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MCDONNELL DOUGLAS

MDAC HELIOSTAT FIELD ARRAY WIND TUNNEL TEST

DATA SUMMARY REPORT

MASTER

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Prepared by:

J. Xerikos
Chief Technology Engineer
Aerodynamics & Hydrodynamics
Vehicle, Energy & Biotechnology
Engineering Division

H. H. Tang
Aerodynamics & Hydrodynamics
Vehicle, Energy & Biotechnology
Engineering Division

Approved by:

R. K. Knowles
Chief Program Engineer
Solar Central Receiver Collector

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY-WEST
5301 Bolsa Avenue, Huntington Beach, CA 92647

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ABSTRACT

A wind tunnel test of the MDAC heliostat configuration in a single heliostat, clustered heliostats and clustered heliostats with fence was performed. The tests were conducted at the Fluid Dynamics and Diffusion Laboratory of Colorado State University during February and March 1978. The purpose of the test was to experimentally evaluate the aerodynamic loadings associated with the air flow patterns within and over clusters of heliostats selected from both perimeter and interior locations of the field array. The heliostat model was scaled by a factor of 1:22, and cluster configurations ranged from 7 to 12 heliostats. The test was successful and data taken appears consistent in terms of peak load with previous data obtained by MDAC in the Douglas Aircraft Low Speed Tunnel. Key test results are as follows:

- For single heliostat pitching moments peak at 30° elevation angle. For clustered heliostats this value is usually lower with no distinct peak evident.
- Effects of having an open, half-closed, or fully-closed heliostat center slot appear to be small.
- Pressure distributions on heliostat surfaces (front and back) are relatively non-uniform, both on planar surfaces and the support post.
- A wind fence with 33% porosity provides significant reduction in the aerodynamic loads with pitching moments and drag forces reduced 50% to one order of magnitude.

Test results are further summarized in Section VII of the report.

FOREWORD

This report summarizes the results of the MDAC heliostat field array wind tunnel test conducted at the Fluid Dynamics & Diffusion Laboratory of Colorado State University during February and March, 1978. The work was under the direction of Dr. Jack E. Cermak, Director and Professor-in-charge of Fluid Mechanics & Wind Engineering Program, and Dr. Jon A. Peterka, Associate Professor of the Civil Engineering Department. The technical monitors were Dr. Jim Xerikos, Chief Technology Engineer, and Dr. Homer H. Tang, Senior Engineer, of MDAC. The work was administered by the Solar Central Receiver Program of MDAC under the cognizance of Dr. Howard H. Dixon, Director, and Mr. Robert K. Knowles, Chief Program Engineer. Mr. John J. Dietrich served as technical representative of the Solar Central Receiver Program. The study was performed under the sponsorship of the United States Department of Energy, Contract Number EY-76-C-03-1108, Modification Number 20.

LIST OF SYMBOLS

A_r	Reference area (0.852 ft^2 for the wind tunnel model)
C_x or X	Drag force coefficient, $C_x = \frac{\text{Drag Force}}{1/2\ \rho_\infty U_\infty^2 A_r}$
C_y or Y	Side force coefficient
C_m	Pitching moment coefficient $C_m = \frac{\text{Pitching Moment}}{1/2\ \rho_\infty U_\infty^2 A_r \ell_r}$
LX	Lever arm for pitching moment, inches
LY	Lever arm for yawing moment, inches
ℓ_r	Reference length (0.968 ft for the wind tunnel model)
U_∞	Velocity, at 30 ft above ground level, ft/sec
ρ_∞	Air density at 30 ft above ground level, slug/ft^3
H	Fence height (20 ft full scale)
α	Mirror tilt angle
ε	Wind azimuth angle

Orientation of the {X, Y, Z} coordinate system relative to the heliostat elevation (pitch) and azimuth (twist) axes and the sign convention for forces and moments are shown on Page 40.

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I. INTRODUCTION

Flow interference phenomena associated with heliostat clusters are not readily amenable to calculation using purely analytical techniques because of the complexity of the interaction between the wind velocity field and the heliostats. Therefore, to obtain an understanding of the problem, it is necessary to rely on experimental methods to determine load data for a given cluster geometry and upstream wind profile. The wind tunnel has proven to be useful for studies of this nature. Steady state flow conditions can be maintained over time periods sufficient for obtaining requisite measurements. Furthermore, suitable instrumentation and measurement techniques are available for the determination of wind loading (forces and moments) on heliostats in the array which is an important factor in establishing an adequate and economical design of the heliostats. A wind-tunnel test plan using a subscale model to acquire the above data was, therefore, established between Colorado State University (CSU) and MDAC for use of the meteorological wind tunnel and associated equipment in the CSU Fluid Dynamics and Diffusion Laboratory (FDDL) and the services of CSU personnel.

The purpose of the test was to experimentally evaluate the aerodynamic loadings associated with the airflow patterns within and over clusters of heliostats selected from both perimeter and interior locations of the field array. The test was conducted during the period of February and March, 1978, and results are summarized in this report.

II. OBJECTIVE

The primary objective of these wind tunnel tests is to determine forces and moments acting on selected heliostats in a field array exposed to a representative atmospheric boundary layer velocity profile. The validity of subscale wind tunnel testing of bluff structures in subsonic air streams for determining full scale wind loads has been well established by previous investigators.+

The test configurations represent typical outer field circular and rectilinear heliostat clusters. The heliostat geometry employed simulates the MDAC inverting heliostat design. Intrafield wind loadings (up to 9 heliostat spacings from the perimeter) were investigated to assure that interior loads did not exceed those experienced by perimeter heliostats. Heliostat orientation was varied corresponding to typical operating conditions. Central heliostat spacings were not treated since the diminished wind profile at inner field stations could not be accurately simulated; however, wind load reductions of 60 to 80 percent relative to perimeter locations are anticipated based on previous CSU test experience.

A further objective of the tests is to investigate wind load reduction in the presence of a fence. For a given fence height and porosity, the distance between the fence and closest heliostat and the angle between the plane of the fence and the wind vector were varied. Secondary objectives include determination of single heliostat loads, principally for reference purposes, as well as evaluation of slot partial and full closure effects.

+ J. E. Cermak, Aerodynamics of Buildings, Annual Review of Fluid Mechanics, Vol. 8, 1976.

III. TEST FACILITY

The test facility used for accomplishment of the aforementioned test objectives is the Meteorological Wind Tunnel in the Fluid Dynamics and Diffusion Laboratory (FDDL) at Colorado State University in Fort Collins, Colorado. The Meteorological Wind Tunnel has a large test section which is 6 feet wide and 90 feet long with a flexible ceiling which can be raised from 6 to 7 1/2 feet high. In addition, 80 feet of the test section floor can be independently heated or cooled to produce thermally stratified flows. Surface roughness, pressure gradient, and humidity can be varied readily. This wind tunnel is well suited for simulation of the atmospheric surface layer including investigation of the flow around tall structures in a thick boundary layer. Instrumentation utilized for this study included hot-wire anemometers, hot-film anemometers, pressure sensors, magnetic tape recorders and cameras.

The performance characteristics and schematic drawing of the tunnel (Figure 1) are presented in the following pages.

PERFORMANCE CHARACTERISTICS

Characteristic	Meteorological Wind Tunnel
1. Dimensions	
Test-section length	88 ft
Test-section area	36 ft^2
Contraction ratio	9:1
Length of temperature controlled boundary	40 ft
2. Wind-tunnel drive	
Total power	400 hp
Type of drive	4-blade propeller
Speed control: coarse	Ward-Leonard DC control
Speed control: fine	pitch control
3. Temperatures	
Ambient air temperature	40°F to 200°F
Temperature of controlled boundary	40°F to 400°F
4. Velocities	
Mean velocities	Approx. 2 fps to 120 fps
Boundary layer thickness*	Up to 48 inches
Turbulence level	Low (about 0.1 percent)
5. Pressures	Adjustable gradients
6. Humidity	Controlled from approximately 20% to 80% relative humidity under average ambient conditions

* Function of boundary roughness and thickening devices at test-section entrance.

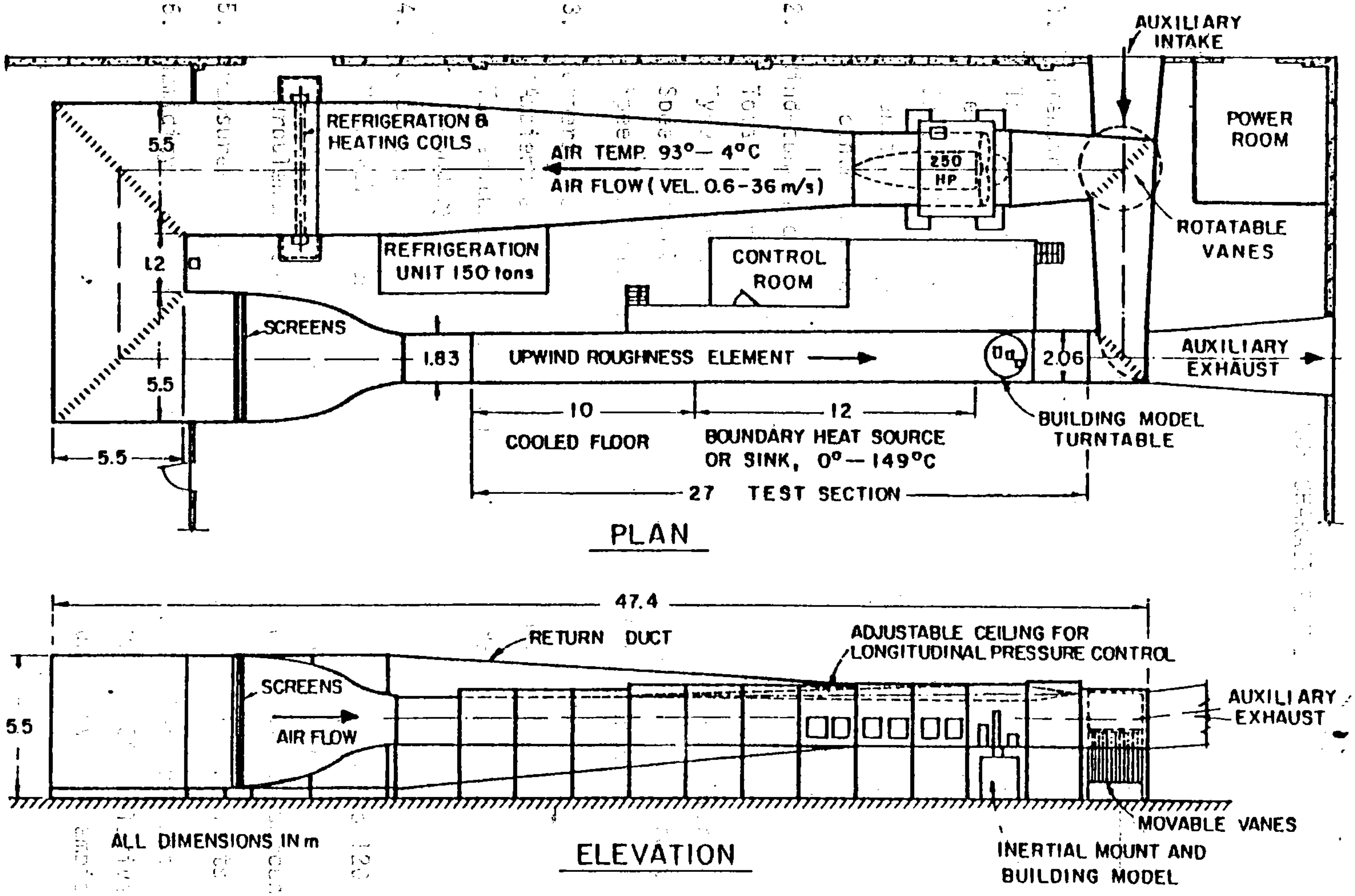


Figure 1. METEOROLOGICAL WIND TUNNEL (Completed in 1963)
FLUID DYNAMICS & DIFFUSION LABORATORY
COLORADO STATE UNIVERSITY

IV. MODEL AND INSTRUMENTATION

A. Model of Heliostat Clusters

Models for specific clusters of the heliostat array were constructed in the machine shop of the Engineering Research Center (location of FDDL). The inverting heliostat model dimensions are shown in Figure 2. These dimensions represent a scale factor of 1:22 relative to the baseline heliostat design. The cluster models include a set of from 7 to 12 heliostats depending upon their position in the field array. The central heliostat in a cluster was mounted on a six-component strain gage balance.

The study also specified that a heliostat be instrumented for measurements of mean pressure on the heliostat surfaces. Physical limitations associated with the installation of pressure tubing limited the number of pressure taps incorporated into the model to 42. These were selected to permit definition of pressure distributions on the surface.

B. For several heliostat clusters the forces and moments were measured with a porous wind fence located upstream of the cluster. The fence had a porosity of about 33 percent. Location and height of the fence were determined in consultation with the CSU technical personnel. The fence height selected was 20 feet (full scale) which approximates the height of a mirror tilted up 30° from the horizontal. The fence extended across the entire width of the tunnel in all cases.

C. Instrumentation

Wind profile measurements were made using a (traversing) hot-film anemometer. Profiles were measured ahead of, within and aft of the cluster. The vertical

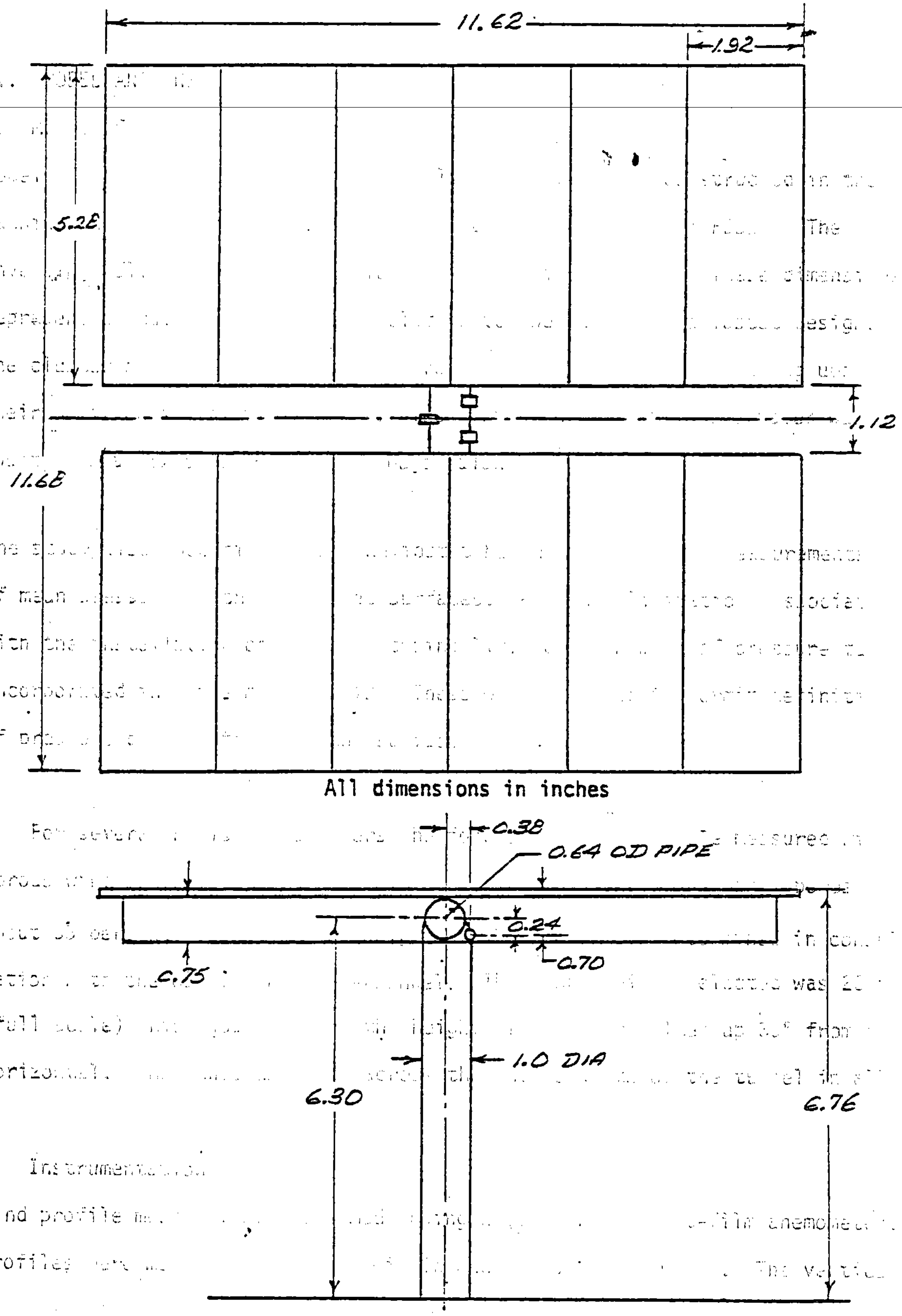


Figure 2. Inverting Heliostat Model Design

profile extended from near the surface, i.e., near the bottom of the heliostats, to a distance approximately four heliostat heights above the surface. A pitot-static tube was located approximately one meter ahead and one meter above the tunnel floor to monitor free-stream velocity. In addition to the hot-film anemometer and pitot-static measurements, tunnel operating conditions were recorded for each test. The data acquisition and reduction facilities available within the Fluid Dynamics and Diffusion Laboratory are described in Appendix I.

V. TEST PROCEDURE AND FREE STREAM CONDITIONS

Test variables were free-stream wind velocity, wind direction, heliostat azimuth angle, heliostat elevation angle, heliostat cluster geometry and upwind exposure (with or without a wind fence). The test matrix is given in the following section. Six different cluster geometries plus one single heliostat for reference purposes were used for the investigation.

The instrumented model heliostat was located on the turntable of the meteorological wind tunnel (see Figure 1). The remaining heliostats were located on or adjacent to the turntable as space permitted. Measurements of the forces and moments for the first cluster were made for various ambient speeds up to 60 mph. These data were examined to determine the signal-to-noise ratio for the strain gage balance to establish the wind speed that can be used to obtain the most reliable results. Thereafter, each test was made at this selected wind speed.

For the first cluster measurements, tests were made at 24 wind directions (15° intervals) for one heliostat configuration to determine sensitivity to wind direction. Thereafter each test was run at five wind directions for each of those cluster configurations. Some specific runs were tested at only two wind directions as described in the test matrix.

The free stream conditions were determined for the best data accuracy as follows:

(a) The mean wind velocity referenced to 10 meters (full scale) is about 55 mph.

(b) The velocity power law profile used to provide a properly scaled atmospheric boundary layer has an 0.135 exponent, i.e.,

$$V_z = V_{z_0} \, (Z/Z_0)^{0.135}.$$

This profile closely resembles the 1/7 power-law behavior typical of fully developed turbulent boundary layer flow, e.g., see Figure 9.

VI. TEST MATRIX

The test consists of six study groups with different purposes in mind. The test matrix is given in Tables 1a to 1d. These study groups are summarized below:

A. Velocity Study

Purpose: To select the free stream wind speed for best data accuracy.

Run Nos.: 1 to 5

Key Parameter Range: V = 0 to 60 mph

B. Tilt Angle Study

Purpose: To determine the tilt angle effect on aerodynamic loading.

Run Nos.: 6 to 40

Key Parameter Range: $\alpha = -10°$ to $180°$

C. Slot Study

Purpose: To determine the slot effect on aerodynamic loading.

Run Nos.: 41 to 50 at $\alpha = 45°$

141 to 150 at $\alpha = 30°$

Key Parameter: Slot geometry including fully open, half-closed and fully closed cases.

D. Cluster Study

Purpose: To simulate the cluster interference effect on several selected heliostat clusters located both at the perimeter and interior of the MDAC field array design.

Run Nos.: 51 to 93

Key Parameter: Five clusters were selected for the test. Their MDAC designated numbers and coordinates are given in Figure 3. Their

Table 1a. HELIOSTAT FIELD-ARRAY WIND-TUNNEL TEST MATRIX

MDAC/CSU

RUN NO.	CONFIG.	NO. OF MIRROR	WIND SPEED	TILT α°	WIND β°	SLOT
A. Velocity Study						
1	Single	1	0 to 60 mph	60	0	Open
2	↓	↓	↓	↓	45	↓
3					90	
4					135	
5					180	
B. Tilt Angle Study						
6	Single	1	55 mph	-10	0	Open
7	↓	↓	↓	↓	45	↓
8					90	
9					135	
10					180	
11				10	0	
12				↓	45	
13					90	
14					135	
15					180	
16				30	0	
17				↓	45	
18					90	
19					135	
20					180	
21				45	0	
22				↓	45	
23					90	
24					135	
25					180	
26				60	0	
27				↓	45	
28					90	
29					135	
30	Single	1	55 mph	60	180	Open
31	↓	↓	↓	90	0	↓
32				↓	45	
33					90	
34					135	
35					180	
36				170	0	
37				↓	45	
38					90	
39					135	
40					180	
C. Slot Study						
41	Single	1	55 mph	45	0	Half Open
42	↓	↓	↓	↓	45	↓
43					90	
44					135	
45					180	
46					0	Closed
47					45	↓
48					90	
49					135	
50					180	
D. Cluster Study						
51	#1	7	55 mph	-10	0	Open
52	↓	↓	↓	-10	45	↓
53				-10	90	
54				-10	180	
55				10	0	

Table 1b. HELIOSTAT FIELD-ARRAY WIND-TUNNEL TEST MATRIX

MDAC/CSU

RUN NO.	CONFIG.	NO. OF MIRROR	WIND SPEED	TILT α°	WIND β°	SLOT
56	#1	7	55 mph	10	45	Open
57				10	90	
58				10	180	
59				30	0	
60				30	45	
61				30	90	
62				30	180	
63				90	0	
64				90	45	
65				90	90	
66				90	180	
67	#2	9		-10	0	
68				-10	45	
69				-10	90	
70				-10	180	
71				10	0	
72				10	45	
73				10	90	
74				10	180	
75				30	0	
76				30	45	
77				30	90	
78				30	180	
79				90	0	
80				90	45	
81				90	90	
82				90	180	
83	Linear A	12		-10	0	
84				-10	8	
86				10	0	
87				10	8	
89	Linear A	12	55 mph	30	0	Open
90				30	8	
92				90	0	
93				90	8	
E. Pressure Distribution Study						
95	#1	7		30	0	
96					±45	
97					±90	
98					180	
99	#2	9			0	
100					±45	
101					±90	
102					180	
103	Single	1			0	
104					±45	
105					±90	
106					180	
107	Linear A	12			0	
108					± 8	

Note: Missing run numbers were those eliminated as a result of the final test plan revision.

Table 1c. HELIOSTAT FIELD-ARRAY WIND-TUNNEL TEST MATRIX

MDAC/CSU

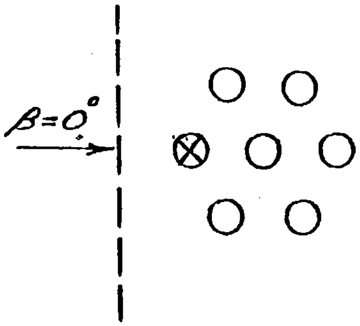
F. Fence Study

RUN NO.	CONFIG.	NO. OF MIRROR	WIND SPEED	TILT α°	WIND β°	SLOT	FENCE DIST.
110	#1	7	55 mph	30	0	Open	1H
111					30		1H
112					0		1.5H
113					30		1.5H
114					0		2H
115					30		2H
116					0		2.5H
117					30		2.5H
118	Linear B	3 Rows (12)			0		No Fence
119					30		No Fence
120					0		1H
121					30		1H
122					0		1.5H
123					30		1.5H
124					0		2H
125					30		2H
126					0		2.5H
127					30		2.5H
128	Linear C	2 Rows (9)			0		No Fence
129					30		No Fence
130					0		1H
131					30		1H
132					0		1.5H
133					30		1.5H
134					0		2H
135					30		2H
136					0		2.5H
137					30		2.5H

Table 1d. HELIOSTAT FIELD ARRAY WIND-TUNNEL TEST MATRIX

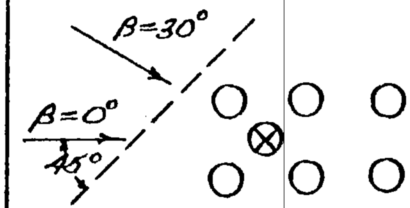
MDAC/CSU

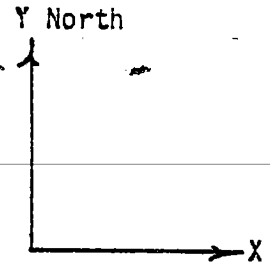
RUN 117A



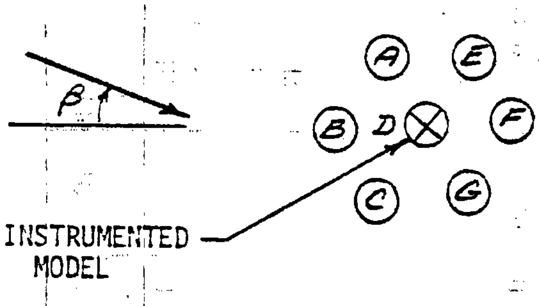
RUN NO.	CONFIG.	NO. OF MIRROR	WIND SPEED	TILT α°	WIND β°	SLOT	FENCE DIST.
117A	#1	7	55 mph	30	0	Open	1H
120A	Linear B	5		30	0		Fence 45° 1H
122A							1.5H
124A							2H
126A							2.5H
121A					30		1H
123A							1.5H
125A							2H
127A							2.5H
141	Single	1	55 mph	30	0	Half Open	No Fence
142					45		
143					90		
144					135		
145					180		
146					0	Closed	
147					45		
148					90		
149					135		
150					180		

RUNS 120A to 127A



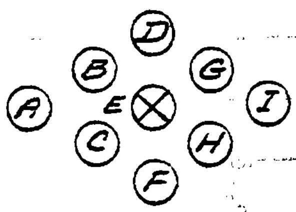


CONFIGURATION #1



		X (meters)	Y (meters)
1745	A	(-183.86,	319.12)
1746	B	(-198.31,	310.35)
1691	C	(-195.95,	291.69)
1690	D	(-182.37,	300.37)
1689	E	(-168.39,	308.43)
1628	F	(-167.64,	290.96)
1629	G	(-180.81,	282.97)

CONFIGURATION #2

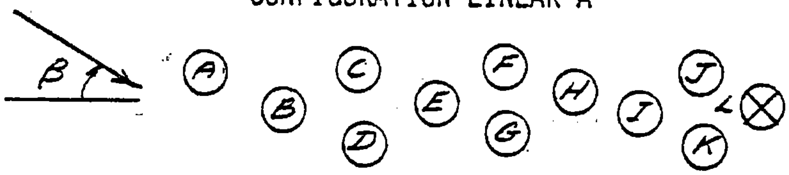


1377	A	(-126.01,	248.59)
1310	B	(-112.78,	240.46)
1311	C	(-127.28,	233.12)
1239	D	(-100.61,	232.79)
1240	E	(-114.66,	226.20)
1241	F	(-128.28,	218,76)
1165	G	(-102.59,	218.74)
1166	H	(-115.78,	212.05)
1088	I	(-104.26,	204.68)

Note: All distances between centers of heliostats should be multiplied by a factor of 1.2 for the Enlarged Inverting Heliostat Field Array.

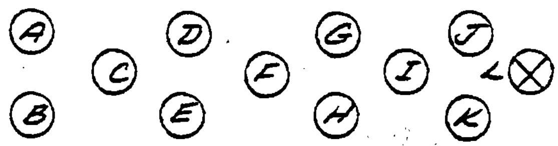
Figure 3. Selected Cluster Configurations.

CONFIGURATION LINEAR A



		X	Y
1743	A	(-153.84,	334.61)
1688	B	(-154.06,	315.83)
1676	C	(-140.26,	305.1)
1627	D	(-154.11,	298.35)
1563	E	(-140.39,	287.78)
1497	F	(-127.81,	278.03)
1498	G	(-140.44,	271.87)
1435	H	(-126.47,	262.86)
1377	I	(-126.01,	248.59)
1310	J	(-112.78,	240.46)
1311	K	(-127.28,	233.12)
1240	L	(-114.66,	226.2)

CONFIGURATION LINEAR B



1752	A	(-275.22,	244.74)
1753	B	(-286.16,	231,85)
1697	C	(-267.88,	227.42)
1635	D	(-250.94,	223.14)
1636	E	(-260.91,	211,39)
1572	F	(-244.1,	207.23)
1506	G	(-228.67,	203.34)
1507	H	(-237.76,	192.63)
1442	I	(-222.37,	188.78)
1383	J	(-206.85,	186.78)
1384	K	(-217.88,	173.78)
1317	L	(-202.48,	171.89)

CONFIGURATION LINEAR C

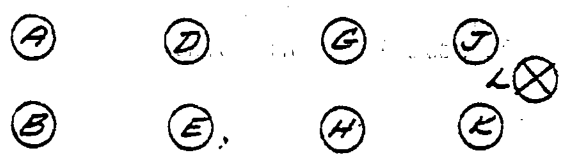


Figure 3. Selected Cluster Configurations (Continued).

locations in the MDAC collector field layout are shown in Figure 4. The distance between any two adjacent heliostat centers varys at different locations. For practical purposes an average value is used for each cluster configuration. They are called "Idealized Cluster Configurations" and are shown in Figure 5.

E. Pressure Study

Purpose: To collect pressure distribution data on the front and back surfaces and also on the surface support column. Tap locations are shown in Figures 6 through 8.

Run Nos.: 95 to 108

Key Parameters: Four cluster configurations and four wind directions, β.

F. Fence Study

Purpose: To study the fence effect on aerodynamic load reduction for several cluster configurations.

Run Nos.: 110 to 137 and 117A to 127A.

Key Parameters: Distance from fence to leading heliostat in cluster.

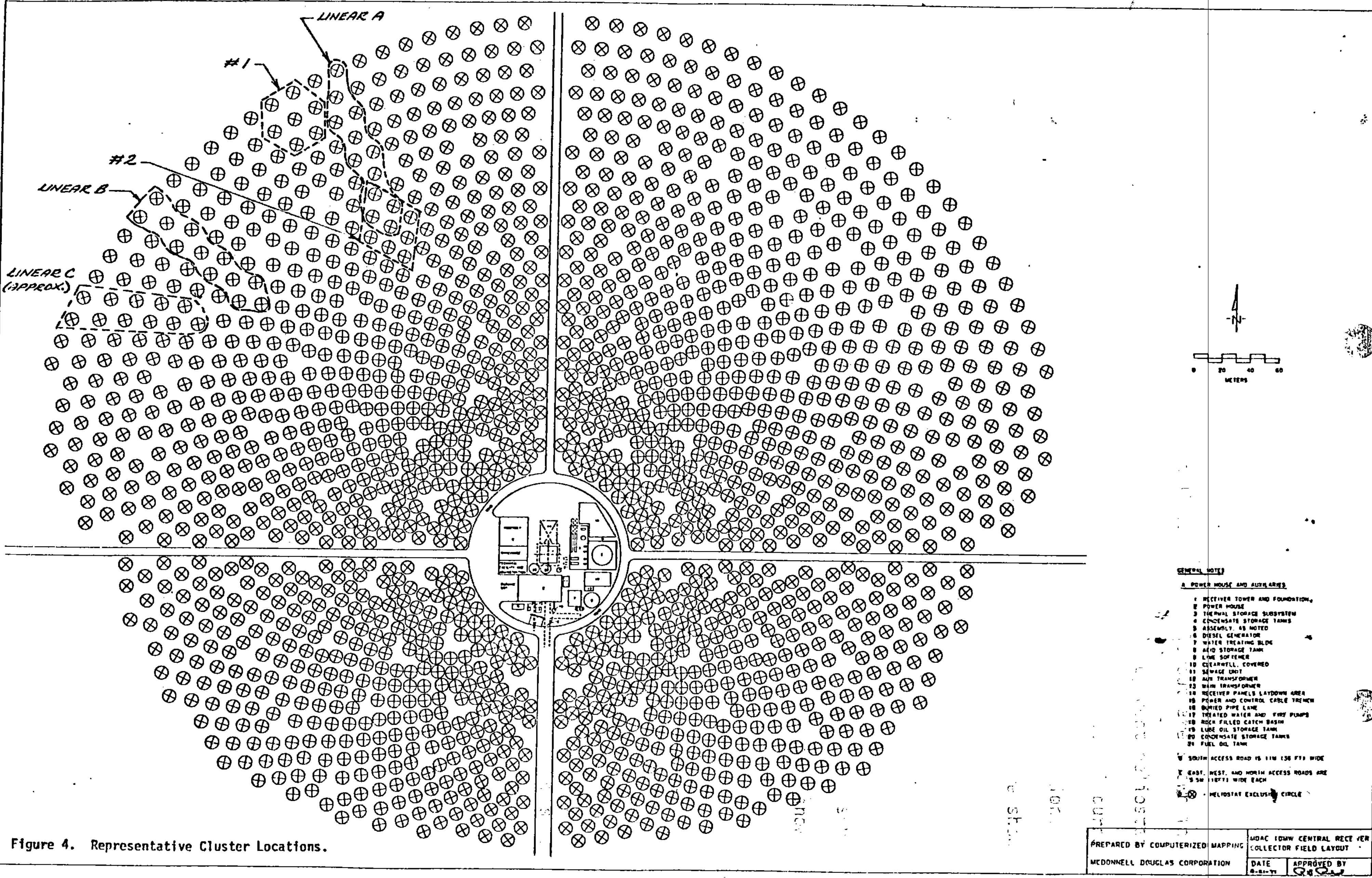
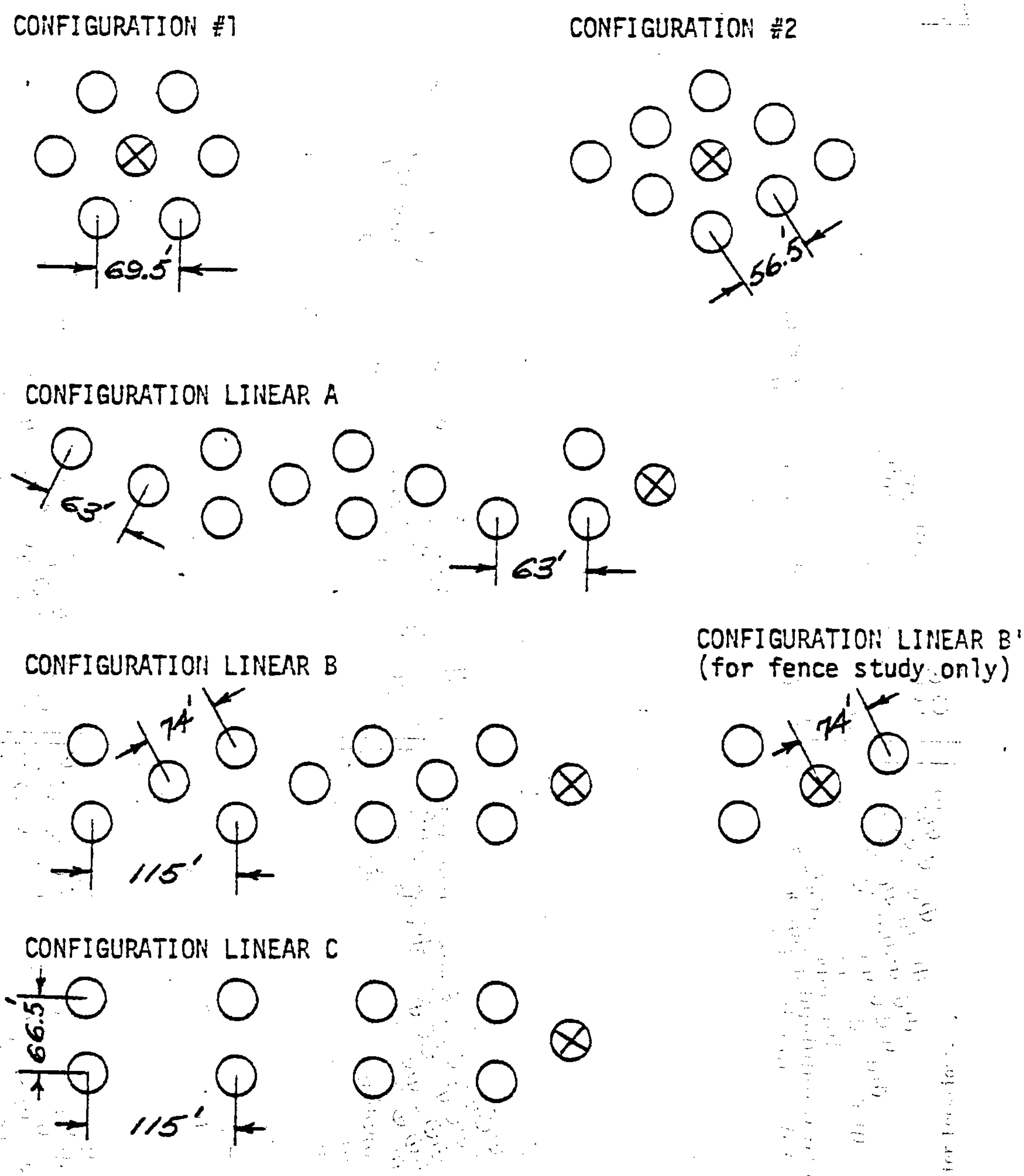


Figure 4. Representative Cluster Locations.



Note: Averages of actual distances between heliostats in the selected cluster are used in these idealized cluster configurations.

Figure 5. Idealized Cluster Configurations.

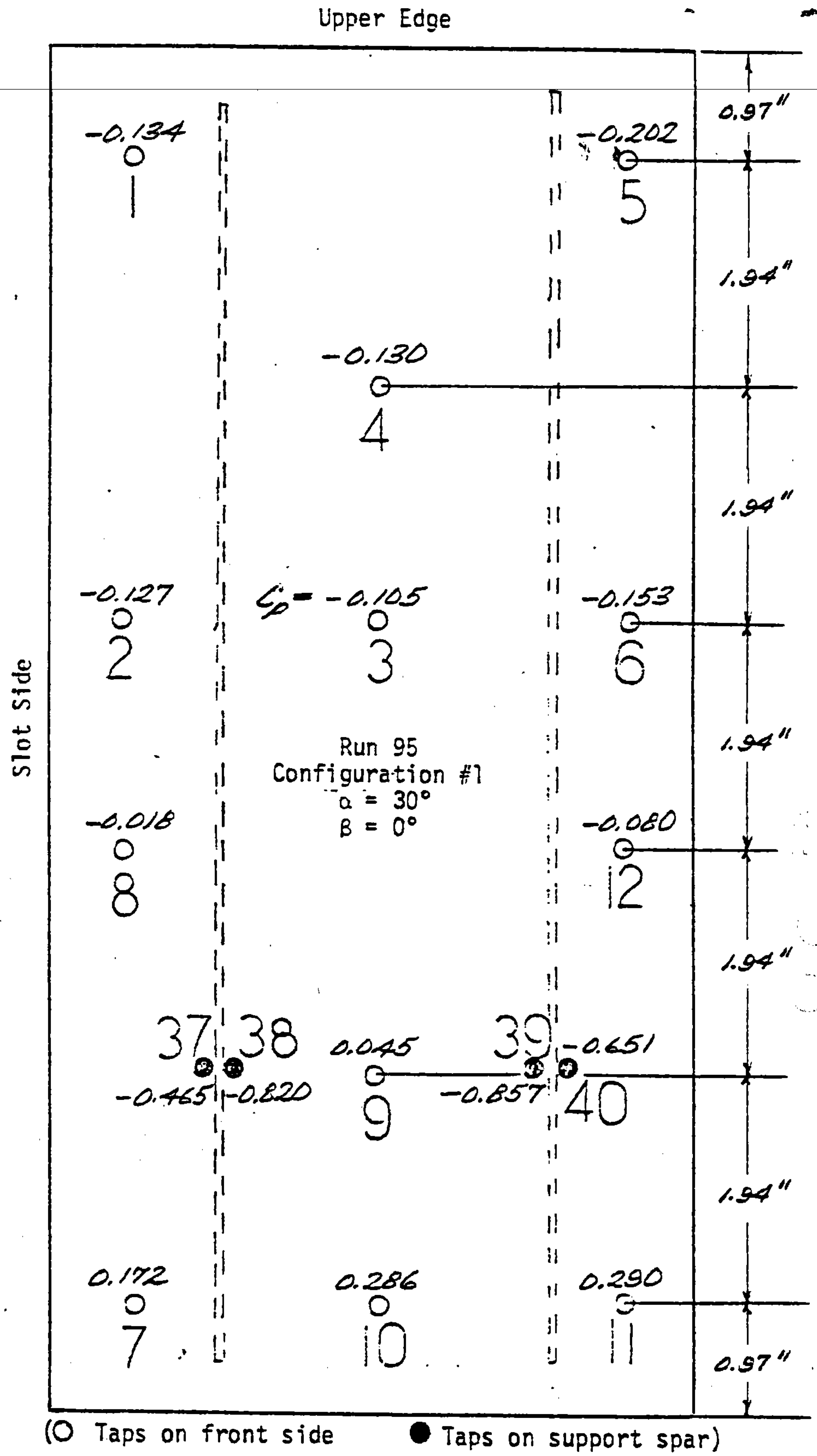


Figure 6. Pressure Tap Locations and Typical Pressure Coefficients - Front Face - Right Panel.

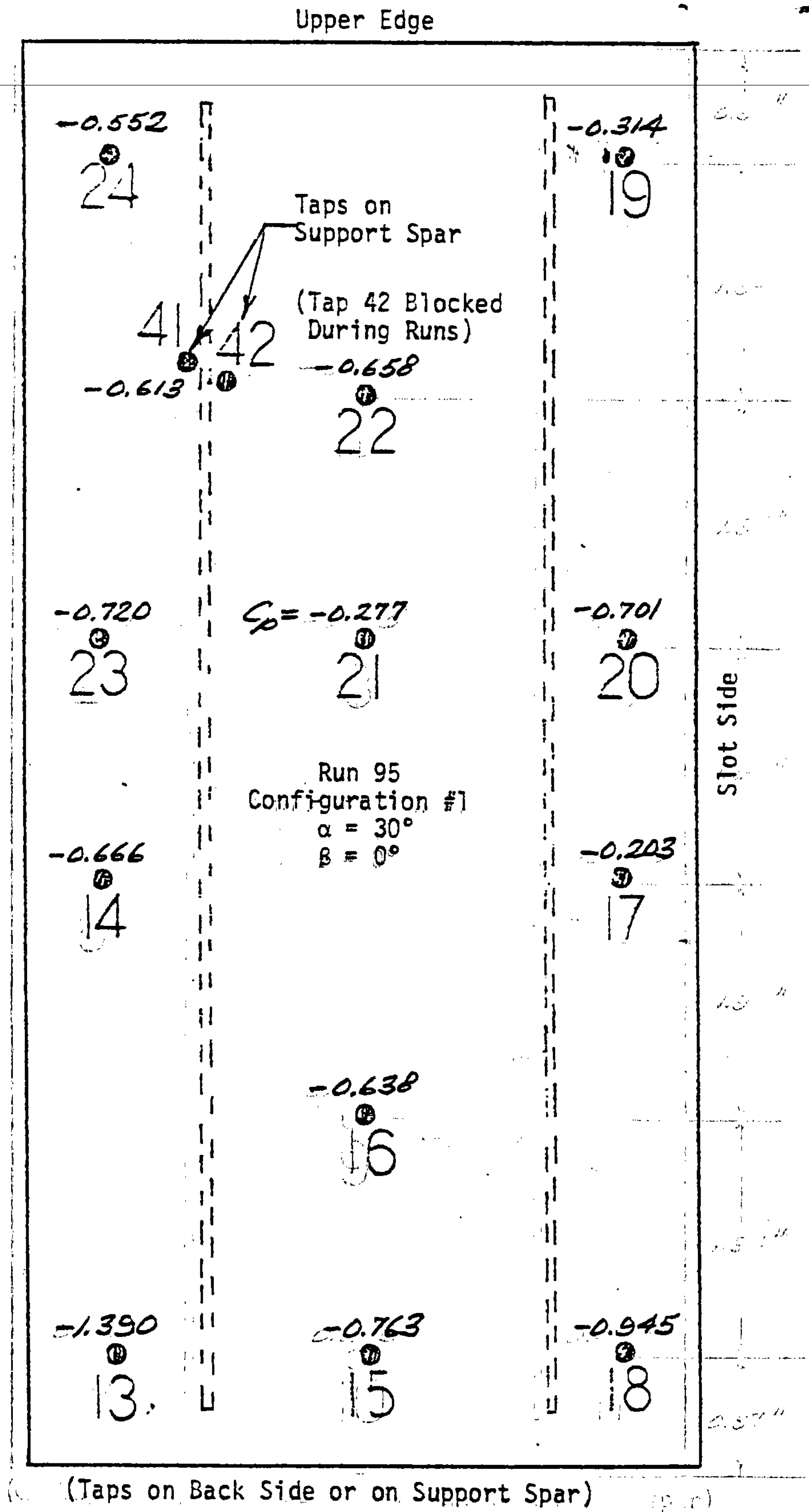


Figure 7. Pressure Tap Locations and Typical Pressure Coefficients - Front Face - Left Panel.

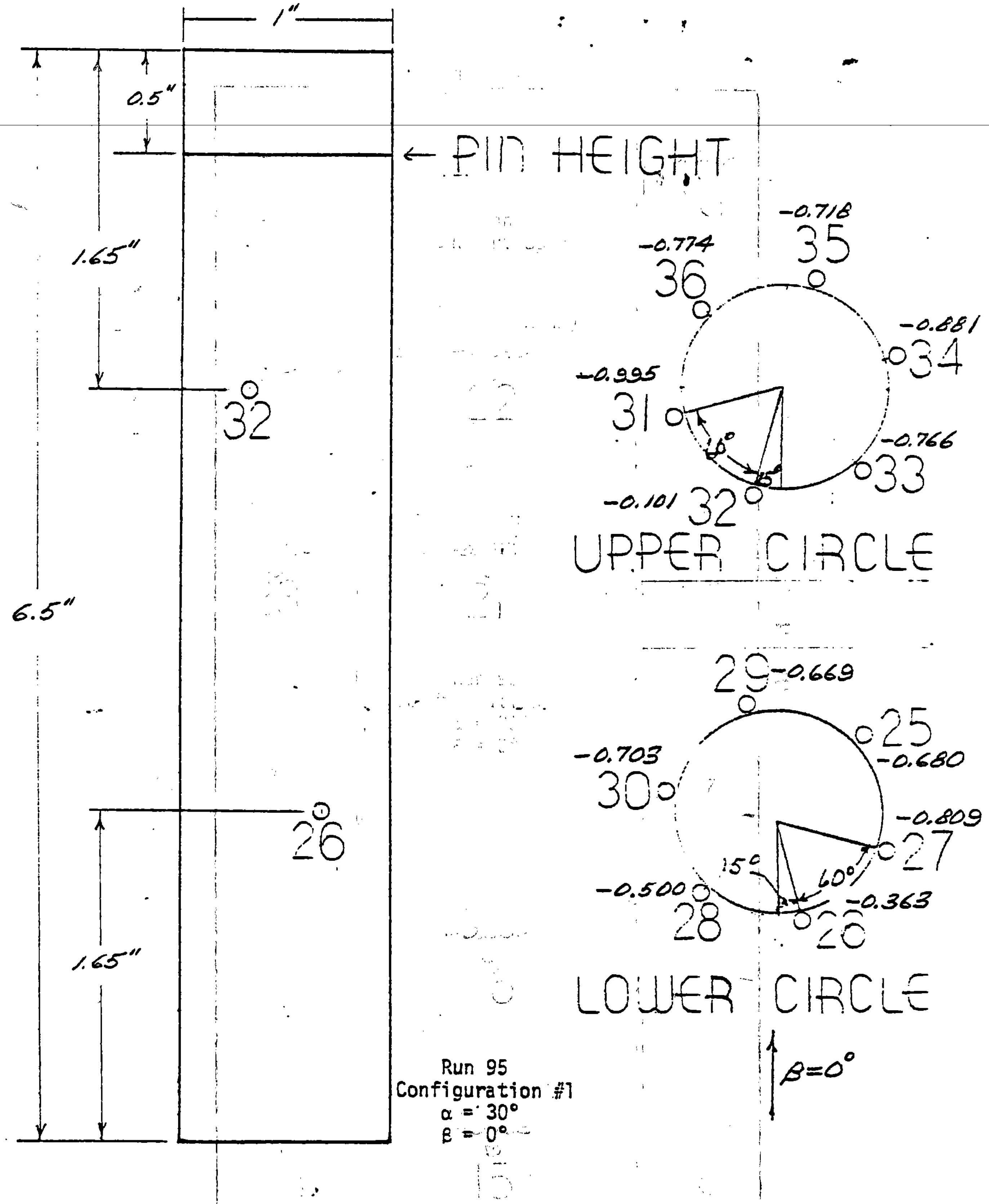


Figure 8. Pressure Tap Locations and Typical Pressure Coefficients - Support Column.

VII. TEST RESULTS AND SUMMARY

The test was completed on March 16, 1978. The data appear to be consistent in terms of peak loads with previous data obtained by MDAC personnel in the Douglas Aircraft Company Low Speed Tunnel, Long Beach, California. The DAC tests involved a uniform velocity profile owing to the large ratio of model height to wall boundary layer thickness.

Current test results are summarized below. (Computer print-outs are given in Appendix II.)

A. Velocity Study

Aerodynamic loadings expressed in coefficient form are relatively insensitive to mean wind velocity (and Reynolds number) for the configurations and range of conditions tested. Consequently, wind velocity was chosen on the basis of the velocity which yields reliable data readings. Accordingly the mean wind velocity referenced to 10 meters (full scale) giving the best instrumentation signal-to-noise ratio was found to be approximately 55 mph and was used for the entire test. Representative atmospheric boundary layer profiles are shown in Figure 9. As indicated small changes in the power law exponent, e.g., 0.135 versus 0.143, should not affect experimental results significantly.

B. Tilt Angle and Cluster Studies

For a single heliostat, pitching moments were observed to peak at $\alpha = 30°$ (and perhaps also at $\alpha = 150°$ based on observations from previous tests at DAC). Typical C_m variation curves are given in Figure 10. For clustered heliostats, values of C_m for the center heliostat are usually lower as compared with those for single heliostat with no distinct peak value evident at $\alpha = 30°$.

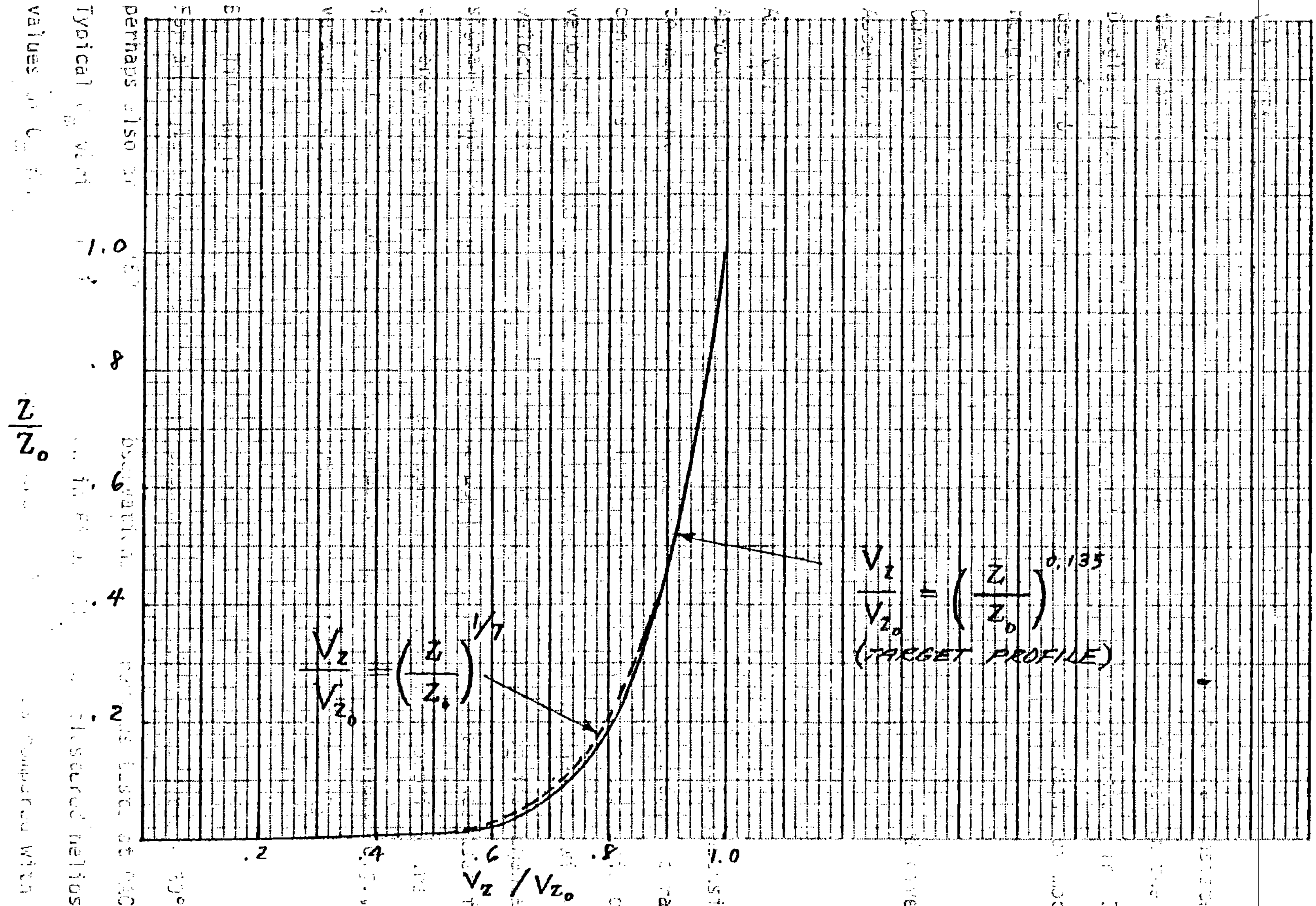


Figure 9. Representative Atmospheric Boundary Layer Profiles.

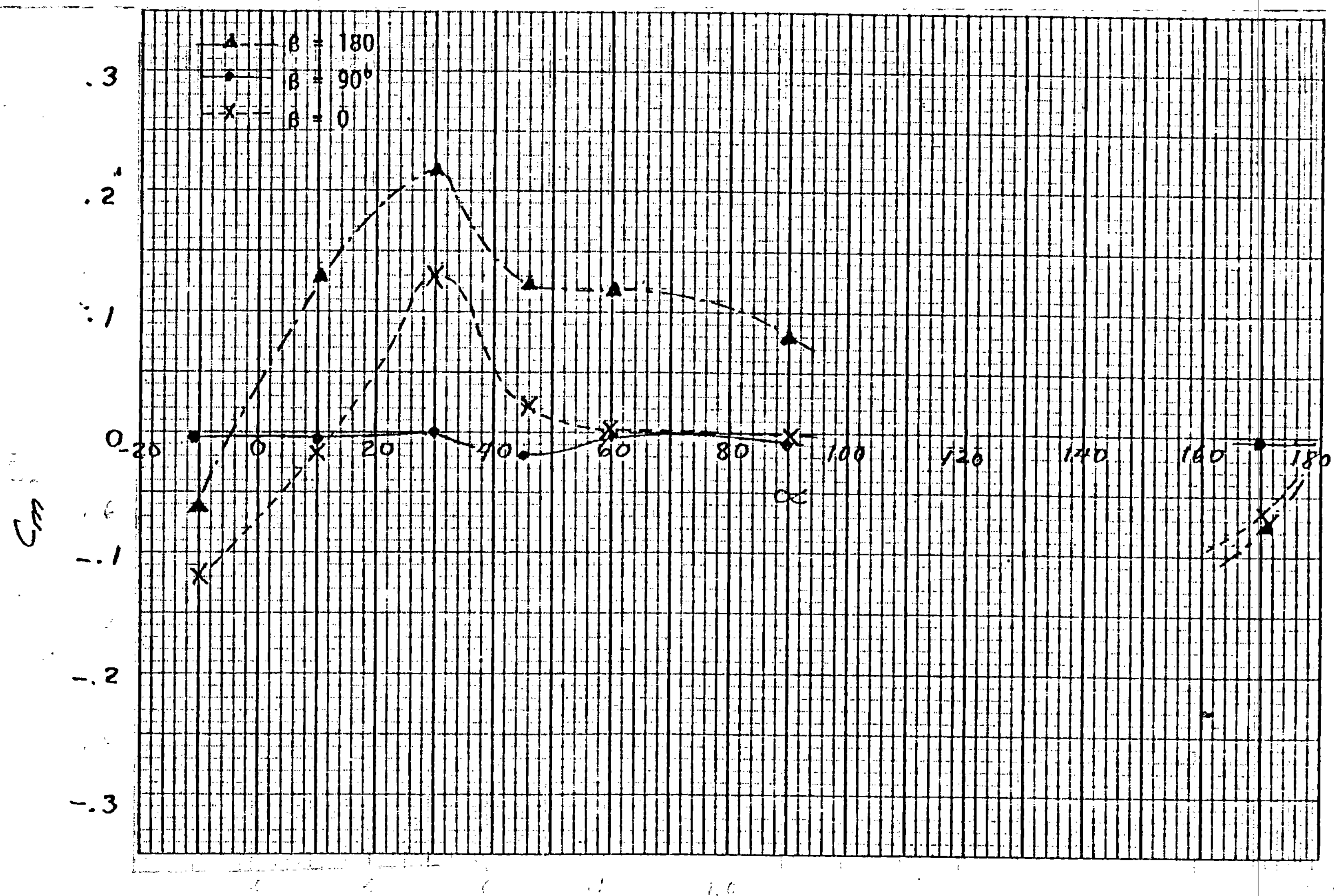


Figure 10. Pitching Moment vs. Tilt Angle - Tilt Angle Study - Single Heliostat.

Figure 9. Representative Atmospheric Boundary Layer Profiles.

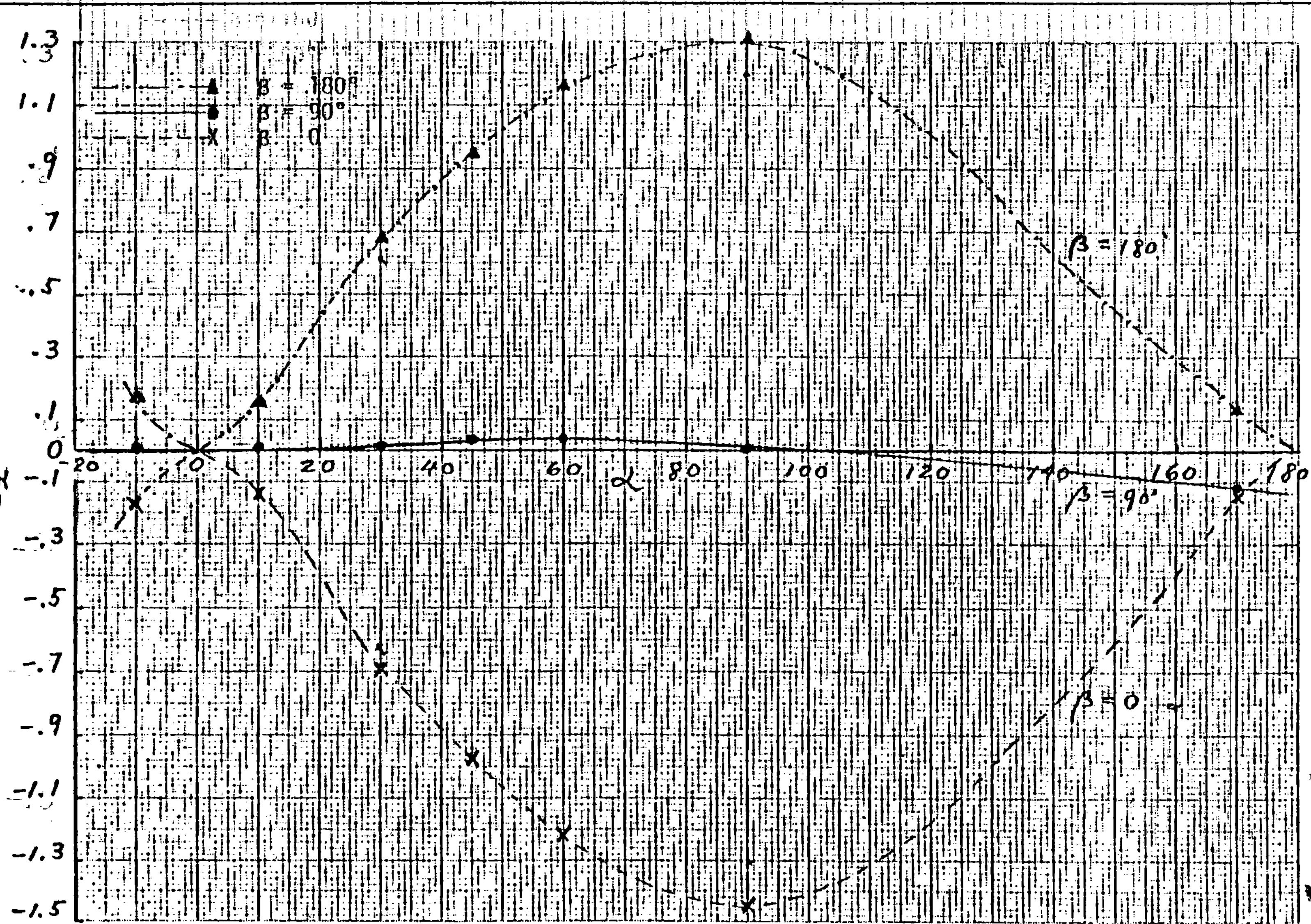


Figure 10. Pitching Moment vs. Tilt Angle - Tilt Angle Study - Single Heliostat.

Figure 11. Drag Force vs. Tilt Angle - Tilt Angle Study.

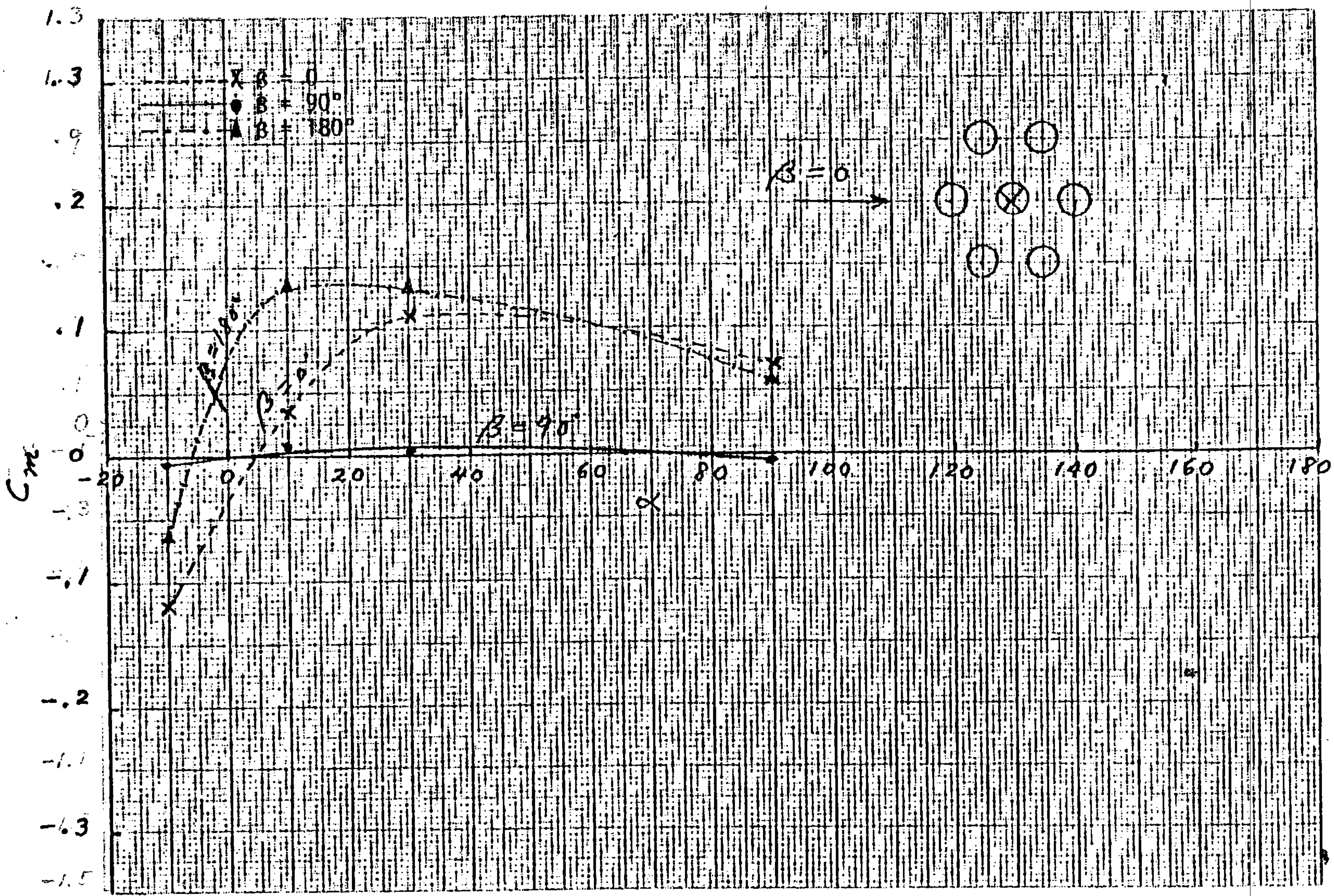


Figure 12. Pitching Moment vs. Tilt Angle - Cluster Configuration #1.

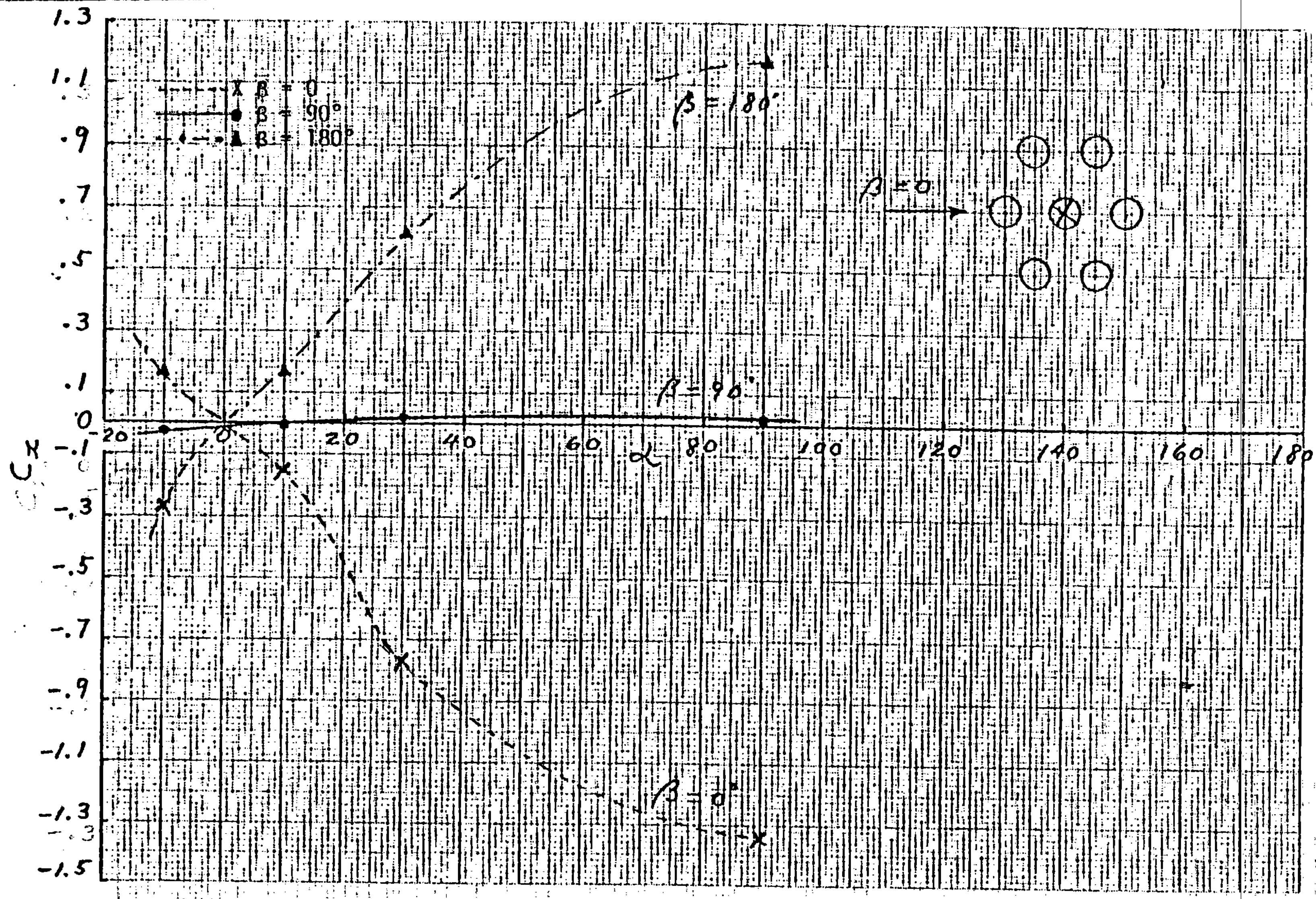


Figure 13. Drag Force vs. Tilt Angle - Cluster Configuration #1.

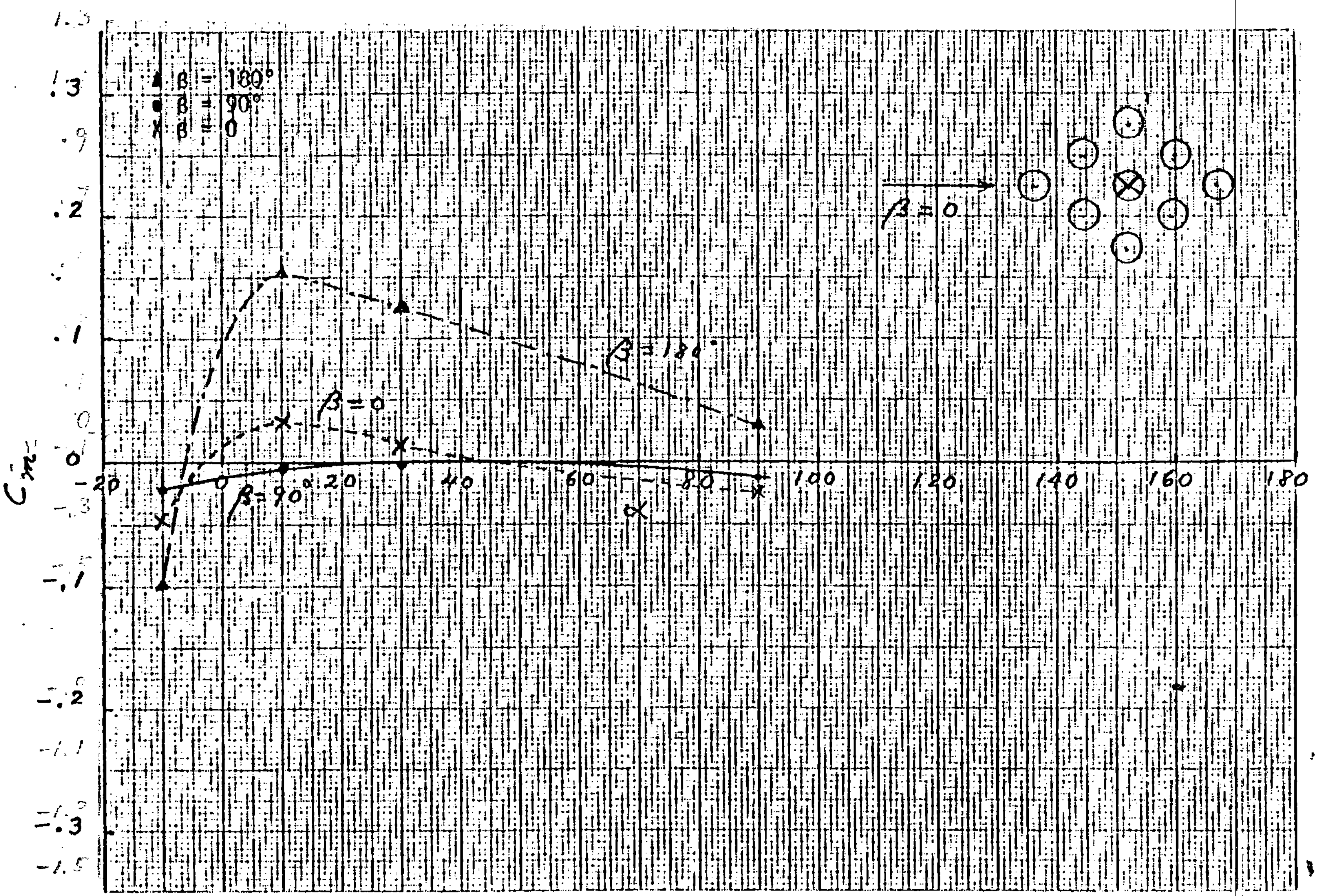


Figure 14. Pitching Moment vs. Tilt Angle - Cluster Configuration #2.

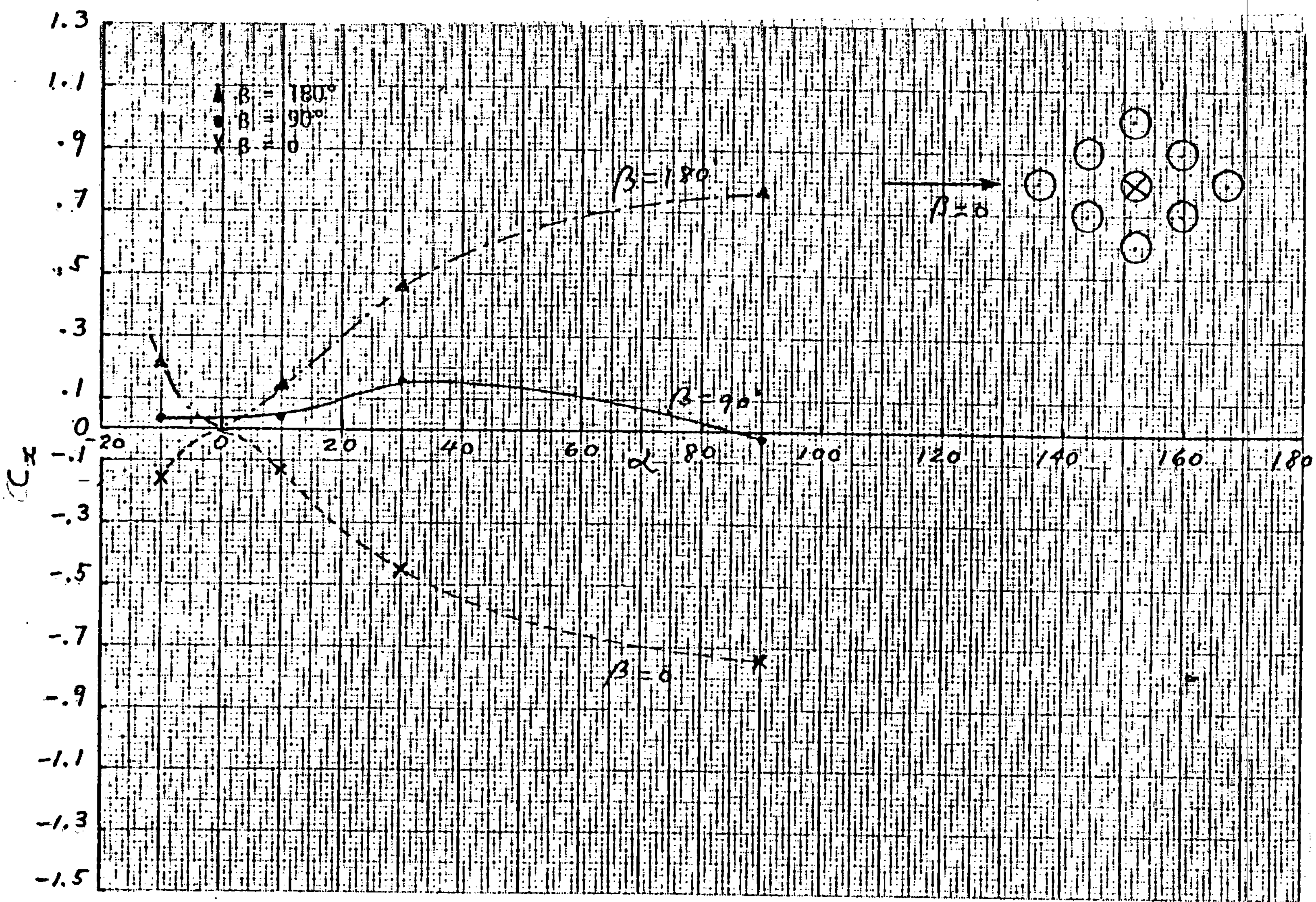
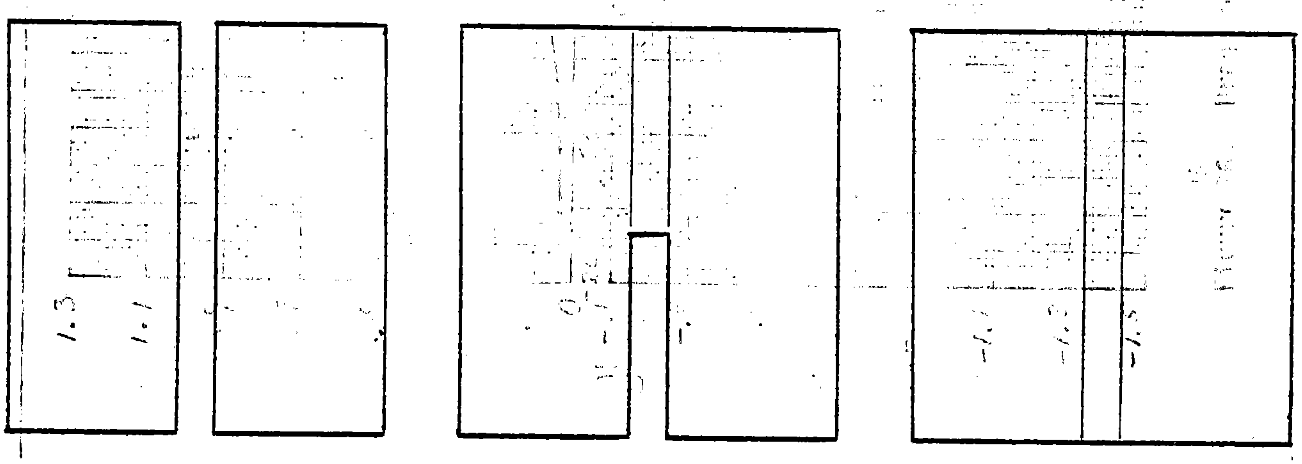


Figure 16. Drag Force vs. Tilt Angle - Cluster Configuration #2.

Typical curves are given in Figures 12 and 14. Drag forces are shown in Figure 11 for single heliostat and in Figures 13 and 15 for clustered heliostats. These forces usually peak at $\alpha = 90°$ and have somewhat lower values for clustered heliostats. Twist moment, yaw moment and side force are much smaller as compared with pitch moment and drag force, respectively. For example, single heliostat twist moment data are shown in Figure 16. The data scatter may be due to the small moments being measured relative to balance peak load capability. A complete set of data are listed in the computer printout given in Appendix II.

C. Slot Study

Slot effects appear to be relatively small as seen in Figures 17 and 18. The selection of slot geometry would consequently be dominated by other design considerations. Panel configurations corresponding to open, half open and closed slots are shown below. Owing to the non-monotonic variation of loads as a function of tilt angle proceeding from an open to fully closed slot, an optimum design from the standpoint of minimizing wind loads could be achieved only over a limited α range.



Open Slot Half Open Slot Closed Slot (Non-inverting)

D. Pressure Study

Pressure distributions on heliostat surfaces (front and back) are relatively non-uniform, both on the planar surfaces and the support post. Typical pressure coefficients at 42 locations are given in Figures 6 through 8. All others are given in Appendix III. While the pressure data were intended to provide local as opposed to integrated load results (owing to the limited number of taps available), an "order-of-magnitude" check was run for a single heliostat (#103, $\alpha = 30°$, $\beta = 0°$) using a surface fit of front and back panel pressure coefficients. The surface fit which passed through the control points corresponding to pressure tap locations allowed interpolation of pressure coefficients at 81 (9 x 9) grid points for use in a Gaussian quadrature procedure. The resulting X-FORCE component of the total panel normal force obtained was within 24% of the load measured directly by the balance, i.e.,

$$C_{X_{BALANCE}} = -0.6888 \quad \text{(RUN \#16)}$$

$$C_{X_{PRESSURE\ INTEGRATION}} = -0.8998 \quad \text{(RUN \#103)}$$

E. Fence Study

The introduction of a wind fence with 33% porosity (provided by 3/8 in. diameter holes) significantly reduced the aerodynamic loads on heliostats as evidenced by the cases tabulated in Tables 2a and 2b. Pitching moments and drag forces have been reduced to 50% or even to one order of magnitude smaller than comparable no fence cases. The fence height, porosity and the distance to the nearest heliostat were selected such that the free streamline grazing the top of the fence would not impinge directly on the instrumented heliostat.

F. Dynamic Loads

No quantitative measurements of dynamic (turbulence or vortex shedding) effects were made owing to the large number of steady state load parameters treated. In addition, smoke filament tests which were tentatively planned in order to gain a qualitative picture of heliostat wake phenomena were deleted owing to limited tunnel occupancy time.

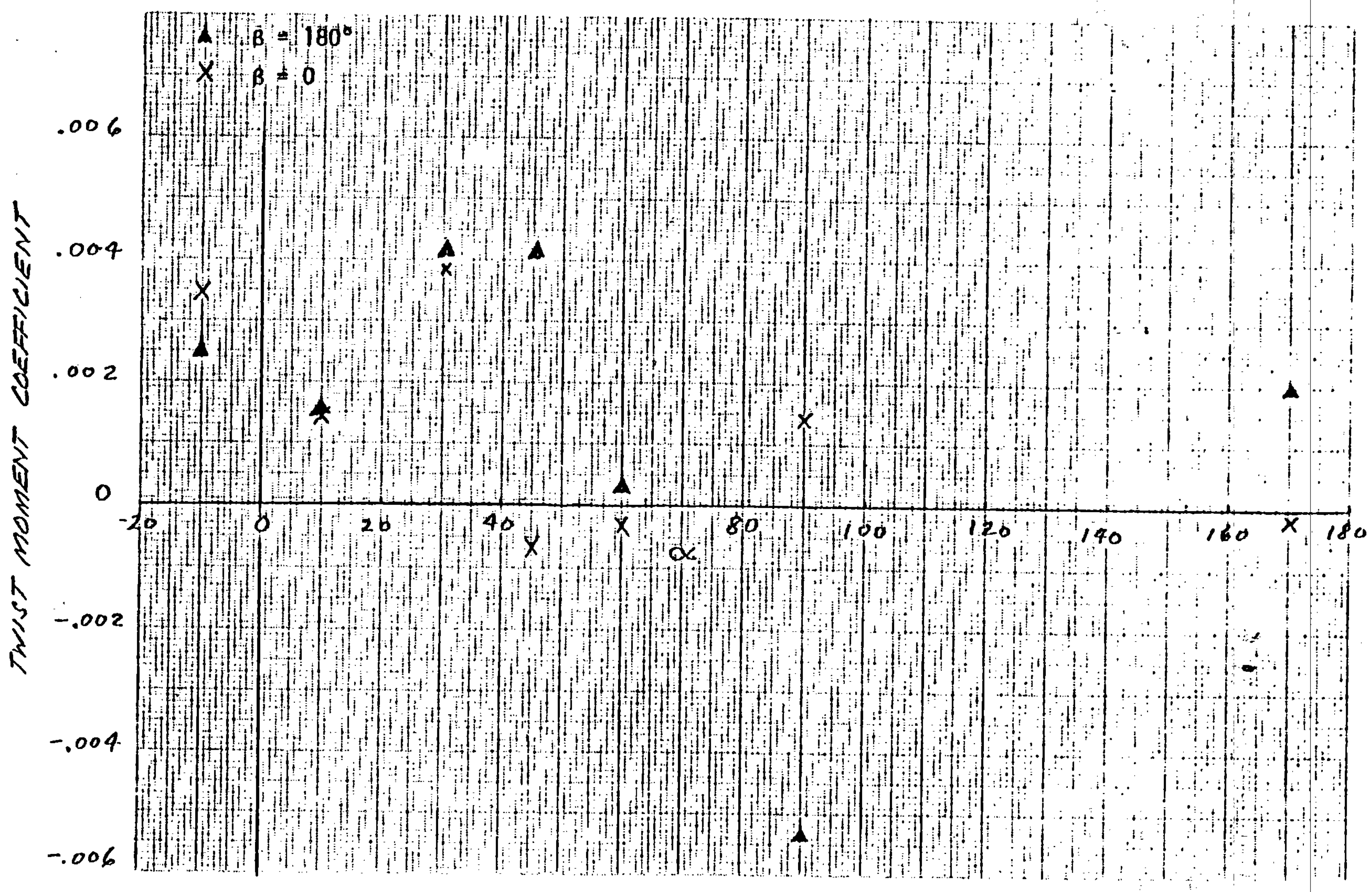


Figure 16. Twist Moment vs Tilt Angle-Single Heliostat.

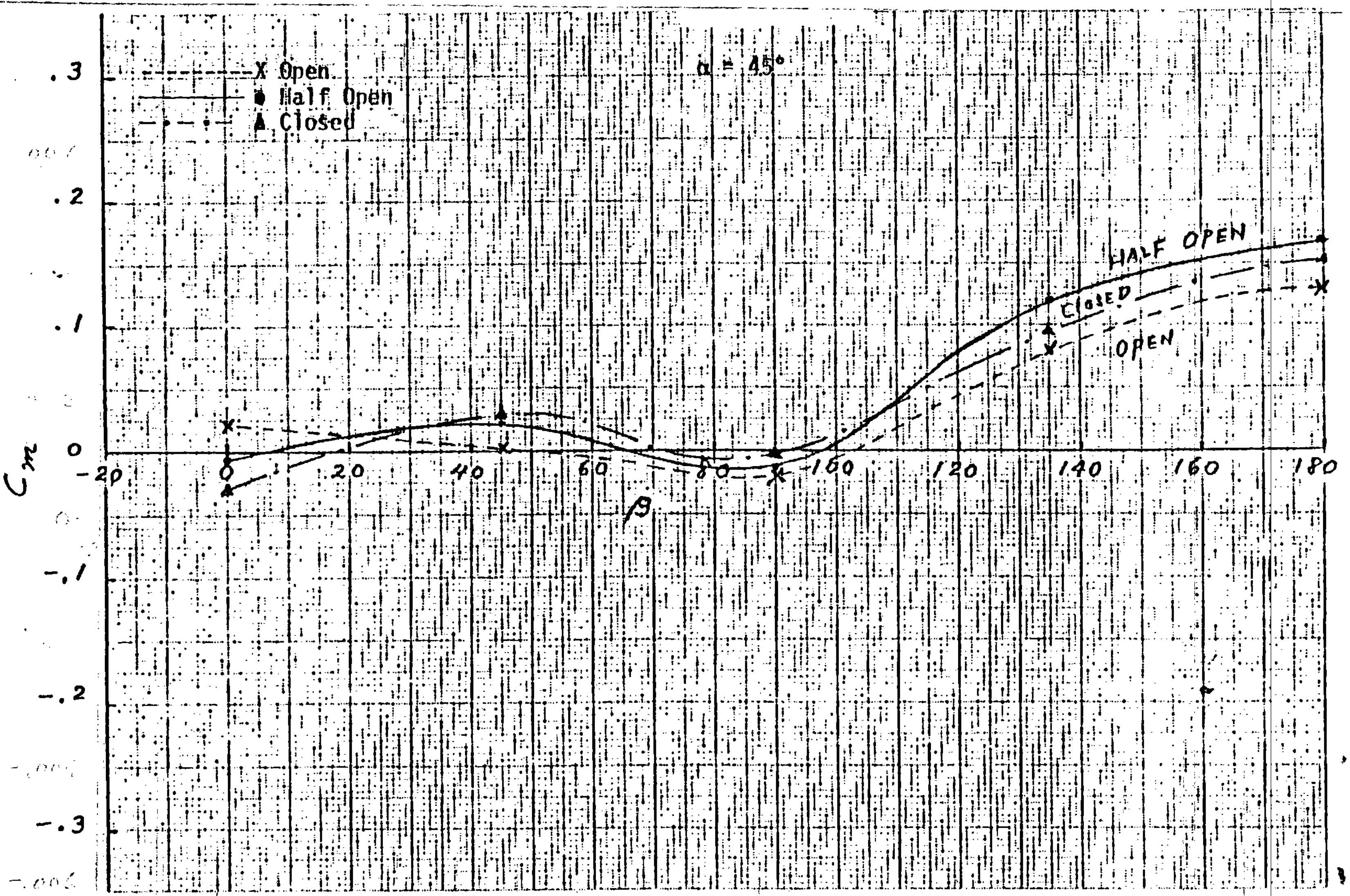


Figure 17. Pitching Moment vs. Wind Angle - Slot Study.

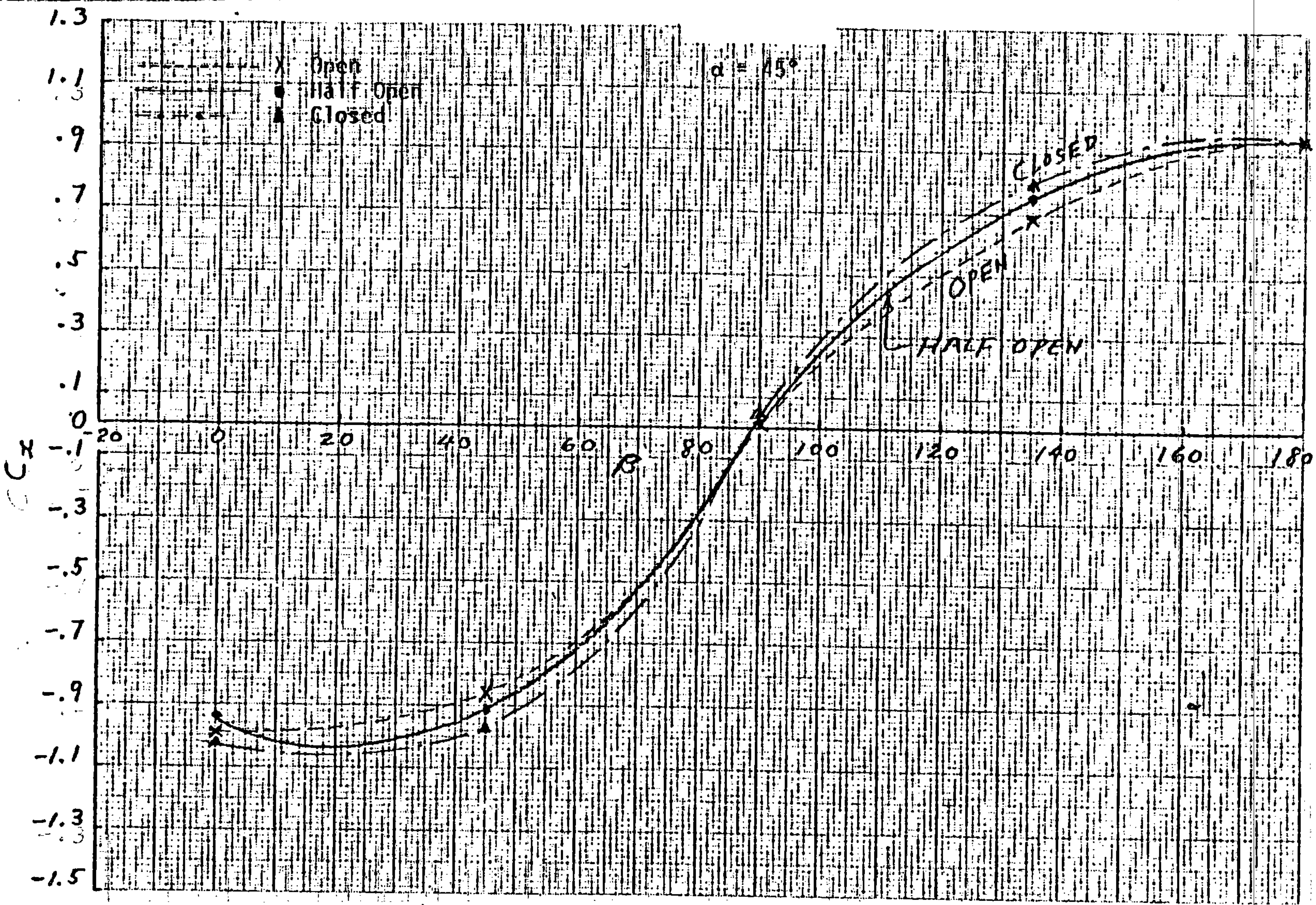
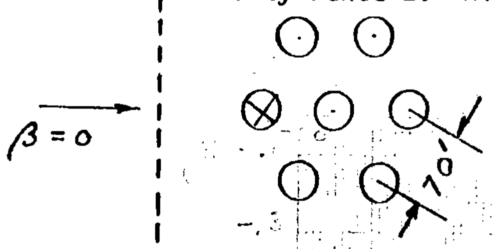


Figure 18. Drag Force vs. Wind Angle - Slot Study.

Table 2a. FENCE STUDY DATA

RUN NO.	16	110	112	114	116	17	111	113	115	117
Config.	1	→	→	→	→	→	→	→	→	→
α	30°	→	→	→	→	→	→	→	→	→
β	0	→	→	→	→	45°	30°	→	→	→
Fence Dist.	No Fence	1H	1.5H	2H	2.5H	No Fence	1H	1.5H	2H	2.5H
C_x	-.6888	-.036	-.036	-.023	.006	-.5915	-.0387	-.025	-.017	-.0014
C_m	.1263	.0119	.0129	.0135	-.006	.0701	.0123	.0058	.0024	-.0064

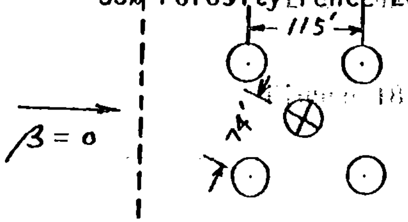
33% Porosity Fence 20' High (1H)



Configuration #1

RUN NO.	118	120	122	124	126	119	121	123	125	127
Config.	Linear B	→	→	→	→	→	→	→	→	→
α	30°	→	→	→	→	→	→	→	→	→
β	0	→	→	→	→	30°	→	→	→	→
Fence Dist.	No Fence	1H	1.5H	2H	2.5H	No Fence	1H	1.5H	2H	2.5H
C_x	-.735	-.013	.011	-.026	.004	-.416	-.021	-.009	-.046	-.029
C_m	.131	.007	-.011	.0028	-.017	.083	.0095	.002	.0219	.007

33% Porosity Fence 20' High (1H)

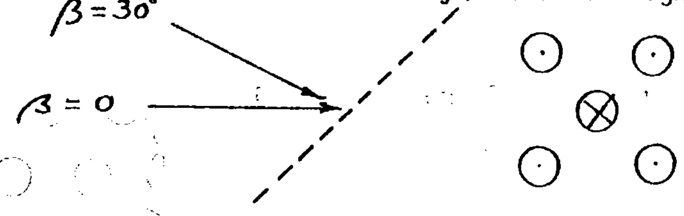


Configuration Linear B

Table 2b. FENCE STUDY DATA

RUN NO.	118	120A	122A	124A	126A	119	121A	123A	125A	127A
Config.	Linear B →									
α	30° →									
β	0 →					30° →				
Fence Dist.	No Fence	1H	1.5H	2H	2.5H	No Fence	1H	1.5H	2H	2.5H
C_x	-.735	-.115	-.191	-.296	-.339	-.416	-.15	-.145	-.177	-.201
C_m	.131	.009	.016	.0326	.0387	.083	-.0273	-.029	-.0328	-.021

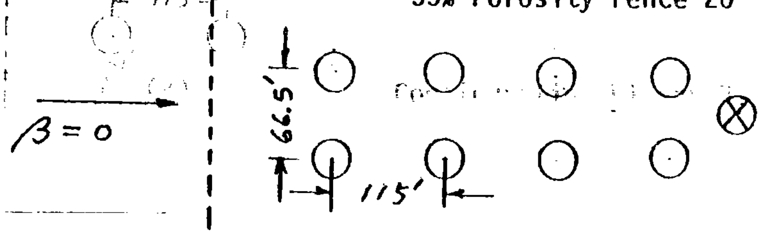
33% Porosity Fence 20' High (1H)



Configuration Linear B

RUN NO.	128	130	132	134	136	129	131	133	135	137
Config.	Linear C →									
α	30° →									
β	0 →					30° →				
Fence Dist.	No Fence	1H	1.5H	2H	2.5H	No Fence	1H	1.5H	2H	2.5H
C_x	-.796	-.315	-.316	-.312	-.31	-.469	-.297	-.275	-.027	-.289
C_m	.1118	.00513	.0486	.0432	.038	.1065	.0426	.040	.00375	.041

33% Porosity Fence 20' High (1H)



Configuration Linear C

Appendix I

DIGITAL DATA ACQUISITION AND REDUCTION FACILITY

Fluid Dynamics and Diffusion Laboratory

A mini-computer based Digital Data Acquisition System (DDAS) is available within the Fluid Dynamics and Diffusion Laboratory (FDDL) for real-time, on-line data acquisition and data reduction. The system is based on a Hewlett Packard System 1000 mini-computer and includes the following hardware:

16 bit, 64 K Hewlett Packard mini-computer
14.7 M byte disk
200 line/min printer
100 card/min card reader
9 track Digidata Inc. digital tape drive and controller
16 channel, 50 KHz Preston Scientific A/D converter
3 remote teletype terminals

The system is also tied to a Tektronix graphic display terminal. Communication with the University CYBER 172 is possible by means of digital tape.

The three remote terminals permit communication with the DDAS from three independent experiments with the FDDL. A real-time operating system in the mini-computer permits simultaneous data acquisition from four independent experiments and, in addition, provides capability for virtually simultaneous data reduction. Analog data is transferred from experiments to the A/D converter over analog lines specially designed for minimum signal distortion. Sixteen channels of controlled output from the computer permit real-time control of an experiment from user software. Control of data acquisition and reduction software can be accomplished through the three remote terminals at the experiment site or through the mini-computer main console. Experimental results can be stored on the computer disk or digital tape, can be output on the printer, can be output to the remote terminals for immediate inspection, or can be transmitted to the graphic display terminal for plotting.

Several standard software packages have been stored in the DDAS to acquire and process data from commonly run experiments including analysis of data from fluctuating pressure measurements, gas-chromatograph measurements of flow-field concentrations, and hot-wire anemometry measurements.

The DDAS system permits data acquisition at significantly higher rates than were previously possible and dramatically reduces the time for data analysis.

Appendix II

FORCE AND MOMENT DATA

All forces and moments listed in this appendix are presented in coefficient form. The dynamic force used to normalize the forces is expressed by

$$\text{DYNAMIC FORCE} = \frac{1}{2}\rho_\infty U_\infty^2 A_r \text{ (lbf)}$$

where U_∞ = free stream velocity at 14.4 inches (ft/sec)

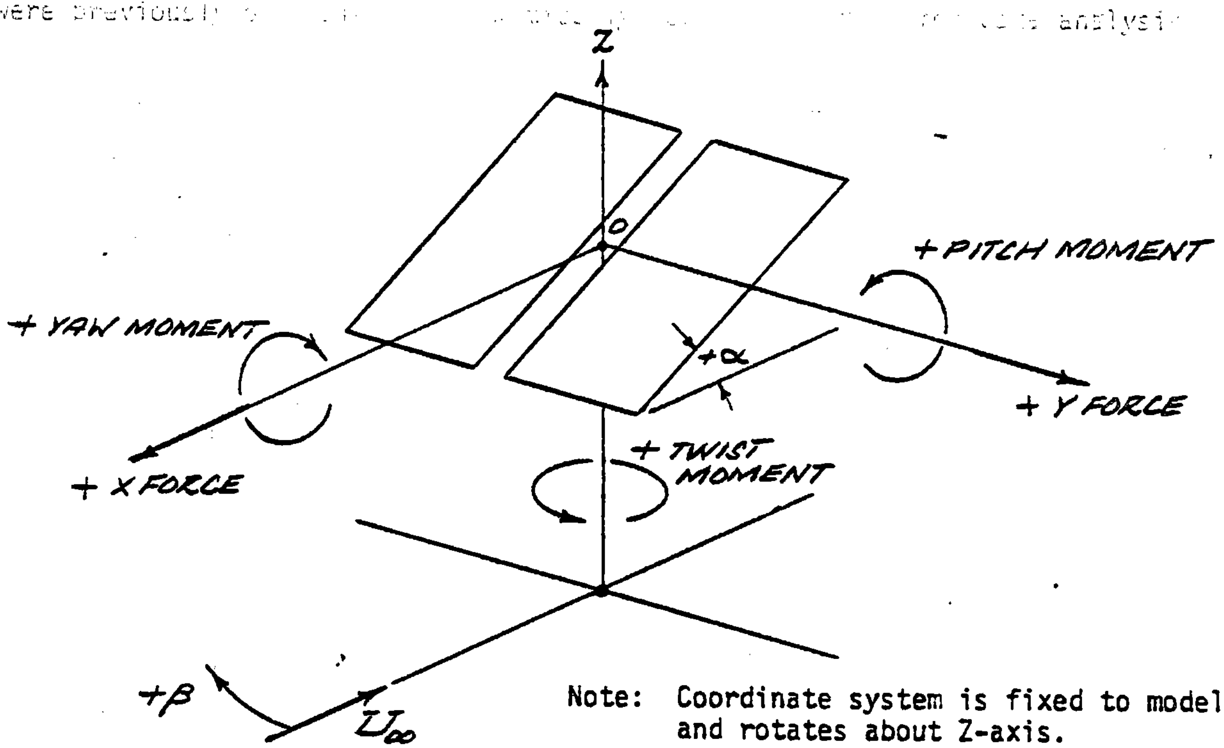
ρ = density (slugs/ft^3)

A_r = reference area = 0.852 (ft^2)

Also L = reference length for normalizing moment coefficients = 0.968 (ft)

LX = lever arm for pitch moment (in)

LY = lever arm for yaw moment (in)



Note: Coordinate system is fixed to model and rotates about Z-axis.

SIGN CONVENTION

RUN NO. = 1 ANGLE OF TILT = 60 ANGLE OF WIND = 0

SINGLE SLOT OPEN

FREE STREAM VELOCITY= 76.00504

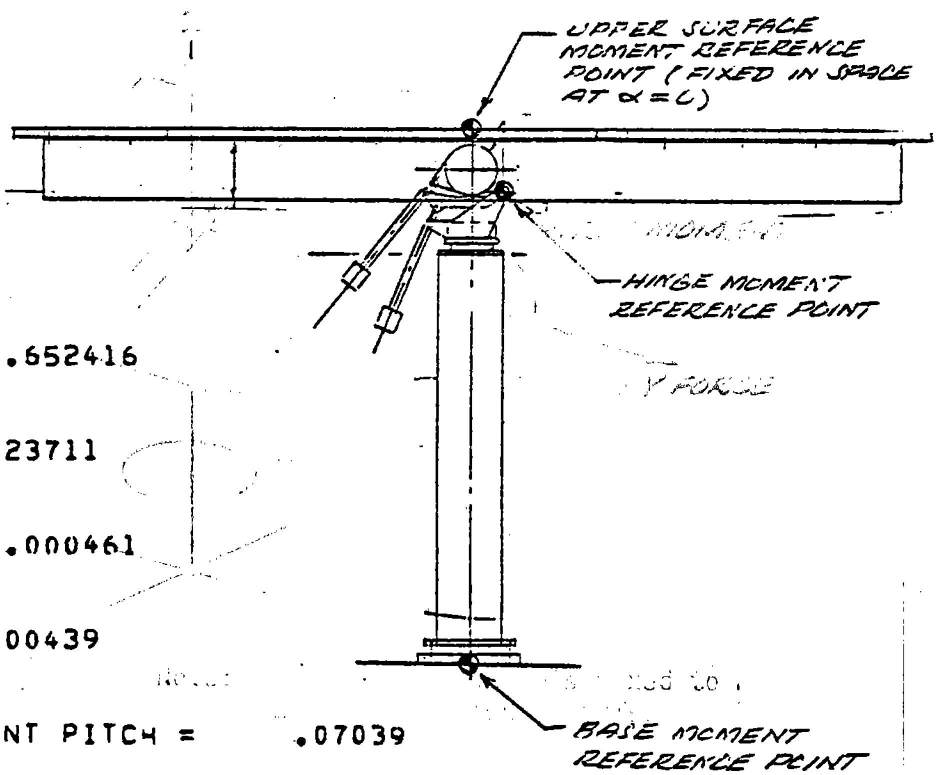
VELOCITY AT 14.4 INC. = 64.247064

DYNAMIC FORCE= 3.39545

INPUT VOLTAGE VALUES FOR THIS RUN

-.589000 .012000 -.002000 -.713000 .037000

LY = 6.0617LX = 7.4556



X FORCE = -1.24201

Y FORCE= .03670

TWIST MOMENT= -.00189

MOMENT AT BASE PITCH = -.652416

MOMENT AT BASE YAW = .023711

MOMENT AT HINGE PITCH = .000461

MOMENT AT HINGE YAW = .00439

MOMENT AT UPPER SURFACE POINT PITCH = .07039

MOMENT AT UPPER SURFACE POINT YAW = .00232

DOE F 1325.8 (7-79)

~~01/25/84~~ STMPO-101

PC

Dany — I hope this helps you. Any questions, pls call. KMm

U.S. DEPARTMENT OF ENERGY
memorandum

Shelved

DATE: MAY 9 1984

REPLY TO ATTN OF: Doug Elliott, DOE/Barstow

SUBJECT: Identification of Reports under Contract DE-AC03-76ET20417 with McDonnell Douglas Astronautics Company

TO: Norma Del Gaudio, ISEA

We are trying to identify and determine the status of reports prepared by MDAC and their subcontractor at Colorado State University under a follow-on modification to the contract listed above. I was responsible for management of this work in 1978-80, but do not have with me my records from that period, or copies of the reports in question. Would you be so kind as to call up and forward to me bibliographic data and abstracts on the following four items? I believe that the reports I am looking for are among them. Once I identify them, I will request copies on aperture card, from which we can make hard copies here. Will you also be able to help us get the aperture card copies when that time comes?

Reports under Contract DE-AC03-76ET20417:

DOE/ET/20417--2 *unable to locate*	Published 3/78	Submitted 1/24/80	
DOE/ET/20417--3 *attached*	Published 7/78	Submitted 2/19/81	PC
DOE/ET/20417--4 *attached*	Published 12/80	Submitted 2/18/81	PC
DOE/ET/20417--5 *unable to locate*	Published 12/80	Submitted 2/18/81	

Could you also check the following two reports, to see if, as I suspect, they are inadvertent re-submissions of the first two above?

~~DOE/ET/20417--T4~~ *attached*	Published 3/78	Submitted 9/4/81	PC
DOE/ET/20417--T1 *attached*	Published 7/78	Submitted 9/3/81	PC

I am hoping that it will turn aout that the reports I need to identify are already patent-cleared and at TIC and NTIS.

Incidentally, you ought to get hold of copies of the two EPRI reports listed on the enclosed flyer (unfortunately, I have no extras at this time); the first is a fairly good summary of the history of our Project through startup, while the second is our bibliography of 550+ documents concerning the Project. The info requested above is in support of our planned update to the second volume as of the end of the Test & Evaluation phase this summer.

S. D. Elliott, Jr., Director,
DOE Solar One Project Office

cc: Mike Lopez, FGS
Mary Soderstrum, B&McD

plus
--T5
--T6
--T7

TIC/ENERGINFO/EDB

1/2/0000001-0000001//   I   PAGE 1

ACCESSION NO.	81R0021145
REPORT NO,PAGE	~~DOE/ET/20417--3~~
TITLE(MONO)	HELIOSTAT FIELD-ARRAY WIND-TUNNEL TEST. REPORT NO. CER78-79JEC-JAP-AK2
EDITOR OR COMP	CERMAK, J.E.; PETERKA, J.A.; KAREEM, A.
CORPORATE AUTH	COLORADO STATE UNIV., FORT COLLINS (USA)
TYPE	R
PAGE NO	60
AVAILABILITY	NTIS, PC A04/MF A01.
CONTRACT NO	CONTRACT AC03-76ET20417
DATE	JUL 1978
CATEGORIES	EDB-141000;140702
PRIMARY CAT	EDB-141000(SOLAR ENERGY; SOLAR COLLECTORS AND CONCENTRATORS)
DESCRIPTORS	*HELIOSTATS--WIND LOADS;AERODYNAMICS;AIR FLOW;BOUNDARY LAYERS; EXPERIMENTAL DATA;PRESSURE MEASUREMENT;REYNOLDS NUMBER;SCALE MODELS;TABLES;TESTING;TURBULENCE;VELOCITY;WIND TUNNELS
DATATAG	EXPERIMENTAL DATA;HELIOSTATS;WIND LOADS

ACCESSION NO.   81R0021182
REPORT NO,PAGE   DOE/ET/20417--4
TITLE(MONO)   THERMAL STABILITY TESTS OF HEAT TRANSFER FLUIDS FOR TRANSFER AND STORAGE OF THERMAL ENERGY
EDITOR OR COMP   SCHNEIDER, G.R.; MORGAN, G.R.
CORPORATE AUTH   ROCKWELL INTERNATIONAL CORP., CANOGA PARK, CA (USA). ROCKETDYNE DIV.; MCDONNELL DOUGLAS ASTRONAUTICS CO., HUNTINGTON BEACH, CA (USA)
TYPE   R
SEC REPT NO   MDC-G--9531
PAGE NO   142
AVAILABILITY   NTIS, PC A07/MF A01.
CONTRACT NO   CONTRACT AC03-76ET20417
DATE   DEC 1980
CATEGORIES   EDB-142000;250600;140700
PRIMARY CAT   EDB-142000(SOLAR ENERGY; HEAT STORAGE)
DESCRIPTORS   *HEAT TRANSFER FLUIDS--THERMAL DEGRADATION; *THERMAL ENERGY STORAGE EQUIPMENT--FOULING; *THERMAL ENERGY STORAGE EQUIPMENT--HEAT TRANSFER FLUIDS;CARBON STEELS;CHEMICAL REACTIONS;DECOMPOSITION;HEAT EXCHANGERS;HIGH TEMPERATURE; POLYMERIZATION;ROCKS;SOLAR THERMAL POWER PLANTS;STABILITY; STAINLESS STEELS;TESTING;VISCOSITY

RECON / EDB PRINTOUT

DOE/ET/20417-T1

ACCESSION NO. 82R0010987
REPORT NO,PAGE [redacted] DE82004174
TITLE(MONO) HELIOSTAT FIELD-ARRAY WIND-TUNNEL TEST
EDITOR OR COMP CERMAK, J.E.; PETERKA, J.A.; KAREEM, A.
CORPORATE AUTH COLORADO STATE UNIV., FORT COLLINS (USA). DEPT. OF CIVIL ENGINEERING
TYPE R
PAGE NO 62
AVAILABILITY NTIS, PC A04/MF A01.
ORDER NUMBER DE82004174
CONTRACT NO CONTRACT AC03-76ET20417
DATE JUL 1978
CATEGORIES EDB-140702;141000
PRIMARY CAT EDB-140702(SOLAR ENERGY; SOLAR THERMAL POWER SYSTEMS; CENTRAL RECEIVER)

ABSTRACT THE CHARACTERISTICS OF THE WIND LOADS PRODUCED BY AIRFLOW PATTERNS IN AND AROUND CERTAIN CONFIGURATIONS OF MODEL HELIOSTAT CLUSTERS ARE INVESTIGATED. CLUSTERS FROM A FIELD ARRAY OF HELIOSTATS WERE CHOSEN SO THAT REPRESENTATIVE WIND FLOW PATTERNS WITHIN TYPICAL ARRAYS COULD BE SIMULATED. TWO COMPACT AND THREE EXTENDED CLUSTERS WERE EXAMINED. IN ADDITION, SOME OF THE CLUSTER CONFIGURATIONS WERE MODIFIED BY PLACING A FENCE UPWIND OF THE MODELS. MEASUREMENTS OF FORCE AND MOMENT COEFFICIENTS WERE TAKEN WITH THE FENCE IN FOUR DIFFERENT POSITIONS, AND DATA ARE COMPARED WITH AND WITHOUT THE FENCE. MEASUREMENTS WERE ALSO MADE OF PRESSURE AND OF VELOCITY PROFILES, AND AIRFLOW PATTERNS WERE VISUALLY DETERMINED WITH THE USE OF SMOKE. FENCE PROTECTION IS FOUND TO SIGNIFICANTLY AFFECT DATA. (LEW)

DESCRIPTORS *HELIOSTATS--WIND LOADS;AIR FLOW;FLOW RATE;PRESSURE MEASUREMENT;VENTILATION BARRIERS;WIND TUNNELS

IC/ENERGINFO/EDE

10/5/0000001-0000001// 1 PAGE 6

C SION NO. 81-0097845

EPORT NO,PAGE DOE/ET/20417--T4

ITLE(MONO) MDAC HELIOSTAT FIELD ARRAY WIND TUNNEL TEST DATA SUMMMARY REPORT

DITOR OF COMP XERIKOS, J.; TANG, H.H.

ORPORATE AUTH MCDONNELL DOUGLAS ASTRONAUTICS CO., HUNTINGTON BEACH, CA (USA)

YPE R

AGE NO 45

VAILABILITY NTIS, PC A03/MF A01.

ONTRACT NO CONTRACT AC03-76ET20417

ATE MAR 1978

ATEGORIES EDB-140702

RIMARY CAT EDB-140702(SOLAR ENERGY; SOLAR THERMAL POWER SYSTEMS; CENTRAL RECEIVER)

BSTRACT

A WIND TUNNEL TEST OF THE MDAC HELIOSTAT CONFIGURATION IN A SINGLE HELIOSTAT, CLUSTERED HELIOSTATS AND CLUSTERED HELIOSTATS WITH FENCE WAS PERFORMED. THE TESTS WERE CONDUCTED AT THE FLUID DYNAMICS AND DIFFUSION LABORATORY OF COLORADO STATE UNIVERSITY DURING FEBRUARY AND MARCH 1978. THE PURPOSE OF THE TEST WAS TO EXPERIMENTALLY EVALUATE THE AERODYNAMIC LOADINGS ASSOCIATED WITH THE AIR FLOW PATTERNS WITHIN AND OVER CLUSTERS OF HELIOSTATS SELECTED FROM BOTH PERIMETER AND INTERIOR LOCATIONS OF THE FIELD ARRAY. THE HELIOSTAT MODEL WAS SCALED BY A FACTOR OF 1:22, AND CLUSTER CONFIGURATIONS RANGED FROM 7 TO 12 HELIOSTATS. THE TEST WAS SUCCESSFUL AND DATA TAKEN APPEARS CONSISTENT IN TERMS OF PEAK LOAD WITH PREVIOUS DATA OBTAINED BY MDAC IN THE DOUGLAS AIRCRAFT LOW SPEED TUNNEL. FOR SINGLE HELIOSTAT PITCHING MOMENTS PEAK AT 30$SUP 0$ ELEVATION ANGLE. FOR CLUSTERED HELIOSTATS THIS VALUE IS USUALLY LOWER WITH NO DISTINCT PEAK EVIDENT. EFFECTS OF HAVING AN OPEN, HALF-CLOSED, OR FULLY-CLOSED HELIOSTAT CENTER SLOT APPEAR TO BE SMALL. PRESSURE DISTRIBUTIONS ON HELIOSTAT SURFACES (FRONT AND BACK) ARE RELATIVELY NON-UNIFORM, BOTH ON PLANAR SURFACES AND THE SUPPORT POST. A WIND FENCE WITH 33% POROSITY PROVIDES SIGNIFICANT REDUCTION IN THE AERODYNAMIC LOADS WITH PITCHING MOMENTS AND DRAG FORCES REDUCED 50% TO ONE ORDER OF MAGNITUDE.

DESCRIPTORS *HELIOSTATS--WIND LOADS;ORIENTATION;TESTING;VENTILATION BARRIERS;WIND TUNNELS

CC[illegible]SION NO.	82R0019303
REPORT NO,PAGE	~~DOE/ET/20417--T5~~;DE82004245
TITLE(MONO)	PRELIMINARY COST ESTIMATES FOR CENTRAL-RECEIVER SOLAR-THERMAL-POWER SYSTEMS, 10-MWE PILOT-PLANT PROGRAM
CORPORATE AUTH	MCDONNELL DOUGLAS ASTRONAUTICS CO., HUNTINGTON BEACH, CA (USA)
TYPE	R
PAGE NO	103
AVAILABILITY	NTIS, PC A06/MF A01.
ORDER NUMBER	DE82004245
CONTRACT NO	CONTRACT AC03-76ET20417
DATE	1 MAR 1976
CATEGORIES	EDB-140702
PRIMARY CAT	EDB-140702(SOLAR ENERGY; SOLAR THERMAL POWER SYSTEMS; CENTRAL RECEIVER)
ABSTRACT	THE PROJECTED COSTS, FUNDING, AND SUPPORTING INFORMATION ARE REVIEWED FOR THE BARSTOW SOLAR PILOT PLANT. STEADY STATE COSTS, FUNDING FOR DESIGN AND DEVELOPMENT, INVESTMENT, AND INITIAL OPERATIONS ARE PRESENTED. UNDERLYING PROGRAMMATICS, GROUNDRULES, AND ASSUMPTIONS ARE SUMMARIZED, AND THE COSTING APPROACH IS INTRODUCED. THE MAJOR PROGRAM CHARACTERISTICS THAT HAVE BEEN USED IN DEFINING THE PILOT PLANT COST ESTIMATES ARE PRESENTED. THE PROGRAMMATICS INCLUDE THE DEFINITION OF THE OVERALL PILOT PLANT PROGRAM REQUIREMENTS, A SUMMARY OF THE MAJOR FEATURES OF EACH SUBSYSTEM, THE MAJOR PROGRAM MILESTONES, PROGRAM SCHEDULE ACTIVITIES, THE MANUFACTURING APPROACH, TEST PROGRAM DEFINITION, AND IDENTIFICATION OF MAJOR PROGRAM SUPPORT REQUIREMENTS. FOR EACH ITEM IN THE WORK BREAKDOWN STRUCTURE, THE SCOPE OF WORK, COST BREAKDOWN, SEMI-ANNUAL FUNDING AND SCHEDULE PLOTS, AND A DESCRIPTION THAT INDICATES THE BASIS OF THE COSTING, INCLUDING A BRIEF TECHNICAL DESCRIPTION, ARE GIVEN. (LEW)
DESCRIPTORS	*BARSTOW SOLAR PILOT PLANT--COST;DESIGN;INVESTMENT; MANUFACTURING;OPERATION;RESEARCH PROGRAMS;SPECIFICATIONS;TESTING

CCESSION NO.	82R0122714
REPORT NO,PAGE	~~DOE/ET/20417--T6~~;DE82007188
TITLE(MONO)	10-MWE PILOT-PLANT-RECEIVER PANEL TEST REQUIREMENTS DOCUMENT SOLAR THERMAL TEST FACILITY
CORPORATE AUTH	MCDONNELL DOUGLAS ASTRONAUTICS CO., HUNTINGTON BEACH, CA (USA)
TYPE	R
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AVAILABILITY	NTIS, PC A10/MF A01.
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DATE	25 AUG 1978
CATEGORIES	EDB-140702
PRIMARY CAT	EDB-140702(SOLAR ENERGY; SOLAR THERMAL POWER SYSTEMS; CENTRAL RECEIVER)
DESCRIPTORS	*BARSTOW SOLAR PILOT PLANT--CENTRAL RECEIVERS; *BARSTOW SOLAR PILOT PLANT--EXTERNAL RECEIVERS; *CENTRAL RECEIVERS--PERFORMANCE TESTING; *EXTERNAL RECEIVERS--PERFORMANCE TESTING;CENTRAL RECEIVER TEST FACILITY; CONTROL SYSTEMS;DESIGN;DOCUMENTATION;OPERATION;QUALITY ASSURANCE;SAFETY;STEADY-STATE CONDITIONS;TRANSIENTS

ACCESSION NO. 82R0070067
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TITLE(MONO) 10-MWE PILOT-PLANT-RECEIVER-PANEL TEST-REQUIREMENTS DOCUMENT: SOLAR THERMAL TEST FACILITY

CORPORATE AUTH MCDONNELL DOUGLAS ASTRONAUTICS CO., HUNTINGTON BEACH, CA (USA)

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CATEGORIES EDB-140702
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ABSTRACT PLANS ARE PRESENTED FOR INSOLATION TESTING OF A FULL-SCALE TEST RECEIVER PANEL AND SUPPORTING HARDWARE WHICH ESSENTIALLY DUPLICATE BOTH PHYSICALLY AND FUNCTIONALLY THE DESIGN PLANNED FOR THE 10 MWE PILOT PLANT. TESTING INCLUDES OPERATION DURING NORMAL START AND SHUTDOWN, INTERMITTENT CLOUD CONDITIONS, AND EMERGENCIES TO DETERMINE THE TRANSIENT AND STEADY STATE OPERATING CHARACTERISTICS AND PERFORMANCE UNDER CONDITIONS EQUAL TO OR EXCEEDING THOSE EXPECTED IN THE PILOT PLANT. THE EFFECTS OF VARIATIONS OF INPUT AND OUTPUT CONDITIONS ON RECEIVER OPERATION ARE ALSO TO BE INVESTIGATED. A BRIEF DESCRIPTION OF THE PILOT PLANT RECEIVER SUBSYSTEM IS PRESENTED, FOLLOWED BY A DETAILED DESCRIPTION OF THE RECEIVER ASSEMBLY TO BE TESTED AT THE SOLAR THERMAL TEST FACILITY. MAJOR SUBASSEMBLIES ARE DESCRIBED, INCLUDING THE RECEIVER PANEL, FLOW CONTROL, ELECTRICAL CONTROL AND INSTRUMENTATION, AND THE STRUCTURAL ASSEMBLY. REQUIREMENTS OF THE SOLAR THERMAL TEST FACILITY FOR THE TESTS ARE GIVEN. SYSTEM SAFETY MEASURES ARE DESCRIBED. THE TESTS, OPERATING CONDITIONS, AND EXPECTED RESULTS ARE PRESENTED. QUALITY ASSURANCE, TASK RESPONSIBILITIES, AND TEST DOCUMENTATION ARE ALSO DISCUSSED. (LEW)

DESCRIPTORS *BARSTOW SOLAR PILOT PLANT--CENTRAL RECEIVERS; *CENTRAL RECEIVERS--PERFORMANCE TESTING;ACCIDENTS;CENTRAL RECEIVER TEST FACILITY;CLOUD COVER;CONTROL SYSTEMS;DESIGN;DOCUMENTATION; EXPERIMENT PLANNING;QUALITY ASSURANCE;SAFETY;SOLAR CONCENTRATORS;SPECIFICATIONS;STEADY-STATE CONDITIONS;THERMAL INSULATION;TOWERS;TRANSIENTS

DOE F 1325.8
(7-79)

STMPO-101
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U.S. DEPARTMENT OF ENERGY

memorandum

DATE JUN 27 1984

REPLY TO ATTN OF: Doug Elliott, DOE/Barstow

SUBJECT: Request for "Hard Copy" of Report DOE/ET/20417-T4, by McDonnell Douglas Astronautics Company (Project File No. STMPO-101)

TO: Norma Del Gaudio, ISEA

Thank you for running down the list of reports under contract ET20417 I provided you with last month. It appears that the report I am looking for is DOE/ET/20417-T4. This was initially submitted as /20417-2 in 1980, but - as you discovered - did not get into the system. We resubmitted it in 1981, but it got tagged with a "T" number. I need one copy (only), to put on the shelf in our on-site Library; can you get me a reasonably clean copy - one that could be reproduced on the Xerox if a "browser" wanted to make one?

The Solar One Visitors' Center is holding an open house with tours of the Plant and lots of local media coverage Saturday, July 21. If anyone from ISEA (or SAN in general) is interested (and doesn't mind dry heat!) we'd be happy to see you. Call me or Pat Tong-Snyder ((619) 254-2810), the V.C. Director, for details.

Doug E.

S. D. Elliott, Jr., Director,
DOE Solar One Project Office

cc: Mike Lopez, FGS
Mary Soderstrum, B&McD

DEPARTMENT OF ENERGY
SAN FRANCISCO OPERATIONS
ENERGY INFORMATION CENTER
1333 BROADWAY
OAKLAND, CALIFORNIA 94612

7-23-84

We are pleased to make
this material available
to you - - -

Doug -
Here is the
report you
requested.
See you in
Sept.
Norma
EIC

-101
STMPO-~~101~~
DOE/ET/20417-T4