5 REPORT DATE
June 1981

6 PERFORMING ORGANIZATION CODE

7 AUTHOR(S)

8 PERFORMING ORGANIZATION REPORT #
WYLE TR-531-48

9 PERFORMING ORGANIZATION NAME AND ADDRESS
WYLE Laboratories
Solar Energy Systems Division
Huntsville, AL 35805

10 WORK UNIT NO.

11 CONTRACT OR GRANT NO
DEN-000006

13 TYPE OF REPORT & PERIOD COVERED
Contractor Report

12 SPONSORING AGENCY NAME AND ADDRESS
National Aeronautics and Space Administration
Washington D.C. 20546

14 SPONSORING AGENCY CODE

15 SUPPLEMENTARY NOTES

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

16. ABSTRACT

This report provides design and operational data for the MSFC Solar Simulator Test Facility. This simulation test facility was constructed to evaluate solar collector performance under simulated outdoor operating conditions. The primary goal of the facility is to evaluate the performance capability and "worst case" failure modes of collectors, which utilize either air or liquid transport media.

The test facility is capable of simulating several environmental parameters such as solar radiation intensity, solar spectrum, collimation, and uniformity, and solar attitude. The facility is also capable of simulating wind conditions of velocity and direction, solar system conditions imposed on the collector such as transport media type and flow rate, collector fluid inlet temperature, and geometric factors of collector tilt and azimuth angles.

Testing in the simulator is performed to acquire collector efficiency data, the collector time constant, incident angle modifier data, and stagnation temperature values.

17 KEY WORDS

18 DISTRIBUTION STATEMENT UC-59c

Unclassified-Unlimited

William A. Brooksbank, Jr.
Mgr., Solar Energy Applications Projects

| 19 SECURITY CLASSIF. (of this report) | 20 SECURITY CLASSIF. (of this page) | 21 NO. OF PAGES | 22 PRICE |
|---|---|---|---|
| Unclassified | Unclassified | 73 | NTIS |

MSFC - Form 3292 (Rev December 1972)

For sale by National Technical Information Service, Springfield, Virginia 22151

N81-30523 #

**End of Document**