NASA Contractor Report 181716

50-METER HOOP COLUMN ANTENNA

PILLOW MEASUREMENTS

REPORT

21 December 1983

HARRIS

(NASA-CR-181716) THE 50-METER HOOP COLUMN ANTENNA PILLOW MEASUREMENTS REPORT (Harris Corp.) 65 p

N89-70618

Unclas

00/32 0191752

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TABLE OF CONTENTS

TABLE OF CONTENTS ii

LIST OF TABLES iii

LIST OF FIGURES iv

1.0 - INTRODUCTION AND SUMMARY 1

2.0 - PILLOW MEASUREMENTS 2

3.0 - ANALYSIS DESCRIPTION AND SHAPE CORRELATION 7

4.0 - RESULTS SUMMARY 23

5.0 - CONCLUSION 24

APPENDIX A - ANALYTIC PILLOW COORDINATES FOR HALF-GORE MODEL 35

APPENDIX B - PILLOW POLYNOMIAL COEFFICIENTS 50

APPENDIX C - COMPARISON OF BESTFIT PLANE TO BESTFIT PARABOLA RMS RESULTS 53

NOTE: ALL UNITS ARE INCHES

TABLE NUMBER	DESCRIPTION OF DATA	PAGE
2.0 - 1	PILLOW TARGET TO ORIGINAL 50-METER TARGET CORRELATION	2
2.0 - 2	ORIGINAL MEASUREMENTS OF PILLOW AND CONTROL POINT TARGETS	5 & 6
3.1 - 1	NON-TRANSFORMED ANALYTICAL PILLOW COORDINATES AND CORRESPONDING TRANSFORMED MEASURED PILLOW TARGET COORDINATES	9
3.1 - 2	ANALYTICAL NODE TO MEASURED TARGET CORRESPONDENCE	10
3.2 - 1	NON-TRANSFORMED ANALYTICAL PILLOW COORDINATES AND CORRESPONDING TRANSFORMED MEASURED PILLOW TARGET COORDINATES FOR PILLOW ONE	12
3.2 - 2	NON-TRANSFORMED ANLAYTICAL PILLOW COORDINATES AND CORRESPONDING TRANSFORMED MEASURED PILLOW TARGET COORDINATES FOR PILLOW TWO	13
3.3 - 1	ANALYTICAL AND MEASURED COORDINATES IN PILLOW COORDINATE SYSTEM FOR PILLOW ONE	14
3.3 - 2	ANALYTICAL AND MEASURED COORDINATES IN PILLOW COORDINATE SYSTEM FOR PILLOW TWO	15
3.4 - 1	ANALYTICAL AND MEASURED COORDINATES IN PILLOW ONE COORDINATE SYSTEM WITH ADJUSTED OFFSETS	18
3.4 - 2	ANALYTICAL AND MEASURED COORDINATES IN PILLOW TWO COORDINATES SYSTEM WITH ADJUSTED OFFSETS	19
3.5 - 1	BESTFIT RESULTS FOR PILLOW ONE	21
3.5 - 2	BESTFIT RESULTS FOR PILLOW TWO	22
APPENDIX A	ANALYTIC COORDINATES FOR HALF-GORE MODEL	36 - 49
APPENDIX B	PILLOW POLYNOMIAL COEFFICIENTS	51 - 52
APPENDIX C	COMPARISON OF BESTFIT PLANE TO BESTFIT PARABOLA RMS RESULTS	54 - 58

LIST OF FIGURES

FIGURE NUMBER	TITLE	PAGE
2.0 - 1	FOUR-GORE CONFIGURATION	3
2.0 - 2	PILLOW TARGET CONFIGURATION	4
3.1 - 1	HALF-GORE ANALYTICAL PILLOW MODEL	8
3.4 - 1	ANALYTIC NODE VERSUS TARGET LOCATION	16
3.4 - 2	TARGET POSITION ADJUSTMENT DESCRIPTION	17
4.2 - 1 thru 4.2 - 5	PLANAR CUT THROUGH PILLOW ONE SHOWING SHAPE CORRELATION	25 - 29
4.2 - 6 thru 4.2 - 10	PLANAR CUT THROUGH PILLOW TWO SHOWING SHAPE CORRELATION	30 - 34

1.0 INTRODUCTION AND SUMMARY

This report is in response to Task Assignment No. 5, Modification No. 8, Subtask 2.2.7, Statement of Work. This report addresses the measurement results of a breadboard antenna describing the surface roughness, and the correlation of that measurement to predicted analytical surface roughness. The results of this report are not expected to be used as a basis for any RF analysis but to simply serve as a data base for future analytical predictions. The antenna breadboard measured is in a gravity deflected environment with limited known boundary conditions. Accurate analytical predictions cannot be achieved without further antenna surface breadboard measurements of mesh and cord tensions. These results will stand alone as a measurement of antenna surface roughness in a gravity environment.

Results taken from Table 3.5-1 and Table 3.5-2:

PILLOW	PREDICTED RMS	MEASURED RMS
One	0.13668 (in.)	0.11338 (in.)
Two	0.18097 (in.)	0.14811 (in.)

2.0 PILLOW MEASUREMENTS

The 50-Meter Surface Verification Model (NAS1-15763; 19 August 1982) is the breadboard model used for pillow measurement. The four-gore surface is depicted graphically in Figure 2.0-1. The target locations of nineteen control point targets and fourty-five measured pillow targets are displayed. Photogrametrically measured pillow targets are also indicated on Figure 1 for location purposes only.

NOTE: Six targets are represented as concentric circles. These six targets are six of the original 50-Meter 184 targets set as discussed in the 50-Meter Final Report and have the following correspondence:

Pillow Target to Original 50-Meter Target Correlation

PILLOW TARGET NUMBER	50-METER TARGET NUMBER
1	32012
5	32103
9	32104
37	32202
41	32203
45	32204

Table 2.0-1

The "as measured" pillow targets and the "as measured" control point targets are listed in Table 2.0-2. All targets are measured in a coordinate system that corresponds to the previously generated 50-Meter Measurement System. This was accomplished by regressing the current control point targets to the correpsonding control point targets measured with the original 50-Meter Surface Breadboard Model (NAS1-15763; 19 August 1982). The six control point targets and the pillow target locations are shown in Figure 2.0-1.

FRONT-GORE TARGET CONFIGURATION

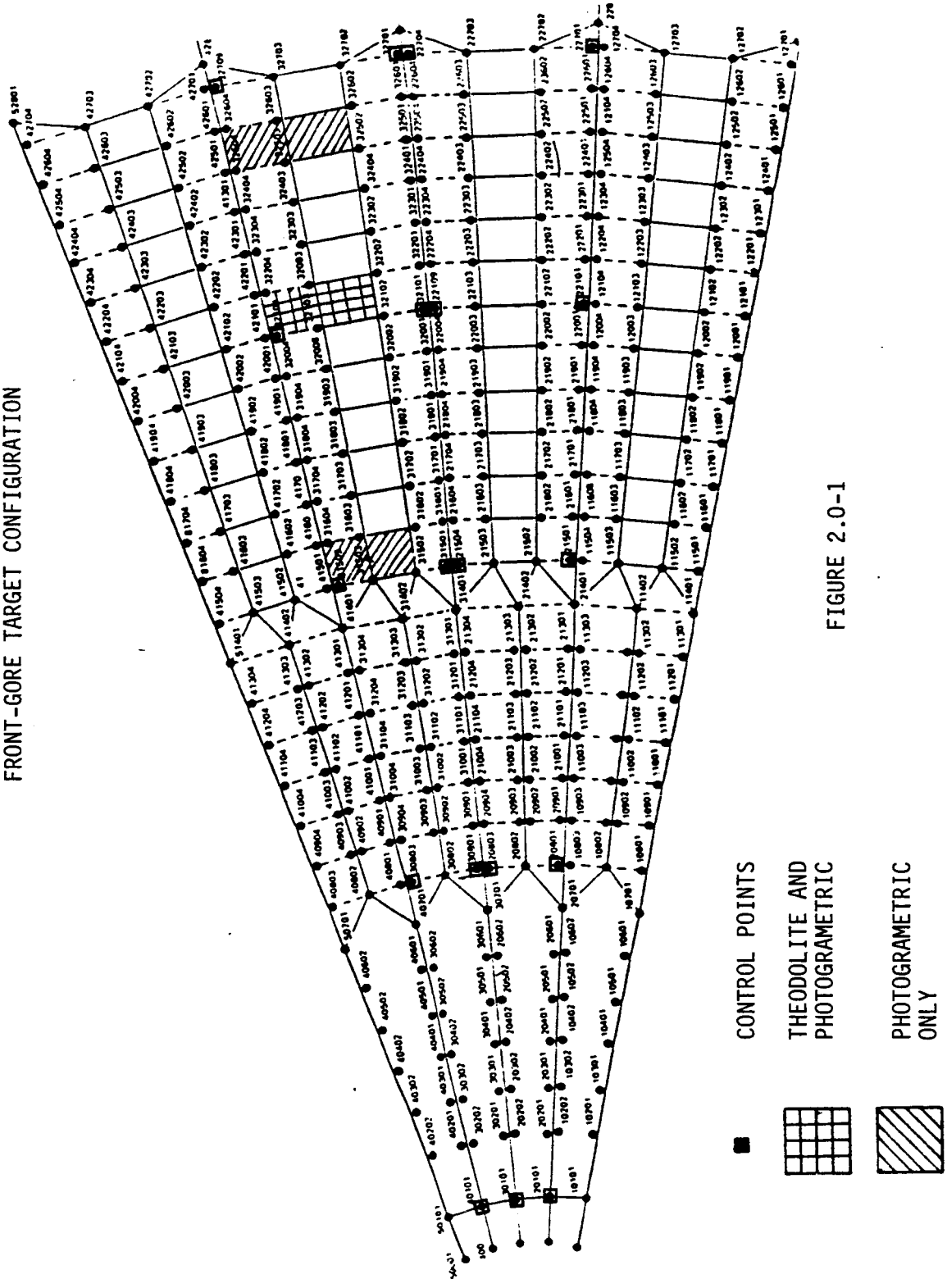

FIGURE 2.0-1

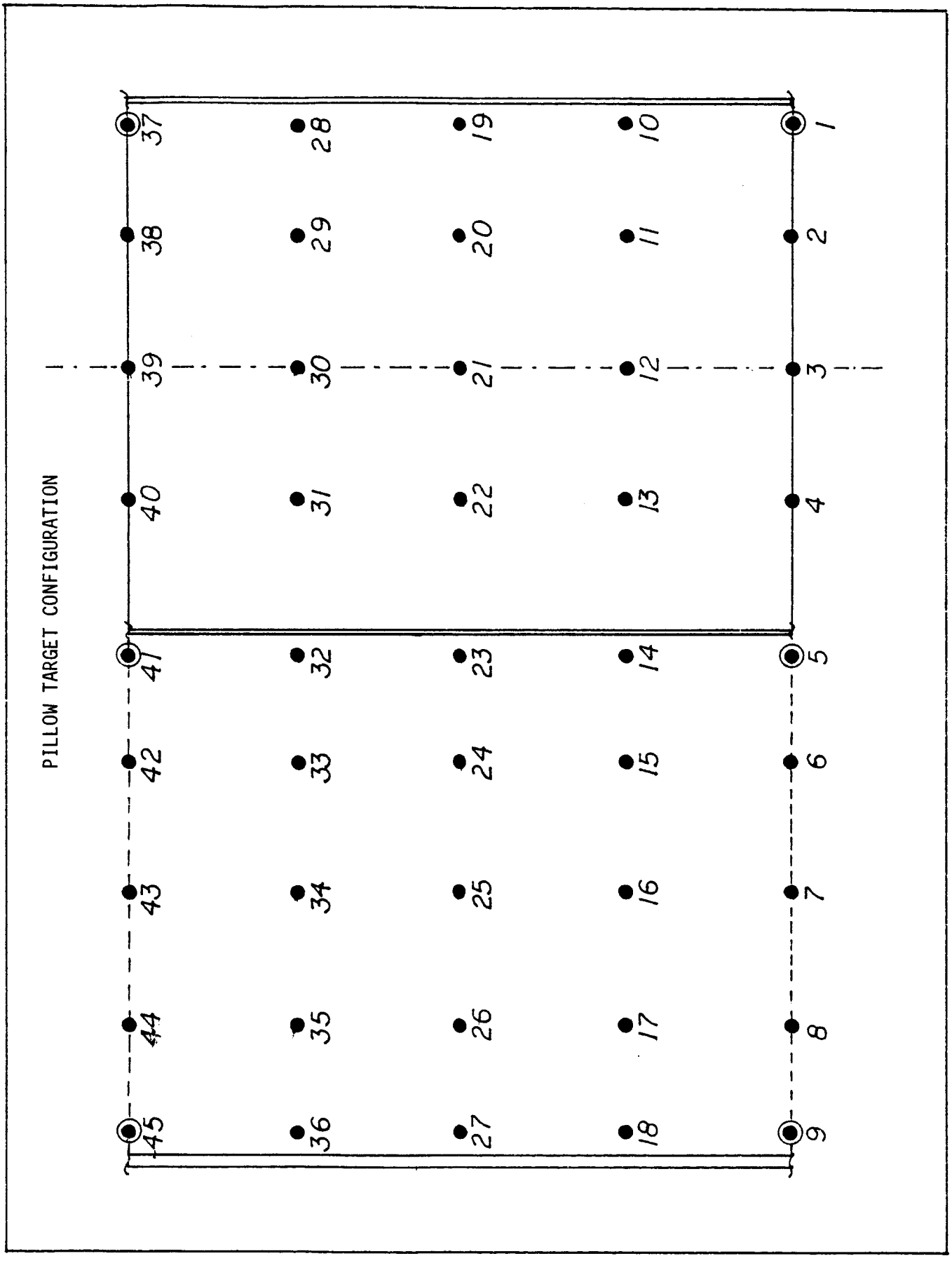
PILLOW TARGET CONFIGURATION
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FIGURE 2.0-2

FILE NAME: XCA63

Table 2.0-2

ORIGINAL MEASUREMENTS OF PILLOW
AND CONTROL POINT TARGETS

1	911	139.57710	347.95970	241.11830	0.00420	0.01390	0.00430	0.01514
2	912	230.02900	9.94620	241.00470	0.00250	0.00740	0.00720	0.01062
3	952	809.58440	165.15800	241.50000	0.00230	0.00360	0.00490	0.00650
4	1000	453.30890	23.48770	241.50280	0.00050	0.00060	0.00090	0.00119
5	1001	650.62430	140.08840	241.50880	0.00190	0.00100	0.00510	0.00553
6	1025	742.97380	101.55320	241.38090	0.00070	0.00190	0.00250	0.00322
7	1072	630.72210	207.21520	241.55630	0.00280	0.00130	0.00660	0.00729
8	3201	695.36800	219.40720	89.31800	0.00300	0.00240	0.00360	0.00526
9	3202	692.83940	226.60240	89.41200	0.00170	0.00260	0.00280	0.00418
10	3203	690.29160	234.16890	89.40710	0.00070	0.00460	0.00080	0.00472
11	3204	687.80490	241.61940	89.32720	0.00190	0.00250	0.00340	0.00463
12	3205	685.18030	249.64870	89.18370	0.00180	0.00380	0.00230	0.00479
13	3206	682.51050	256.27280	89.40370	0.00250	0.00270	0.00500	0.00621
14	3207	679.58040	263.64140	89.47640	0.00190	0.00370	0.00230	0.00475
15	3208	676.72300	270.66720	89.35240	0.00230	0.00550	0.00330	0.00681
16	3209	674.19130	277.29000	89.11470	0.00260	0.00570	0.00210	0.00661
17	3210	702.05090	221.52800	91.27280	0.00090	0.00280	0.00090	0.00308
18	3211	699.65390	228.72600	91.44870	0.00120	0.00030	0.00310	0.00334
19	3212	697.14030	236.37780	91.49610	0.00280	0.00480	0.00480	0.00734
20	3213	694.59130	244.04710	91.38220	0.00120	0.00120	0.00360	0.00398
21	3214	691.93700	252.06750	91.15250	0.00180	0.00440	0.00210	0.00520
22	3215	689.20630	258.90560	91.37160	0.00080	0.00270	0.00080	0.00293
23	3216	686.26280	266.15900	91.41310	0.00190	0.00410	0.00200	0.00494
24	3217	683.37600	273.36480	91.30830	0.00100	0.00220	0.00240	0.00341
25	3218	680.74130	280.08140	91.06550	0.00060	0.00150	0.00040	0.00166
26	3219	708.85450	223.66480	93.23110	0.00130	0.00100	0.00320	0.00360
27	3220	706.53200	230.94690	93.44400	0.00120	0.00280	0.00470	0.00560
28	3221	703.90990	238.68930	93.50930	0.00380	0.00870	0.00510	0.01078
29	3222	701.39810	246.34000	93.37410	0.00070	0.00140	0.00170	0.00231
30	3223	698.66500	254.56120	93.13660	0.00080	0.00170	0.00160	0.00247
31	3224	695.90620	261.47040	93.34870	0.00150	0.00050	0.00420	0.00449
32	3225	692.98420	268.74920	93.40260	0.00120	0.00430	0.00450	0.00634
33	3226	690.07060	276.10510	93.29720	0.00180	0.00120	0.00410	0.00464
34	3227	687.47760	282.78070	93.05930	0.00140	0.00180	0.00270	0.00353
35	3228	715.61030	225.84320	95.18770	0.00160	0.00150	0.00530	0.00574
36	3229	713.18770	233.30430	95.40680	0.00200	0.00200	0.00510	0.00583
37	3230	710.68000	241.00140	95.45610	0.00300	0.00370	0.00770	0.00905
38	3231	708.10940	248.70550	95.34910	0.00110	0.00240	0.00400	0.00479
39	3232	705.31820	257.08240	95.12080	0.00170	0.00400	0.00180	0.00470
40	3233	702.61370	263.92150	95.31440	0.00140	0.00200	0.00290	0.00379
41	3234	699.64460	271.30210	95.37560	0.00200	0.00550	0.00120	0.00597
42	3235	696.67770	278.70690	95.25750	0.00120	0.00330	0.00310	0.00468
43	3236	693.96340	285.46090	94.95080	0.00170	0.00330	0.00230	0.00437
44	3237	722.30720	227.97730	97.10540	0.00110	0.00120	0.00480	0.00507
45	3238	719.88420	235.39970	97.27720	0.00240	0.00340	0.00710	0.00823
46	3239	717.29070	243.23790	97.31120	0.00310	0.00460	0.00250	0.00608
47	3240	714.66670	251.16490	97.22270	0.00190	0.00230	0.00500	0.00582
48	3241	711.87870	259.51260	97.06210	0.00200	0.00230	0.00200	0.00365
49	3242	709.16510	266.34500	97.28710	0.00060	0.00200	0.00260	0.00333
50	3243	706.25180	273.80810	97.32690	0.00050	0.00140	0.00170	0.00226
51	3244	703.28240	281.17440	97.21140	0.00240	0.00180	0.00540	0.00618
52	3245	700.60320	288.15020	96.92410	0.00140	0.00210	0.00080	0.00265
53	20101	161.43260	21.41360	1.98010	0.00200	0.00430	0.00570	0.00741
54	20801	378.47810	50.66940	20.00320	0.00790	0.01500	0.00750	0.01854
55	20803	378.48990	50.69300	20.00480	0.00350	0.00320	0.00290	0.00556

56	21501	580.32510	77.36020	54.43830	0.00140	0.00080	0.00100	0.00190
57	21504	565.88620	150.69360	54.51710	0.00100	0.00200	0.00150	0.00269
58	21801	665.99210	88.88030	74.29850	0.00080	0.00080	0.00080	0.00139
59	21804	649.44880	172.79640	74.34650	0.00120	0.00230	0.00230	0.00347
60	22101	750.87620	100.03700	96.92390	0.00150	0.00170	0.00220	0.00316
61	22109	732.03070	195.03540	96.87660	0.00210	0.00130	0.00440	0.00505
62	22701	918.40600	121.74750	150.05260	0.00150	0.00380	0.00710	0.00819
63	22704	895.18270	239.28300	150.12120	0.00160	0.00350	0.00810	0.00897
64	23972	-0.07630	-0.00600	241.75640	0.00280	0.01190	0.01220	0.01727
65	23973	971.97090	-0.08750	242.30990	0.00590	0.00650	0.01200	0.01487
66	23974	841.69570	485.90640	241.95510	0.00740	0.00240	0.01210	0.01439
67	30101	157.20650	42.38100	2.00320	0.00320	0.00170	0.00540	0.00650
68	30801	368.74250	99.32570	19.99970	0.00450	0.00560	0.00350	0.00799
69	30803	353.11450	145.10590	20.00290	0.00190	0.00700	0.00290	0.00781
70	31301	509.58390	137.03420	43.10020	0.00070	0.00170	0.00140	0.00231
71	31501	565.55810	151.88460	54.50290	0.00090	0.00160	0.00120	0.00219
72	31504	541.64010	222.80040	54.56230	0.00100	0.00090	0.00160	0.00209
73	31801	621.44540	255.52300	74.41990	0.00120	0.00100	0.00260	0.00303
74	31804	541.64110	222.80110	54.56040	0.00020	0.00060	0.00070	0.00094
75	32101	731.71280	196.16600	96.84340	0.00120	0.00160	0.00250	0.00320
76	32104	700.60250	288.14820	96.91340	0.00110	0.00190	0.00290	0.00364
77	32701	894.81240	240.59580	150.13540	0.00230	0.00340	0.00570	0.00702
78	32704	856.28820	353.98540	150.05480	0.00240	0.00480	0.00760	0.00930
79	40101	150.22440	62.68550	1.99380	0.00410	0.00420	0.00510	0.00778

3.0 ANALYSIS DESCRIPTION AND SHAPE CORRELATION

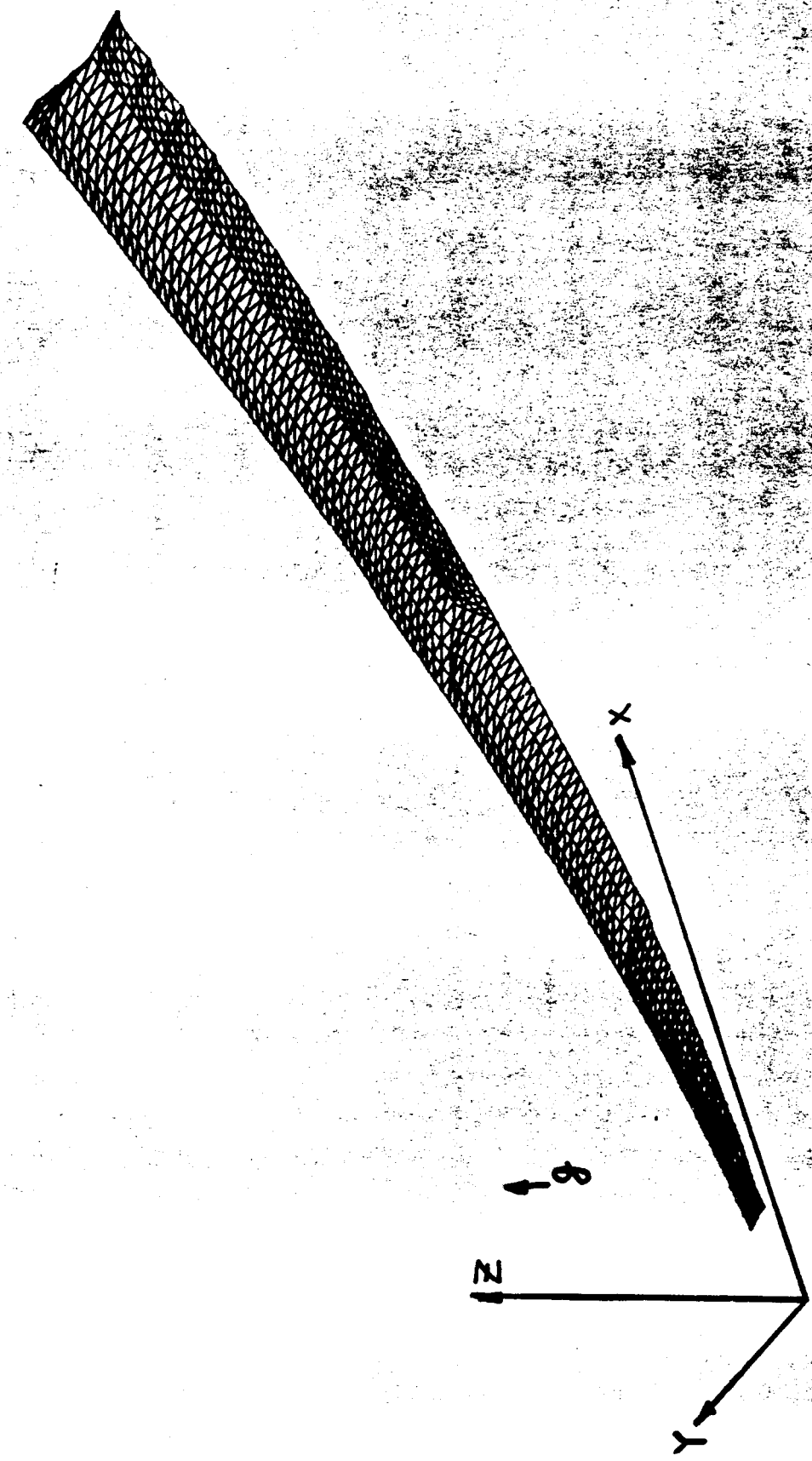
The purpose of the pillow measurement is to verify the ability to analytically predict the shape of the reflective surface, thus establishing the data base for future analytical predictions.

3.1 Analytical Model Description

The analytically predicted target coordinates are arrived at by use finite element structural analysis methods using a triangular membrane element capable of orthotropic mechanical properties. The effect of the gravity environment is taken into acocunt as well as idealized boundary conditions. The actual boundary conditions are not known but are taken to be within reasonable limits of expected conditions.

The analytical model is shown in Figure 3.1-1. The half-gore model represents a symmetrically reflective model about the gore centerline. The gore center line is the x-axis (Y = 0.0). Note that the measured coordinates do not compare to the analytical coordinates until a transformation of coordinate systems is performed. Appendix A lists the un-transformed coordinates of the half-gore analytical model. Listed in Table 3.1-1 are the analytical coordinates that correspond to the pillow targets (in the half-gore analytic coordinate system). The measured pillow targets transformed to the half-gore coordinate system and in the last three columns, the Delta X, Delta Y, and Delta Z of the two sets of coordinates.

Listed in Table 3.1-2 is the analytical node to measured target correlation to relate half-gore coordinates to target coordinates.



HALF-GORE ANALYTICAL PILLOW MODEL

FIGURE 3.1-1

Table 3.1-1

NON-TRANSFORMED ANALYTICAL PILLOW COORDINATES AND CORRESPONDING TRANSFORMED MEASURED PILLOW TARGET COORDINATES

1	-1	728.77002	-15.89762	88.96219	728.60500	-15.58521	88.97221	-0.16375	0.31001	0.00994
2	2	728.73638	-7.94909	89.11941	728.51390	-7.90053	89.10079	-0.22077	0.04819	-0.01848
3	3	728.71445	-0.00051	89.20051	728.52433	0.14524	89.13128	-0.18866	0.14463	-0.06870
4	4	728.73638	7.94909	89.11941	728.55562	8.06089	89.08561	-0.17937	0.11094	-0.03354
5	-5	728.77002	15.89762	88.96219	728.64212	16.57388	88.97848	-0.12692	0.67105	0.01616
6	6	728.34842	23.83653	89.28268	728.23187	23.75839	89.23187	-0.11565	-0.07754	-0.05041
7	7	727.97805	31.78306	89.39011	727.81346	31.73831	89.34033	-0.16332	-0.04440	-0.04940
8	8	727.65761	39.73155	89.28866	727.35376	39.36839	89.24903	-0.30151	-0.36037	-0.03933
9	-9	727.38802	47.67629	88.97426	727.07487	46.50911	89.04096	-0.31074	-1.15820	0.06619
10	-10	735.88325	-16.05279	90.92938	735.66970	-15.72669	90.94068	-0.21190	0.32359	0.01121
11	11	735.82451	-7.94947	91.17789	735.70515	-8.08219	91.15160	-0.11844	-0.13169	-0.02609
12	12	735.80687	-0.00051	91.25830	735.77577	0.03375	91.23510	-0.03086	0.03399	-0.02302
13	13	735.82451	7.94947	91.17789	735.81822	8.17853	91.15618	-0.00624	0.22730	-0.02155
14	-14	735.88325	16.05279	90.92938	735.87348	16.69299	90.96218	-0.00969	0.63528	0.03255
15	15	735.46600	23.99160	91.23148	735.47418	24.10146	91.21566	0.00812	0.10902	-0.01570
16	16	735.09594	31.93816	91.33721	735.00578	31.97587	91.29221	-0.08946	0.03742	-0.04465
17	17	734.77304	39.88688	91.24438	734.57613	39.78719	91.22105	-0.19540	-0.09892	-0.02315
18	-18	734.48833	48.14168	90.93921	734.22919	47.05073	91.00840	-0.25714	-1.08256	0.06865
19	-19	742.99794	-16.20799	92.89127	742.85480	-15.89188	92.91255	-0.14204	0.31368	0.02112
20	20	742.93173	-7.95078	93.16459	742.98852	-8.19130	93.16100	0.05635	-0.23867	-0.00356
21	21	742.91457	-0.00052	93.25061	742.98481	0.04607	93.26308	0.06970	0.04623	0.01237
22	22	742.93173	7.95078	93.16459	743.05677	8.16118	93.16256	0.12408	0.20878	-0.00202
23	-23	742.99794	16.20799	92.89127	743.10163	16.89281	92.96166	0.10289	0.67955	0.06985
24	24	742.58049	24.14661	93.19224	742.69845	24.37825	93.20842	0.11706	0.22986	0.01605
25	25	742.20955	32.09318	93.29956	742.25878	32.26992	93.29754	0.04885	0.17538	-0.00200
26	26	741.87424	40.35236	93.20447	741.85200	40.23318	93.22644	-0.02207	-0.11826	0.02180
27	-27	741.58975	48.60714	92.90012	741.53164	47.44409	93.01849	-0.05767	-1.15410	0.11746
28	-28	750.11414	-16.36296	94.84771	750.00769	-16.00191	94.88296	-0.10563	0.35827	0.03498
29	29	750.05139	-8.10670	95.10729	750.10364	-8.09817	95.13855	0.05185	0.00847	0.03102
30	30	750.03304	-0.00065	95.19222	750.19452	0.05910	95.22415	0.16023	0.05929	0.03168
31	31	750.05139	8.10670	95.10729	750.22759	8.24404	95.15236	0.17484	0.13629	0.04472
32	-32	750.11414	16.36296	94.84771	750.26724	17.14302	94.96147	0.15192	0.77406	0.11288
33	33	749.69375	24.30142	95.15746	749.89327	24.54410	95.18921	0.19799	0.24081	0.03150
34	34	749.30739	32.55876	95.27048	749.44150	32.54812	95.28619	0.13308	-0.01056	0.01559
35	35	748.97384	40.81784	95.16984	748.99962	40.57533	95.20257	0.02558	-0.24065	0.03248
36	-36	748.69227	49.07267	94.85698	748.58876	47.90055	94.92580	-0.10271	-1.16310	0.06829
37	-37	757.23182	-16.51796	96.79876	757.09005	-16.13505	96.81408	-0.14068	0.37997	0.01520
38	38	757.19096	-8.25934	96.97750	757.17312	-8.26791	97.02184	-0.01770	-0.00850	0.04400
39	39	757.16435	-0.00066	97.07021	757.22763	0.05182	97.09274	0.06280	0.05208	0.02235
40	40	757.19096	8.25934	96.97750	757.28169	8.46671	97.04060	0.09003	0.20578	0.06261
41	-41	757.23182	16.51796	96.79876	757.31498	17.33648	96.91781	0.08252	0.81222	0.11813
42	42	756.78770	24.76660	97.14191	756.93016	24.73396	97.17718	0.14137	-0.03239	0.03500
43	43	756.40092	33.02385	97.25661	756.55829	32.79882	97.25285	0.15616	-0.22330	-0.00373
44	44	756.06998	41.28306	97.14738	756.10160	40.79007	97.17170	0.03137	-0.48920	0.02413
45	-45	755.79593	49.53828	96.80974	755.79585	48.31561	96.91535	-0.00008	-1.21326	0.10479

FILE NAME: WASNOW

Table 3.1-2

ANALYTICAL NODE TO TARGET CORRELATION

1	374	7.
2	958	3.
3	390	390.
4	375	6.
5	373	8.
6	389	4.
7	388	388.
8	957	5.
9	955	9.
10	379	16.
11	391	12.
12	395	395.
13	367	17.
14	380	15.
15	394	13.
16	382	382.
17	376	14.
18	366	18.
19	368	25.
20	392	21.
21	396	396.
22	372	26.
23	381	24.
24	383	22.
25	387	387.
26	377	23.
27	365	27.
28	370	34.
29	393	30.
30	384	384.
31	371	35.
32	369	33.
33	385	31.
34	386	386.
35	378	32.
36	364	36.
37	341	43.
38	953	39.
39	357	357.
40	342	42.
41	340	44.
42	356	40.
43	355	355.
44	952	41.
45	950	45.

EOF..

Listed in Table 3.1-1 and all subsequent ten column data sets is the following information.

COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7	COL 8	COL 9	COL 10
TARGET NUM	ANAL X (in.)	ANAL Y (in.)	ANAL Z (in.)	MEAS X (in.)	MEAS Y (8n.)	MEAS Z (in.)	DEL X (in.)	DEL Y (in.)	DEL Z (in.)

3.2 Pillow by Pillow Correlation

The comparison of the analytical pillow targets is done on a pillow by pillow basis. Therefore, the pillow shown in Figure 2.0-2 is divided into two separate entities with the pillow on the right side of the figure designated as pillow one and the pillow on the left side of the figure designated as pillow two. The two pillows are analyzed separately. Using the target positions of each pillow as a set, the measured pillow was regressed to the analytical pillow for both pillows. This allowed for errors in the global transformation to be removed and each pillow to more exactly fit the analytical pillows separately. The two separate pillows are listed in Table 3.2-1 and Table 3.2-2. These tables list the analytical coordinates, the measured coordinates and the X, Y, Z Deltas.

3.3 Transform to Pillow Coordinate System

As an aid in analysis, the pillow target sets were again transformed to pillow coordinate systems as shown in Figure 2.0-2. The analytical coordinates were used as the vertex of the coordinates. Table 3.3-1 and Table 3.3-2 list the pillow target sets in the pillow coordinate systems.

3.4 Account for Target Offset

The analytical mesh pillow model is shown in Figure 3.4-1, superimposed on the area of surface containing the measured targets. Listed on Figure 3.4-1 are target offsets arrived at by measuring the distance from the cord center line to the target center point. The target offsets are required to define the analytical versus measured target position. Notice

FILE NAME: JDSPILL1

Table 3.2-1

NON-TRANSFORMED ANALYTICAL AND MEASURED COORDINATES, PILLOW ONE

1	-1	728.77002	-15.89760	88.96219	728.74116	-15.55000	88.99752	-0.02886	0.34760	0.03533
2	2	728.73638	-7.94911	89.11941	728.63616	-7.92472	89.13042	-0.10022	0.02439	0.01101
3	3	728.71445	-0.00056	89.20051	728.63117	0.05913	89.16617	-0.08328	0.05970	-0.03434
4	4	728.73638	7.94911	89.11941	728.64710	7.91395	89.12626	-0.08928	-0.03516	0.00685
5	-5	728.77002	15.89760	88.96219	728.71663	16.36166	89.02572	-0.05339	0.46406	0.06353
6	-10	735.88325	-16.05279	90.92938	735.75278	-15.67825	90.94709	-0.13047	0.37454	0.01771
7	11	735.82451	-7.94948	91.17789	735.77348	-8.09265	91.16160	-0.05103	-0.14317	-0.01629
8	12	735.80687	-0.00057	91.25830	735.82811	-0.03910	91.24997	0.02124	-0.03853	-0.00833
9	13	735.82451	7.94948	91.17789	735.85465	8.04313	91.17721	0.03014	0.09366	-0.00068
10	-14	735.88325	16.05279	90.92938	735.89314	16.49231	90.99050	0.00989	0.43952	0.06112
11	-19	742.99794	-16.20795	92.89127	742.88392	-15.82980	92.89996	-0.11402	0.37815	0.00869
12	20	742.93173	-7.95084	93.16459	743.00205	-8.18840	93.15169	0.07032	-0.23756	-0.01289
13	21	742.91457	-0.00058	93.25061	742.98270	-0.01450	93.25863	0.06813	-0.01392	0.00802
14	22	742.93173	7.95084	93.16459	743.03857	8.03836	93.16439	0.10684	0.08753	-0.00020
15	-23	742.99794	16.20795	92.89127	743.06631	16.70302	92.97099	0.06837	0.49507	0.07972
16	-28	750.11414	-16.36302	94.84771	749.98300	-15.92668	94.85143	-0.13114	0.43634	0.00372
17	29	750.05139	-8.10672	95.10729	750.06326	-8.08375	95.11042	0.01187	0.02297	0.00313
18	30	750.03304	-0.00060	95.19222	750.13792	0.01085	95.20088	0.10488	0.01145	0.00867
19	31	750.05139	8.10672	95.10729	750.15507	8.13292	95.13523	0.10368	0.02620	0.02794
20	-32	750.11414	16.36302	94.84771	750.17734	16.96362	94.95187	0.06320	0.60060	0.10417
21	-37	757.23182	-16.51791	96.79876	757.01211	-16.04659	96.76393	-0.21971	0.47132	-0.03483
22	38	757.19096	-8.25938	96.97750	757.07964	-8.23998	96.97544	-0.11132	0.01940	-0.00206
23	39	757.16435	-0.00061	97.07021	757.11789	0.01577	97.05145	-0.04646	0.01639	-0.01876
24	40	757.19096	8.25938	96.97750	757.15544	8.36604	97.00544	-0.03552	0.10667	0.02794
25	-41	757.23182	16.51791	96.79876	757.17149	17.16770	96.88965	-0.06033	0.64979	0.09089

EOF.

FILE NAME: JDSPILL2

Table 3.2-2

NON-TRANSFORMED ANALYTICAL MEASURED COORDINATES, PILLOW TWO

1	-5	728.77002	15.89760	88.96219	728.72621	16.76549	89.04735	-0.04381	0.86790	0.08516
2	6	728.34842	23.83655	89.28268	728.33034	23.89601	89.27978	-0.01808	0.05946	-0.00290
3	7	727.97805	31.78307	89.39011	727.92771	31.81544	89.36630	-0.05034	0.03237	-0.02381
4	8	727.65761	39.73150	89.28866	727.48368	39.38727	89.25548	-0.17393	-0.34423	-0.03318
5	-9	727.38803	47.67624	88.97426	727.21837	46.47291	89.03019	-0.16966	-1.20333	0.05593
6	-14	735.88325	16.05279	90.92938	735.90090	16.87744	91.01991	0.01765	0.82465	0.09053
7	15	735.46600	23.99163	91.23148	735.51625	24.23017	91.25183	0.05025	0.23854	0.02035
8	16	735.09594	31.93813	91.33721	735.06388	32.04490	91.30694	-0.03206	0.10677	-0.03027
9	17	734.77304	39.88693	91.24438	734.64994	39.79658	91.21566	-0.12310	-0.09035	-0.02872
10	-18	734.48833	48.14164	90.93921	734.31730	47.00419	90.98545	-0.17103	-1.13745	0.04624
11	-23	742.99794	16.20795	92.89127	743.07253	17.06951	93.00790	0.07459	0.86157	0.11663
12	24	742.58049	24.14660	93.19224	742.68416	24.49861	93.23296	0.10367	0.35202	0.04072
13	25	742.20955	32.09323	93.29956	742.26031	32.33045	93.30051	0.05076	0.23722	0.00095
14	26	741.87424	40.35240	93.20447	741.86930	40.23287	93.20891	-0.00494	-0.11953	0.00444
15	-27	741.58975	48.60711	92.90012	741.56295	47.38823	92.98352	-0.02680	-1.21888	0.08340
16	-32	750.11414	16.36302	94.84771	750.18218	17.31170	94.99606	0.06804	0.94868	0.14835
17	33	749.69375	24.30138	95.15746	749.82267	24.65698	95.20248	0.12892	0.35560	0.04502
18	34	749.30739	32.55874	95.27048	749.38698	32.60035	95.27752	0.07959	0.04161	0.00705
19	35	748.97384	40.81784	95.16984	748.96126	40.56624	95.17331	-0.01258	-0.25160	0.00347
20	-36	748.69227	49.07265	94.85698	748.56533	47.83500	94.87928	-0.12694	-1.23765	0.02230
21	-41	757.23182	16.51791	96.79876	757.17480	17.49763	96.94115	-0.05702	0.97973	0.14239
22	42	756.78770	24.76666	97.14191	756.80450	24.83945	97.17896	0.01680	0.07279	0.03705
23	43	756.40092	33.02382	97.25661	756.44821	32.84301	97.23275	0.04729	-0.18081	-0.02385
24	44	756.06997	41.28311	97.14738	756.00773	40.77324	97.13107	-0.06224	-0.50986	-0.01631
25	-45	755.79593	49.53827	96.80974	755.71640	48.24066	96.85685	-0.07953	-1.29760	0.04711

FILE NAME: JDSN1

Table 3.3-1

ANALYTICAL MEASURED COORDINATES, PILLOW ONE

1	1	-14.77504	-15.89760	-0.00380	-14.79346	-15.55000	0.03793	-0.01842	0.34760	0.04173
2	2	-14.76565	-7.94911	0.15670	-14.85934	-7.92472	0.19397	-0.09368	0.02439	0.03727
3	3	-14.76523	-0.00056	0.24071	-14.85464	0.05913	0.22976	-0.08941	0.05969	-0.01096
4	4	-14.76565	7.94911	0.15670	-14.84990	7.91395	0.18705	-0.08424	-0.03516	0.03035
5	5	-14.77504	15.89760	-0.00380	-14.80961	16.36166	0.07164	-0.03457	0.46406	0.07544
6	10	-7.39480	-16.05279	0.00083	-7.51587	-15.67825	0.05260	-0.12106	0.37454	0.05177
7	11	-7.38534	-7.94948	0.25601	-7.43886	-8.09265	0.25388	-0.05352	-0.14317	-0.00213
8	12	-7.38096	-0.00057	0.33822	-7.36270	-0.03910	0.32454	0.01826	-0.03853	-0.01368
9	13	-7.38534	7.94948	0.25601	-7.35647	8.04313	0.24734	0.02887	0.09365	-0.00867
10	14	-7.39480	16.05279	0.00083	-7.36902	16.49231	0.05712	0.02579	0.43952	0.05629
11	19	-0.01457	-16.20795	-0.00003	-0.12217	-15.82980	0.03867	-0.10760	0.37815	0.03870
12	20	-0.00571	-7.95084	0.28105	0.05865	-8.18840	0.24992	0.06436	-0.23756	-0.03114
13	21	0.00062	-0.00058	0.36854	0.06843	-0.01450	0.35815	0.06781	-0.01392	-0.01039
14	22	-0.00571	7.95084	0.28105	0.09723	8.03836	0.25245	0.10294	0.08752	-0.02861
15	23	-0.01457	16.20795	-0.00003	0.07254	16.70302	0.05863	0.08711	0.49507	0.05867
16	28	7.36567	-16.36302	-0.00655	7.24024	-15.92668	0.03191	-0.12543	0.43634	0.03846
17	29	7.37421	-8.10672	0.26037	7.38648	-8.08375	0.26023	0.01227	0.02297	-0.00014
18	30	7.37911	-0.00060	0.34712	7.48251	0.01085	0.32758	0.10341	0.01145	-0.01954
19	31	7.37421	8.10672	0.26037	7.48159	8.13292	0.25973	0.10738	0.02620	-0.00064
20	32	7.36567	16.36302	-0.00655	7.45429	16.96362	0.07705	0.08862	0.60060	0.08360
21	37	14.74590	-16.51791	-0.01866	14.52484	-16.04659	0.00620	-0.22106	0.47132	0.02485
22	38	14.75404	-8.25938	0.16451	14.64619	-8.23998	0.19213	-0.10786	0.01940	0.02762
23	39	14.75305	-0.00061	0.26096	14.70327	0.01577	0.25523	-0.04978	0.01638	-0.00573
24	40	14.75404	8.25938	0.16451	14.72723	8.36604	0.20089	-0.02681	0.10666	0.03638
25	41	14.74590	16.51791	-0.01866	14.71191	17.16770	0.08500	-0.03399	0.64979	0.10366

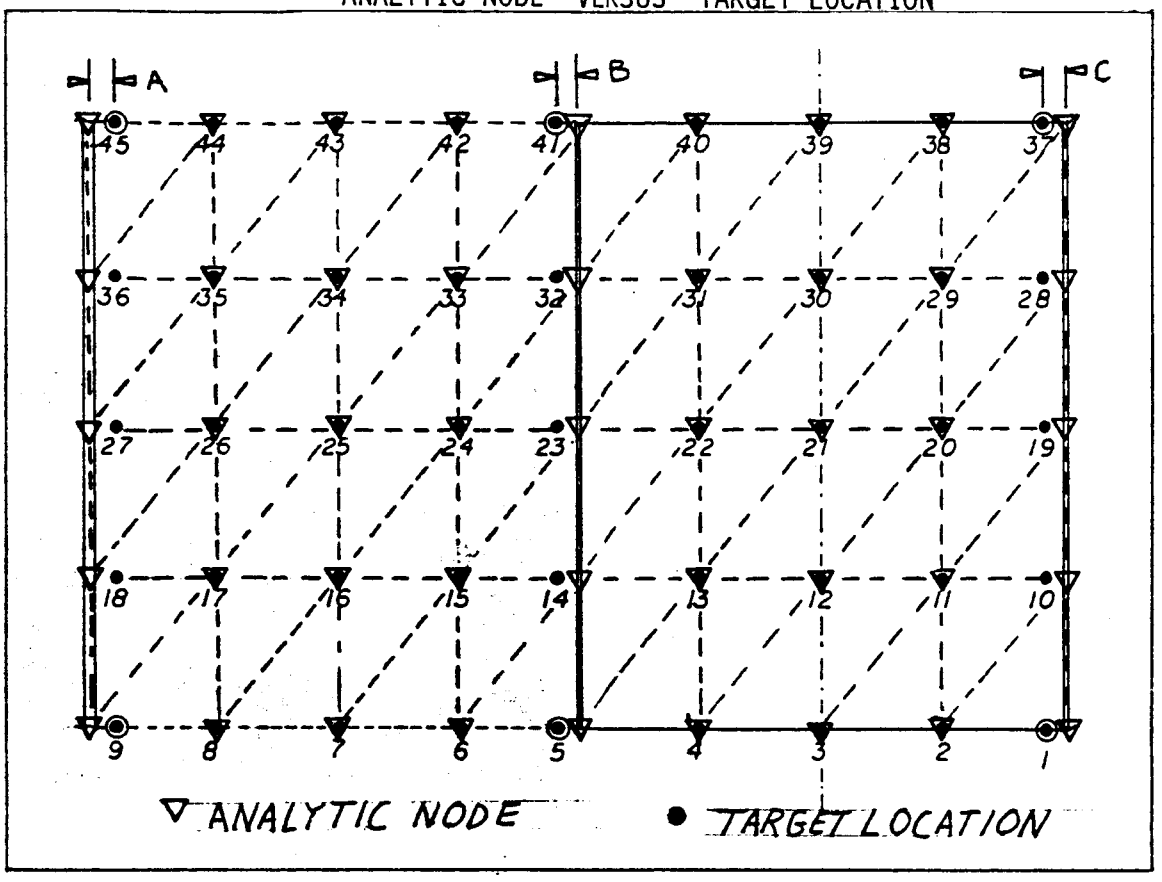
FILE NAME: JDSN2

Table 3.3-2

TRANSFORMED ANALYTICAL AND MEASURED COORDINATES, PILLOW TWO

1	-5	-14.77364	-15.59792	-0.21417	-14.75692	-14.72891	-0.13071	0.01672	0.86901	0.08346
2	6	-14.76269	-7.64805	0.11275	-14.77838	-7.58786	0.11405	-0.01569	0.06019	0.00130
3	7	-14.75874	0.30709	0.22058	-14.81221	0.34161	0.21062	-0.05347	0.03452	-0.00996
4	8	-14.76218	8.26191	0.11377	-14.95290	7.92555	0.13207	-0.19072	-0.33636	0.01830
5	-9	-14.77344	16.21076	-0.21179	-14.97224	15.01595	-0.09856	-0.19880	-1.19481	0.11323
6	-14	-7.39337	-15.75122	-0.20963	-7.31783	-14.92809	-0.13682	0.07554	0.82313	0.07281
7	-15	-7.38312	-7.80166	0.09841	-7.31935	-7.56551	0.10185	0.06377	0.23615	0.00344
8	16	-7.37933	0.15345	0.20452	-7.41379	0.26150	0.18259	-0.03446	0.10805	-0.02193
9	17	-7.38283	8.10874	0.10666	-7.51281	8.02382	0.11275	-0.12998	-0.08492	0.00609
10	-18	-7.39325	16.36793	-0.20966	-7.59320	15.23900	-0.10618	-0.19995	-1.12893	0.10348
11	-23	-0.01310	-15.90462	-0.21059	0.12576	-15.04708	-0.12818	0.13886	0.85754	0.08241
12	24	-0.00335	-7.95524	0.09641	0.12203	-7.60805	0.10395	0.12538	0.34719	0.00754
13	25	0.00002	0.00003	0.20429	0.05907	0.23482	0.18891	0.05905	0.23479	-0.01538
14	26	-0.00307	8.26594	0.10387	-0.01163	8.14675	0.11088	-0.00856	-0.11919	0.00701
15	-27	-0.01305	16.52513	-0.21171	-0.06762	15.30859	-0.10976	-0.05457	-1.21654	0.10195
16	-32	7.36717	-16.05818	-0.21721	7.51179	-15.11330	-0.10351	0.14462	0.94488	0.11370
17	33	7.37641	-8.10896	0.09905	7.52741	-7.75928	0.10399	0.15100	0.34968	0.00494
18	34	7.37943	0.15742	0.21283	7.45970	0.19554	0.19798	0.08027	0.03812	-0.01485
19	35	7.37656	8.42318	0.10660	7.35485	8.17237	0.11627	-0.02171	-0.25081	0.00967
20	-36	7.36713	16.68234	-0.21796	7.19908	15.45138	-0.14808	-0.16805	-1.23096	0.06988
21	-41	14.74743	-16.21199	-0.22941	14.77132	-15.23067	-0.08859	0.02389	0.98132	0.14082
22	42	14.75567	-7.95163	0.12167	14.78474	-7.87962	0.15207	0.02907	0.07201	0.03040
23	43	14.75872	0.31458	0.23719	14.79036	0.13188	0.20377	0.03164	-0.18270	-0.03342
24	44	14.75608	8.58041	0.12199	14.67049	8.07372	0.12885	-0.08559	-0.50669	0.00686
25	-45	14.74732	16.83958	-0.22847	14.62903	15.54666	-0.14655	-0.11829	-1.29292	0.08192

ANALYTIC NODE VERSUS TARGET LOCATION

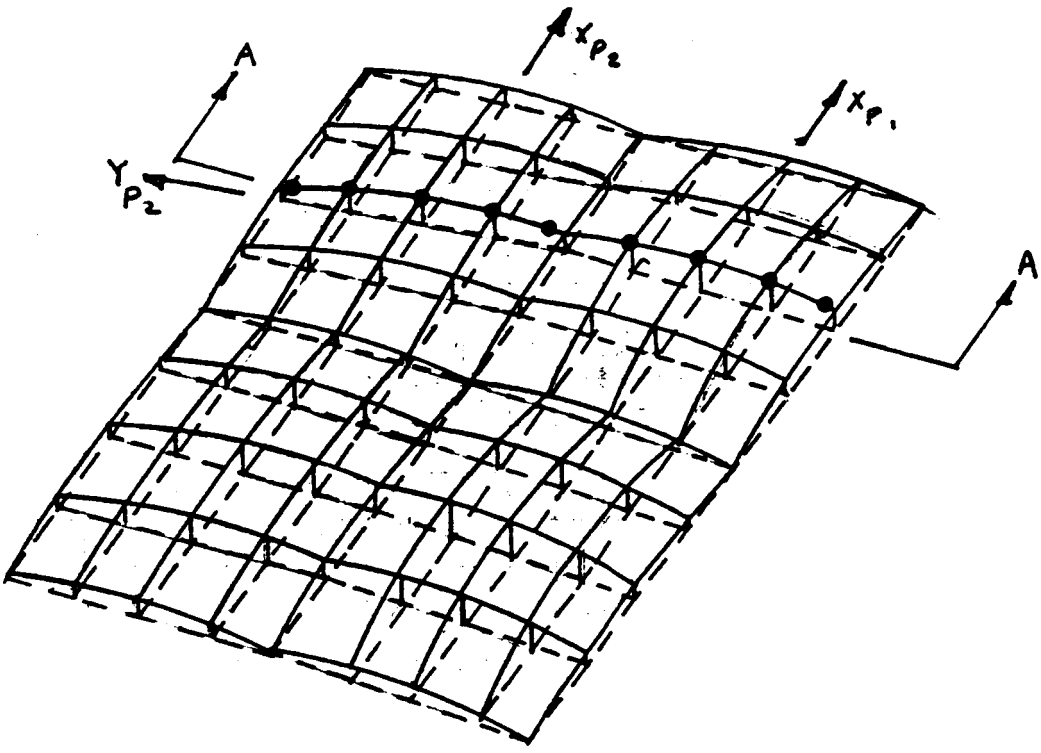


TARGET OFFSETS

A, 45 = .65"	B, 41 = .65"	C, 37 = .45"
A, 36 = .58"	B, 32 = .60"	C, 28 = .45"
A, 27 = .58"	B, 23 = .50"	C, 19 = .43"
A, 18 = .51"	B, 14 = .50"	C, 10 = .45"
A, 9 = .60"	B, 5 = .50"	C, 1 = .45"

FIGURE 3.4-1

TARGET POSITON ADJUSTMENT DESCRIPTION



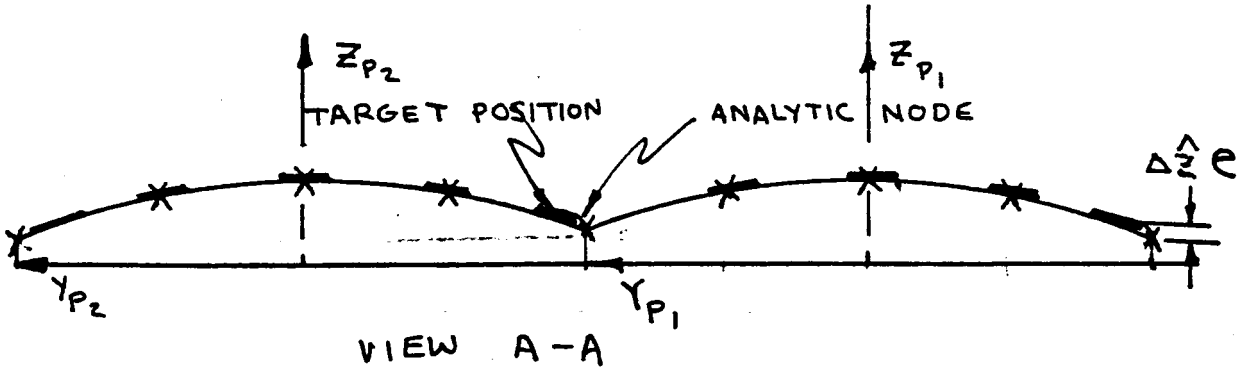


FIGURE 3.4-2

FILE NAME: JDSN1A

Table 3.4-1

ANALYTICAL MEASURED COORDINATES IN PILLOW ONE COORDINATE SYSTEM
WITH ADJUSTED OFFSETS

1	1	-14.77504	-15.89760	-0.00380	-14.79346	-16.00000	0.03451	-0.01842	-0.10240	0.03831
2	2	-14.76565	-7.94911	0.15670	-14.85934	-7.92472	0.19397	-0.09369	0.02439	0.03727
3	3	-14.76523	-0.00056	0.24071	-14.85464	0.05913	0.22976	-0.08941	0.05969	-0.01095
4	4	-14.76565	7.94911	0.15670	-14.84990	7.91395	0.18705	-0.08425	-0.03516	0.03035
5	5	-14.77504	15.89760	-0.00380	-14.80961	15.86166	0.06739	-0.03457	-0.03594	0.07119
6	10	-7.39480	-16.05279	0.00083	-7.51587	-16.12825	0.03297	-0.12107	-0.07546	0.03214
7	11	-7.38534	-7.94948	0.25601	-7.43886	-8.09265	0.25388	-0.05352	-0.14317	-0.00213
8	12	-7.38096	-0.00057	0.33822	-7.36270	-0.03910	0.32454	0.01826	-0.03853	-0.01368
9	13	-7.38534	7.94948	0.25601	-7.35647	8.04313	0.24734	0.02887	0.09365	-0.00867
10	14	-7.39480	16.05279	0.00083	-7.36902	16.06231	0.03433	0.02578	0.00952	0.03350
11	19	-0.01457	-16.20795	-0.00003	-0.12217	-16.25981	0.01908	-0.10760	-0.05186	0.01911
12	20	-0.00571	-7.95084	0.28105	0.05865	-8.18840	0.24992	0.06436	-0.23756	-0.03113
13	21	0.00062	-0.00058	0.36854	0.06843	-0.01450	0.35815	0.06781	-0.01392	-0.01039
14	22	-0.00571	7.95084	0.28105	0.09723	8.03836	0.25245	0.10294	0.08752	-0.02860
15	23	-0.01457	16.20795	-0.00003	0.07254	16.20302	0.03590	0.08711	-0.00493	0.03593
16	28	7.36567	-16.36302	-0.00655	7.24024	-16.37668	0.01271	-0.12543	-0.01366	0.01926
17	29	7.37421	-8.10672	0.26037	7.38648	-8.08375	0.26023	0.01227	0.02297	-0.00014
18	30	7.37911	-0.00060	0.34712	7.48251	0.01085	0.32758	0.10340	0.01145	-0.01954
19	31	7.37421	8.10672	0.26037	7.48159	8.13292	0.25973	0.10738	0.02620	-0.00064
20	32	7.36567	16.36302	-0.00655	7.45429	16.36362	0.05157	0.08862	0.00060	0.05812
21	37	14.74590	-16.51791	-0.01866	14.52484	-16.49659	-0.00163	-0.22106	0.02132	0.01703
22	38	14.75404	-8.25938	0.16451	14.64619	-8.23998	0.19213	-0.10785	0.01940	0.02762
23	39	14.75305	-0.00061	0.26096	14.70327	0.01577	0.25523	-0.04978	0.01638	-0.00573
24	40	14.75404	8.25938	0.16451	14.72723	8.36604	0.20089	-0.02681	0.10666	0.03638
25	41	14.74590	16.51791	-0.01866	14.71191	16.51770	0.07350	-0.03399	-0.00021	0.09216
								RMS	RMS	Δ NORM
								.13668	.11338	

FILE NAME: JDSN2A

Table 3.4-2

ANALYTICAL AND MEASURED COORDINATES IN PILLOW TWO COORDINATES SYSTEM
WITH ADJUSTED OFFSETS

1	5	-14.77364	-15.59792	-0.21417	-14.75692	-15.22891	-0.15874	0.01672	0.36901	0.05543
2	6	-14.76269	-7.64805	0.11275	-14.77838	-7.58786	0.11405	-0.01569	0.06019	0.00130
3	7	-14.75874	0.30709	0.22058	-14.81221	0.34161	0.21062	-0.05347	0.03452	-0.00996
4	8	-14.76218	8.26191	0.11377	-14.95290	7.92555	0.13207	-0.19072	-0.33636	0.01830
5	9	-14.77344	16.21076	-0.21179	-14.97224	15.61595	-0.13234	-0.19880	-0.59481	0.07945
6	14	-7.39337	-15.75122	-0.20963	-7.31783	-15.42809	-0.16297	0.07554	0.32313	0.04666
7	15	-7.38312	-7.80166	0.09841	-7.31935	-7.56551	0.10185	0.06377	0.23615	0.00344
8	16	-7.37933	0.15345	0.20452	-7.41379	0.26150	0.18259	-0.03446	0.10805	-0.02193
9	17	-7.38283	8.10874	0.10666	-7.51281	8.02382	0.11275	-0.12998	-0.08492	0.00609
10	18	-7.39325	16.36793	-0.20966	-7.59320	15.74900	-0.13281	-0.19995	-0.61893	0.07685
11	23	-0.01310	-15.90462	-0.21059	0.12576	-15.54708	-0.15411	0.13886	0.35754	0.05648
12	24	-0.00335	-7.95524	0.09641	0.12203	-7.60805	0.10395	0.12538	0.34719	0.00754
13	25	0.00002	0.00003	0.20429	0.05907	0.23482	0.18891	0.05905	0.23479	-0.01538
14	26	-0.00307	8.26594	0.10387	-0.01163	8.14675	0.11088	-0.00856	-0.11919	0.00701
15	27	-0.01305	16.52513	-0.21171	-0.06762	15.88859	-0.13993	-0.05457	-0.63654	0.07178
16	32	7.36717	-16.05818	-0.21721	7.51179	-15.71330	-0.13584	0.14462	0.34488	0.08137
17	33	7.37641	-8.10896	0.09905	7.52741	-7.75928	0.10399	0.15100	0.34968	0.00494
18	34	7.37943	0.15742	0.21283	7.45970	0.19554	0.19798	0.08027	0.03812	-0.01485
19	35	7.37656	8.42318	0.10660	7.35485	8.17237	0.11627	-0.02171	-0.25081	0.00967
20	36	7.36713	16.68234	-0.21796	7.19908	16.03138	-0.17900	-0.16805	-0.65096	0.03896
21	41	14.74743	-16.21199	-0.22941	14.77132	-15.88067	-0.12644	0.02389	0.33132	0.10297
22	42	14.75567	-7.95163	0.12167	14.78474	-7.87962	0.15207	0.02907	0.07201	0.03040
23	43	14.75872	0.31458	0.23719	14.79036	0.13188	0.20377	0.03164	-0.18270	-0.03342
24	44	14.75608	8.58041	0.12199	14.67049	8.07372	0.12885	-0.08559	-0.50669	0.00686
25	45	14.74732	16.83958	-0.22847	14.62903	16.19666	-0.18449	-0.11829	-0.64292	0.04398
								RMS	RMS	Δ NORM
								.18097	.14811	

that the target offsets indicate that the targets do not align to a straight line as indicated by the drawing. The analytical targets are each equally spaced across the width of the pillow area whereas the measured targets are spaced as close as practical to equal spacing across the pillow area.

The comparison of analytical to measured target position addresses the pillow system "Z" direction (which is a function of the pillow X and pillow Y position). Therefore, each target "Z" position should be adjusted to correspond to the analytical target position. This is shown graphically in Figure 3.4-2. The adjustment is shown as "del Z hat" and is applied to bias the position of the measured target to the analytical node. The amount of adjustment was determined by fitting each row of five nodes in each pillow with a fifth order polynomial Z = F (Y), adjusting the Y coordinate by the measured offsets listed on Figure 3.4-1 and computing the new Z value. The polynomial derived for each row is listed in Appendix B. Only measured targets that have offsets listed on Figure 3.4-1 were adjusted. The results of adjusting the data points is listed in Table 3.4-1 and Table 3.4-2.

3.5 Pillow Bestfit

The target positions listed in Table 3.4 are the analytical and measured coordinates in the analytical coordinate system, thus a comparison of the data sets can be made. Each pillow data set was bestfit using a plane tangent to the analytical surface over this small an area when compared to using a parabola of such large focal length are virtually identical, see Appendix C.

Table 3.5-1 lists the bestfit plane coordinates of the analytical and measured coordinate sets for pillow one, and the errors from the bestfit as indicated. Table 3.5-2 lists the same data for pillow two.

FILE NAME: JDSN1B

Table 3.5-1

BESTFIT RESULTS FOR PILLOW ONE

1	1	-14.77504	-15.89760	-0.00380	-14.79346	-16.00000	0.03451	-0.15256	-0.11659	-0.03597
2	2	-14.76565	-7.94911	0.15670	-14.85934	-7.92472	0.19397	0.00794	0.03627	-0.02833
3	3	-14.76523	-0.00056	0.24071	-14.85464	0.05913	0.22976	0.09195	0.06552	0.02643
4	4	-14.76565	7.94911	0.15670	-14.84990	7.91395	0.18705	0.00794	0.01637	-0.00843
5	5	-14.77504	15.89760	-0.00380	-14.80961	15.86166	0.06739	-0.15256	-0.10980	-0.04276
6	10	-7.39480	-16.05279	0.00083	-7.51587	-16.12825	0.03297	-0.14828	-0.11898	-0.02930
7	11	-7.38534	-7.94948	0.25601	-7.43886	-8.09265	0.25388	0.10690	0.09534	0.01156
8	12	-7.38096	-0.00057	0.33822	-7.36270	-0.03910	0.32454	0.18911	0.15940	0.02971
9	13	-7.38534	7.94948	0.25601	-7.35647	8.04313	0.24734	0.10690	0.07558	0.03132
10	14	-7.39480	16.05279	0.00083	-7.36902	16.06231	0.03433	-0.14827	-0.14400	-0.00427
11	19	-0.01457	-16.20795	-0.00003	-0.12217	-16.25981	0.01908	-0.14949	-0.13373	-0.01576
12	20	-0.00571	-7.95084	0.28105	0.05865	-8.18840	0.24992	0.13159	0.09048	0.04111
13	21	0.00062	-0.00058	0.36854	0.06843	-0.01450	0.35815	0.21908	0.19201	0.02707
14	22	-0.00571	7.95084	0.28105	0.09723	8.03836	0.25245	0.13159	0.07971	0.05188
15	23	-0.01457	16.20795	-0.00003	0.07254	16.20302	0.03590	-0.14948	-0.14352	-0.00596
16	28	7.36567	-16.36302	-0.00655	7.24024	-16.37668	0.01271	-0.15636	-0.14096	-0.01540
17	29	7.37421	-8.10672	0.26037	7.38648	-8.08375	0.26023	0.11056	0.09975	0.01081
18	30	7.37911	-0.00060	0.34712	7.48251	0.01085	0.32758	0.19731	0.16045	0.03686
19	31	7.37421	8.10672	0.26037	7.48159	8.13292	0.25973	0.11057	0.08595	0.02462
20	32	7.36567	16.36302	-0.00655	7.45429	16.36362	0.05157	-0.15635	-0.12895	-0.02740
21	37	14.74590	-16.51791	-0.01866	14.52484	-16.49659	-0.00163	-0.16882	-0.15616	-0.01266
22	38	14.75404	-8.25938	0.16451	14.64619	-8.23998	0.19213	0.01435	0.03082	-0.01647
23	39	14.75305	-0.00061	0.26096	14.70327	0.01577	0.25523	0.11081	0.08715	0.02366
24	40	14.75404	8.25938	0.16451	14.72723	8.36604	0.20089	0.01436	0.02597	-0.01161
25	41	14.74590	16.51791	-0.01866	14.71191	16.51770	0.07350	-0.16881	-0.10809	-0.06072
								RMS	RMS	Δ NORM
								.13668	.11338	

FILE NAME: JDSN2B

Table 3.5-2

BESTFIT RESULTS FOR PILLOW TWO

1	5	-14.77364	-15.59792	-0.21417	-14.75692	-15.22891	-0.15874	-0.21417	-0.18499	-0.02918
2	6	-14.76269	-7.64805	0.11275	-14.77838	-7.58786	0.11405	0.11275	0.08842	0.02433
3	7	-14.75874	0.30709	0.22058	-14.81221	0.34161	0.21062	0.22058	0.18563	0.03495
4	8	-14.76218	8.26191	0.11377	-14.95290	7.92555	0.13207	0.11377	0.10770	0.00607
5	9	-14.77344	16.21076	-0.21179	-14.97224	15.61595	-0.13234	-0.21179	-0.15609	-0.05570
6	14	-7.39337	-15.75122	-0.20963	-7.31783	-15.42809	-0.16297	-0.20963	-0.18982	-0.01982
7	15	-7.38312	-7.80166	0.09841	-7.31935	-7.56551	0.10185	0.09841	0.07564	0.02277
8	16	-7.37933	0.15345	0.20452	-7.41379	0.26150	0.18259	0.20452	0.15701	0.04751
9	17	-7.38283	8.10874	0.10666	-7.51281	8.02382	0.11275	0.10666	0.08781	0.01885
10	18	-7.39325	16.36793	-0.20966	-7.59320	15.74900	-0.13281	-0.20966	-0.15712	-0.05253
11	23	-0.01310	-15.90462	-0.21059	0.12576	-15.54708	-0.15411	-0.21059	-0.18155	-0.02905
12	24	-0.00335	-7.95524	0.09641	0.12203	-7.60805	0.10395	0.09641	0.07715	0.01926
13	25	0.00002	0.00003	0.20429	0.05907	0.23482	0.18891	0.20429	0.16275	0.04154
14	26	-0.00307	8.26594	0.10387	-0.01163	8.14675	0.11088	0.10387	0.08536	0.01851
15	27	-0.01305	16.52513	-0.21171	-0.06762	15.88859	-0.13993	-0.21171	-0.16482	-0.04689
16	32	7.36717	-16.05818	-0.21721	7.51179	-15.71330	-0.13584	-0.21721	-0.16386	-0.05335
17	33	7.37641	-8.10896	0.09905	7.52741	-7.75928	0.10399	0.09905	0.07660	0.02245
18	34	7.37943	0.15742	0.21283	7.45970	0.19554	0.19798	0.21283	0.17124	0.04159
19	35	7.37656	8.42318	0.10660	7.35485	8.17237	0.11627	0.10660	0.09018	0.01642
20	36	7.36713	16.68234	-0.21796	7.19908	16.03138	-0.17900	-0.21796	-0.20445	-0.01351
21	41	14.74743	-16.21199	-0.22941	14.77132	-15.88067	-0.12644	-0.22941	-0.15504	-0.07437
22	42	14.75567	-7.95163	0.12167	14.78474	-7.87962	0.15207	0.12167	0.12411	-0.00244
23	43	14.75872	0.31458	0.23719	14.79036	0.13188	0.20377	0.23719	0.17645	0.06074
24	44	14.75608	8.58041	0.12199	14.67049	8.07372	0.12885	0.12199	0.10218	0.01981
25	45	14.74732	16.83958	-0.22847	14.62903	16.19666	-0.18449	-0.22847	-0.21050	-0.01797
								RMS	RMS	Δ NORM
								.18097	.14811	

The data sets of Table 8 are formated as follows:

COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7	COL 8	COL 9	COL 10
TARGET NUM	ANAL X (in.)	ANAL Y (in.)	ANAL Z (in.)	MEAS X (in.)	MEAS Y (in.)	MEAS Z (in.)	ANAL Z BESTFIT ERROR (in.)	MEAS Z BESTFIT ERROR (in.)	ANAL - MEAS. DELTA (in.)

4.0 RESULTS SUMMARY

4.1 Bestfit Results

Taken from Table 3.5-1 and Table 3.5-2 the bestfit results are:

	50-METER PILLOW MEASUREMENT	BESTFIT RESULTS
PILLOW	PREDICTED RMS	MEASURED RMS
One	0.13668	0.11338
Two	0.18097	0.14811

4.2 Shape Comparison

The shape of the analytical and measured pillow for pillow one and pillow two are compared by taking cutting planes through the five rows of target position. The shape is shown in Figures 4.2-1 through Figure 4.2-10. Refer to Figure 2.0-2 for location of each cutting plane location.

5.0 CONCLUSION

The results of the 50-Meter Model pillow shows good correlation. The planar views from Figures 4.2 shows close analytical shape approximation. The bestfit results shown in Table 3.5-1 for pillow one show agreement to within seventeen percent. This is a pillow area that is cord dominated, suggesting that some cord tension error may exist due to boundary conditions. Pillow two bestfit results listed in Table 3.5-2 shows similar agreement to within eighteen percent.

The analytical predictions are based upon ideal boundary conditions and not on the actual surface breadboard boundary conditions. Unknown mesh and cord tensions are contribution to the measured pillow shape. Consideration of all the unknowns would most likely yield even better correlation.

The good correlation of the pillow shapes shown in Figures 4.2-1 through 4.2-5 and 4.2-6 through 4.2-10 indicate good analysis predictions and accurate measurement results.

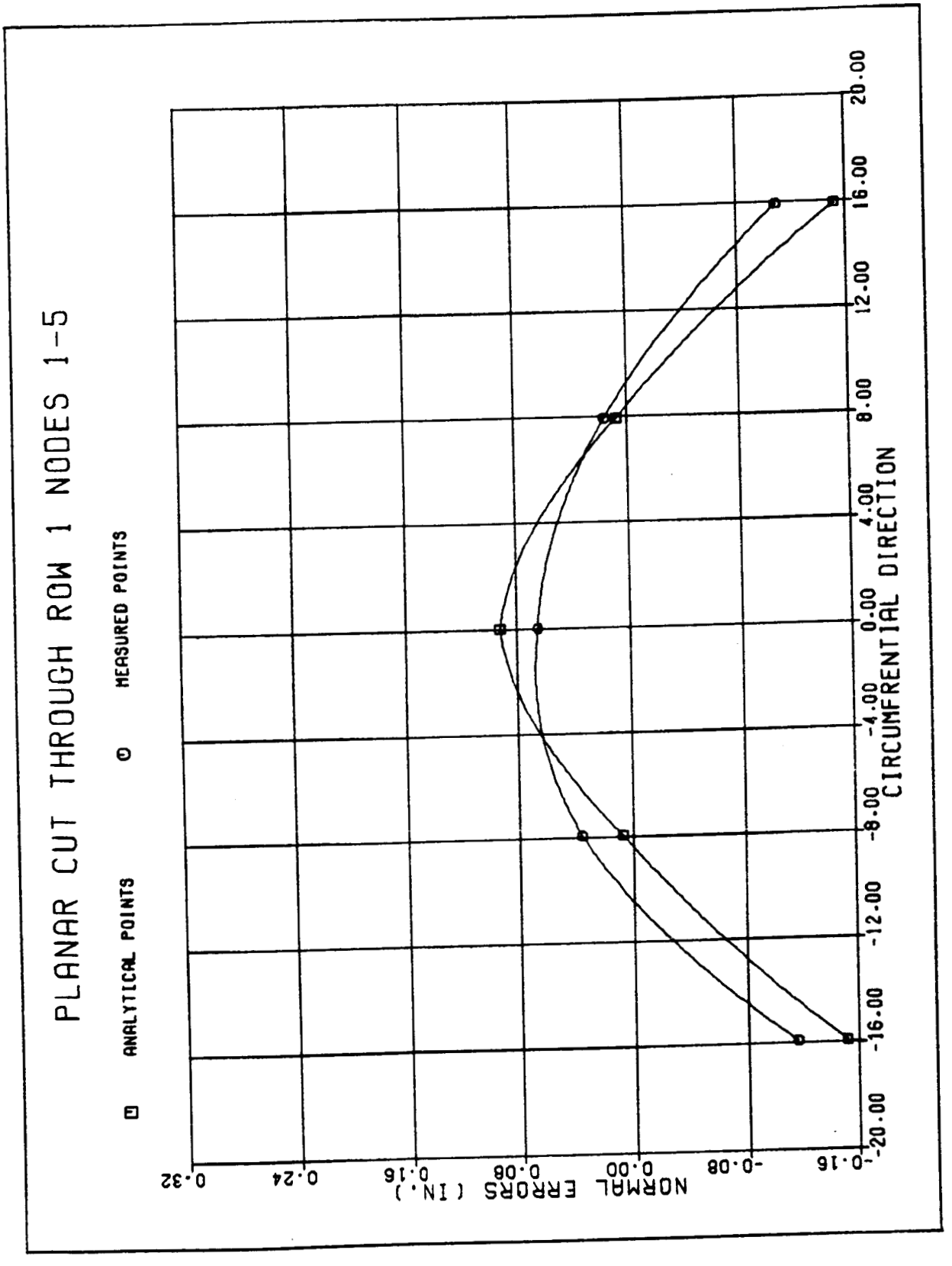

PLANAR CUT THROUGH ROW 1 NODES 1-5
ANALYTICAL POINTS
MEASURED POINTS
NORMAL ERRORS (IN.)
0.32
0.24
0.16
0.08
0.00
-0.08
-0.16
CIRCUMFRENTIAL DIRECTION
-20.00
-16.00
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00

FIGURE 4.2-1

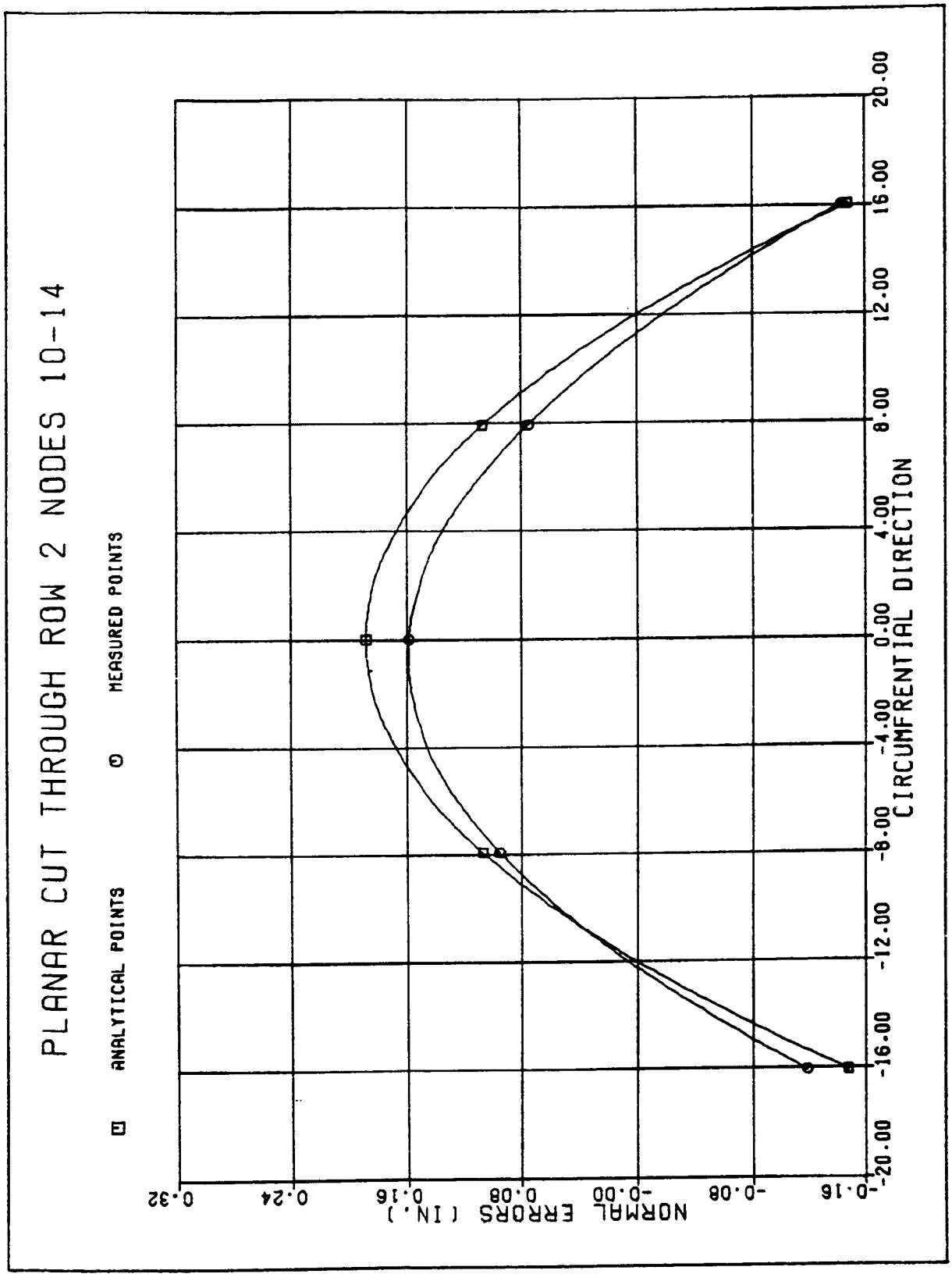

PLANAR CUT THROUGH ROW 2 NODES 10-14
ANALYTICAL POINTS
MEASURED POINTS
NORMAL ERRORS (IN.)
0.32
0.24
0.16
0.08
-0.00
-0.08
-0.16
CIRCUMFRENTIAL DIRECTION
-20.00
-16.00
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00

FIGURE 4.2-2

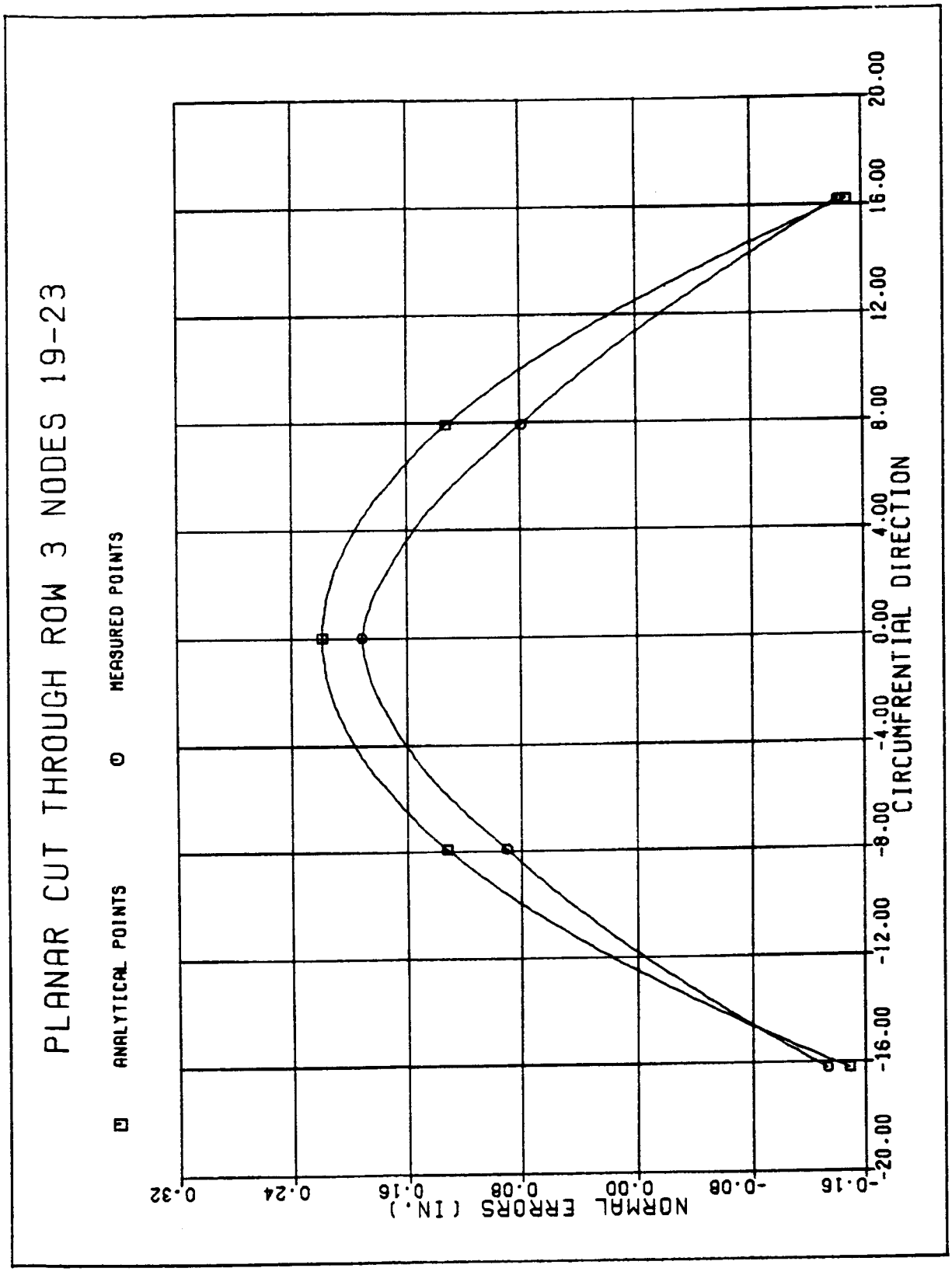

PLANAR CUT THROUGH ROW 3 NODES 19-23
ANALYTICAL POINTS
MEASURED POINTS
NORMAL ERRORS (IN.)
0.32
0.24
0.16
0.08
0.00
-0.08
-0.16
CIRCUMFRENTIAL DIRECTION
-20.00
-16.00
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00

FIGURE 4.2-3

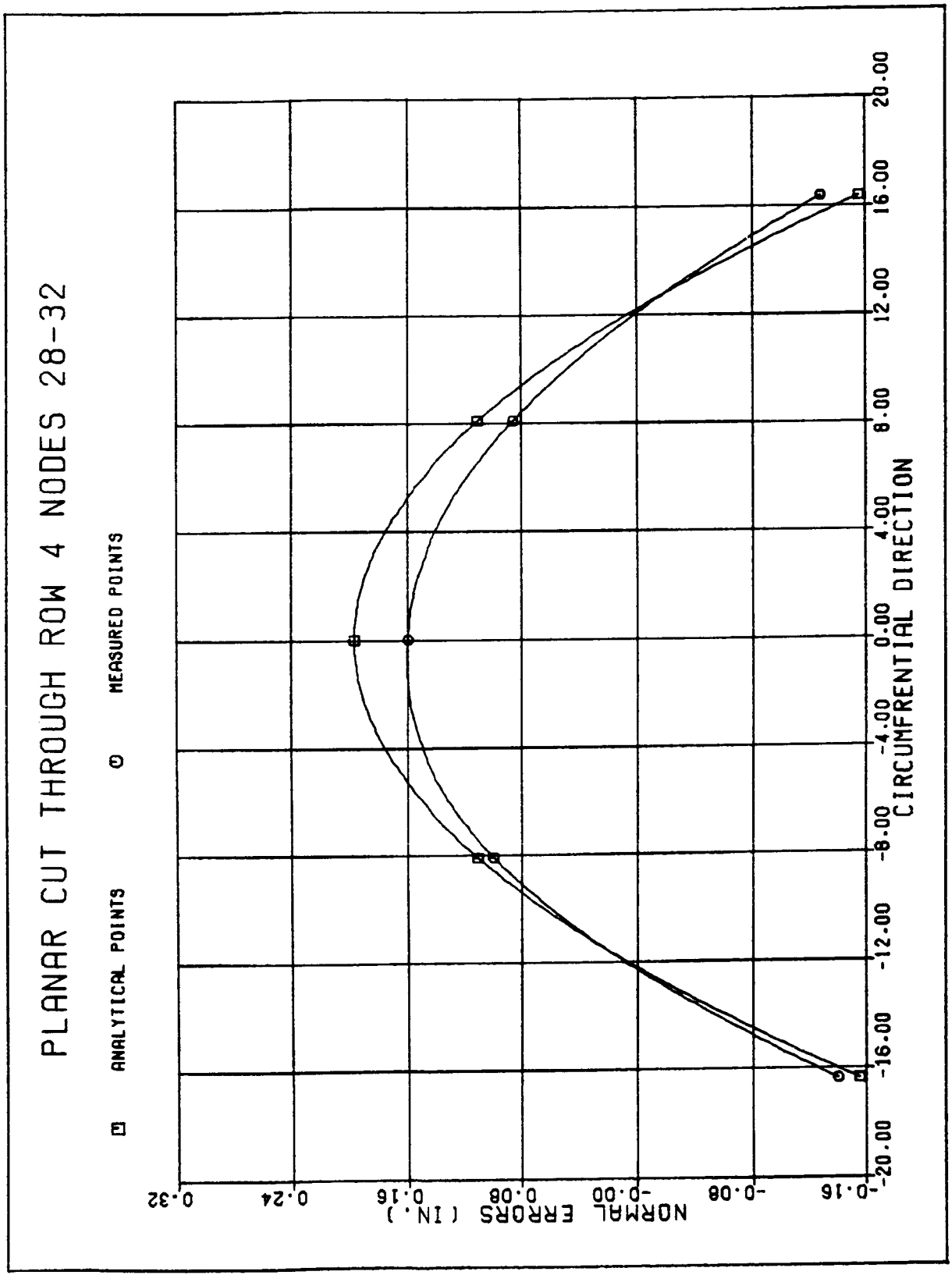

PLANAR CUT THROUGH ROW 4 NODES 28-32
ANALYTICAL POINTS
MEASURED POINTS
NORMAL ERRORS (IN.)
0.32
0.24
0.16
0.08
-0.00
-0.08
-0.16
CIRCUMFRENTIAL DIRECTION
-20.00
-16.00
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00

FIGURE 4.2-4

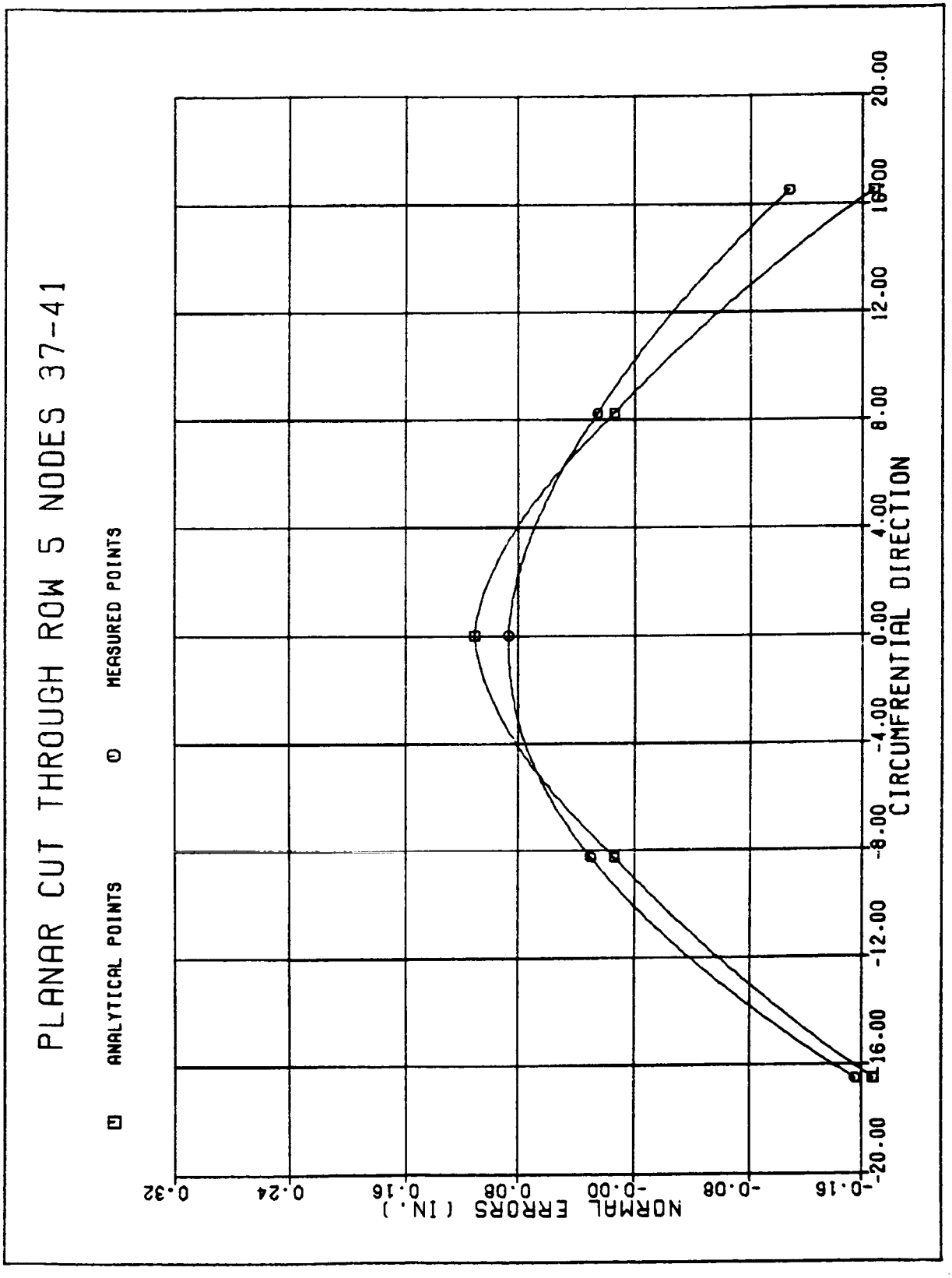

PLANAR CUT THROUGH ROW 5 NODES 37-41
ANALYTICAL POINTS
MEASURED POINTS
NORMAL ERRORS (IN.)
0.32
0.24
0.16
0.08
-0.00
-0.08
-0.16
CIRCUMFRENTIAL DIRECTION
-20.00
-16.00
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00

FIGURE 4.2-5

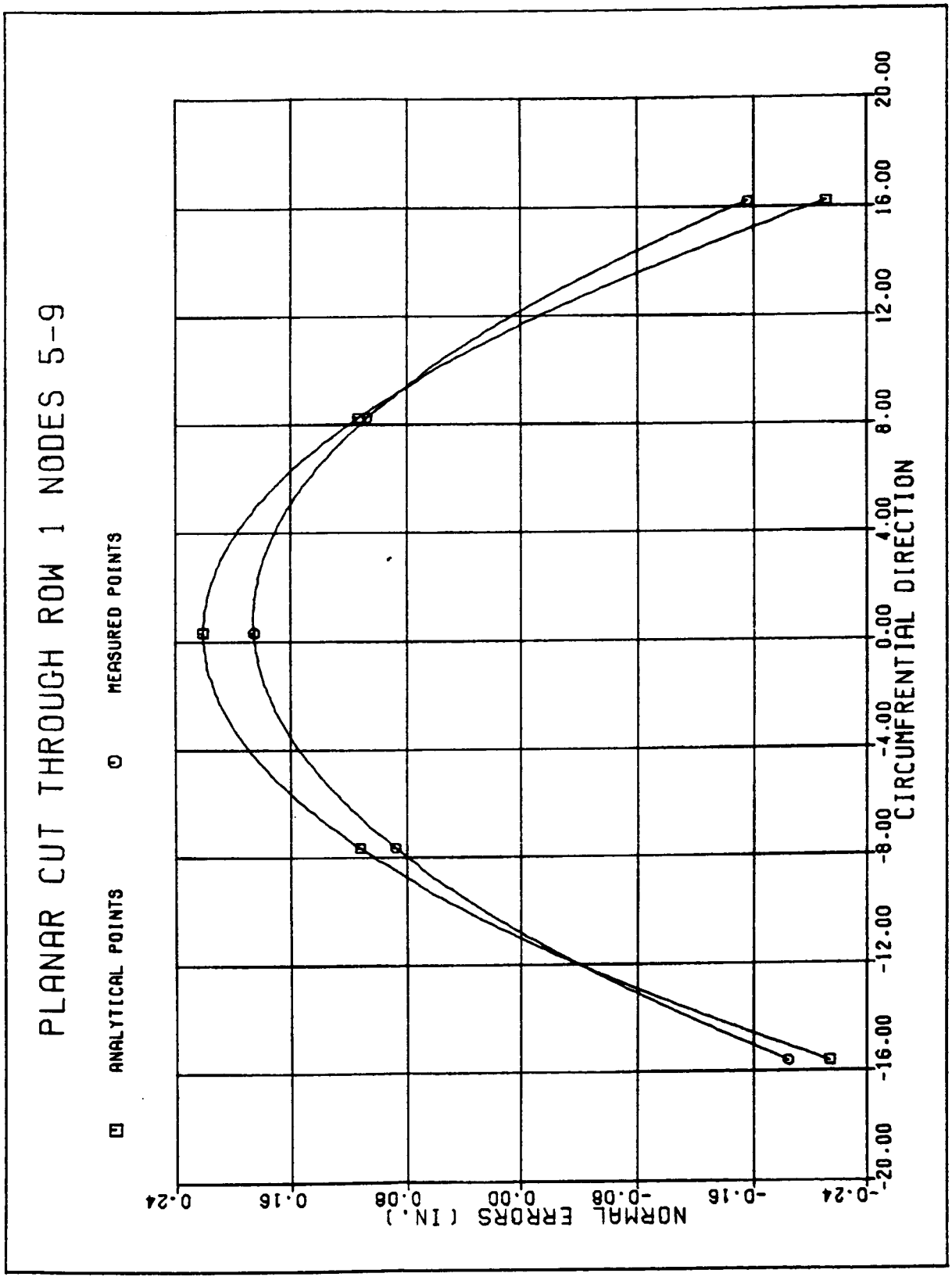

PLANAR CUT THROUGH ROW 1 NODES 5-9
ANALYTICAL POINTS
MEASURED POINTS
NORMAL ERRORS (IN.)
0.24
0.16
0.08
0.00
-0.08
-0.16
-0.24
CIRCUMFRENTIAL DIRECTION
-20.00
-16.00
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00

FIGURE 4.2-6

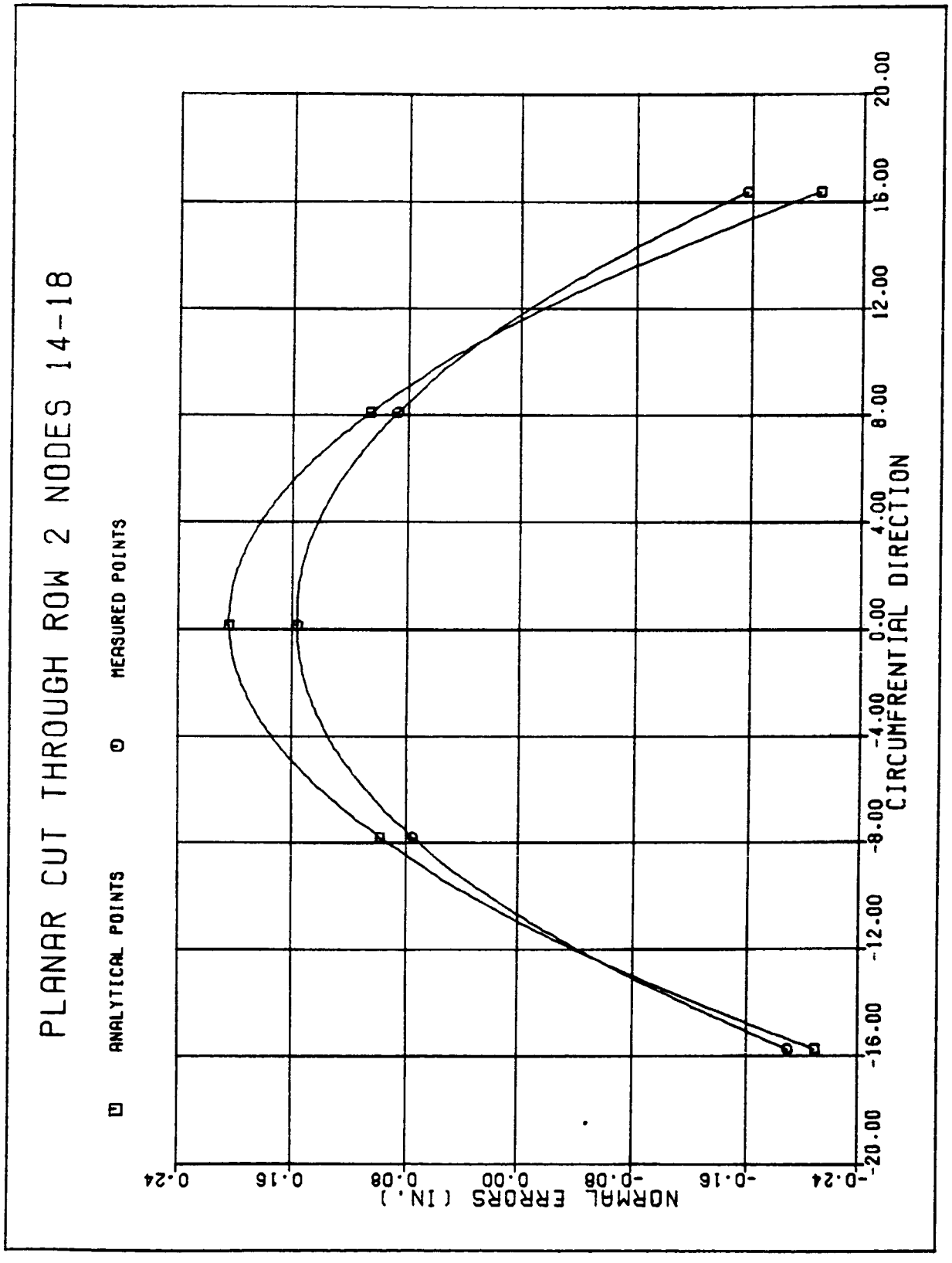

PLANAR CUT THROUGH ROW 2 NODES 14-18
ANALYTICAL POINTS
MEASURED POINTS
NORMAL ERRORS (IN.)
0.24
0.16
0.08
0.00
-0.08
-0.16
-0.24
CIRCUMFRENTIAL DIRECTION
-20.00
-16.00
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00

FIGURE 4.2-7

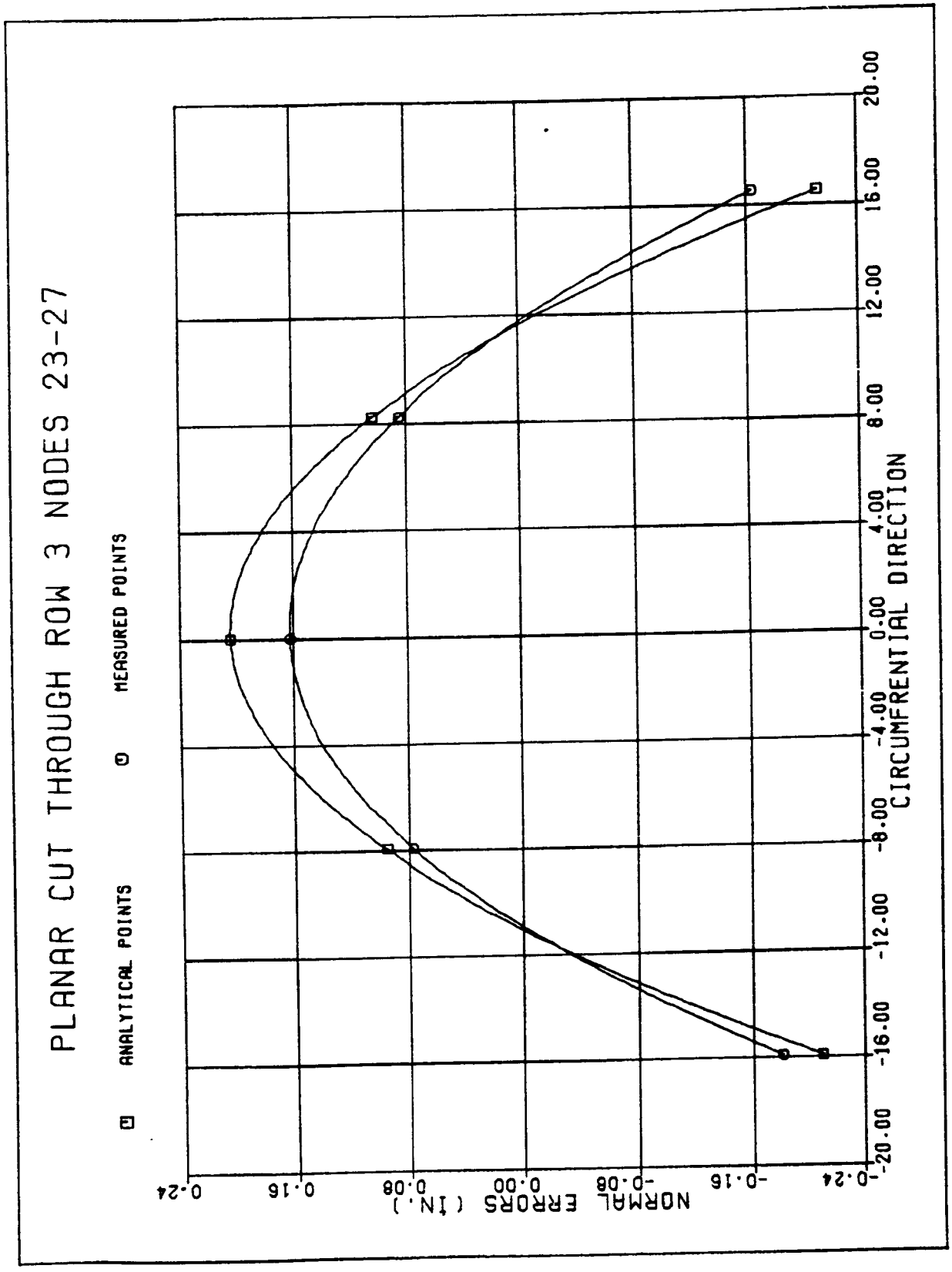


FIGURE 4.2-8

PILLOW MEASUREMENT REPORT

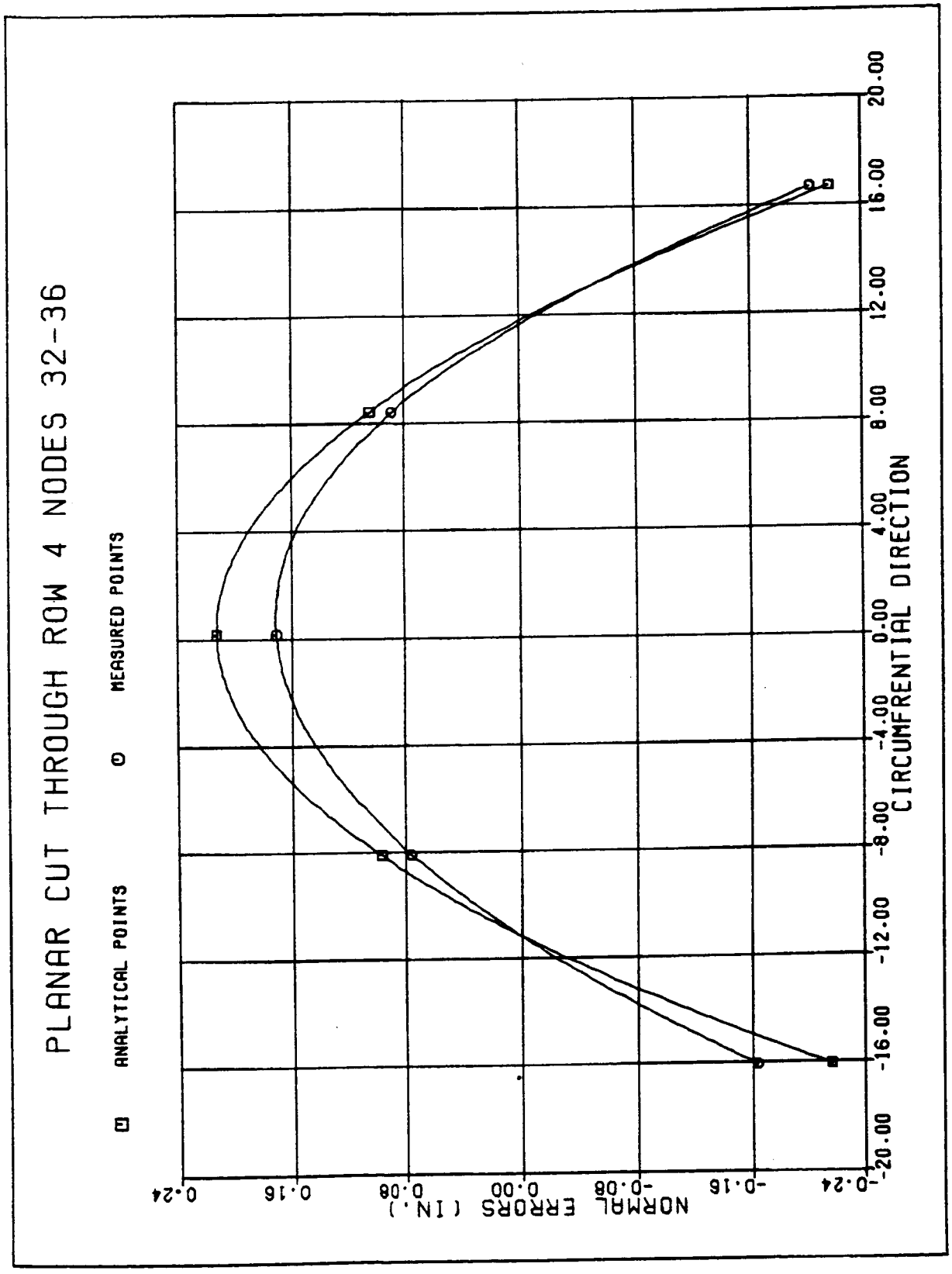


FIGURE 4.2-9

PILLOW MEASUREMENT REPORT

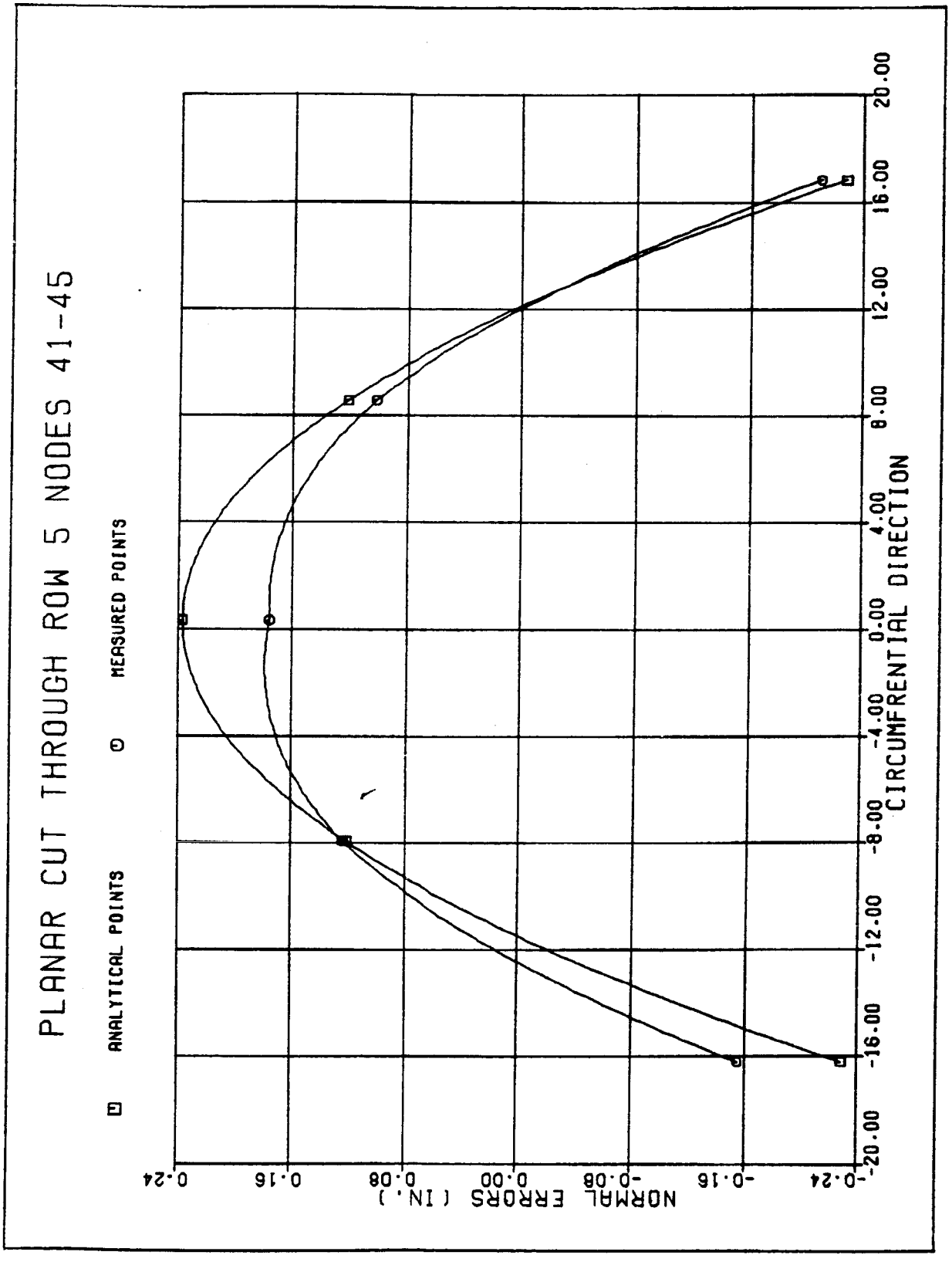


FIGURE 4.2-10

PILLOW MEASUREMENT REPORT

APPENDIX A

ANALYTICAL COORDINATES OF HALF-GORE PILLOW MODEL

FILE NAME: 295A*TEMP1

1	151	924.63680	50.50206	150.54436
2	152	925.03348	40.40372	150.62822
3	153	925.50997	30.30361	150.49546
4	154	930.21597	30.61857	151.86778
5	155	934.41278	41.01987	153.48819
6	156	938.62735	51.41322	155.11341
7	157	938.22913	61.49539	155.10344
8	158	933.59954	61.19198	153.46229
9	159	928.97038	60.88861	151.81992
10	160	929.29249	50.80652	152.09476
11	161	929.71345	40.71147	152.09147
12	162	933.95620	51.11048	153.61831
13	163	917.37373	60.12869	147.78233
14	164	910.40722	59.67218	145.38420
15	165	903.44230	59.21579	142.98144
16	166	903.73199	49.12457	143.42164
17	167	911.08196	39.47910	145.95158
18	168	918.52487	29.83644	148.19184
19	169	918.04799	39.94072	148.32083
20	170	917.66146	50.04274	148.19290
21	171	910.69505	49.58348	145.81320
22	172	896.76278	48.96936	141.02835
23	173	897.14194	39.16991	141.17715
24	174	897.61303	29.37444	141.02672
25	175	905.14187	19.74847	142.99823
26	176	912.10517	19.90161	145.42168
27	177	919.07046	20.05524	147.83941
28	178	904.11369	39.32376	143.56256
29	179	904.58328	29.52731	143.42045
30	180	911.55125	29.68075	145.81775
31	181	926.00951	5.05246	150.24673
32	182	926.01549	10.10470	150.24757
33	183	926.02484	15.15694	150.24934
34	184	905.07766	14.69671	143.16496
35	185	911.98350	9.79660	145.72885
36	186	918.94714	4.89558	148.12781
37	187	918.97180	9.94965	148.07732
38	188	919.01118	15.00403	147.98456
39	189	912.03431	14.85026	145.60655
40	190	898.16359	14.69693	140.63160
41	191	898.14867	9.79793	140.67979
42	192	898.13669	4.89880	140.71135
43	193	905.00949	-0.00027	143.35427
44	194	911.95043	-0.00011	145.82015
45	195	918.94138	0.00005	148.14370
46	196	905.04135	9.79771	143.27315
47	197	905.01882	4.89858	143.33474
48	198	911.95956	4.89778	145.79811
49	199	889.48714	58.30121	138.25110
50	200	882.49684	57.84301	135.92353
51	201	875.50806	57.38492	133.59134
52	202	875.81062	47.59444	134.00871
53	203	883.18417	38.25432	136.47199
54	204	890.63691	28.91702	138.66551
55	205	890.16573	38.71236	138.81760

56	206	889.78270	48.51092	138.67895
57	207	882.79786	48.05271	136.34081
58	208	868.81034	47.43989	131.68054
59	209	869.18420	37.94650	131.81619
60	210	869.64099	28.45638	131.66673
61	211	877.17975	19.13343	133.57058
62	212	884.17803	19.28744	135.90935
63	213	891.17831	19.44158	138.24211
64	214	876.18692	38.10042	134.13647
65	215	876.64315	28.61015	133.98942
66	216	883.64118	28.76370	136.32472
67	217	877.12472	14.23553	133.74754
68	218	884.07486	9.49145	136.23609
69	219	891.06871	4.74631	138.58951
70	220	891.09058	9.64592	138.52445
71	221	891.12627	14.54466	138.41095
72	222	884.11713	14.39059	136.10376
73	223	870.16158	14.23470	131.31106
74	224	870.14264	9.48957	131.37846
75	225	870.12720	4.74419	131.42556
76	226	877.06017	-0.00113	133.95452
77	227	884.04530	-0.00090	136.33576
78	228	891.06300	-0.00066	138.61059
79	229	877.08975	9.49004	133.86387
80	230	877.06831	4.74423	133.93191
81	231	884.05275	4.74514	136.31108
82	232	861.50686	56.46719	128.99968
83	233	854.49435	56.00754	126.74026
84	234	847.48328	55.54800	124.47635
85	235	847.78633	46.06133	124.86888
86	236	855.17657	37.02780	127.25235
87	237	862.63935	27.99713	129.37836
88	238	862.18280	37.48742	129.52688
89	239	861.80574	46.98052	129.40010
90	240	854.79700	46.52098	127.13145
91	241	840.75993	45.90783	122.60949
92	242	841.12291	36.72167	122.73684
93	243	841.56118	27.53846	122.59505
94	244	849.10062	18.52000	124.44919
95	245	856.12631	18.67325	126.71405
96	246	863.15392	18.82645	128.97292
97	247	848.15224	36.87469	124.98704
98	248	848.59036	27.69159	124.84624
99	249	855.61576	27.84447	127.10965
100	250	849.04893	13.77627	124.62730
101	251	856.03028	9.18556	127.04015
102	252	863.04772	4.59360	129.33477
103	253	863.06902	9.33929	129.26529
104	254	863.10380	14.08369	129.14640
105	255	856.06959	13.93060	126.90715
106	256	842.05212	13.77522	122.27724
107	257	842.03104	9.18328	122.35581
108	258	842.01399	4.59100	122.41167
109	259	848.98779	-0.00149	124.84012
110	260	856.00337	-0.00144	127.14136

111	261	863.04251	-0.00140	129.35781
112	262	849.01542	9.18390	124.74592
113	263	848.99510	4.59096	124.81629
114	264	856.00968	4.59201	127.11603
115	265	833.43774	54.62737	120.02280
116	266	826.40319	54.16628	117.83319
117	267	819.36999	53.70529	115.63920
118	268	819.66797	44.52508	116.00988
119	269	827.06877	35.80005	118.31649
120	270	834.53589	27.07765	120.37954
121	271	834.09815	36.26113	120.51939
122	272	833.73246	45.44710	120.39994
123	273	826.70105	44.98610	118.20205
124	274	812.62067	44.37127	113.82112
125	275	812.97281	35.49321	113.94348
126	276	813.39322	26.61775	113.81285
127	277	820.92916	17.90624	115.62169
128	278	827.97656	18.05987	117.81315
129	279	835.02578	18.21340	119.99871
130	280	820.02311	35.64660	116.12271
131	281	820.44351	26.77132	115.99246
132	282	827.49048	26.92455	118.18359
133	283	820.88034	13.31585	115.79860
134	284	827.88712	8.87873	118.13319
135	285	834.92427	4.44028	120.36289
136	286	834.94465	9.03284	120.29201
137	287	834.97809	13.62391	120.17194
138	288	827.92374	13.47054	118.00204
139	289	813.85659	13.31482	113.53439
140	290	813.83377	8.87656	113.62221
141	291	813.81538	4.43788	113.68567
142	292	820.82238	-0.00121	116.01355
143	293	827.86248	-0.00131	118.23361
144	294	834.91954	-0.00142	120.38658
145	295	820.84834	8.87705	115.91765
146	296	820.82900	4.43771	115.98902
147	297	827.86795	4.43873	118.20834
148	298	805.28091	52.78180	111.32594
149	299	798.22494	52.31931	109.20670
150	300	791.17026	51.85690	107.08319
151	301	791.46344	42.98432	107.43448
152	302	798.87488	34.56873	109.66497
153	303	806.34601	26.15551	111.66802
154	304	805.92597	35.03121	111.79700
155	305	805.57132	43.90912	111.68249
156	306	798.51825	43.44672	109.55546
157	307	784.39395	42.82991	105.31892
158	308	784.73496	34.26067	105.43666
159	309	785.13851	25.69380	105.31399
160	310	792.67310	17.29050	107.07407
161	311	799.74153	17.44466	109.19662
162	312	806.81169	17.59870	111.31339
163	313	791.80743	34.41470	107.54238
164	314	792.21070	25.84791	107.42134
165	315	799.27913	26.00182	109.54214

166	316	792.62750	12.85372	107.24658
167	317	799.65859	8.57071	109.50686
168	318	806.71503	4.28649	111.67533
169	319	806.73441	8.72546	111.60410
170	320	806.76638	13.16292	111.48443
171	321	799.69256	13.00887	109.37929
172	322	785.57880	12.85283	105.06131
173	323	785.55591	8.56880	105.15281
174	324	785.53777	4.28426	105.21882
175	325	792.57381	-0.00073	107.45797
176	326	799.63627	-0.00085	109.60492
177	327	806.71077	-0.00098	111.69929
178	328	792.59759	8.56918	107.36333
179	329	792.57959	4.28406	107.43366
180	330	799.64100	4.28502	109.58016
181	331	777.03483	50.93038	102.92527
182	332	769.95401	50.46626	100.89094
183	333	762.87437	50.00223	98.85243
184	334	763.16364	41.43805	99.18043
185	335	770.58884	33.33296	101.32095
186	336	778.06738	25.22992	103.24991
187	337	777.66433	33.79701	103.37052
188	338	777.32050	42.36607	103.26178
189	339	770.24296	41.90204	101.21809
190	340	756.06997	41.28311	97.14738
191	341	756.40092	33.02382	97.25661
192	342	756.78770	24.76666	97.14191
193	343	764.32307	16.67264	98.84386
194	344	771.41589	16.82732	100.88347
195	345	778.51033	16.98189	102.91746
196	346	763.49715	33.17838	99.28088
197	347	763.88367	24.92128	99.16790
198	348	770.97629	25.07570	101.20633
199	349	764.28270	12.38967	99.00418
200	350	771.34105	8.26131	101.17709
201	351	778.42085	4.13192	103.26841
202	352	778.43870	8.41668	103.19905
203	353	778.46841	12.70014	103.08285
204	354	771.37158	12.54543	101.05624
205	355	757.20961	12.38887	96.89811
206	356	757.19096	8.25938	96.97750
207	357	757.17607	4.12952	97.03511
208	358	764.23585	-0.00061	99.19959
209	359	771.32124	-0.00061	101.26984
210	360	778.41707	-0.00061	103.29167
211	361	764.25631	8.25976	99.11221
212	362	764.24071	4.12942	99.17719
213	363	771.32526	4.13038	101.24640
214	364	748.69227	49.07265	94.85698
215	365	741.58975	48.60711	92.90012
216	366	734.48833	48.14164	90.93921
217	367	734.77304	39.88693	91.24438
218	368	742.20955	32.09323	93.29956
219	369	749.69375	24.30138	95.15746
220	370	749.30739	32.55874	95.27048

221	371	748.97384	40.81784	95.16984
222	372	741.87424	40.35240	93.20447
223	373	727.65761	39.73150	89.28866
224	374	727.97805	31.78307	89.39011
225	375	728.34842	23.83655	89.28268
226	376	735.88325	16.05279	90.92938
227	377	742.99794	16.20795	92.89127
228	378	750.11414	16.36302	94.84771
229	379	735.09594	31.93813	91.33721
230	380	735.46600	23.99163	91.23148
231	381	742.58049	24.14660	93.19224
232	382	735.84766	11.92424	91.07810
233	383	742.93173	7.95084	93.16459
234	384	750.03609	3.97651	95.17098
235	385	750.05139	8.10672	95.10729
236	386	750.07729	12.23558	95.00034
237	387	742.95871	12.08037	93.05219
238	388	728.75175	11.92353	89.04960
239	389	728.73638	7.94911	89.11941
240	390	728.72411	3.97438	89.16995
241	391	735.80687	-0.00057	91.25830
242	392	742.91457	-0.00058	93.25061
243	393	750.03304	-0.00060	95.19222
244	394	735.82451	7.94948	91.17789
245	395	735.81087	3.97435	91.23772
246	396	742.91795	3.97522	93.22888
247	397	720.26378	47.20927	87.09845
248	398	713.14057	46.74236	85.21865
249	399	706.01840	46.27552	83.33496
250	400	706.29782	38.33115	83.61819
251	401	713.74428	30.84967	85.58895
252	402	721.23316	23.36988	87.37639
253	403	720.86314	31.31653	87.48210
254	404	720.54029	39.26481	87.38900
255	405	713.41967	38.79796	85.50113
256	406	699.16152	38.17530	81.73957
257	407	699.47108	30.53858	81.83370
258	408	699.82518	22.90355	81.73345
259	409	707.35917	15.43095	83.32459
260	410	714.49473	15.58661	85.20904
261	411	721.63169	15.74219	87.08823
262	412	706.60966	30.69415	83.70381
263	413	706.96343	23.05916	83.60526
264	414	714.09887	23.21463	85.48879
265	415	707.32766	11.45736	83.46318
266	416	714.43612	7.63946	85.46388
267	417	721.56334	3.82069	87.38730
268	418	721.57664	7.79571	87.32857
269	419	721.59927	11.76965	87.22965
270	420	714.45990	11.61393	85.35908
271	421	700.20945	11.45675	81.51386
272	422	700.19636	7.63792	81.57689
273	423	700.18588	3.81884	81.62255
274	424	707.29180	-0.00045	83.63051
275	425	714.42114	-0.00049	85.54384

276	426	721.56087	-0.00052	87.40674
277	427	707.30719	7.63826	83.55592
278	428	707.29523	3.81881	83.61146
279	429	714.42403	3.81949	85.52365
280	430	691.75311	45.34045	79.64911
281	431	684.60992	44.87222	77.84702
282	432	677.46769	44.40404	76.04116
283	433	677.74108	36.77094	76.30315
284	434	685.19643	29.60248	78.18934
285	435	692.68937	22.43552	79.90577
286	436	692.33566	30.07071	80.00421
287	437	692.02385	37.70731	79.91823
288	438	684.88307	37.23914	78.10845
289	439	670.58477	36.61460	74.50206
290	440	670.88323	29.29038	74.58916
291	441	671.22114	21.96765	74.49617
292	442	678.75396	14.80711	76.03104
293	443	685.90968	14.96326	77.83745
294	444	693.06669	15.11934	79.63875
295	445	678.04161	29.44645	76.38193
296	446	678.37928	22.12382	76.29062
297	447	685.53482	22.27971	78.09636
298	448	678.72580	10.98909	76.16115
299	449	685.85763	7.32719	78.07553
300	450	693.00635	3.66449	79.91698
301	451	693.01794	7.48386	79.86240
302	452	693.03797	11.30226	79.77038
303	453	685.87872	11.14605	77.97757
304	454	671.58538	10.98851	74.29451
305	455	671.57347	7.32579	74.35436
306	456	671.56391	3.66284	74.39790
307	457	678.69377	-0.00031	76.31825
308	458	685.84439	-0.00034	78.15010
309	459	693.00425	-0.00038	79.93492
310	460	678.70743	7.32611	76.24818
311	461	678.69680	3.66280	76.30037
312	462	685.84691	3.66350	78.13128
313	463	663.16328	43.46634	72.51069
314	464	656.00104	42.99682	70.78614
315	465	648.83968	42.52737	69.05796
316	466	649.10641	35.20637	69.29941
317	467	656.56950	28.35170	71.10145
318	468	664.06567	21.49835	72.74700
319	469	663.72809	28.82116	72.83817
320	470	663.42759	36.14530	72.75902
321	471	656.26752	35.67581	71.02717
322	472	641.93097	35.04960	67.57586
323	473	642.21810	28.03866	67.65615
324	474	642.54003	21.02904	67.57007
325	475	650.07131	14.18136	69.04812
326	476	657.24619	14.33799	70.77689
327	477	664.42225	14.49454	72.50072
328	478	649.39550	28.19521	69.37162
329	479	649.71714	21.18566	69.28730
330	480	656.89174	21.34206	71.01548

331	481	650.04598	10.51943	69.17076
332	482	657.19980	7.01401	70.99955
333	483	664.36825	3.50785	72.76173
334	484	664.37866	7.17115	72.71049
335	485	664.39649	10.83341	72.62407
336	486	657.21863	10.67670	70.90786
337	487	642.88403	10.51889	67.38840
338	488	642.87259	7.01276	67.44749
339	489	642.86341	3.50640	67.49070
340	490	650.01699	-0.00017	69.31921
341	491	657.18793	-0.00020	71.06923
342	492	664.36633	-0.00024	72.77848
343	493	650.02940	7.01309	69.25292
344	494	650.01975	3.50632	69.30229
345	495	657.19016	3.50693	71.05165
346	496	634.49776	41.58715	65.68384
347	497	627.31715	41.11639	64.03797
348	498	620.13733	40.64568	62.38861
349	499	620.39687	33.63755	62.60972
350	500	627.86686	27.09745	64.32658
351	501	635.36575	20.55847	65.90002
352	502	635.04420	27.56818	65.98436
353	503	634.75506	34.57898	65.91194
354	504	627.57644	34.10827	64.25898
355	505	613.20297	33.48019	60.96460
356	506	613.47865	26.78318	61.03784
357	507	613.78486	20.08737	60.95809
358	508	621.31450	13.55339	62.37750
359	509	628.50777	13.71060	64.02794
360	510	635.70215	13.86774	65.67360
361	511	620.67428	26.94033	62.67519
362	512	620.98018	20.24455	62.59728
363	513	628.17334	20.40167	64.24719
364	514	621.29171	10.04797	62.49286
365	515	628.46645	6.69962	64.23569
366	516	635.65339	3.35061	65.91943
367	517	635.66283	6.85735	65.87105
368	518	635.67898	10.36307	65.78957
369	519	628.48322	10.20574	64.15003
370	520	614.10890	10.04746	60.79597
371	521	614.09762	6.69847	60.85485
372	522	614.08856	3.34923	60.89813
373	523	621.26500	-0.00017	62.63278
374	524	628.45544	-0.00016	64.30058
375	525	635.65141	-0.00015	65.93513
376	526	621.27657	6.69876	62.57023
377	527	621.26764	3.34922	62.61682
378	528	628.45766	3.34976	64.28425
379	529	605.75943	39.70303	59.17209
380	530	598.56130	39.23108	57.60501
381	531	591.36389	38.75918	56.03459
382	532	591.61647	32.06421	56.23052
383	533	599.09146	25.83937	57.86626
384	534	606.59233	19.61556	59.36843
385	535	606.28652	26.31146	59.44585

386	536	606.00903	33.00834	59.38008
387	537	598.81276	32.53632	57.80528
388	538	584.40781	31.90727	54.65058
389	539	584.67396	25.52610	54.70415
390	540	584.96355	19.14660	54.63385
391	541	592.48542	12.92685	56.02676
392	542	599.69672	13.08338	57.59655
393	543	606.90901	13.23984	59.16175
394	544	591.88225	25.68279	56.28736
395	545	592.17192	19.30283	56.21898
396	546	599.38199	19.45934	57.79457
397	547	592.46522	9.57834	56.13210
398	548	599.65980	6.38641	57.78829
399	549	606.86456	3.19387	59.39222
400	550	606.87331	6.54338	59.34676
401	551	606.88806	9.89208	59.27029
402	552	599.67486	9.73541	57.70919
403	553	585.26638	9.57770	54.50943
404	554	585.25784	6.38501	54.56217
405	555	585.24942	3.19226	54.61044
406	556	592.44511	-0.00046	56.26230
407	557	599.65233	-0.00037	57.84868
408	558	606.86385	-0.00027	59.40717
409	559	592.45302	6.38562	56.20328
410	560	592.44628	3.19262	56.24682
411	561	599.65317	3.19304	57.83335
412	562	576.94954	37.81412	52.98645
413	563	569.73242	37.34094	51.50949
414	564	562.51567	36.86780	50.03068
415	565	562.79135	30.48976	50.04002
416	566	570.28505	24.58443	51.51996
417	567	577.77981	18.67811	52.99057
418	568	577.48016	25.05425	53.11393
419	569	577.20347	31.43403	53.11324
420	570	569.99785	30.96124	51.57744
421	571	555.53869	27.29826	48.87149
422	572	555.81305	18.19616	48.99275
423	573	556.12748	9.09459	48.88553
424	574	563.68000	3.19259	50.02948
425	575	570.87755	6.38471	51.50876
426	576	578.07597	9.57727	52.98289
427	577	563.04345	21.39042	50.29142
428	578	563.33878	12.28911	50.29049
429	579	570.55764	15.48345	51.65298
430	580	563.67908	0.00038	50.04681
431	581	570.86928	0.00007	51.57530
432	582	578.05523	-0.00025	53.11817
433	583	578.05671	3.19304	53.10222
434	584	578.06381	6.38564	53.05697
435	585	570.87038	3.19275	51.55847
436	586	548.06611	35.92065	47.15396
437	587	540.83363	35.44667	45.75428
438	588	533.60173	34.97274	44.35162
439	589	533.83339	25.87660	44.72737
440	590	541.34222	17.24723	46.23728

441	591	548.89325	8.61956	47.50098
442	592	548.57509	17.72162	47.62833
443	593	548.29935	26.82462	47.51220
444	594	541.06575	26.35067	46.12324
445	595	526.58665	25.87625	43.32737
446	596	526.84587	17.24730	43.45249
447	597	527.14717	8.61955	43.32656
448	598	534.73835	0.00061	44.35192
449	599	541.98573	0.00063	45.75465
450	600	549.23410	0.00066	47.15229
451	601	534.09513	17.24711	44.83973
452	602	534.39654	8.61947	44.71397
453	603	541.64441	8.61937	46.11035
454	604	519.12199	34.02380	41.63186
455	605	511.87411	33.54877	40.31481
456	606	504.62676	33.07379	38.99487
457	607	504.85239	24.45122	39.33722
458	608	512.36209	16.29738	40.76512
459	609	519.90697	8.14461	41.97403
460	610	519.60549	16.77252	42.10088
461	611	519.34409	25.40133	41.98637
462	612	512.09886	24.92631	40.65842
463	613	497.59052	24.45091	38.01718
464	614	497.83733	16.29764	38.13077
465	615	498.11984	8.14536	38.01711
466	616	505.70101	0.00052	38.99701
467	617	512.96376	0.00054	40.31767
468	618	520.22740	0.00056	41.63339
469	619	505.10122	16.29746	39.43953
470	620	505.38411	8.14521	39.32539
471	621	512.64612	8.14494	40.64698
472	622	490.11691	32.12281	36.44153
473	623	482.85437	31.64682	35.20822
474	624	475.59229	31.17086	33.97216
475	625	475.81146	23.02299	34.27804
476	626	483.32328	15.34577	35.61081
477	627	490.86439	7.66947	36.74850
478	628	490.58174	15.82189	36.86246
479	629	490.33285	23.97503	36.75967
480	630	483.07268	23.49901	35.51564
481	631	468.53474	23.02273	33.04188
482	632	468.76895	15.34602	33.14356
483	633	469.03293	7.67016	33.04214
484	634	476.60429	0.00050	33.97497
485	635	483.88178	0.00050	35.21184
486	636	491.16007	0.00050	36.44403
487	637	476.04749	15.34584	34.36892
488	638	476.31178	7.67002	34.26723
489	639	483.58849	7.66980	35.50526
490	640	461.05398	30.21800	31.58688
491	641	453.77769	29.74110	30.43773
492	642	446.50181	29.26421	29.28599
493	643	446.71347	21.59205	29.55703
494	644	454.22616	14.39232	30.79444
495	645	461.76296	7.19335	31.85933

496	646	461.49894	14.86930	31.96087
497	647	461.26279	22.54587	31.86962
498	648	453.98855	22.06893	30.71041
499	649	439.42281	21.59180	28.40531
500	650	439.64408	14.39251	28.49556
501	651	439.88987	7.19391	28.40565
502	652	447.45154	0.00046	29.28899
503	653	454.74286	0.00047	30.44159
504	654	462.03487	0.00049	31.58978
505	655	446.93637	14.39238	29.63696
506	656	447.18231	7.19382	29.54701
507	657	454.47301	7.19364	30.70085
508	658	431.93684	28.30958	27.07024
509	659	424.64770	27.83183	26.00632
510	660	417.35891	27.35410	24.93995
511	661	417.56208	20.15854	25.17755
512	662	425.07444	13.43709	26.31907
513	663	432.60633	6.71623	27.30948
514	664	432.36053	13.91496	27.39940
515	665	432.13750	21.11411	27.31926
516	666	424.85023	20.63626	26.24586
517	667	410.25839	20.15825	24.11097
518	668	410.46644	13.43711	24.18983
519	669	410.69441	6.71656	24.11053
520	670	418.24643	0.00025	24.94177
521	671	425.55066	0.00032	26.00935
522	672	432.85547	0.00038	27.07280
523	673	417.77156	13.43715	25.24679
524	674	417.99965	6.71654	25.16769
525	675	425.30328	6.71649	26.23659
526	676	402.76903	26.39783	22.89528
527	677	395.46791	25.91929	21.91706
528	678	388.16707	25.44076	20.93659
529	679	388.36152	18.72231	21.13556
530	680	395.87195	12.47994	22.18433
531	681	403.39827	6.23808	23.10081
532	682	403.17028	12.95869	23.18011
533	683	402.96067	19.67969	23.11131
534	684	395.66120	19.20104	22.12279
535	685	381.04743	18.72155	20.14144
536	686	381.24341	12.47911	20.19509
537	687	381.45355	6.23770	20.12620
538	688	388.99285	-0.00065	20.93311
539	689	396.30899	-0.00037	21.91599
540	690	403.62564	-0.00009	22.89502
541	691	388.55757	12.47951	21.19094
542	692	388.76791	6.23771	21.12301
543	693	396.08308	6.23797	22.11221
544	694	373.55353	24.48294	19.06929
545	695	366.24073	24.00365	18.18298
546	696	358.92807	23.52436	17.29548
547	697	359.13020	17.28424	17.30254
548	698	366.64563	11.52323	18.19059
549	699	374.16145	5.76165	19.07160
550	700	373.94503	12.00050	19.19424

551	701	373.74248	18.24198	19.19402
552	702	366.43675	17.76271	18.24872
553	703	351.58919	17.28777	16.70066
554	704	351.56831	11.52703	16.93217
555	705	351.55394	5.76351	17.09017
556	706	359.08606	-0.00112	17.78873
557	707	366.62356	-0.00106	18.43145
558	708	374.15552	-0.00099	19.13642
559	709	359.10635	11.52547	17.56907
560	710	359.09133	5.76303	17.73208
561	711	366.62920	5.76208	18.37121
562	712	344.29293	22.56518	15.60594
563	713	336.97061	22.08530	14.80228
564	714	329.64856	21.60543	13.99620
565	715	329.61627	15.85005	14.34280
566	716	336.91663	10.56938	15.38886
567	717	344.22770	5.28546	16.32603
568	718	344.24011	11.04923	16.18256
569	719	344.26173	16.80964	15.94277
570	720	336.93834	16.33008	15.14737
571	721	322.29528	15.84952	13.51940
572	722	322.27334	10.56830	13.75009
573	723	322.26039	5.28405	13.88151
574	724	329.57952	-0.00105	14.74351
575	725	336.90248	-0.00109	15.56321
576	726	344.22484	-0.00114	16.37065
577	727	329.59538	10.56832	14.56650
578	728	329.58314	5.28393	14.69984
579	729	336.90514	5.28473	15.51947
580	730	314.99539	20.64511	12.47232
581	731	307.66423	20.16465	11.75461
582	732	300.33331	19.68420	11.03462
583	733	300.30609	14.40691	11.32887
584	734	307.61662	9.60648	12.26436
585	735	314.93317	4.80388	13.12883
586	736	314.94568	10.08755	13.00159
587	737	314.96649	15.36855	12.78258
588	738	307.63640	14.88772	12.05446
589	739	292.97727	14.40696	10.59006
590	740	292.95900	9.60620	10.78324
591	741	292.94745	4.80305	10.89324
592	742	300.27316	-0.00084	11.66682
593	743	307.60241	-0.00089	12.41400
594	744	314.92965	-0.00095	13.16550
595	745	300.28843	9.60585	11.51738
596	746	300.27745	4.80274	11.62993
597	747	307.60605	4.80317	12.37665
598	748	285.66327	18.72276	9.68365
599	749	278.32412	18.24178	9.05277
600	750	270.98516	17.76080	8.41984
601	751	270.96358	12.96280	8.66117
602	752	278.28575	8.64321	9.47204
603	753	285.61204	4.32204	10.22673
604	754	285.62308	9.12483	10.12168
605	755	285.64021	13.92543	9.94049

606	756	278.30200	13.44418	9.29966
607	757	263.62708	12.96291	8.01097
608	758	263.61278	8.64308	8.16811
609	759	263.60325	4.32151	8.25729
610	760	270.93650	-0.00064	8.93524
611	761	278.27326	-0.00068	9.59338
612	762	285.60832	-0.00073	10.25663
613	763	270.94973	8.64281	8.81401
614	764	270.94073	4.32127	8.90531
615	765	278.27703	4.32155	9.56313
616	766	256.30011	16.79838	7.24337
617	767	248.95399	16.31692	6.69996
618	768	241.60799	15.83548	6.15471
619	769	241.59163	11.51750	6.34807
620	770	248.92454	7.67922	7.03671
621	771	256.26016	3.83989	7.68136
622	772	256.26920	8.16130	7.59689
623	773	256.28262	12.48107	7.45078
624	774	248.93715	11.99924	6.89854
625	775	234.24824	11.51765	5.78717
626	776	234.23772	7.67922	5.91181
627	777	234.23045	3.83959	5.98229
628	778	241.57107	-0.00047	6.56461
629	779	248.91464	-0.00051	7.13249
630	780	256.25692	-0.00055	7.70502
631	781	241.58146	7.67901	6.46878
632	782	241.57467	3.83932	6.54092
633	783	248.91791	3.83958	7.10862
634	784	226.90995	14.87219	5.15422
635	785	219.55787	14.39035	4.69910
636	786	212.20588	13.90851	4.24236
637	787	212.19416	10.07125	4.39323
638	788	219.53653	6.71469	4.96238
639	789	226.88069	3.35752	5.49818
640	790	226.88754	7.19709	5.43209
641	791	226.89736	11.03549	5.31735
642	792	219.54581	10.55331	4.85461
643	793	204.84509	10.07153	3.92316
644	794	204.83801	6.71483	4.01970
645	795	204.83294	3.35735	4.07405
646	796	212.18068	-0.00033	4.55934
647	797	219.53019	-0.00036	5.03571
648	798	226.87863	-0.00040	5.51636
649	799	212.18753	6.71456	4.48575
650	800	212.18304	3.35712	4.54111
651	801	219.53220	3.35732	5.01741
652	802	194.08129	12.72065	3.28174
653	803	183.30871	12.01462	2.77640
654	804	172.53627	11.30862	2.26822
655	805	172.53808	7.95711	2.36656
656	806	183.29912	5.30213	2.96282
657	807	194.06317	2.64988	3.53373
658	808	194.06787	6.00806	3.48654
659	809	194.07407	9.36524	3.40252
660	810	183.30427	8.65983	2.88786

661	811	161.87899	7.95293	1.77851
662	812	161.97268	5.30245	1.79658
663	813	162.04543	2.65138	1.81166
664	814	172.78189	-0.00015	2.47298
665	815	183.45955	-0.00020	3.01591
666	816	194.14350	-0.00024	3.54915
667	817	172.62143	5.30543	2.42294
668	818	172.70246	2.65165	2.45823
669	819	183.37870	2.65124	3.00058
670	917	926.03750	20.20917	150.25207
671	918	926.00697	0.00021	150.24681
672	920	924.34178	60.58528	150.17597
673	925	896.47900	58.75951	140.57397
674	927	898.18052	19.59576	140.56910
675	928	898.12788	-0.00043	140.72500
676	930	868.52083	56.92692	131.25454
677	932	870.18342	18.97953	131.22597
678	933	870.11483	-0.00136	131.45099
679	935	840.47366	55.08854	122.20795
680	937	842.07680	18.36675	122.17851
681	938	842.00034	-0.00153	122.44360
682	940	812.33817	53.24438	113.44082
683	942	813.88356	17.75255	113.42447
684	943	813.80069	-0.00110	113.72383
685	945	784.11688	51.39458	104.95536
686	947	785.60638	17.13627	104.94586
687	948	785.52376	-0.00061	105.25823
688	950	755.79593	49.53827	96.80974
689	952	757.23182	16.51791	96.79876
690	953	757.16435	-0.00061	97.07021
691	955	727.38803	47.67624	88.97426
692	957	728.77002	15.89760	88.96219
693	958	728.71445	-0.00056	89.20051
694	960	698.89726	45.80875	81.44735
695	962	700.22497	15.27527	81.43500
696	963	700.17761	-0.00042	81.65023
697	965	670.32641	43.93592	74.23153
698	967	671.59950	14.65094	74.21966
699	968	671.55636	-0.00027	74.42459
700	970	641.67919	42.05797	67.32614
701	972	642.89760	14.02473	67.31452
702	973	642.85615	-0.00014	67.51760
703	975	612.95831	40.17503	60.73576
704	977	614.12231	13.39616	60.72238
705	978	614.08142	-0.00018	60.92553
706	980	584.16719	38.28733	54.46089
707	982	585.27509	12.77031	54.45254
708	983	585.24100	-0.00056	54.65428
709	985	555.29916	36.39466	48.55071
710	987	556.48344	0.00069	48.54490
711	989	526.37041	34.49885	42.94593
712	991	527.49196	0.00058	42.94404
713	993	497.37993	32.59884	37.67202
714	995	498.43916	0.00050	37.67141
715	997	468.33068	30.69493	32.73336

716	999	469.32760	0.00050	32.73344
717	1001	439.22635	28.78736	28.13167
718	1003	440.16092	0.00045	28.13200
719	1005	410.07047	26.87639	23.87117
720	1007	410.94282	0.00019	23.87007
721	1009	380.86654	24.96226	19.95392
722	1011	381.67722	-0.00093	19.94647
723	1013	351.61550	23.04508	16.40723
724	1015	351.54549	-0.00119	17.17473
725	1016	322.32678	21.12559	13.18768
726	1018	322.25561	-0.00100	13.91235
727	1019	293.00259	19.20376	10.31239
728	1021	292.94208	-0.00078	10.91913
729	1022	263.64638	17.27984	7.78487
730	1024	263.59816	-0.00059	8.27792
731	1025	234.26213	15.35404	5.60766
732	1027	234.22618	-0.00043	5.99824
733	1028	204.85400	13.42668	3.78404
734	1030	204.82984	-0.00029	4.08609
735	1031	161.76395	10.60261	1.75749

EOF..

APPENDIX B

POLYNOMIAL COEFFICIENTS OF PILLOW

$$Z = A_0 + A_1 Y + A_2 Y^2 + A_3 Y^3 + A_4 Y^4$$

PILLOW NODES		COEFFICIENTS
1 - 5	$A_0 =$	.24071
	$A_1 =$	0.0
	$A_2 =$	-.145021518 E-02
	$A_3 =$	0.0
	$A_4 =$	.191012971 E-05
10 - 14		.33822
		0.0
		-.12981917 E-02
		0.0
		-.43013248 E-07
19 - 23		.36854
		0.0
		-.13779570 E-02
		0.0
		.95405251 E-07
28 - 32		.34712
		0.0
		-.13197269 E-02
		0.0
		-.43969161 E-08
37 - 41		.26096
		0.0
		-.15435536 E-02
		0.0
		.190113764 E-05

NODES	COEFFICIENTS
5 - 9	.22040
	.10984922 E-02
	-.16899606 E-02
	.164414211 E-06
	-.955316837 E-07
14 - 18	.20440
	.102189705 E-02
	-.161325802 E-02
	-.143287334 E-06
	.285247435 E-07
23 - 27	.20429
	.954954016 E-03
	-.15863633 E-02
	-.466840693 E-07
	.219105579 E-07
32 - 36	.21272
	.957247918 E-03
	-.16112524 E-02
	.721238486 E-07
	.184512365 E-07
41 - 45	.23702
	.107476329 E-02
	-.168227854 E-02
	.147612910 E-06
	-.901057212 E-07

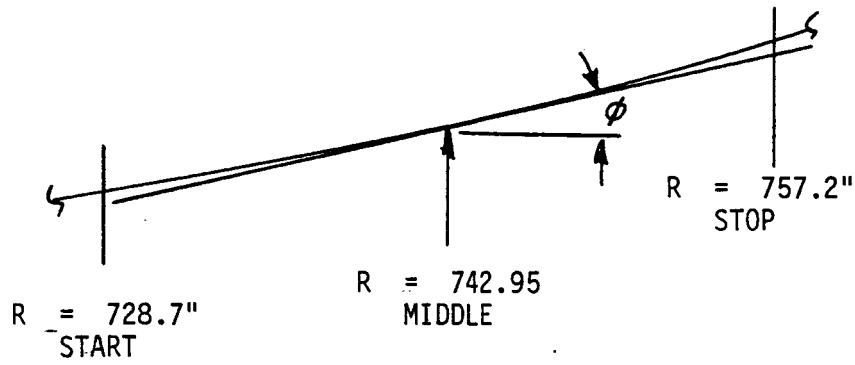
APPENDIX C

COMPARISON OF BEST FIT PLANE

TO BESTFIT PARABOLA

APPENDIX C

COMPARISON OF BESTFIT PLANE TO BESTFIT PARABOLA



PARABOLA

$$Z = \frac{R^2}{(4)(f)} \qquad Z_{start} = \frac{(728.7)^2}{(4)(1222.8)} = 108.563$$

$$Z_{stop} = \frac{(757.2)^2}{(4)(1222.8)} = 117.221$$

PLANE Tanget at Midpoint, R = 742.95, Z_{mid} = 112.8505

$$\phi = \tan^{-1} \frac{742.95}{(2)(1222.8)} = 16.89828°$$

$$Z_{start} = 112.8505 - [(742.95 - 728.7) \tan \phi]$$

$$Z_{start} = 108.521$$

$$Z_{stop} = 112.8505 + [(757.2 - 742.95) \tan \phi]$$

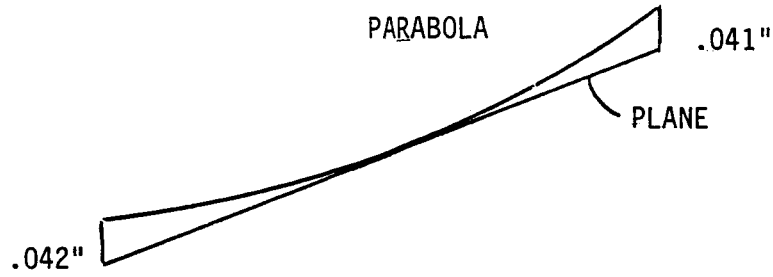
$$Z_{stop} = 117.1795$$

APPENDIX C

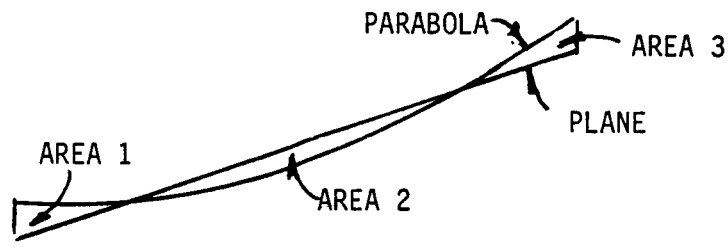
Delta Z at start and stop points

Delta Z start = 108.563 - 108.521 = .042

stop = 117.221 - 117.180 = .041



Because the data points will be bestfit then the bestfit plane will actually lie over the bestfit parabola as shown below:



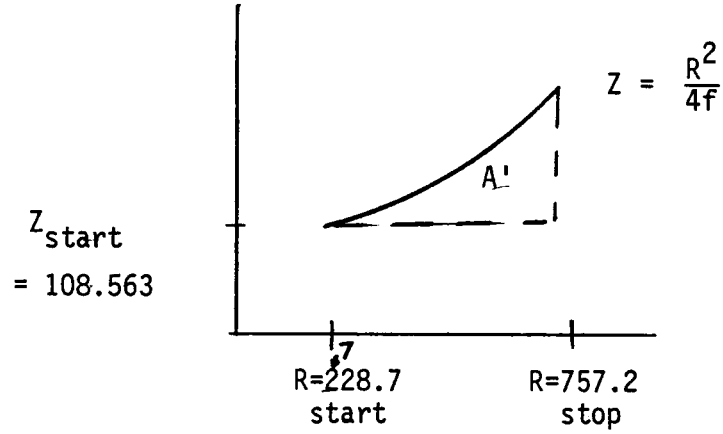
If a continum of data points existed over the entire range of the bestfit, then

AREA 1 + AREA 3 = AREA 2

and $$\int_{R_1}^{R_2} \text{PARABOLA } dR = \int_{R_1}^{R_2} \text{PLANE } dR$$

APPENDIX C

AREA OF PARABOLA

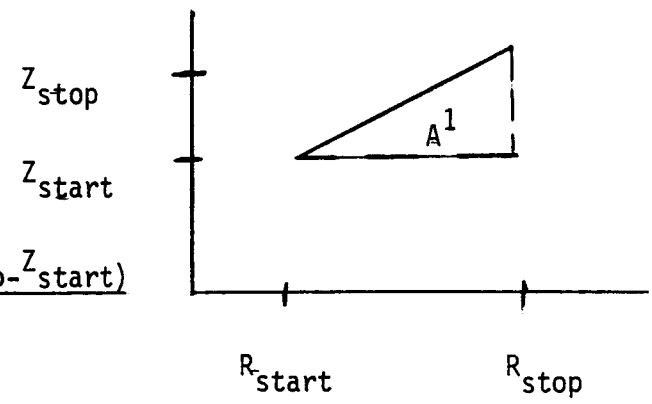


PARABOLA $$A^1 = \frac{1}{4f} \int_{R_{start}}^{R_{stop}} R^2 \, dR - (R_{stop} - R_{start})(Z\ start)$$

$$A^1 = \frac{1}{14673.6} \left[R^3 \Big|_{728.7}^{757.2} \right] - 3094.0455$$

$$A^1 = 122.5901$$

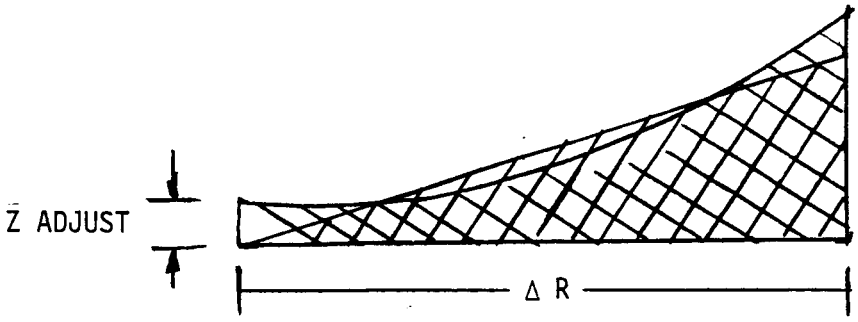
AREA OF PLANE



$$A^1 = \frac{(R_{stop}-R_{start})*(Z_{stop}-Z_{start})}{2}$$

A^1_{line} = 123.38363

APPENDIX C



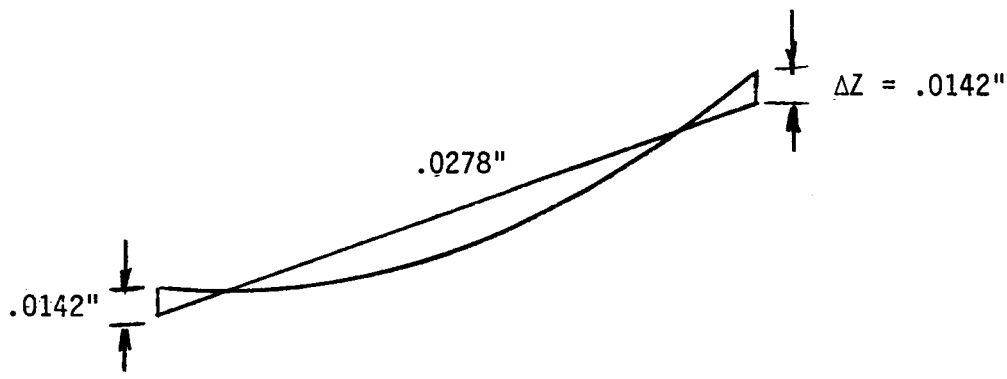
For both areas to be equal

A^1 parabola + (Z adjust * ΔR) = A^1 line

122.5901 + (Z adjust * 28.5) = 123.38363

$$Z\ ADJUST = \frac{123.38363-122.5901}{28.5} = .0278$$

Thus the errors introduced at the points indicated are:



The RMS errors at these points are approximately:

(.707)(.0142) = .01004" RMS

(.707)(.0278) = .01966" RMS

The average RMS .015" RMS

APPENDIX C

With the magnitude of roughness results derived the effect of using the plane versus using a parabola is:

$$\sqrt{RMS^2_{derived} + RMS^2_{error}} = RMS_{possible}$$

Using the smallest roughness value obtained, the possible RMS could be:

$$\sqrt{(.11338)^2 + (.015)^2} = .11437" \text{ RMS}$$

Using the largest roughness value obained, the possible RMS could be:

$$\sqrt{(.18097)^2 + (.015)^2} = .18159" \text{ RMS}$$

Because of the insignificant differences, the best fit plane results are reported

i.e. .11338" versus .11437" RMS

.18097" versus .18159" RMS