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ILS LOCALIZER PERFORMANCE STUDY

PART 1

DALLAS/FORT WORTH REGIONAL AIRPORT AND MODEL VALIDATION—SYRACUSE HANCOCK AIRPORT

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FINAL REPORT

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16. Abstract

The TSC electromagnetic scattering model has been used to predict the course deviation indications (CDI) at the planned Dallas Fort Worth Regional Airport. The results show that the CDI due to scattering from the modeled airport structures are within Category I requirements on all four modeled runways when the capture effect localizer (Alford 1B) is used but only marginally acceptable when the standard V-Ring localizer is used. Category II requirements for the designated Category II runway are met only by the capture effect antenna.

The report also presents the results of the TSC validation test in which Syracuse Hancock Airport was modeled. Theoretical and flight recorded data were compared and good agreement was obtained.

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PREFACE

On June 6, 1972, the Transportation Systems Center (TSC) made a presentation to FAA on the expected ILS Localizer beam quality at the Dallas Fort Worth Regional Airport. This document presents in report form the information that was given at that presentation.

TABLE OF CONTENTS

Section	Page
1.0 INTRODUCTION..	1
2.0 MODEL VALIDATION FOR HANCOCK AIRPORT, SYRACUSE, NEW YORK..	3
3.0 DALLAS FORT WORTH REGIONAL AIRPORT STUDY.............	12
3.1 Summary of Results..............................	16
3.2 Antenna Patterns................................	16
3.3 CDI's for Individual Runways....................	28
4.0 CONCLUSIONS...	68
REFERENCES..	69
APPENDIX A - COORDINATES AND SIZES OF SYRACUSE AIRPORT STRUCTURES USED IN THE TSC ELECTROMAGNETIC SCATTERING MODEL	A-1
APPENDIX B - COORDINATES AND SIZES OF THE TERMINAL BUILDINGS AT DALLAS FORT WORTH REGIONAL AIRPORT......................	B-1
APPENDIX C - COORDINATES AND SIZE OF THE HOTEL AT DALLAS FORT WORTH REGIONAL AIRPORT AS USED IN THE TSC MODEL........	C-1
APPENDIX D - COORDINATES AND SIZE OF CONTROL TOWER AT THE DALLAS FORT WORTH REGIONAL AIRPORT..........................	D-1

LIST OF ILLUSTRATIONS

Figure		Page
1.	Photograph of Syracuse Hancock Airport..................	4
2.	Airport Layout Plan for Syracuse Hancock Airport. The structures which have been modeled are numbered........	5/6
3.	Theoretical CDI vs Flight Recording of 9/22/71 (3a) and 1/10/72 (3b) at Syracuse Airport.......................	7/8
4a.	Theoretical CDI's at Syracuse Hancock Airport Using an 8-Loop Localizer....................................	10
4b.	Theoretical CDI's at Syracuse Hancock Airport Using a V-Ring Localizer....................................	11
5.	Layout of Dallas Fort Worth Regional Airport Showing Four Instrumented Runways...........................	13
6.	Computer Generated Layout of the Scattering Structures to be used in the Model of the Dallas Fort Worth Regional Airport..	15
7.	Sketch of the CDI Envelopes for each of the Runways....	17
8.	Carrier Plus Sideband V-Ring Antenna Pattern...........	19/20
9.	Carrier Plus Sideband Alford Clearance Antenna Pattern	21/22
10.	Carrier Plus Sideband Alford 14 Element Array Course Antenna Pattern......................................	23/24
11a.	Expected V-Ring Localizer CDI Clearance Patterns as a Function of Azimuth.................................	26
11b.	Expected Alford Localizer CDI Clearance Pattern as a Function of Azimuth.................................	27
12a.	Runway 17L - Illuminated Surfaces......................	29
12b.	Runway 17L - Clearance Orbit (V-Ring Antenna)..........	30
12c.	Runway 17L - Clearance Orbit (Alford Antenna)..........	31
12d.	Runway 17L. Detail of CDI Course Structure Due to Scattering from Hotel Alone, V-Ring Antenna used.......	32
12e.	Runway 17L - Detail of CDI Course Structure Due to Scattering from Hotel Alone, Alford Antenna Used (Note Different Scale)...	33

LIST OF ILLUSTRATIONS (CONT.)

Figure		Page
12f.	Runway 17L - CDI Due to Scattering from All Modeled Structures (V-Ring Localizer Used)	34
12g.	Runway 17L - CDI Due to Scattering from All Modeled Structures (Alford Localizer Used)	35
12h.	Runway 17L - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (V-Ring Antenna Used)	36
12i.	Runway 17L - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (Alford Antenna Used)	37
13a.	Runway 17R - Illuminated Surfaces	39
13b.	Runway 17R - Clearance Orbit (V-Ring Antenna)	40
13c.	Runway 17R - Clearance Orbit (Alford Antenna)	41
13d.	Runway 17R - Detail of CDI Course Structure Due to Scattering from Hotel Alone, V-Ring Antenna Used	42
13e.	Runway 17R - Detail of CDI Course Structure Due to Scattering from Hotel Alone, Alford Antenna Used (Note Different Scale)	43
13f.	Runway 17R - CDI Due to Scattering from All Modeled Structures (V-Ring Localizer Used)	44
13g.	Runway 17R - CDI Due to Scattering from All Modeled Structures (Alford Localizer Used)	45
13h.	Runway 17R - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (V-Ring Antenna Used)	46
13i.	Runway 17R - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (Alford Antenna Used)	47
14a.	Runway 35L - Illuminated Surfaces	49
14b.	Runway 35L - Clearance Orbit (V-Ring Antenna)	50
14c.	Runway 35L - Clearance Orbit (Alford Antenna)	51
14d.	Runway 35L - Detail of CDI Course Structure Due to Scattering from Hotel Alone, V-Ring Antenna Used	52

Figure		Page
14e.	Runway 35L - Detail of CDI Course Structure Due to Scattering from Hotel Alone, Alford Antenna Used (Note Different Scale)	53
14f.	Runway 35L - CDI Due to Scattering from All Modeled Structures (V-Ring Localizer Used)	54
14g.	Runway 35L - CDI Due to Scattering from All Modeled Structures (Alford Localizer Used)	55
14h.	Runway 35L - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (V-Ring Antenna Used)	56
14i.	Runway 35L - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (Alford Antenna Used)	57
15a.	Runway 35R - Illuminated Surfaces	59
15b.	Runway 35R - Clearance Orbit (V-Ring Antenna)	60
15c.	Runway 35R - Clearance Orbit (Alford Antenna)	61
15d.	Runway 35R - Detail of CDI Course Structure Due to Scattering from Hotel Alone, V-Ring Antenna Used	62
15e.	Runway 35R - Detail of CDI Course Structure Due to Scattering from Hotel Alone, Alford Antenna Used (Note Different Scale)	63
15f.	Runway 35R - CDI Due to Scattering from All Modeled Structures (V-Ring Localizer Used)	64
15g.	Runway 35r - CDI Due to Scattering from All Modeled Structures (Alford Localizer Used)	65
15h.	Runway 35R - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (V-Ring Antenna Used)	66
15i.	Runway 35R - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (Alford Antenna Used)	67

LIST OF ILLUSTRATIONS (CONT.)

Figure		Page
A-1.	Computer Generated Drawing of the Structures Modeled for Syracuse Airport. Only the Solid Lines in the Drawings of the Buildings Represent Illuminated Surfaces	A-9/A-10
B-1.	Plan for Typical Terminal	B-2
B-2.	Cross Section for Terminals in Areas 2W, 2E, and 4E	B-2
B-3.	Cross Section for Terminal in Area 3E	B-3

LIST OF TABLES

Table		Page
A-1.	BUILDING SIZES AND LOCATIONS MODELED AT HANCOCK SYRACUSE AIRPORT	A-2

1.0 INTRODUCTION

TSC has been working on the development of a predictive electromagnetic scattering and signal detection model for determination of ILS performance. The model as presently conceived, is an outgrowth of the efforts of IBM, of Ohio University, of Andrew Alford Company, and most recently of TSC.[1] While still in the model development phase, TSC was asked, in May of 1972 if the model was far enough advanced to predict the extent of ILS Localizer beam bending at runways which would be outfitted with three category I and one category II Localizers. These were to be installed at the new Dallas Fort Worth Regional Airport where some signal derogation was expected because of the large size and close proximity of the various planned airport structures.

TSC responded by stating that the model was in fact far enough advanced to be used for the intended purposes. Specifically, TSC was asked to determine if category I and category II tolerances could be met by either of two types of antennas presently planned for Dallas Fort Worth, a standard V-Ring and an Alford Capture Effect Localizer. However, at the same time TSC also cautioned that the model had not as yet been verified for an actual airport environment and the results, therefore, could be considered only tentative until such verification was made. Because model verification was considered of prime importance, TSC advanced its development schedule for verification and a decision was reached to make every effort to obtain flight recordings of an existing airport to obtain model verification before the Dallas Fort Worth study was completed. Working with J. Koch of the Flight Inspection Office (North East Region) TSC did obtain a set of repeatable flyability recordings (Hancock airport at Syracuse, New York) and with the help of J. Rubino from OSEM and R. Walsh, the Deputy Commissioner at the Syracuse airport, all the data necessary as input for the model was obtained. The model was highly confirmed by agreement between the computed course bends and the flight recordings in most details of amplitude and phase. These results, obtained on June 2, and the results of the Dallas Fort Worth study were presented four days later on June 6. This report comprises essentially that presentation.

The organization of the report is as follows: The airport layout in the vicinity of the localizer equipped runways is presented. All possible candidates for signal degradation with their location, size, shadowing and segmentation *as actually used in the model* are delineated as well as the illuminating localizer antenna pattern used in the model. Finally, the calculated course deviation indication (CDI) is presented for an aircraft flying a specified glide path.

No attempt is made to explain the underlying theoretical basis for the model in this report. Instead the reader is referred to the TSC report No. DOT-TSC-FAA-72-7 for a detailed analysis of the physics of the model.[1]

The Syracuse airport verification studies are presented first, followed by the Dallas Fort Worth Regional Airport analysis.

2.0 MODEL VALIDATION FOR HANCOCK AIRPORT, SYRACUSE, NEW YORK

As explained in the introduction, TSC obtained a set of flight recordings for only one airport, Hancock Airport at Syracuse, New York, which therefore served as the candidate for the TSC model validation study.

Hancock Airport has a category I Eight - Loop Localizer on runway 28 operating with a nominal 4° course width and elevated 19 feet above ground level at its location 2000 feet beyond the end of the runway. The Localizer was used as the origin for the location of airport structures in the model. A Photograph of the airport is shown in Figure 1 and the airport structures in the vicinity of runway 28 are shown in Figure 2. All structures used in the model validation study, some two dozen buildings, are delineated in Figure 2 by the different numbers assigned to them; their precise locations and sizes are given in Appendix A. Based on the sizes and locations of these reflecting structures, the model predicted a course deviation indication (CDI) on the runway centerline as shown in Figure 3, where the flight recorded and theoretical CDI's are compared. For the theoretical model the aircraft was assumed to be on a glide path of 2.5°, the antenna course width was taken as 3.64° (FAA specs) and the antenna height as 12 feet (which is an approximation to account for the bulge in the runway ahead of the actual 19 foot antenna elevation).

Theoretical and flight test data are in good agreement in both the magnitude and phase of the derogation, (Figure 3). The validation could have been more precise had we known how far off centerline the pilot actually flew (the theoretical results are presented for a centerline flight only), whether hangar doors were open, partially open or closed during the flight test (the theoretical results are for the conservative case of closed hangar doors)

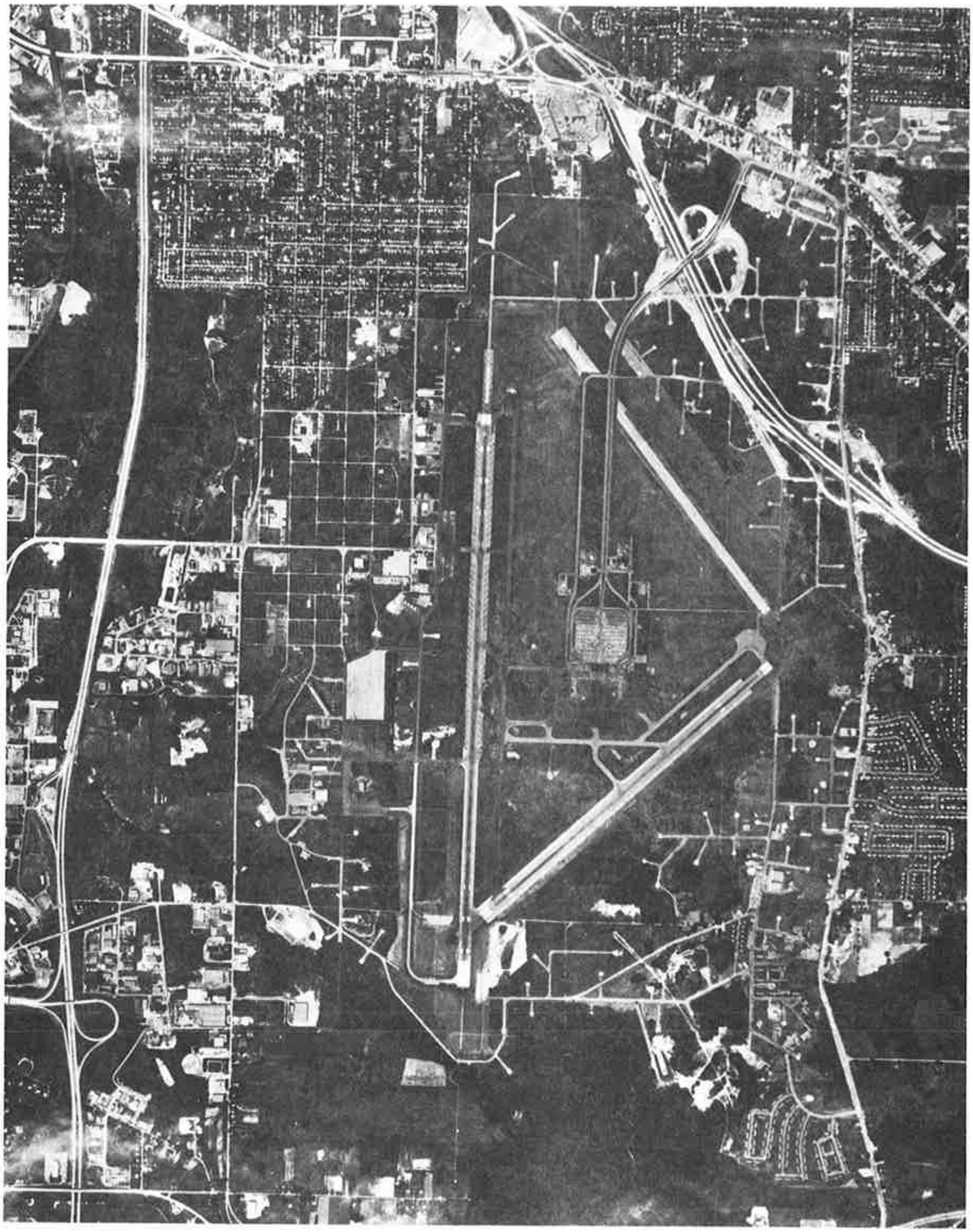


Figure 1. Photograph of Syracuse Hancock Airport

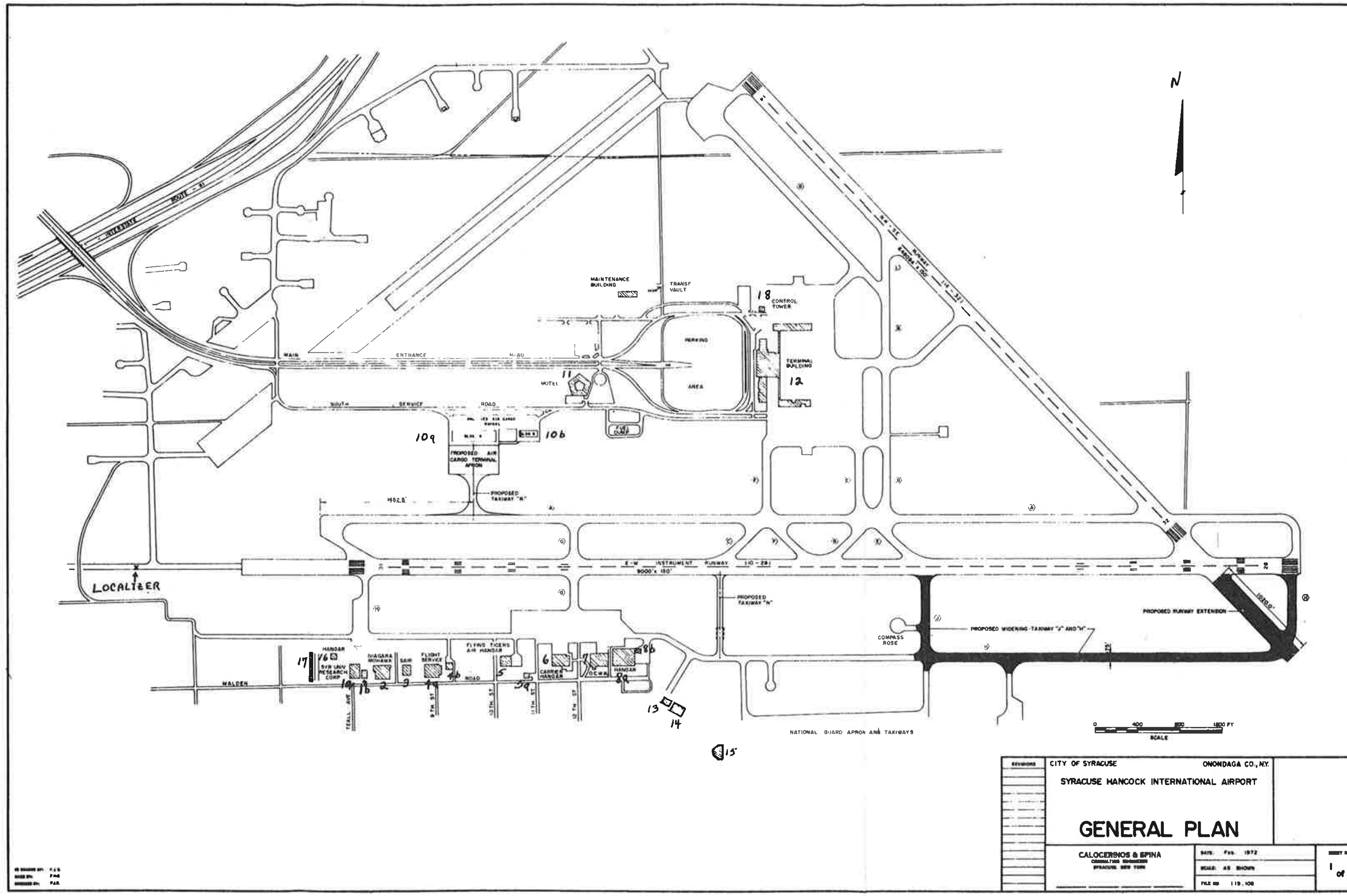


Figure 2. Airport Layout Plan for Syracuse Hancock Airport. The structures which have been modeled are numbered

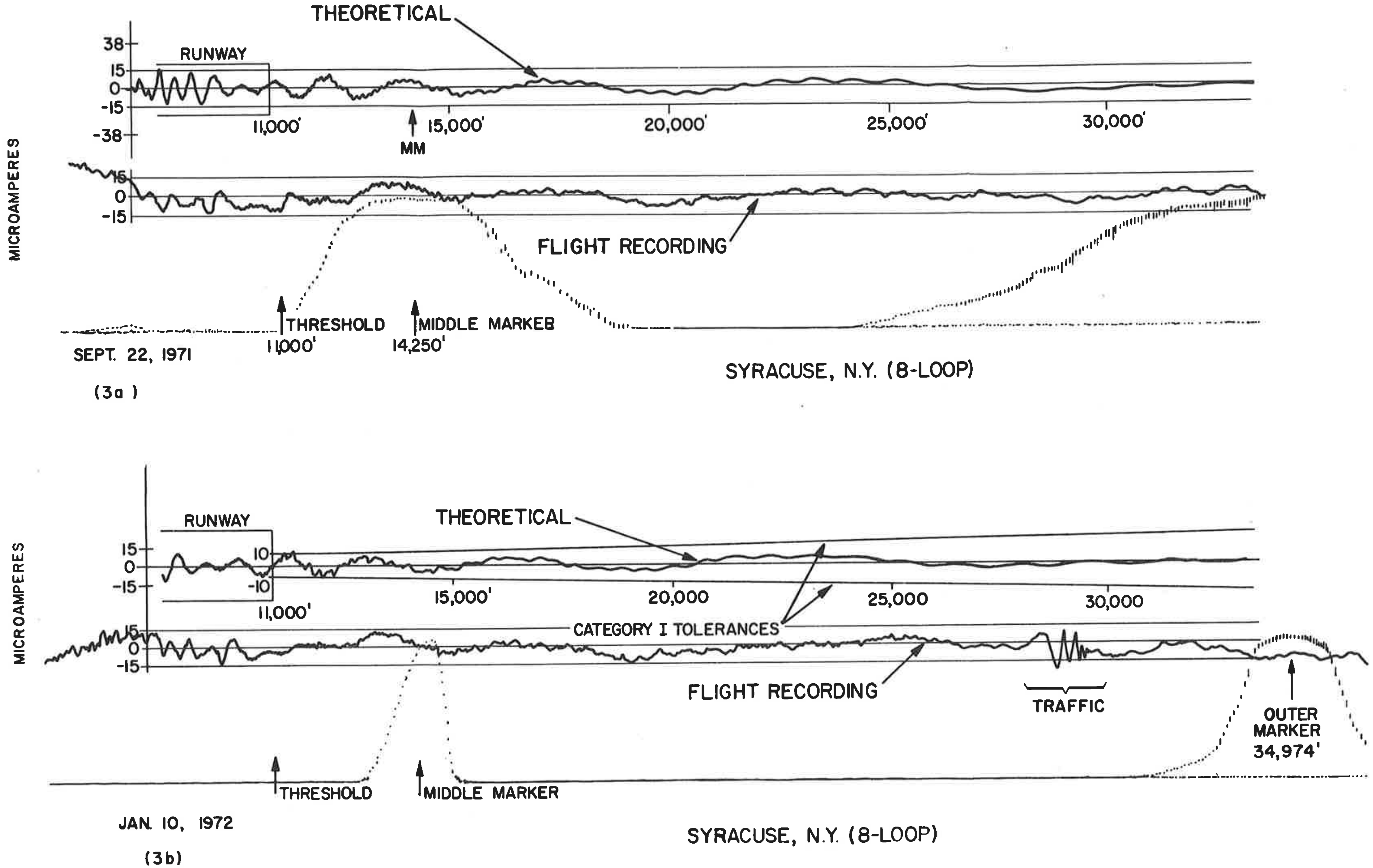


Figure 3. Theoretical CDI vs Flight Recording of 9/22/71 (3a) and 1/10/72 (3b) at Syracuse Airport

and the precise speed of the aircraft*. Therefore, it is recommended that for future validation studies these kinds of information be obtained and recorded.

Having obtained model validation, TSC was asked to compare a standard V-Ring with the existing 8-Loop Localizer at Syracuse as an exploration of the possibility of commissioning runway 28 for category II. The model's predictions are shown in Figure 4. It appears that runway 28 could become category II commissioned with the V-Ring Localizer antenna.

*In Figure 3, the middle marker location, 14,250', on the theoretical and on the flight data graphs was lined up. If the aircraft had maintained a constant speed of 200 ft/sec., all other points on the two graphs would also line up. They do not and therefore *precise* comparison of the phase of the derogation is not directly possible.

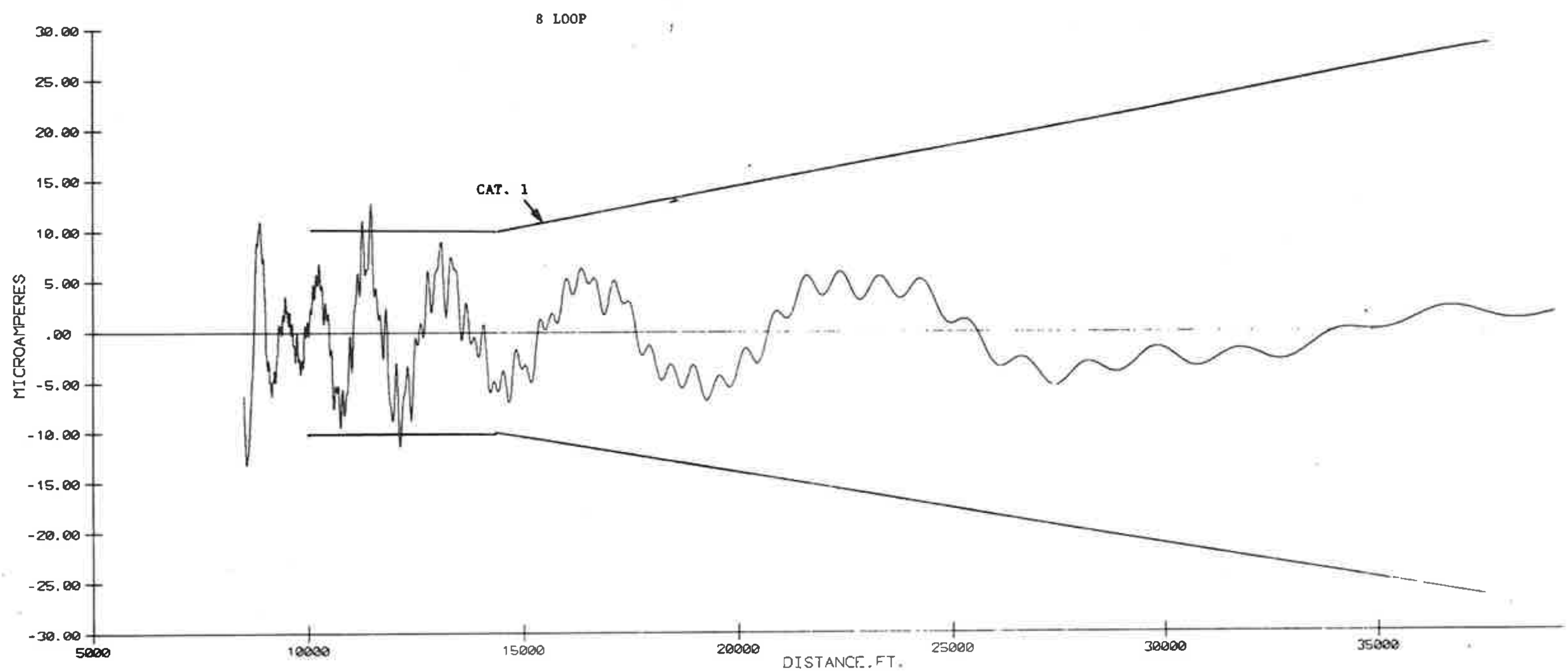


Figure 4a. Theoretical CDI's at Syracuse Hancock Airport Using an 8-Loop Localizer

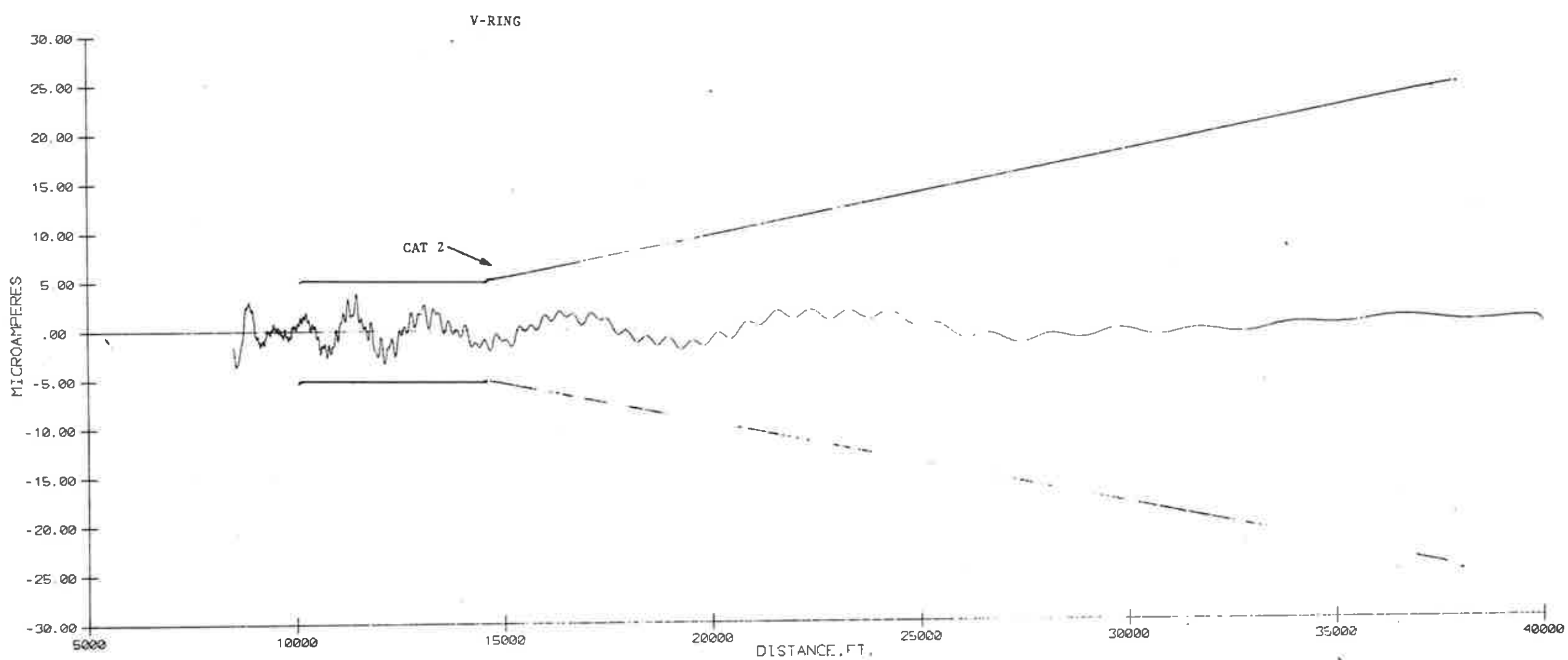


Figure 4b. Theoretical CDI's at Syracuse Hancock Airport Using a V-Ring Localizer

3.0 DALLAS FORT WORTH REGIONAL AIRPORT STUDY

As discussed earlier, TSC was asked to apply its electromagnetic scattering localizer model to predict the derogation due to proposed airport structures at the new Dallas Fort Worth Regional Airport. TSC was given a general layout of the proposed instrumented runways at the airport, the proposed structures and two candidates for localizer antennas. This Section contains the results of applying the model to the specific set of airport structures supplied to TSC. These may be seen in Figure 5. which shows a general layout of the planned four instrumented runways, 35R, 35L, 17R and 17L.* These run north and south; the cross marks on the north and south ends indicate the location of the localizers. The cross mark circumscribed by a circle is to be the category II localizer, while the remaining three are designated as category I localizers.

The large semicircles symmetrical about either side of the center highway will be terminals. For phase 1 of the airport construction only those semicircles which are shown shaded will be constructed, namely, those in the areas marked 2W, 2E, 3E and 4E, and only these four have been modeled. The terminals are 120 feet wide (thickness of the semicircle), are between 42 and 46 feet tall and are approximately 3000 feet long. They may contain as much as 60% glass, so that our results which assume perfect conductivity, a good approximation for metal reinforced concrete, will yield a conservative estimate of the derogation due to scattering from the terminals. The precise sizes and locations of these terminals as used in the model are given in Appendix B.

The planned hotel for the airport is shown in the 3W area in Figure 5. This is to be a 124 foot high structure of curved shape approximately 320 feet long and 60 feet deep. The hotel will be approximately 30% glass but part of this glass will be shielded by metal reinforced concrete balconies (the structure itself contains

*Standard FAA notation for runway designations is used in this report.

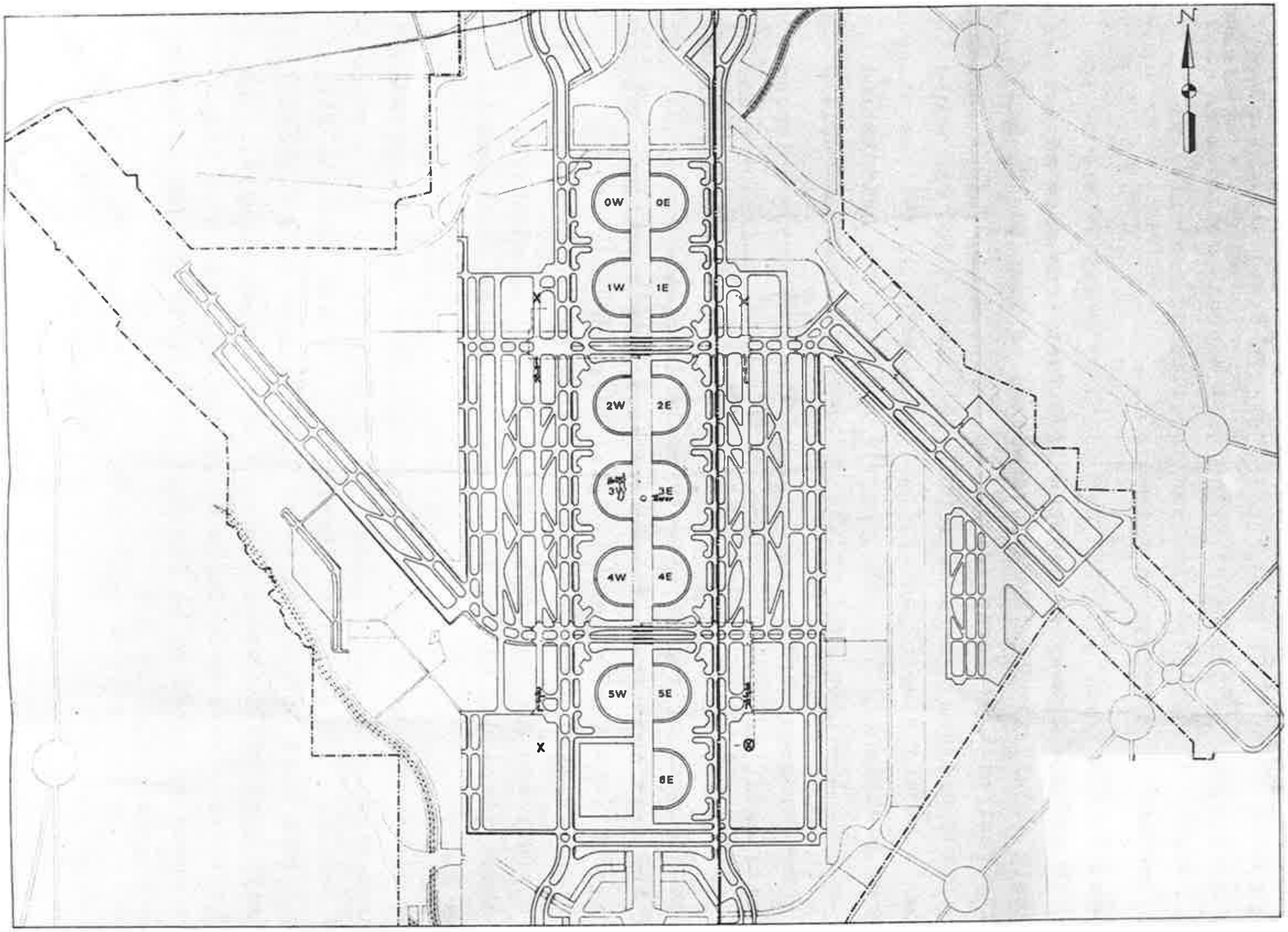


Figure 5. Layout of Dallas Fort Worth Regional Airport Showing Four Instrumented Runways

18 inch square metal grids in 4-inch pre cast concrete panels) so the assumption of perfect conductivity should yield estimates of the derogation due to the hotel which will be only slightly on the high side. The precise size and location of the hotel as used in the model are shown in Appendix C.

Finally, the tower located just south of areas 3W and 3E in the center of the highway is located 3200 feet from each of the north-south runways. The tower is composed of four ten by ten foot, 174 feet high pillars arranged in a circle of 20 foot radius. On top of the pillars sits a 16 foot high eleven sided cab whose floor has a 19 and a half foot radius. The walls of the cab slope outward at a angle of 15°. The precise location and orientation of the control tower as used in the model is given in Appendix D.

A computer generated layout plan of the scattering objects as inputted into the model is shown in Figure 6: the four terminals, the hotel and the control tower (this latter has been drawn in by hand because of its relatively small lateral dimensions). Each of the terminals was divided into 50 straight sections set at the appropriate angles to each other (see Appendix B), the hotel into straight sections of no more than 50 feet each also set at the appropriate angles to each other to make up the given curved shape (Appendix C) and the tower modeled as explained in Appendix D.

The difference of depth of modulation (DDM) due to scattering from these structures was obtained for an aircraft flying a glide path of 2-1/2°. Two different localizers, a V-Ring and the Alford Capture Effect with course widths of 3.17° placed 9 feet above ground were used and compared for each of the four runways. The comparisons are always made for the dynamic runs in which the aircraft speed is taken to be 200 feet per second and the aircraft receiver time constant is 0.4.

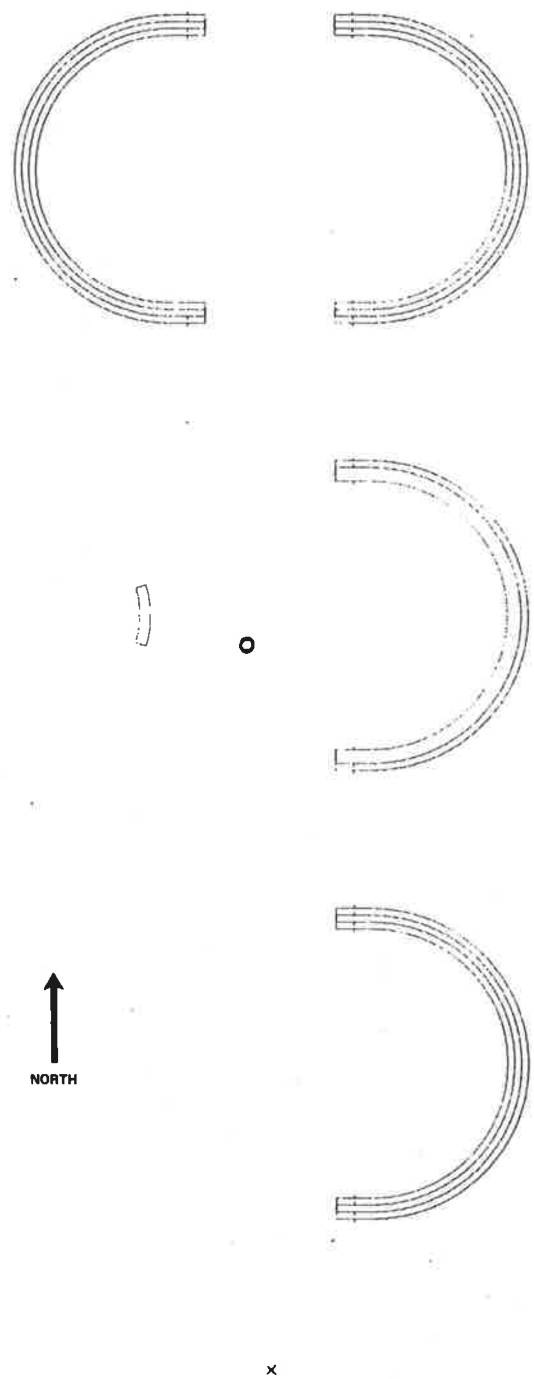


Figure 6. Computer Generated Layout of the Scattering Structures to be used in the Model of the Dallas Fort Worth Regional Airport

3.1 SUMMARY OF RESULTS

A summary of the results obtained from the Dallas Fort Worth Regional Airport Study is shown in Figure 7 where the envelopes of the CDI's are sketched for each of the runways in the case of the V-Rings, and for the worse case in the case of the Alford antenna.

The Figure clearly indicates that the Alford antenna meets category II requirements for the structures modeled. The V-Ring antenna does not meet category II but is marginally acceptable for category I on the other runways. Since other structures which were not modeled in this study, such as hangars to be constructed, will undoubtedly add to the total derogation, it is clear that any marginally acceptable localizer should not be used before checking into the effect of these additional structures. Based on the <u>modeled</u> structures, however, the TSC model suggests that the Alford antenna be used for the category II runway and probably for runway 35L. The V-Ring is marginally acceptable for runways 35R and 17R.

3.2 ANTENNA PATTERNS

Figures 8, 9, 10 and 11 show the antenna patterns generated by the localizers modeled for this study. Figure 8 shows the carrier and sideband V-Ring antenna pattern. Figures 9 and 10 show the Alford Clearance and Course patterns, respectively. Figure 11 compares the expected CDI patterns for the V-Ring and Alford antennas.

Information on the Alford antenna was supplied only out to an azimuth of 60°, hence the limited azimuthal range shown on the Alford antenna patterns in the figures. With regard to the Alford antenna, note that the CDI drops below 150 microamps near 45°. However, new FAA specs allow this drop off, requiring the CDI to be above 150 microamps only out to ± 35°.

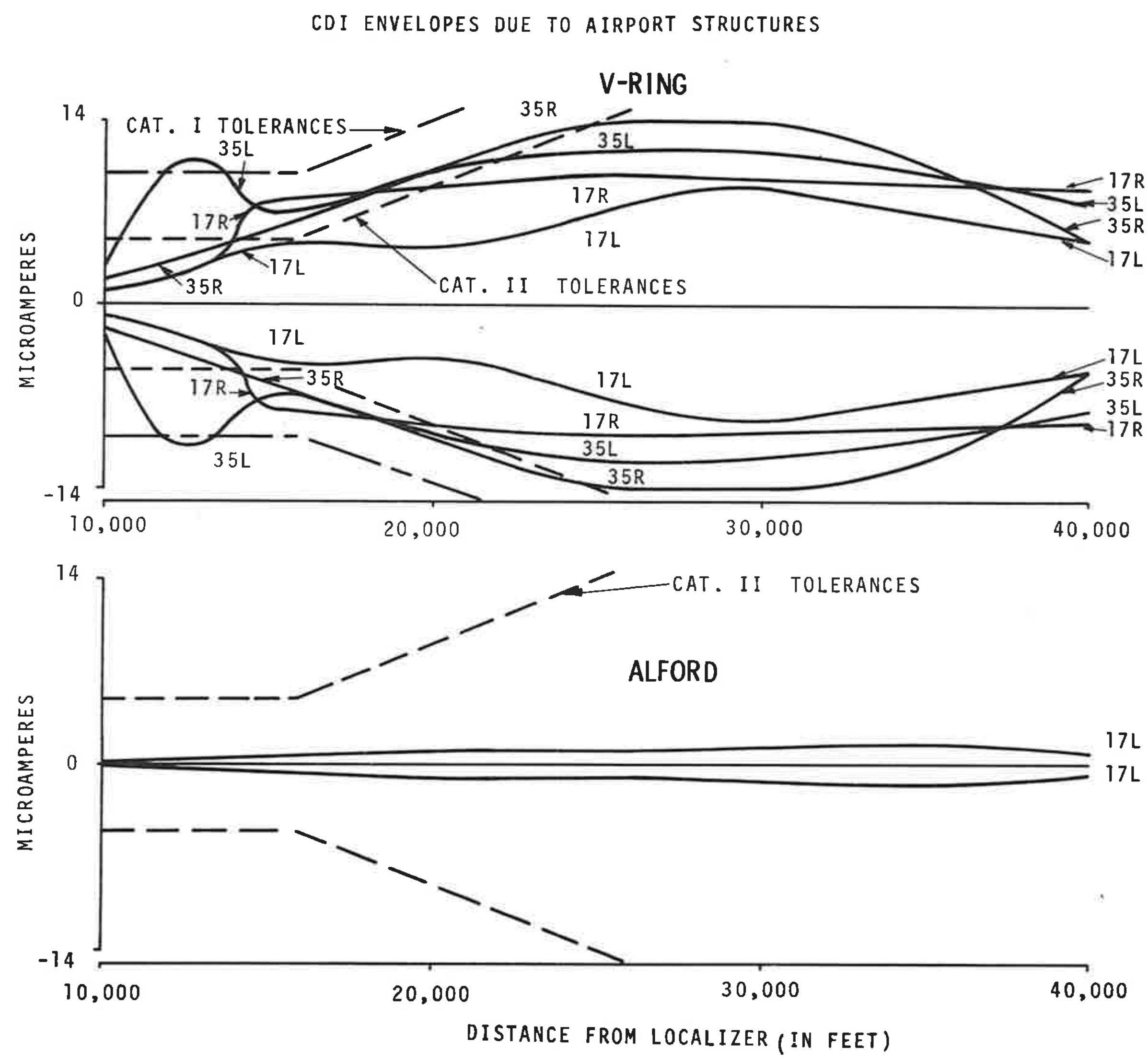


Figure 7. Sketch of the CDI Envelopes for each of the Runways

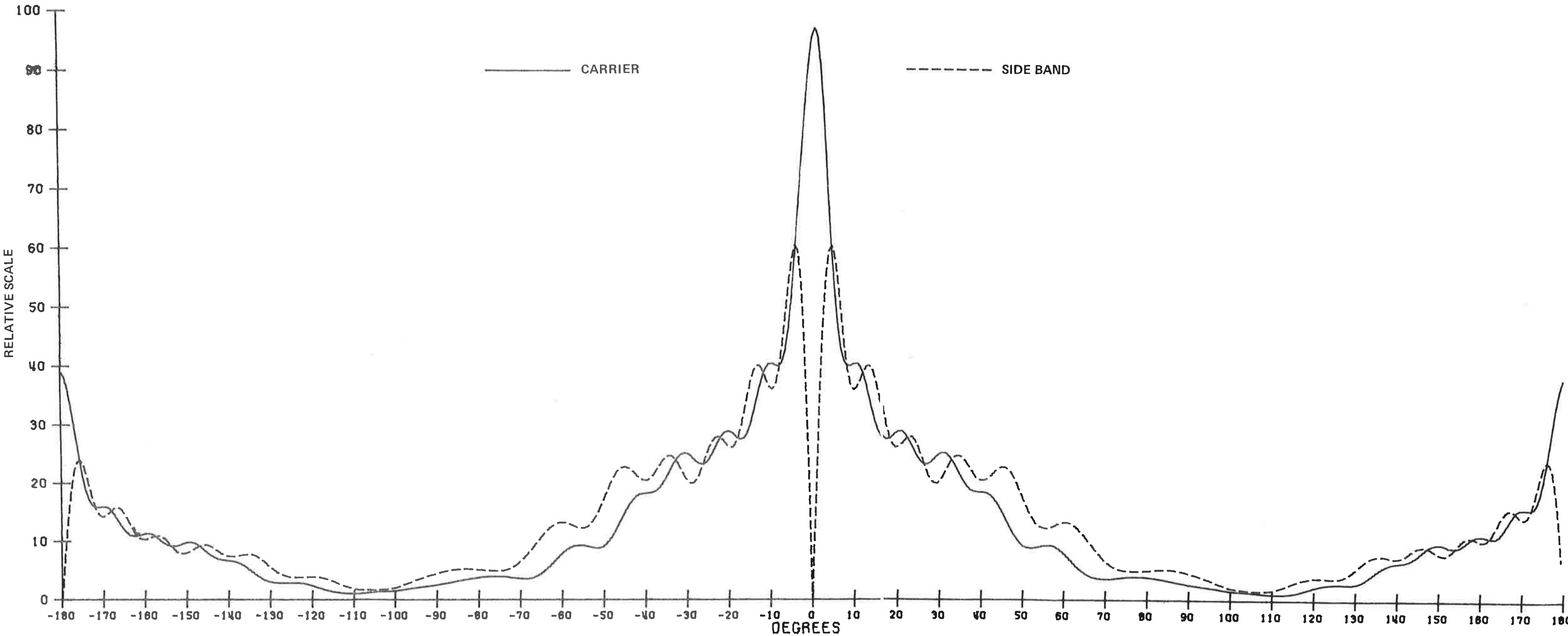


Figure 8. Carrier Plus Sideband V-Ring Antenna Pattern

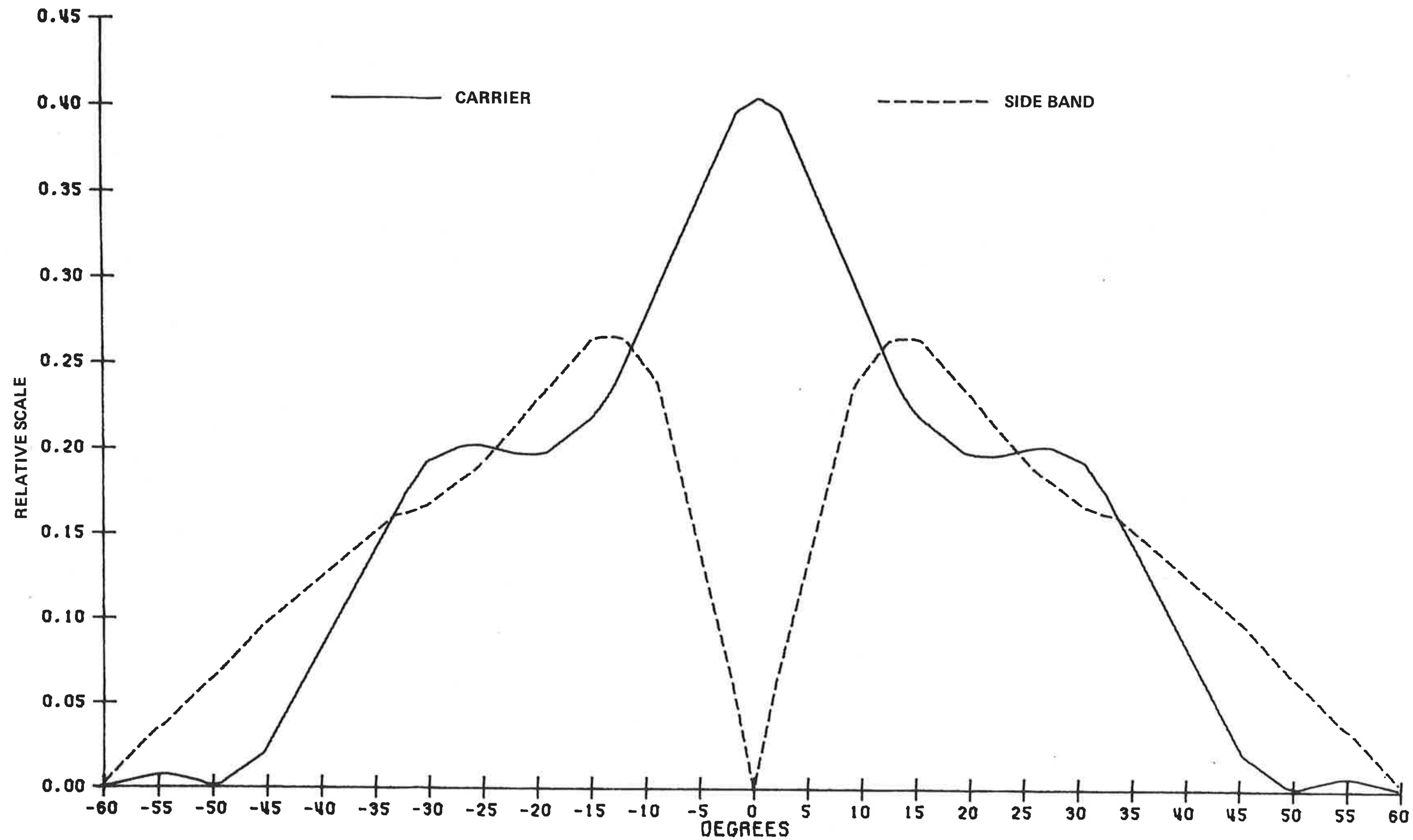


Figure 9. Carrier Plus Sideband Alford Clearance Antenna Pattern

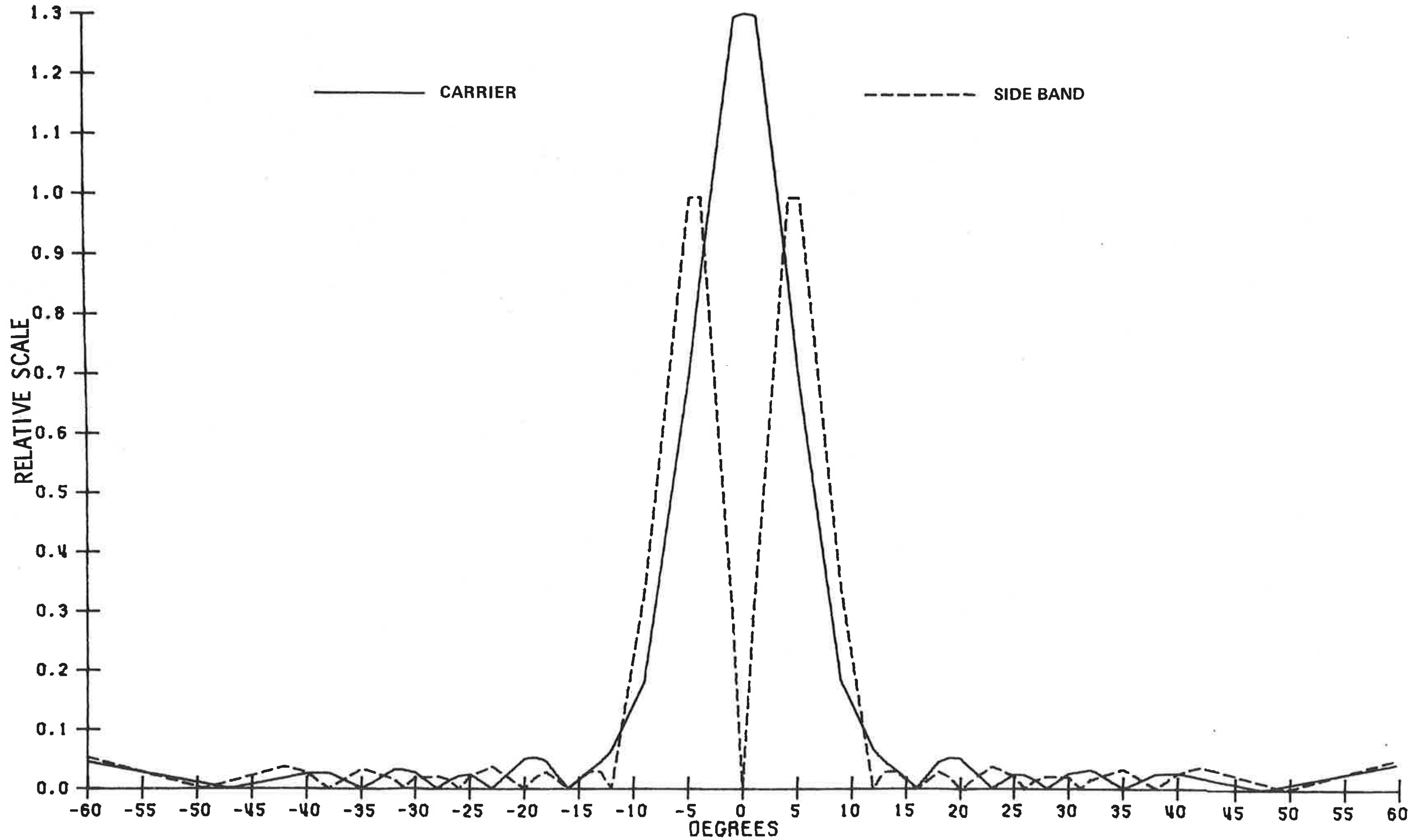


Figure 10. Carrier Plus Sideband Alford 14 Element Array Course Antenna Pattern

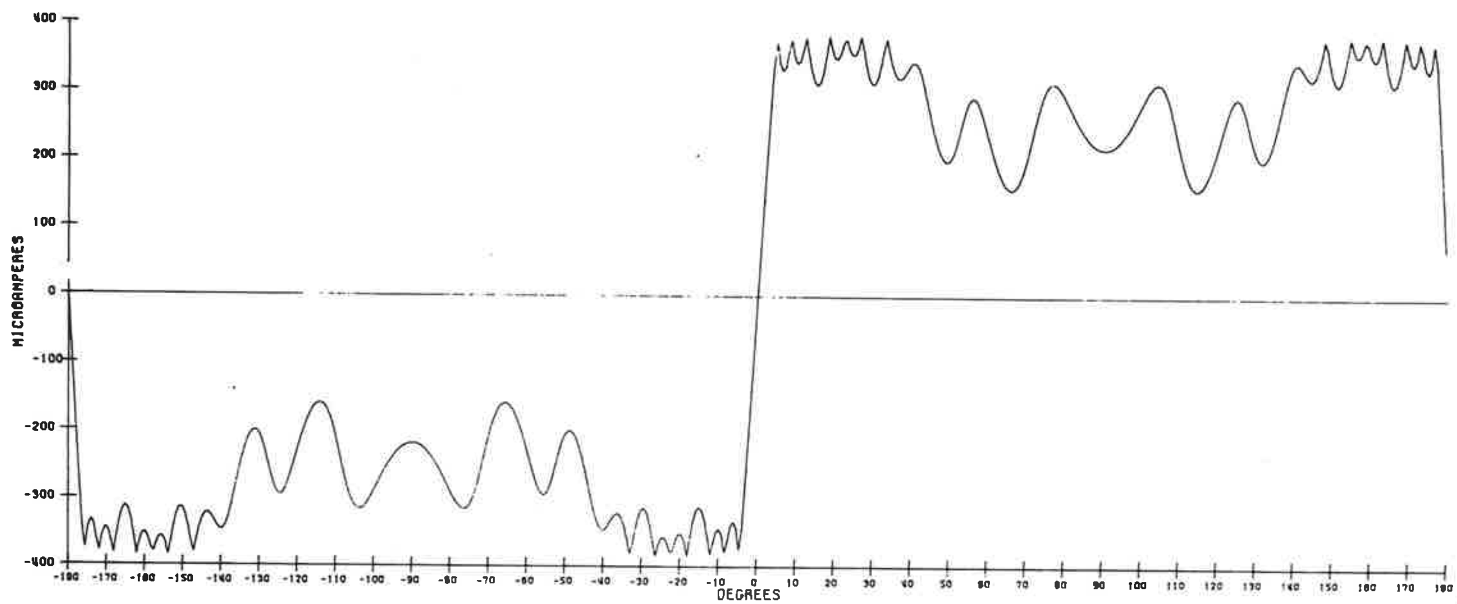


Figure 11a. Expected V-Ring Localizer CDI Clearance Patterns as a Function of Azimuth

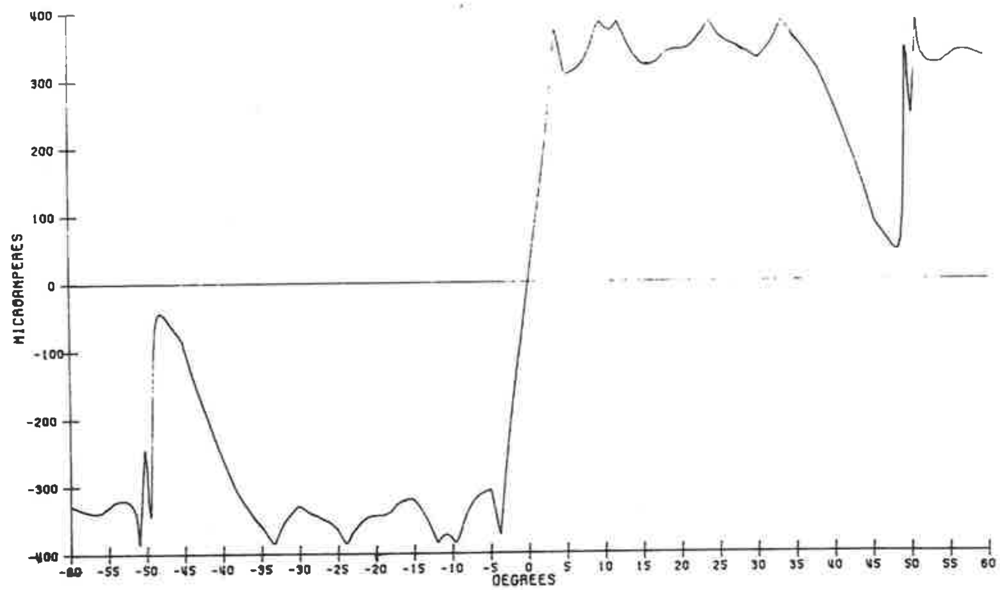


Figure 11b. Expected Alford Localizer CDI Clearance Pattern as a Function of Azimuth

3.3 CDI'S FOR INDIVIDUAL RUNWAYS

The four modeled instrumented runways are treated individually each being described by a figure containing nine sheets; (Figures 12, 13, 14 and 15, each with sheets a through i).

Sheet a of each figure shows a computer generated plot of the surfaces illuminated by the localizer operating for the runway under consideration. In most cases these will be seen to be only parts of buildings rather than the building itself since there is blocking by other structures and by parts of the same structure. These figures showing only the illuminated parts of structures should be examined in conjunction with Figure 6 showing the complete structure.

On Sheets b and c of each figure the clearance orbits for the V-Ring and for the Alford antenna are compared. The clearance orbits are performed at a 25,000 foot range and at 600 feet above the localizer. Again it is to be noted that the CDI for the Alford antenna dips below 150 μamps and even becomes negative, however, always for angles greater than ±35°, thus remaining within FAA specs.

Sheets d and e of each figure are the flyability runs in which the V-Ring and the Alford localizers are compared for one scattering object, the hotel. Since the hotel was expected to produce the worse derogration, it was deemed important to obtain its derogation alone. In fact, the hotel did produce the major contribution to the derogation, however, not to the extent that modifications in building size or location were called for.

Finally, Sheets f, g, h and i of each figure show the flyability runs in which all modeled airport structures are included in the computation of the total CDI. On Sheets f and g the total CDI's using the V-Ring and the Alford antennas are compared using the same scale for each, while on Sheets h and i the CDI's are drawn to individual scales which allow the CDI structures to be examined much more closely.

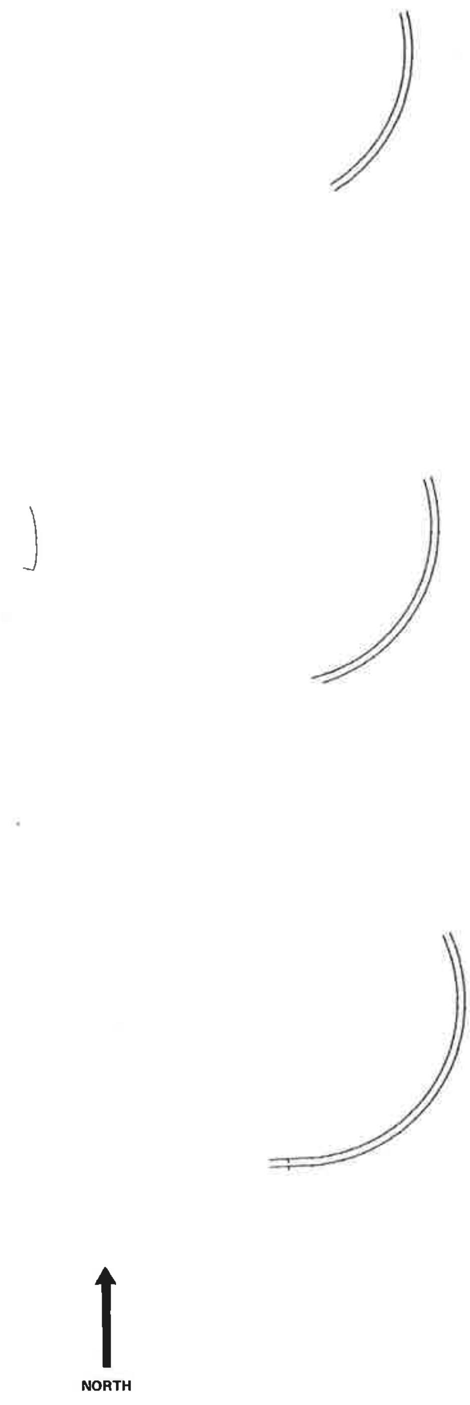


Figure 12a. Runway 17L - Illuminated Surfaces

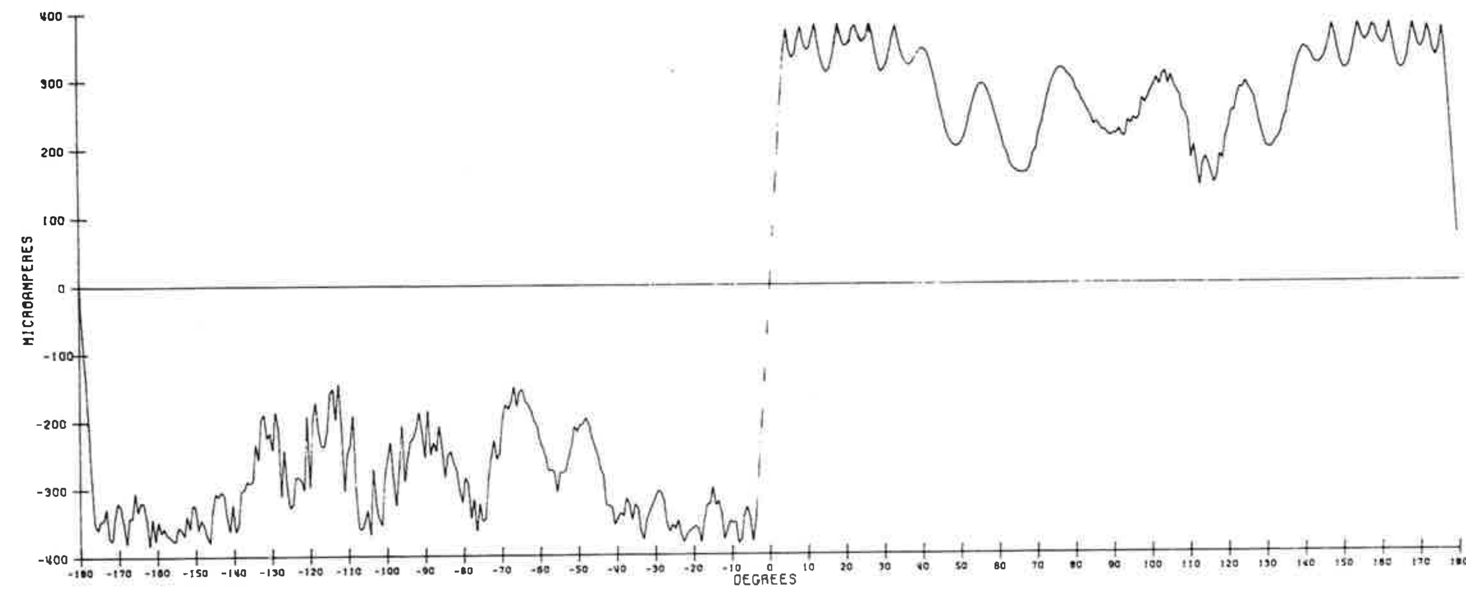


Figure 12b. Runway 17L - Clearance Orbit (V-Ring Antenna)

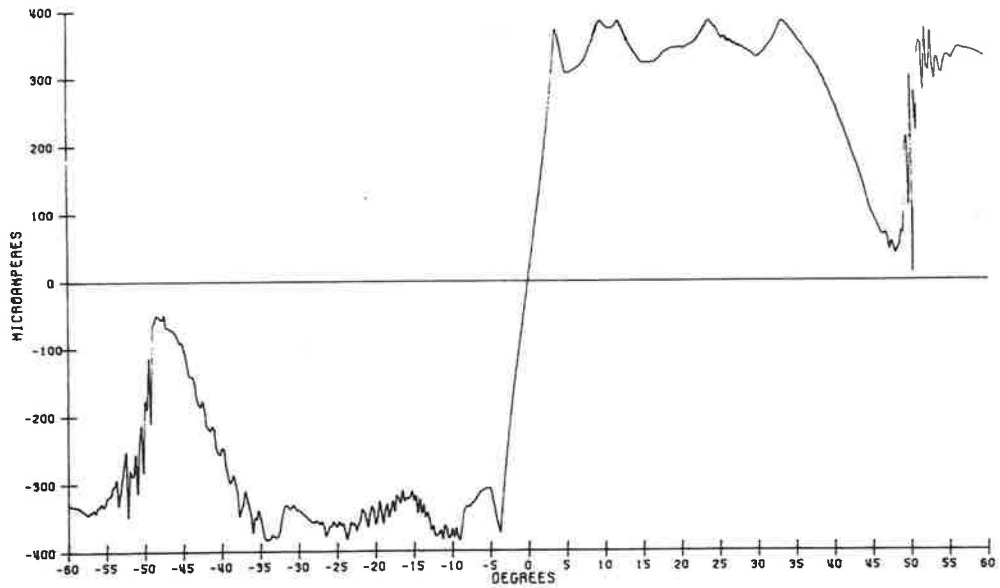


Figure 12c. Runway 17L - Clearance Orbit (Alford Antenna)

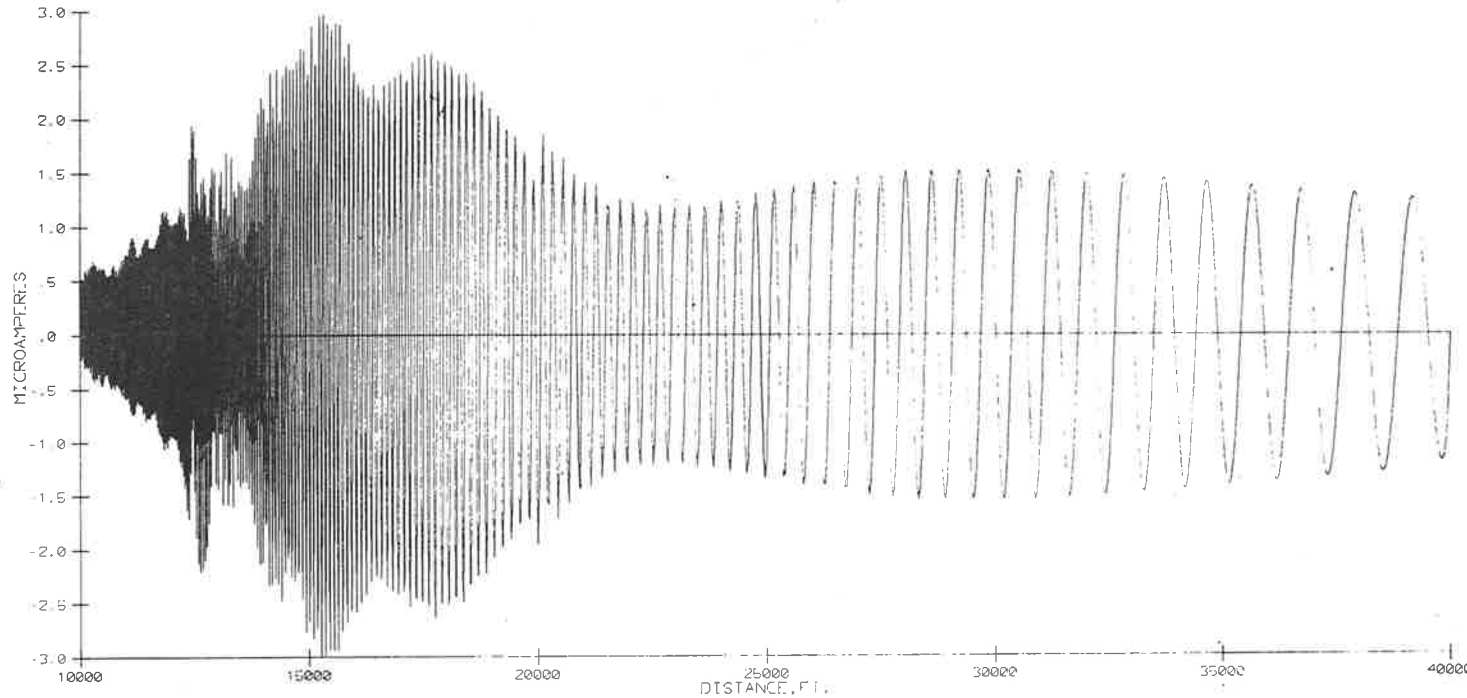


Figure 12d. Runway 17L. Detail of CDI Course Structure Due to Scattering from Hotel Alone, V-Ring Antenna Used.

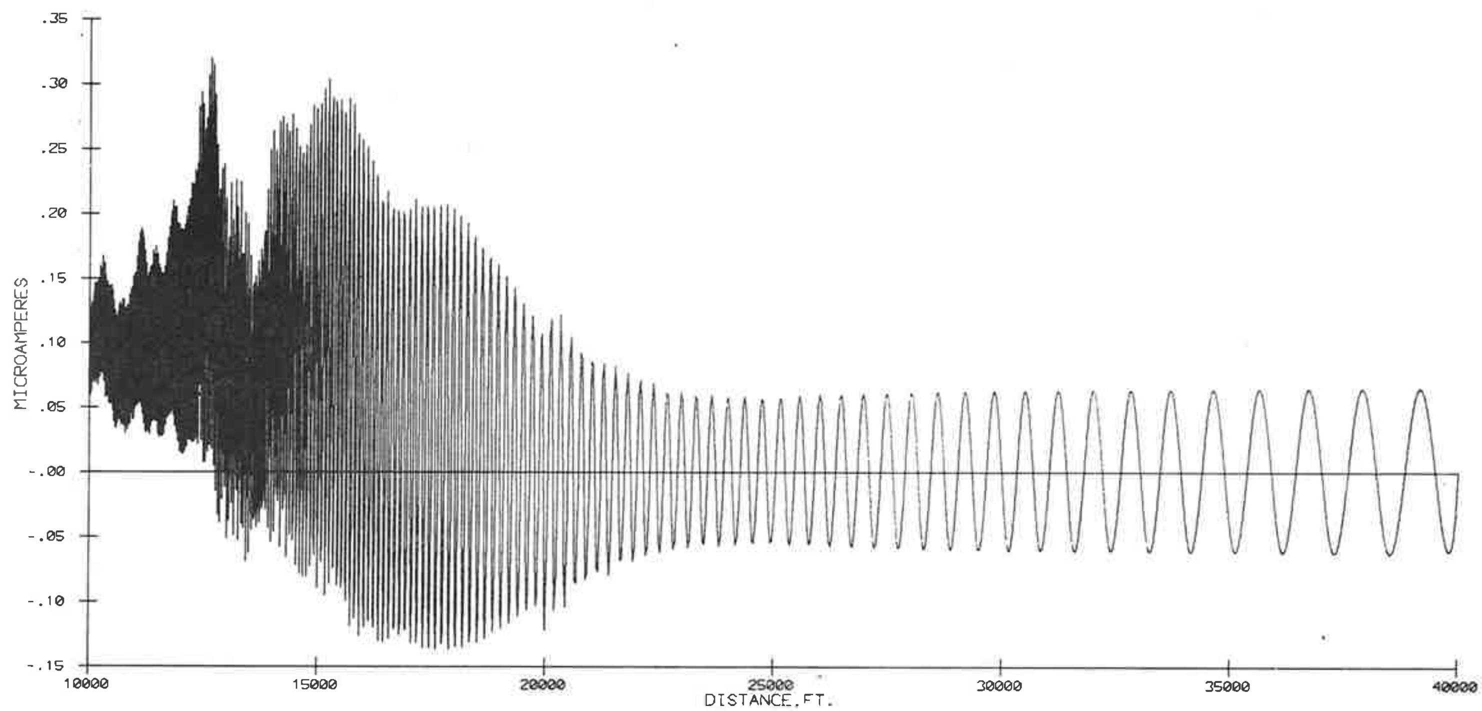


Figure 12e. Runway 17L - Detail of CDI Course Structure Due to Scattering from Hotel Alone, Alford Antenna Used (Note Different Scale)

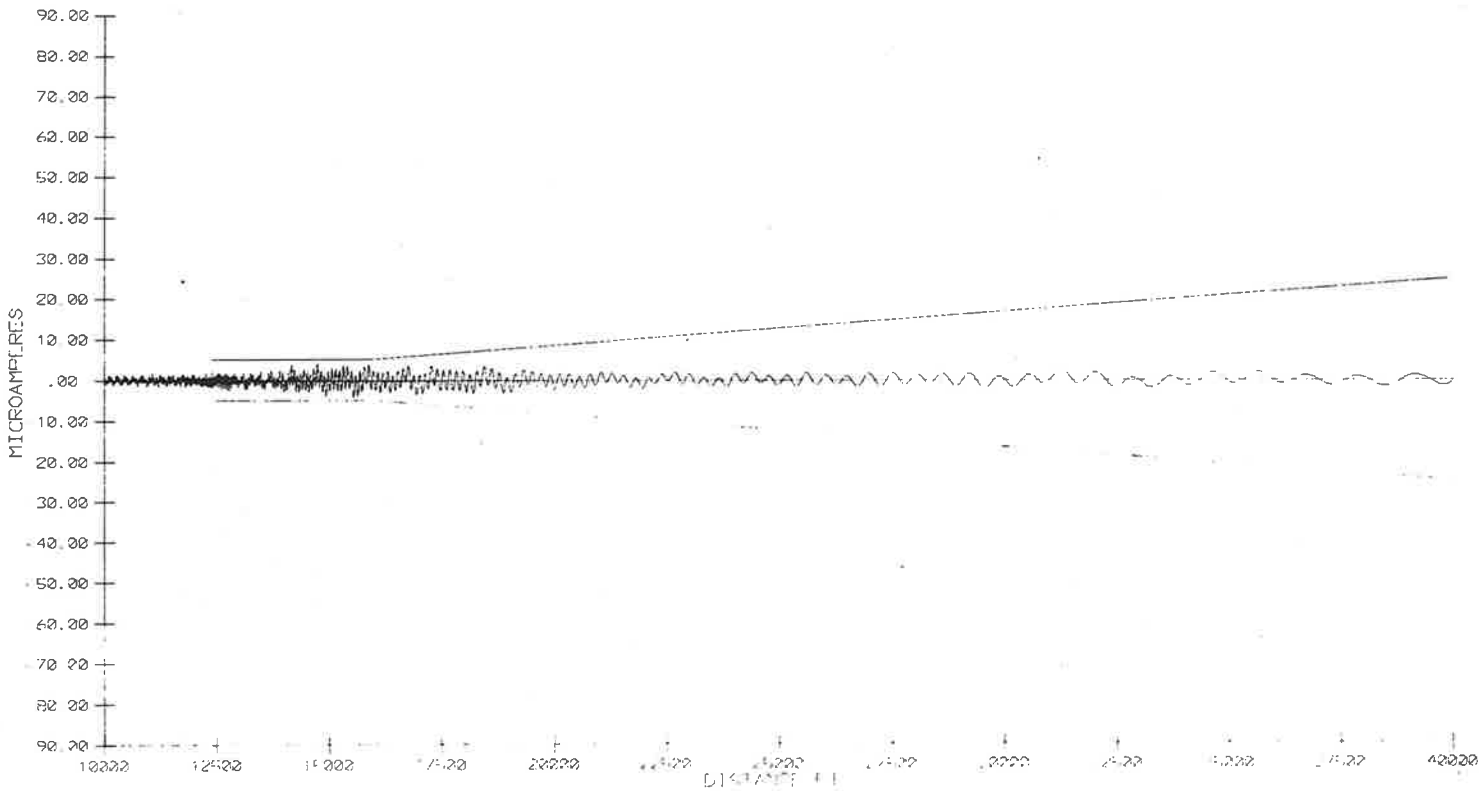


Figure 12f. Runway 17L - CDI Due to Scattering from All Modeled Structures (V-Ring Localizer Used)

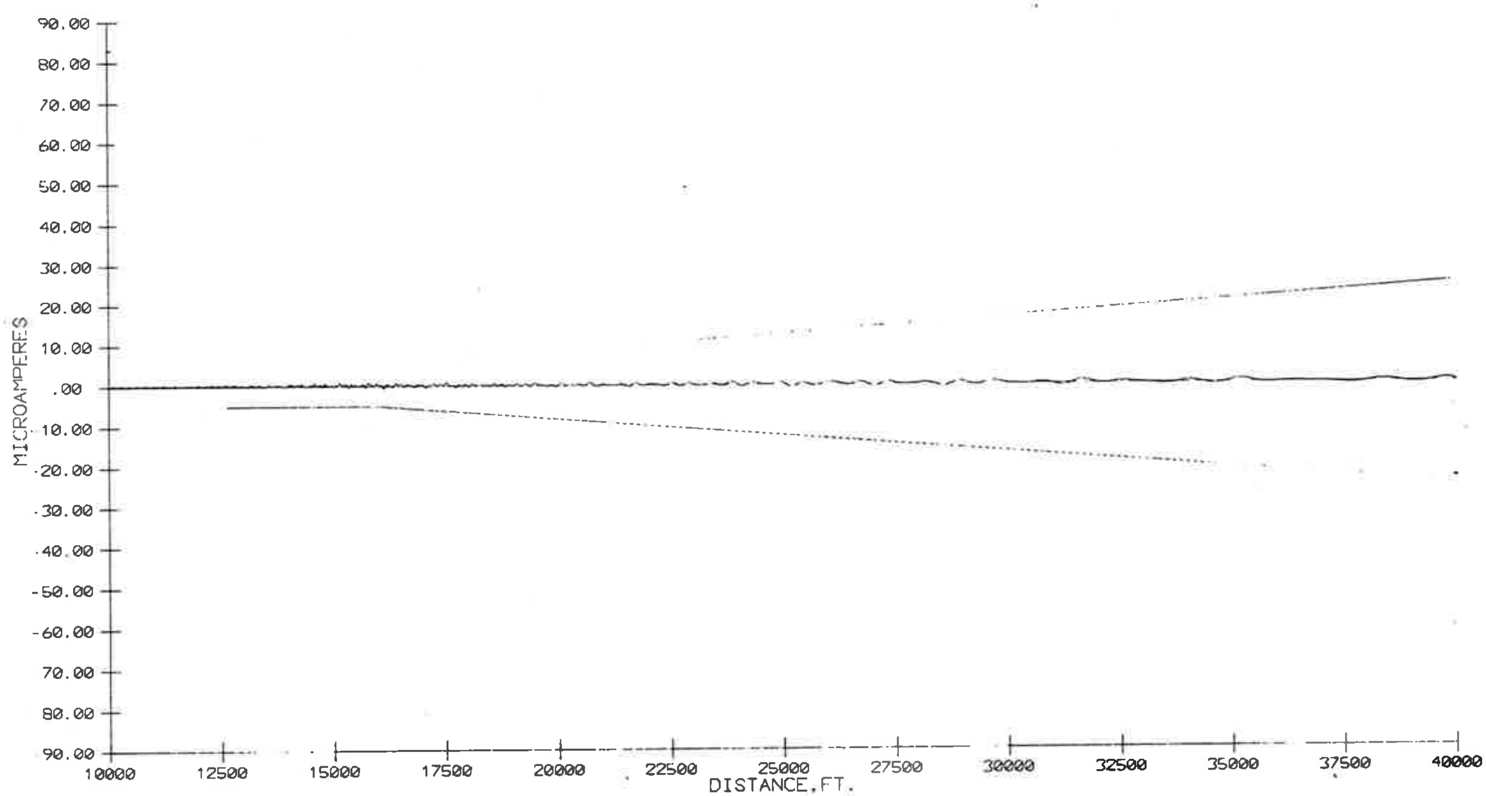


Figure 12g. Runway 17L - CDI Due to Scattering from All Modeled Structures (Alford Localizer Used)

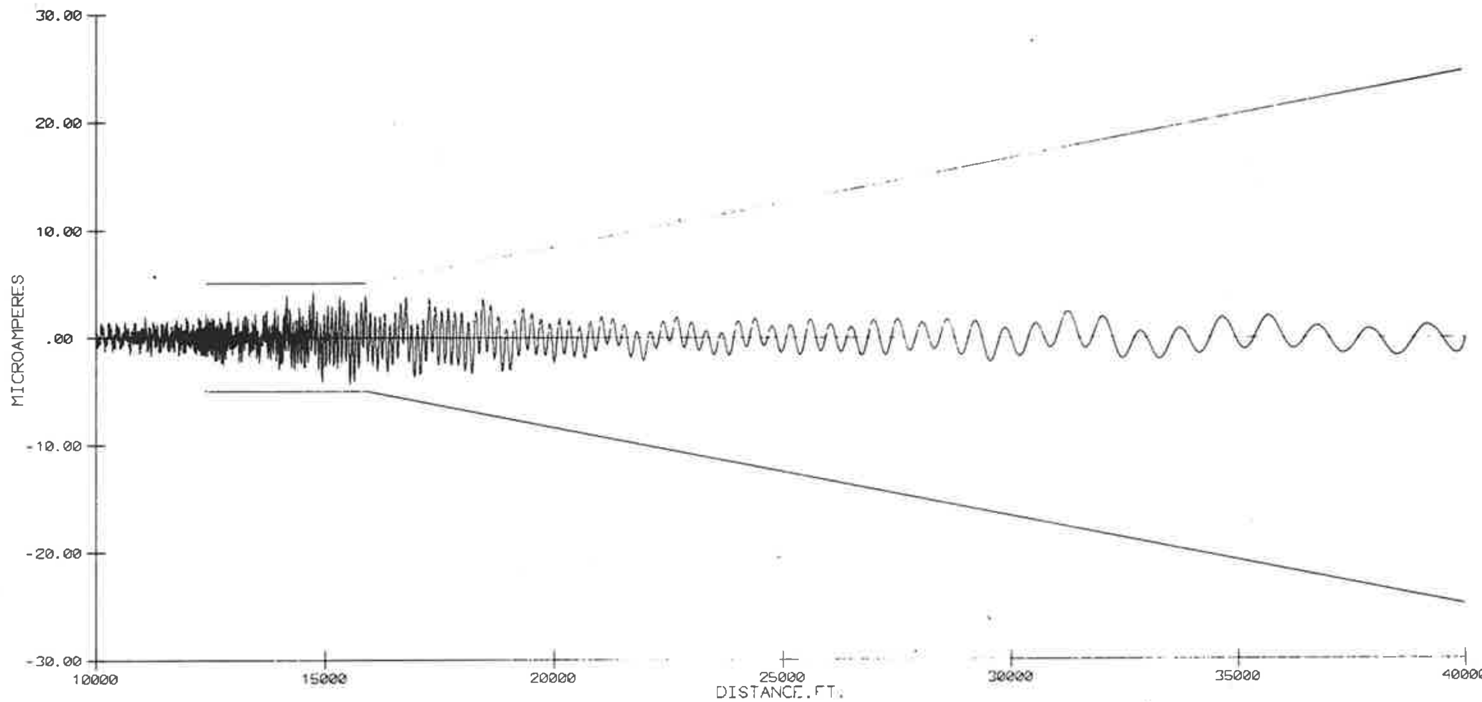


Figure 12h. Runway 17L - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (V-Ring Antenna Used)

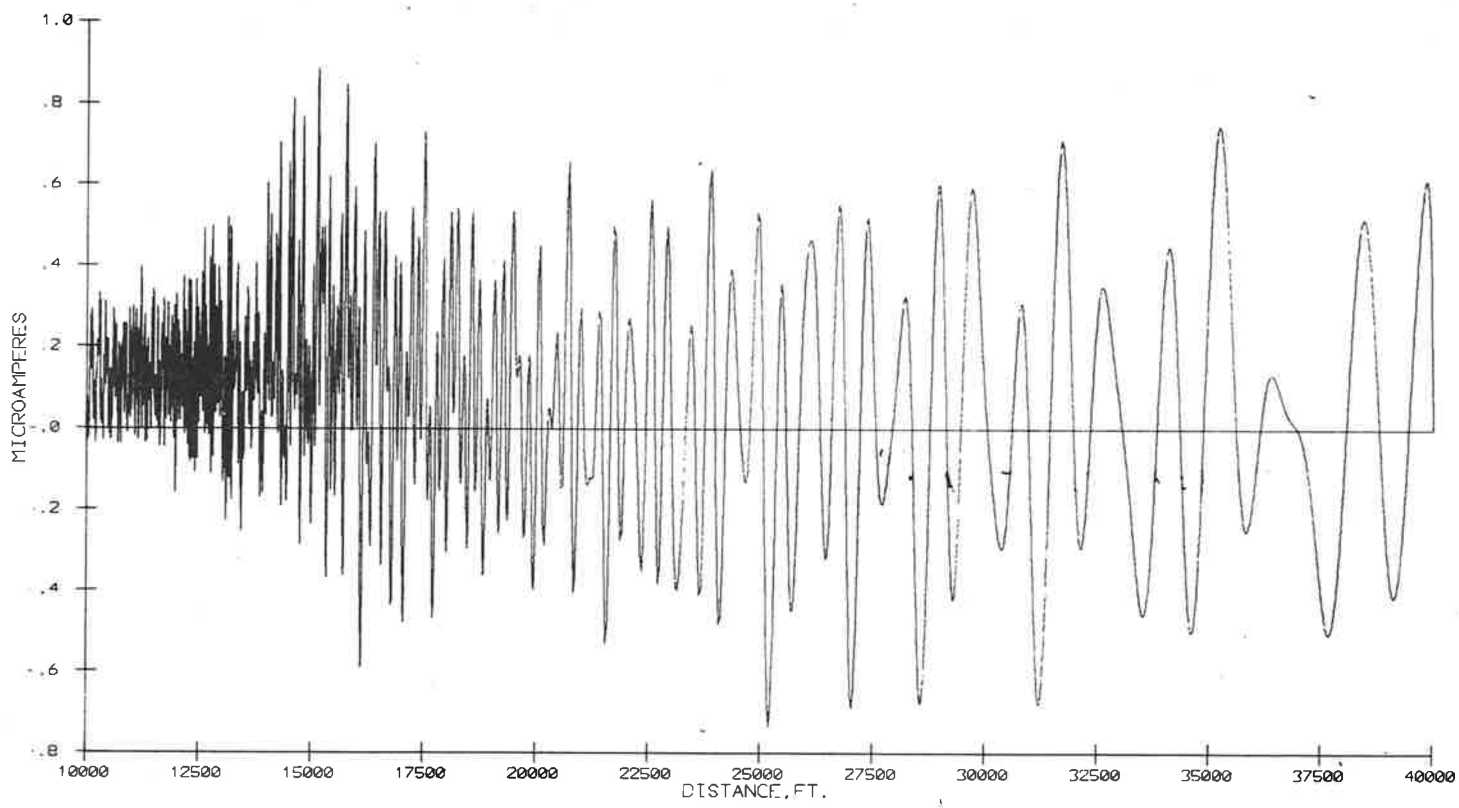


Figure 12i. Runway 17L - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (Alford Antenna Used)

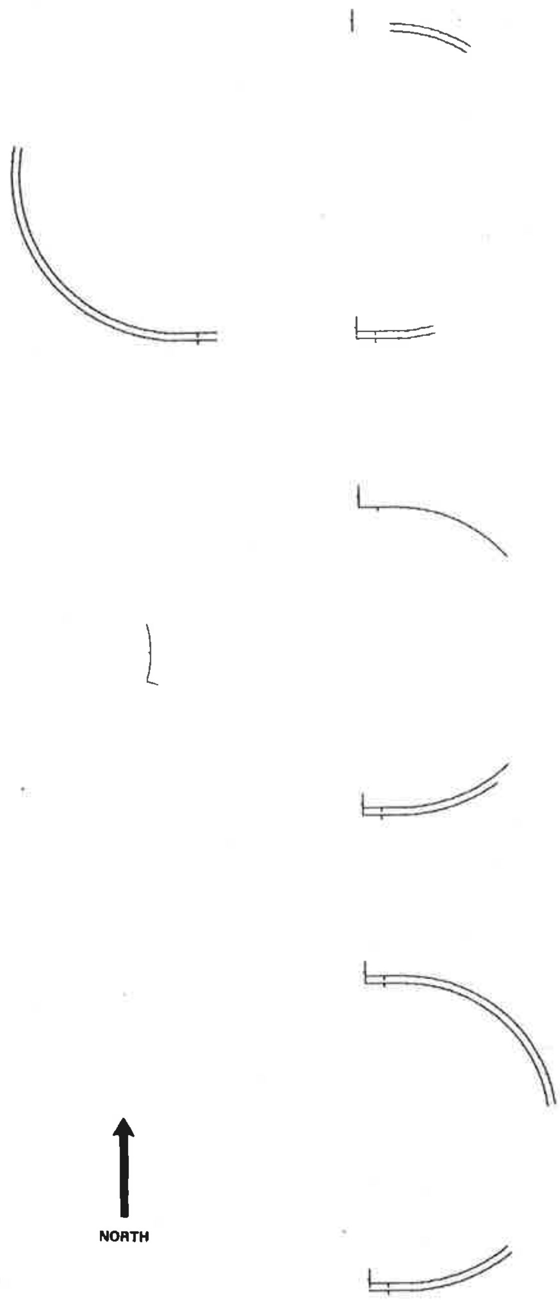


Figure 13a. Runway 17R - Illuminated Surfaces

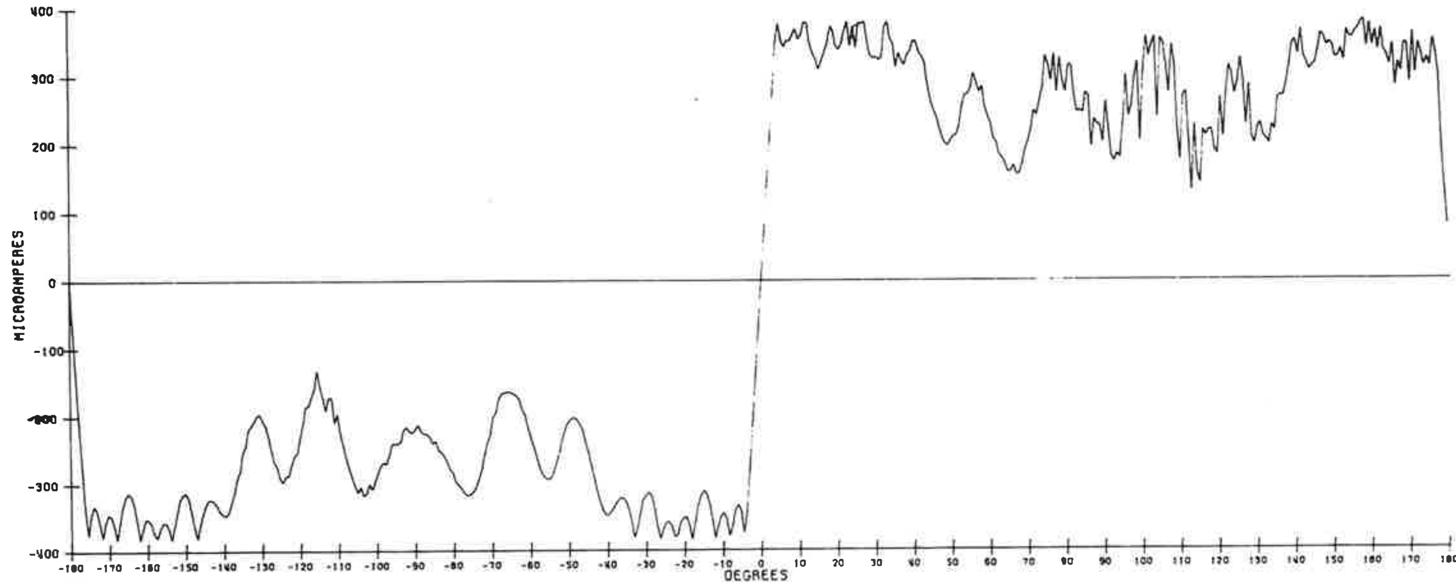


Figure 13b. Runway 17R - Clearance Orbit (V-Ring Antenna)

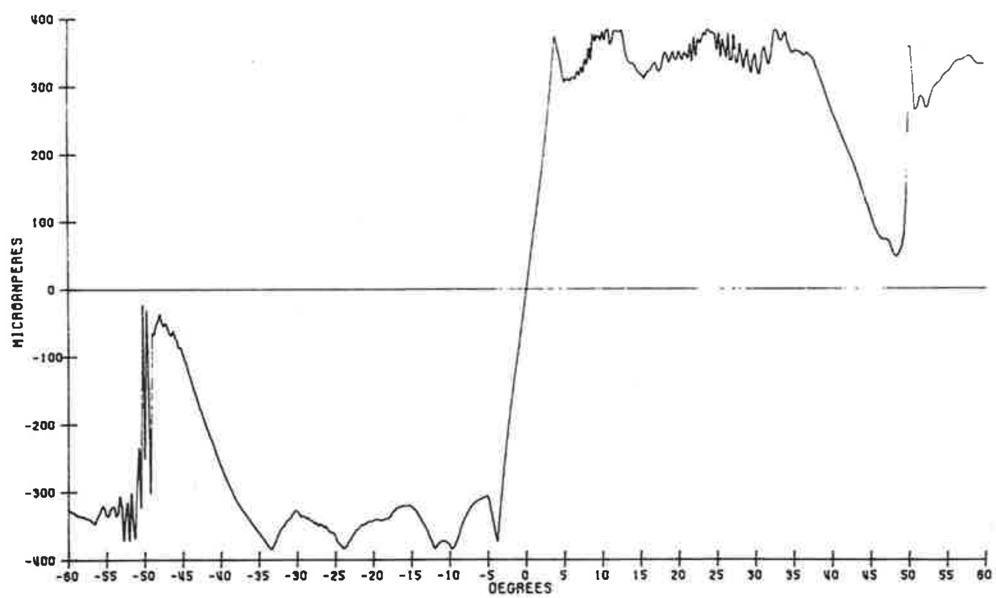


Figure 13c. Runway 17R - Clearance Orbit (Alford Antenna)

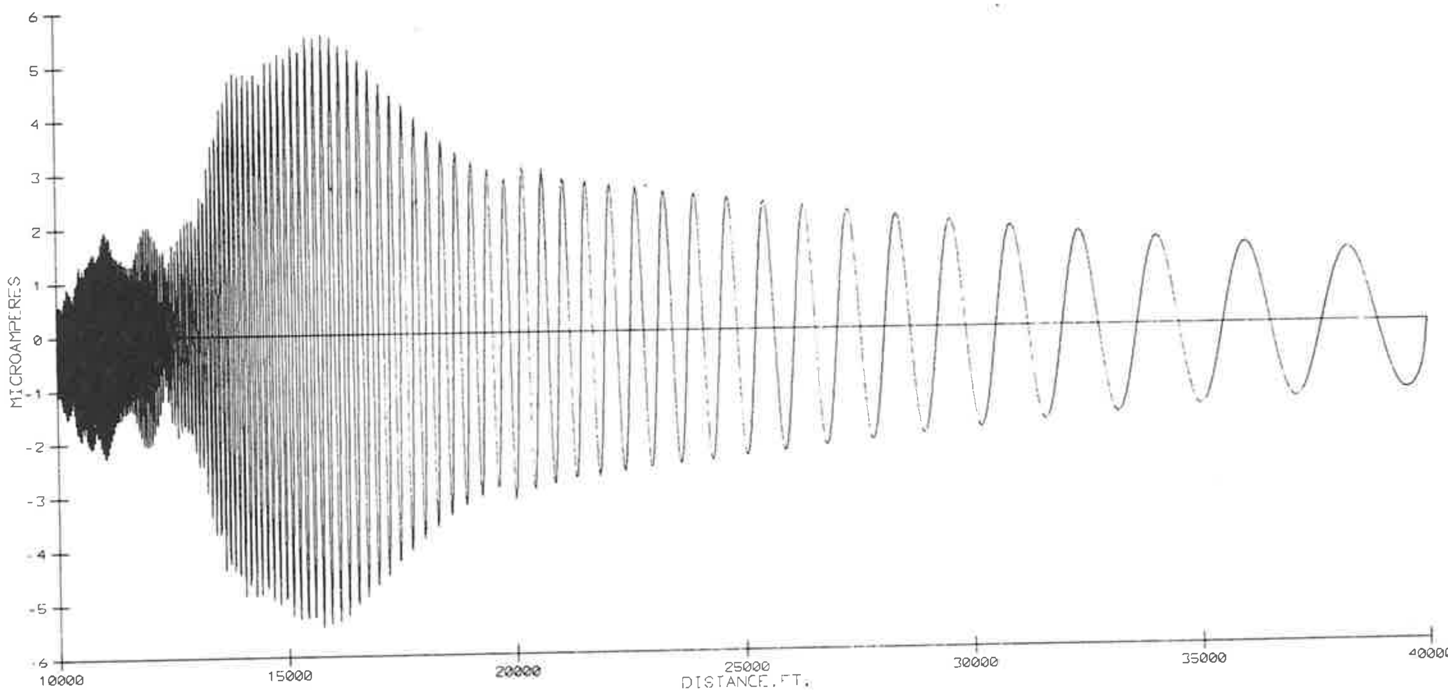


Figure 13d. Runway 17R - Detail of CDI Course Structure Due to Scattering from Hotel Alone, V-Ring Antenna Used.

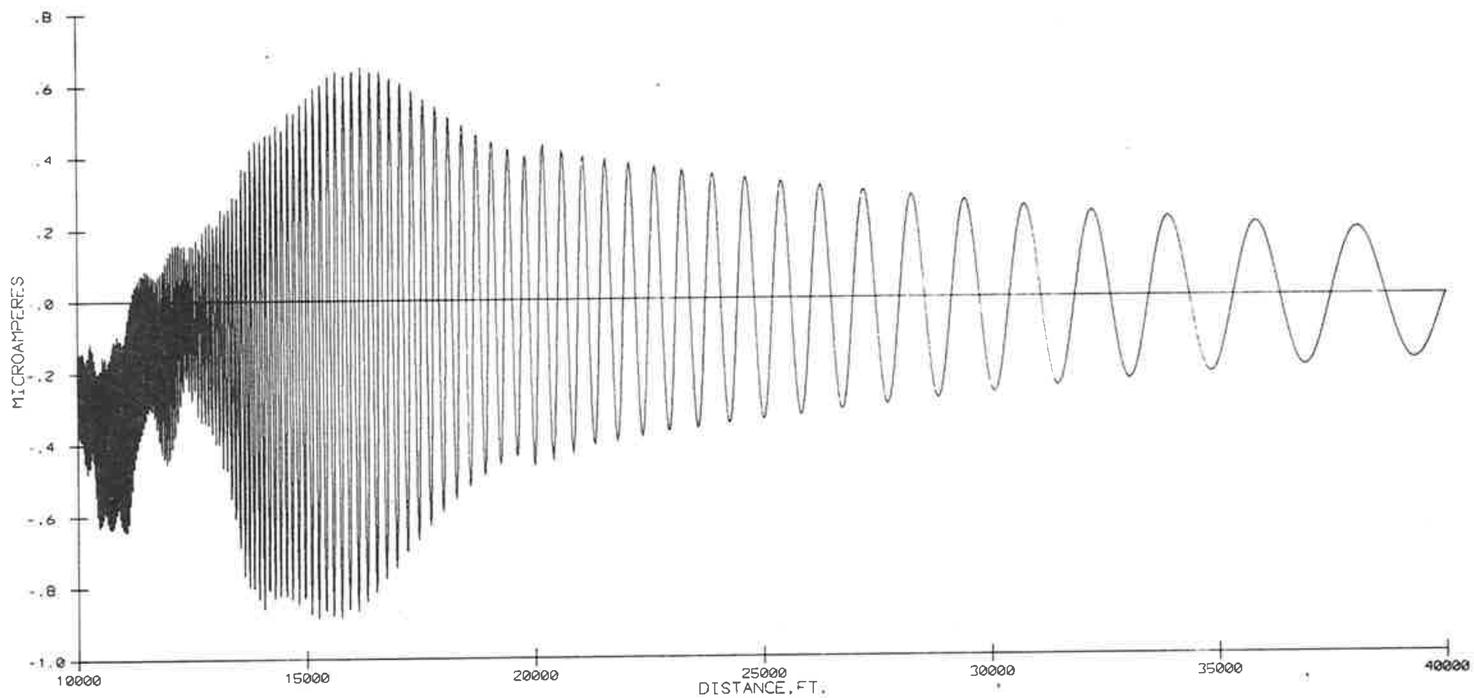


Figure 13e. Runway 17R - Detail of CDI Course Structure Due to Scattering from Hotel Alone, Alford Antenna Used (Note Different Scale)

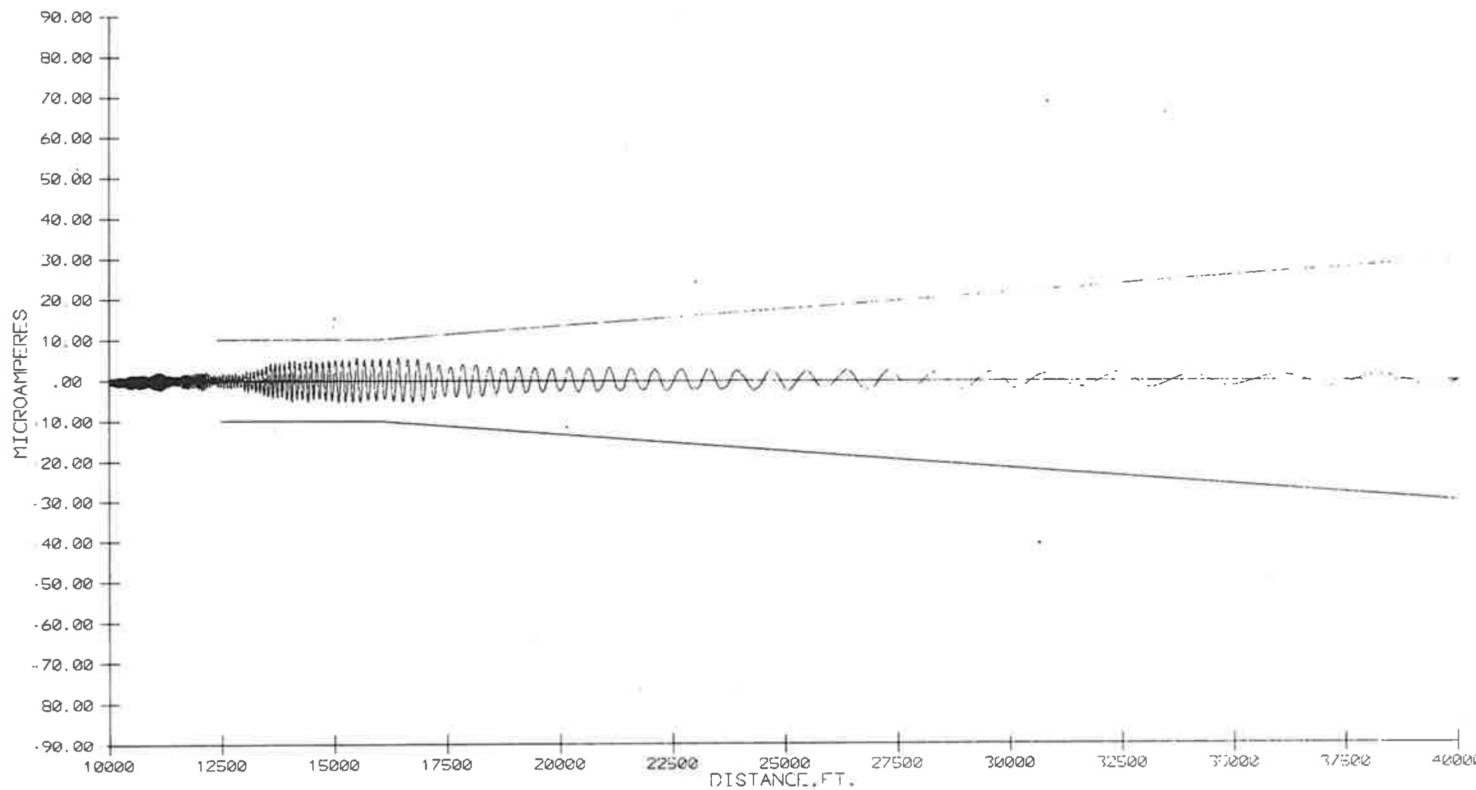


Figure 13f. Runway 17R - CDI Due to Scattering from All Modeled Structures (V-Ring Localizer Used)

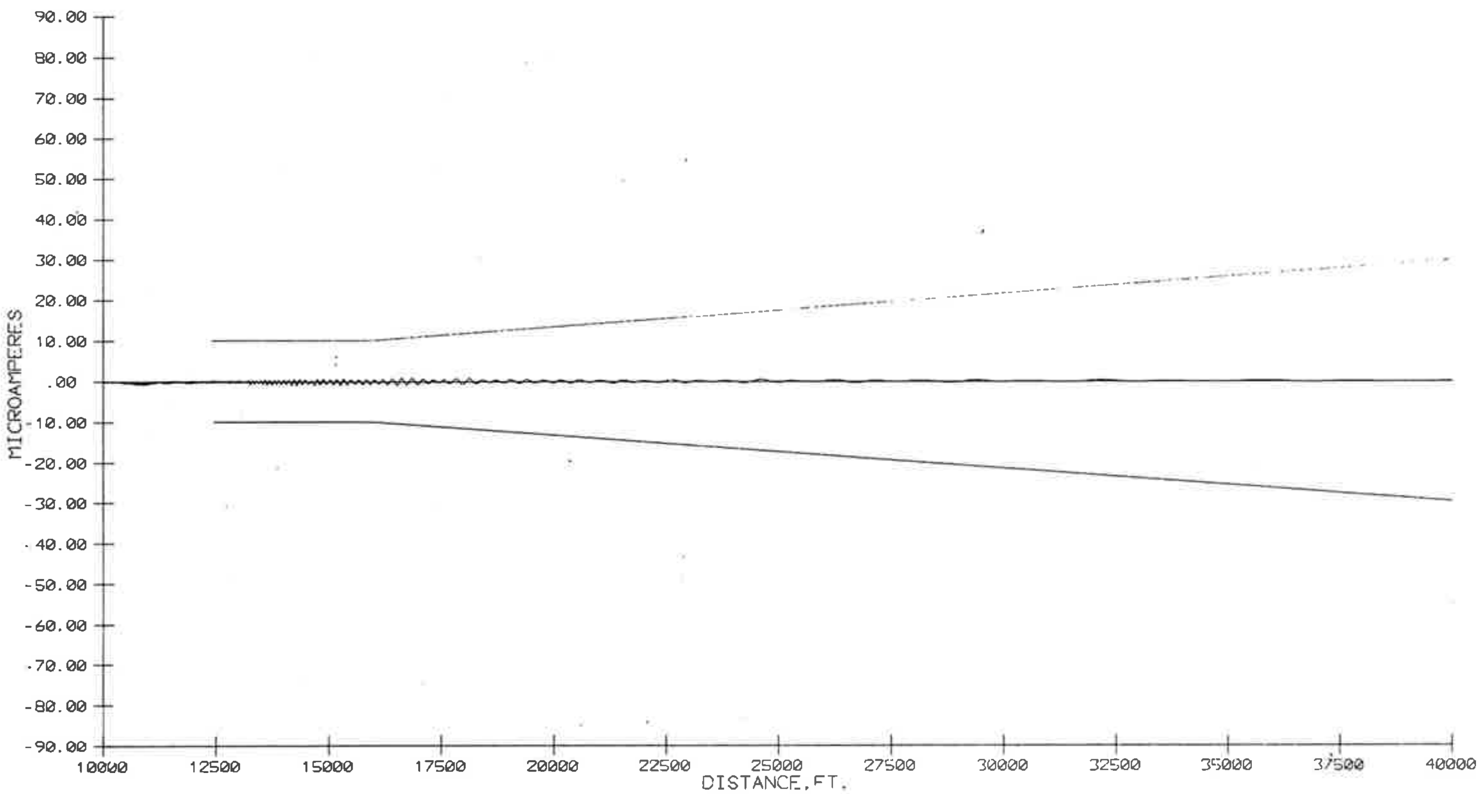


Figure 13g. Runway 17R - CDI Due to Scattering from All Modeled Structures (Alford Localizer Used)

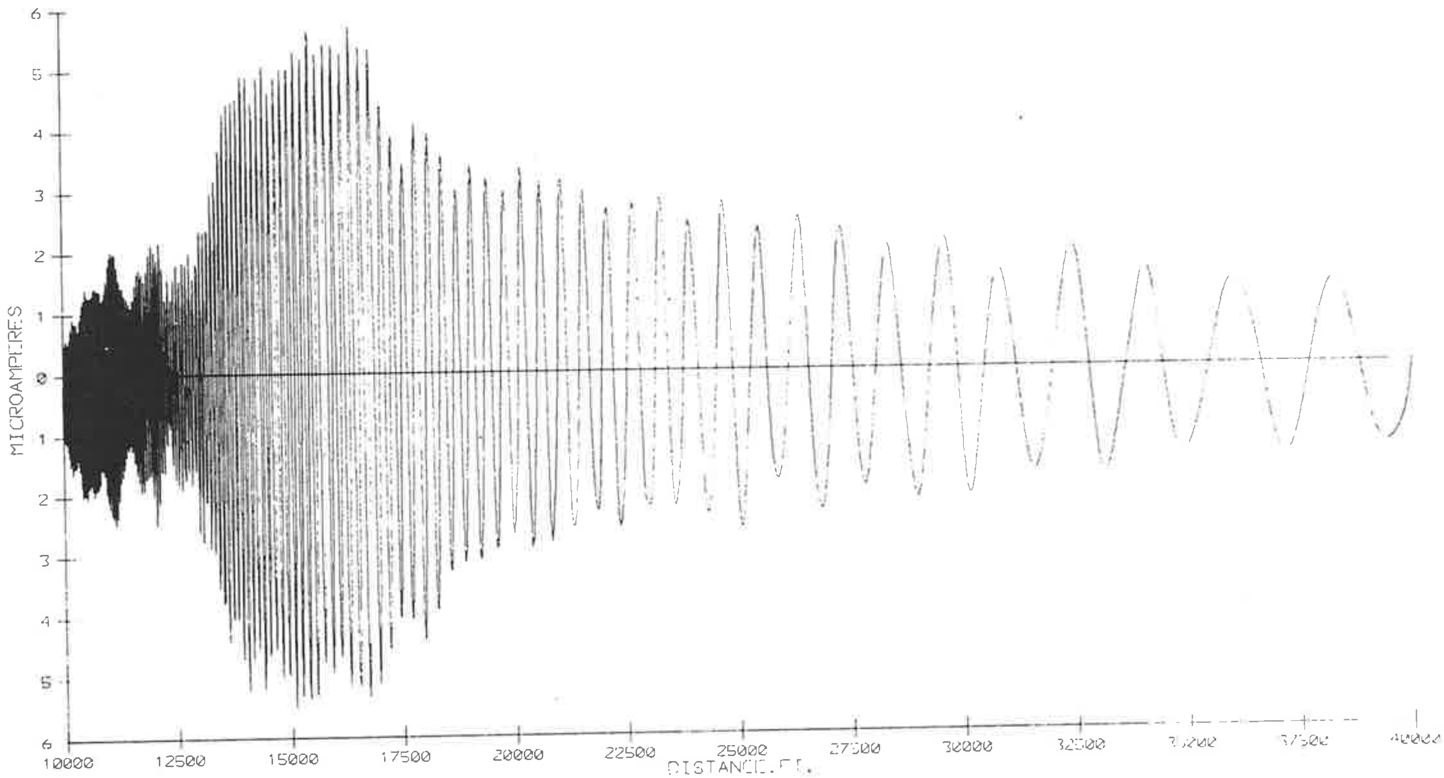


Figure 13h. Runway 17R - CDI Due to Scattering from All Modeled Structures Showing Course Structure detail (V-Ring Antenna Used)

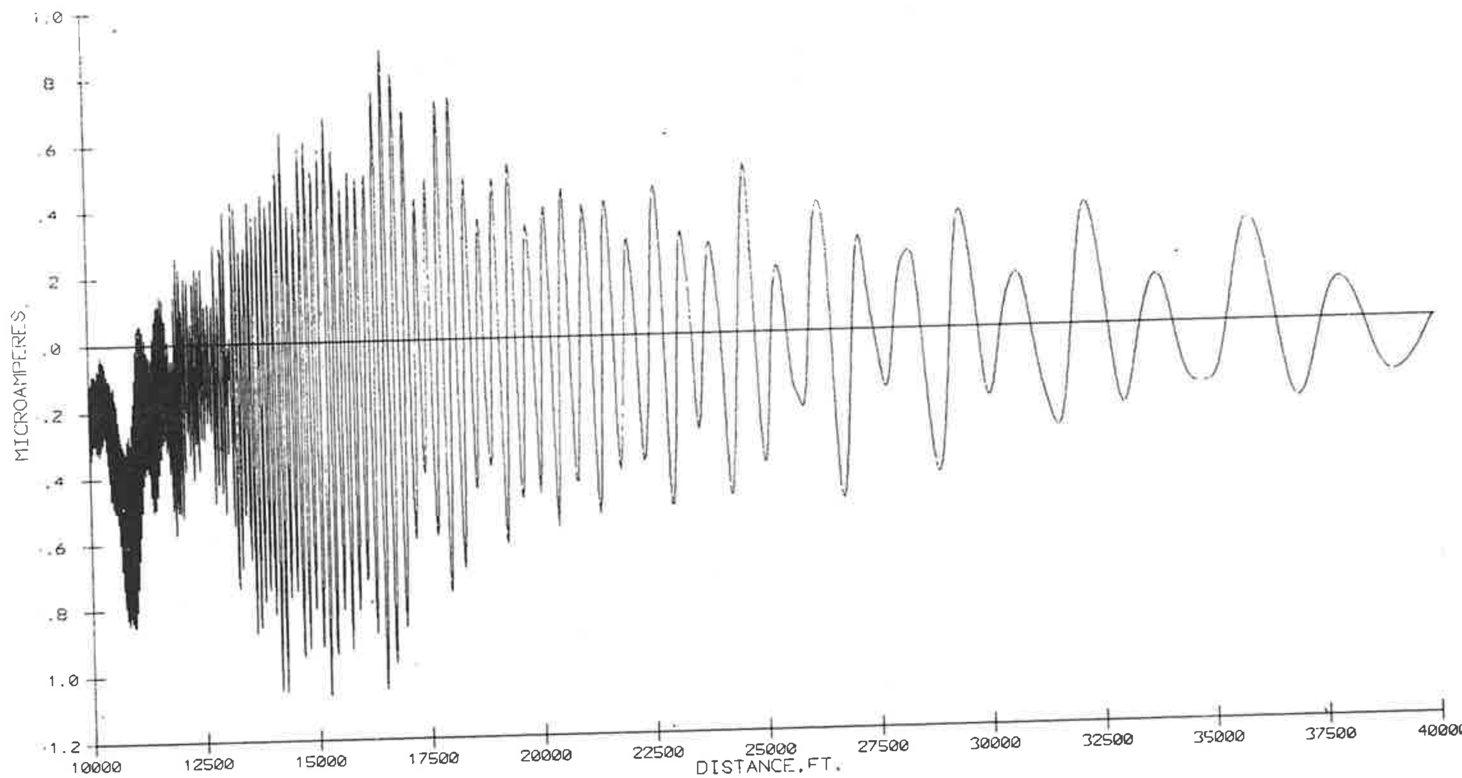


Figure 13i. Runway 17R - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (Alford Antenna Used)

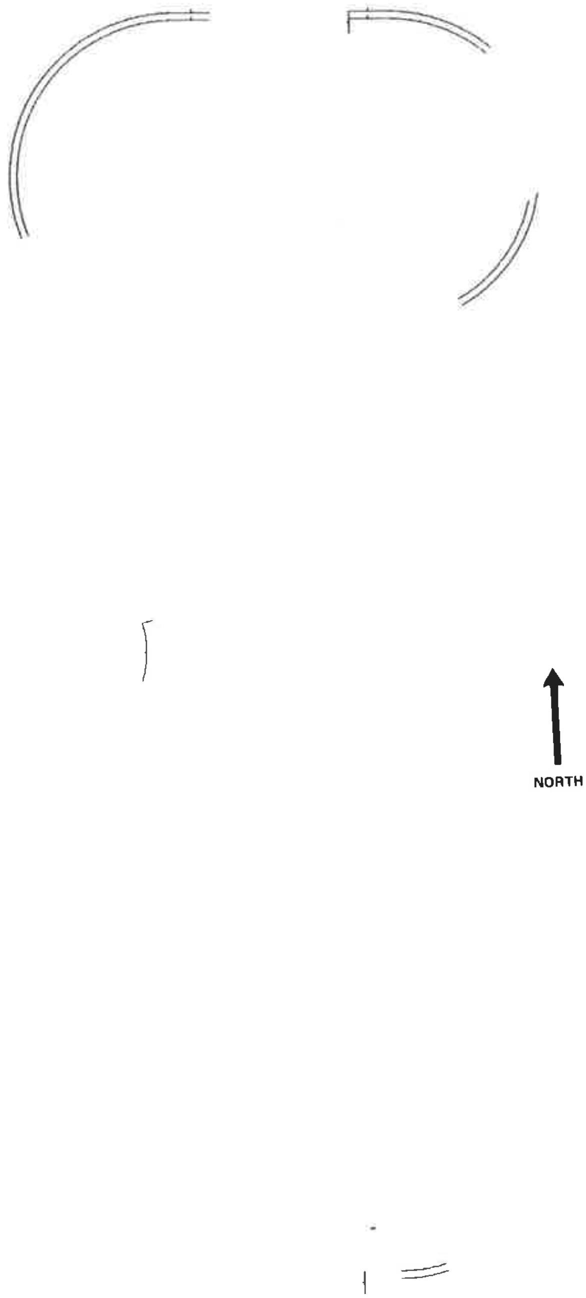


Figure 14a. Runway 35L - Illuminated Surfaces

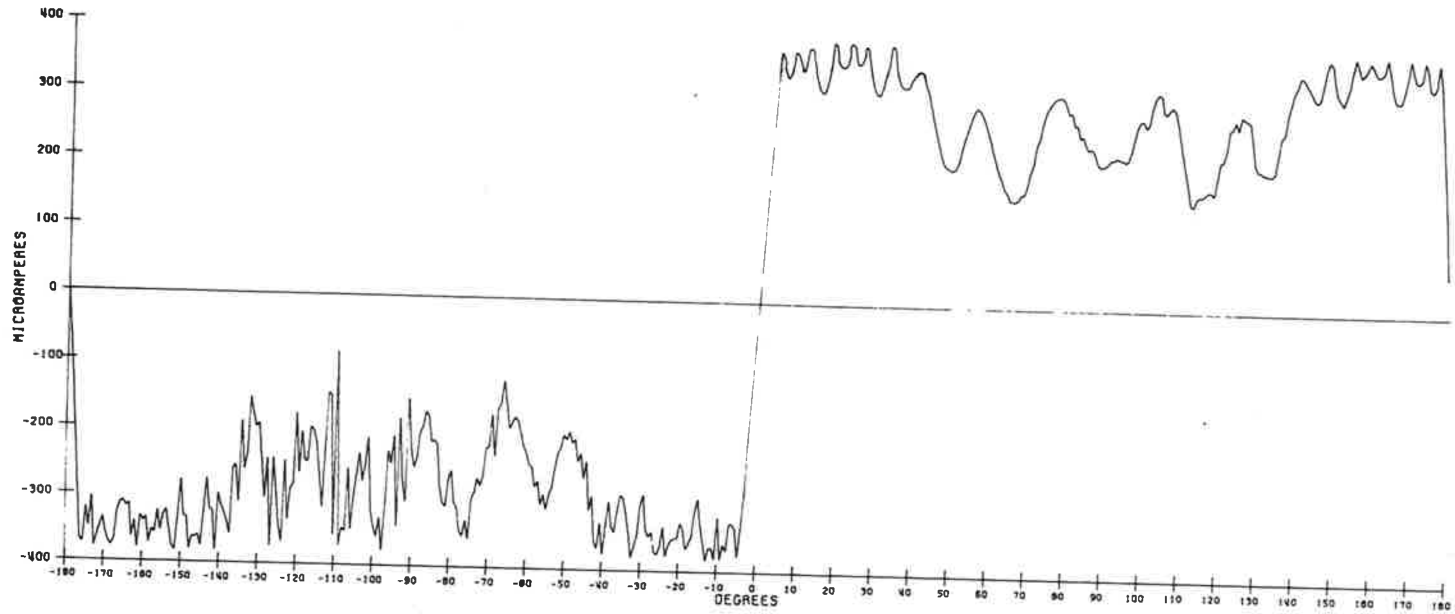


Figure 14b. Runway 35L - Clearance Orbit (V-Ring Antenna)

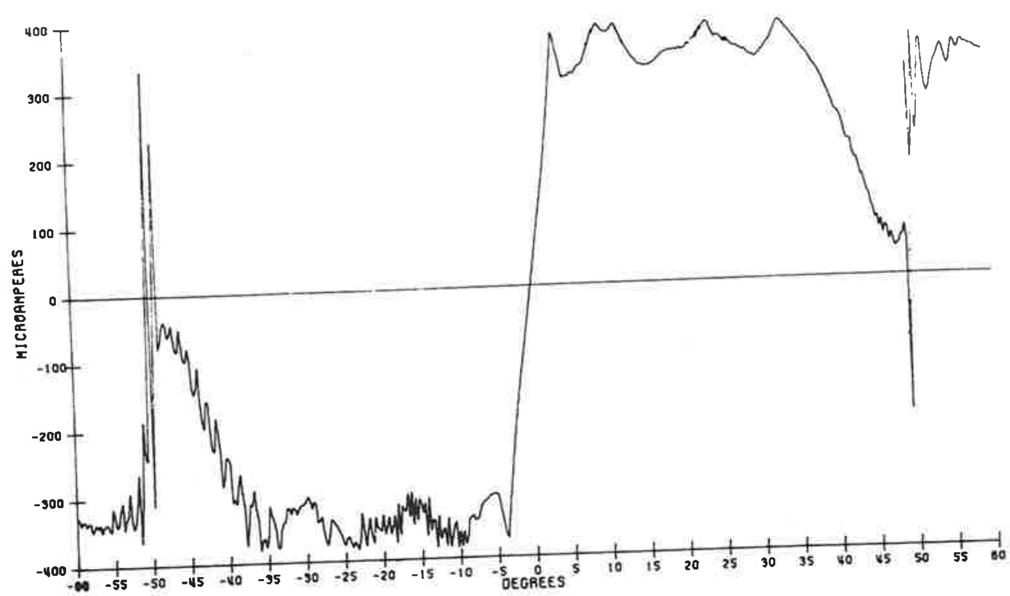


Figure 14c. Runway 35L - Clearance Orbit (Alford Antenna)

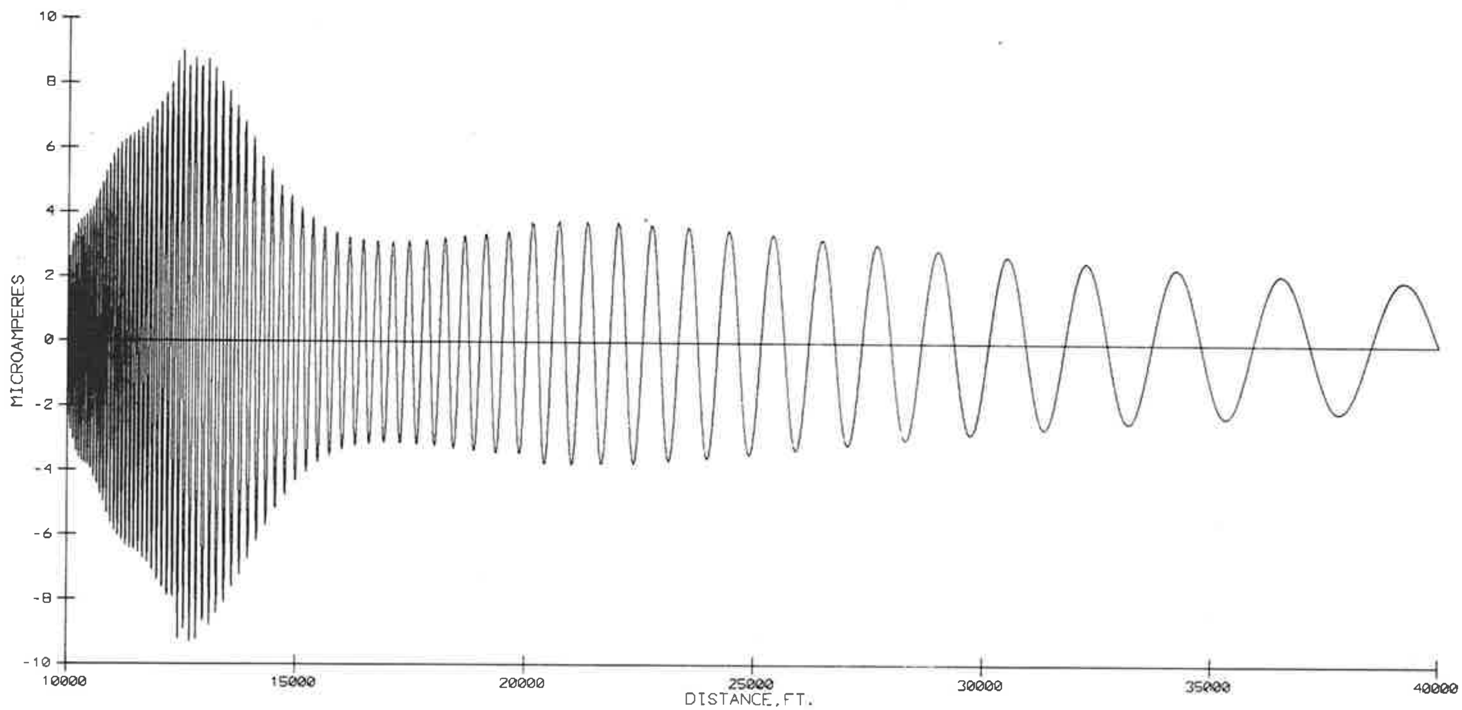


Figure 14d. Runway 35L - Detail of CDI Course Structure Due to Scattering from Hotel Alone, V-Ring Antenna Used.

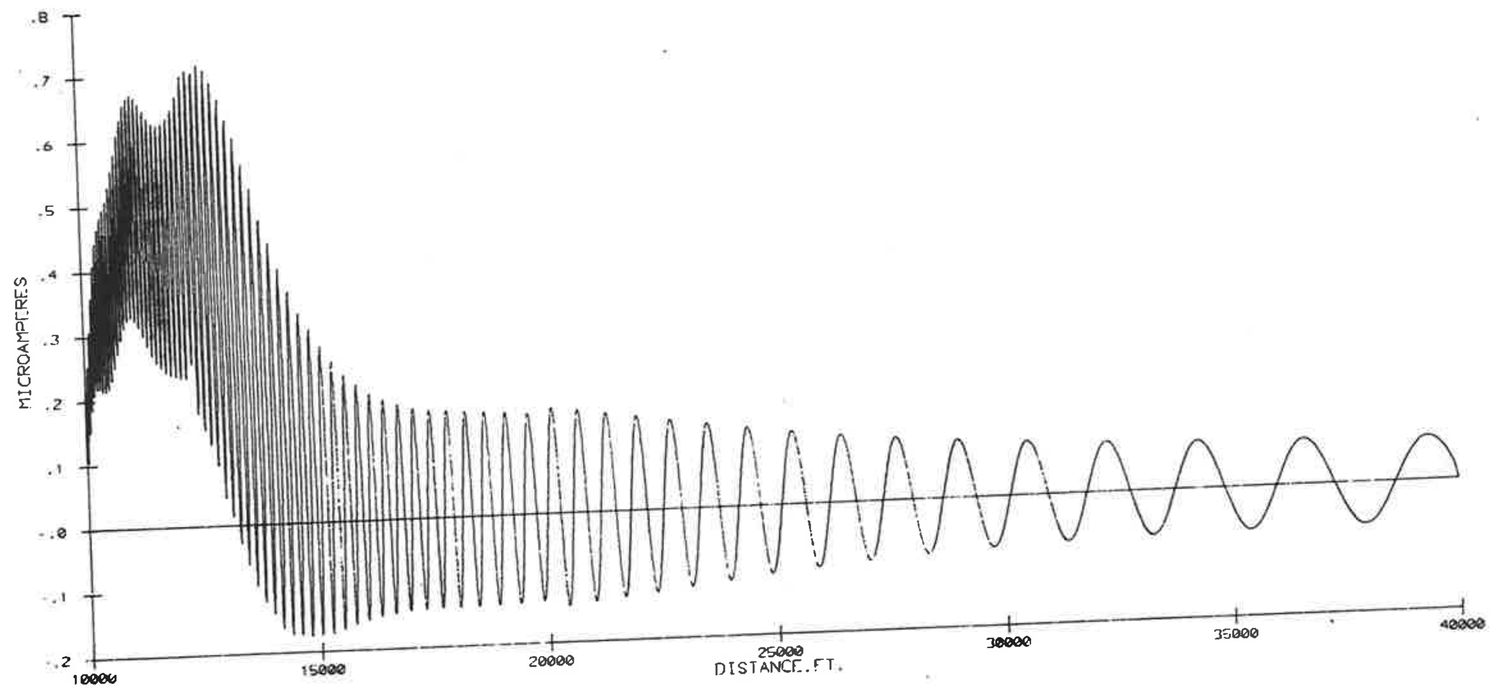


Figure 14e. Runway 35L - Detail of CDI Course Structure Due to Scattering from Hotel Alone, Alford Antenna Used (Note Different Scale)

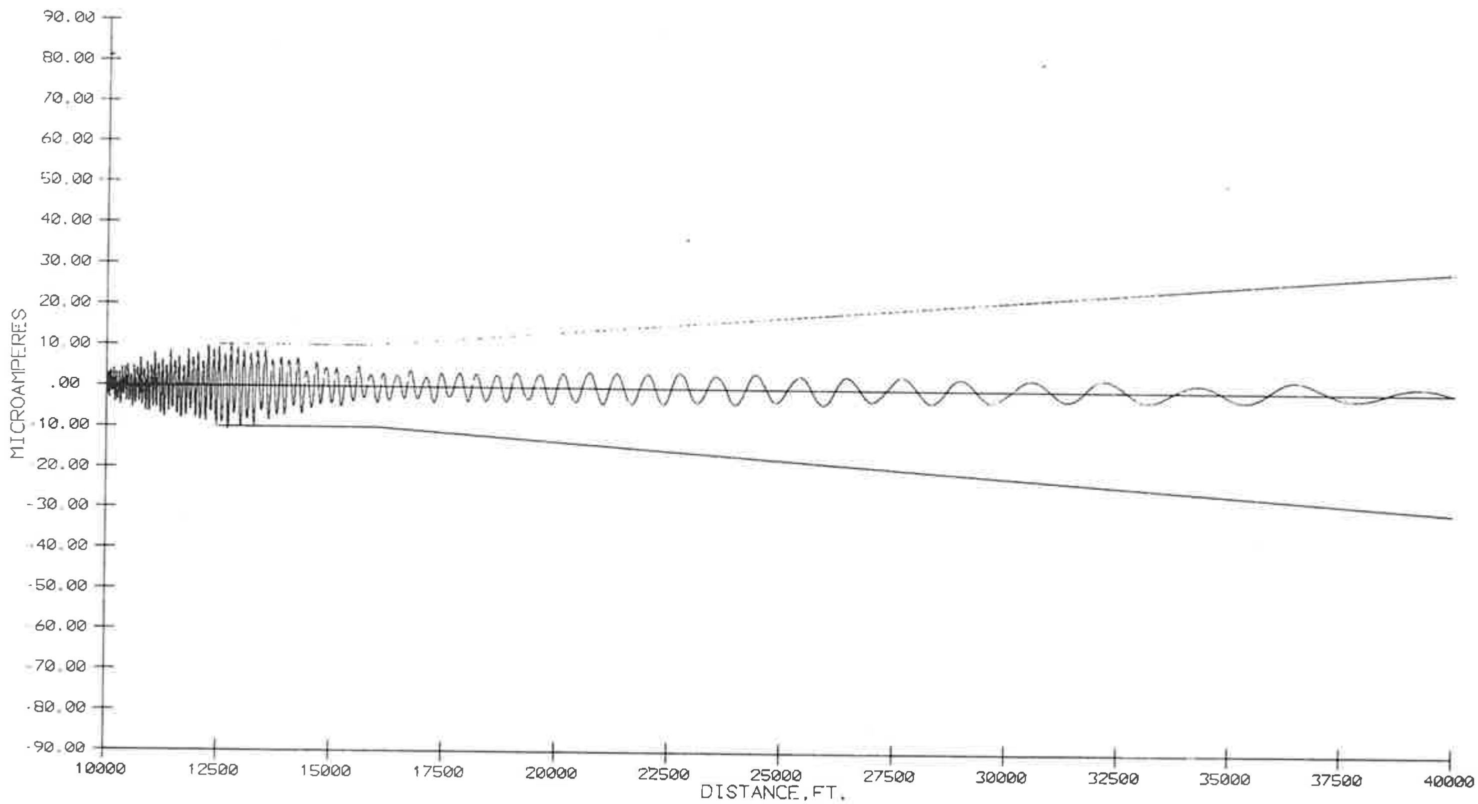


Figure 14f. Runway 35L - CDI Due to Scattering from All Modeled Structures (V-Ring Localizer Used)

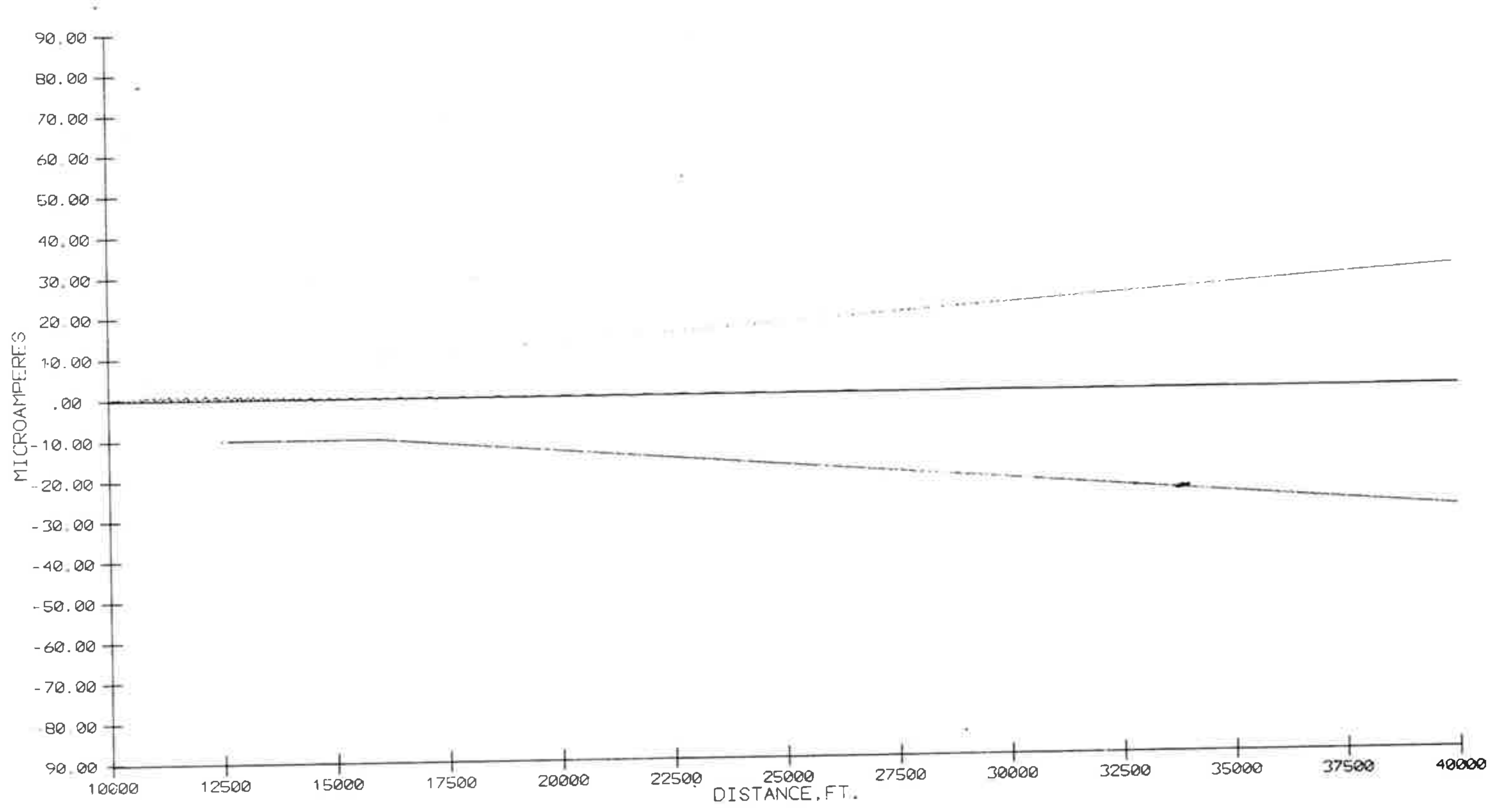


Figure 14g. Runway 35L - CDI Due to Scattering from All Modeled Structures (Alford Localizer Used)

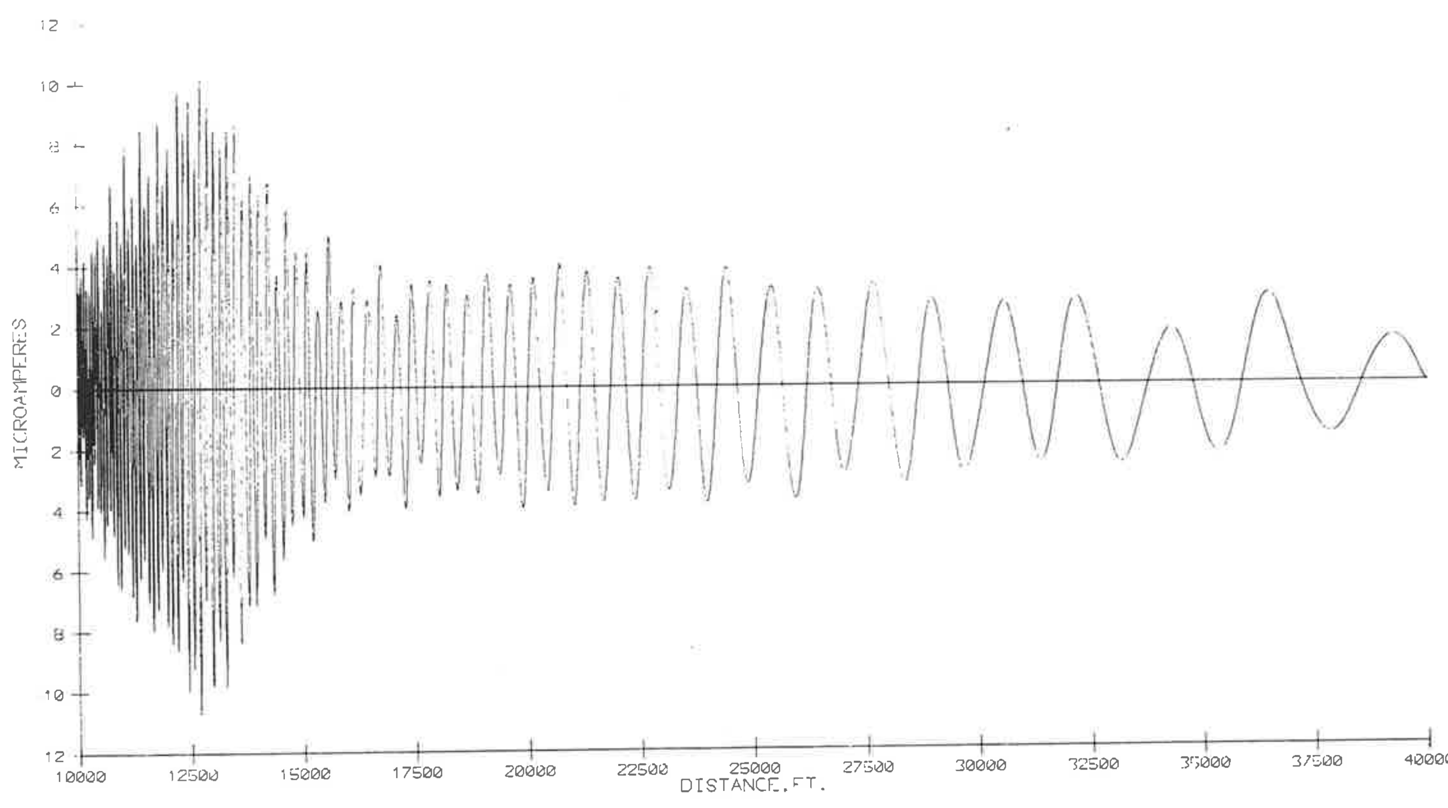


Figure 14h. Runway 35L - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (V-Ring Antenna Used)

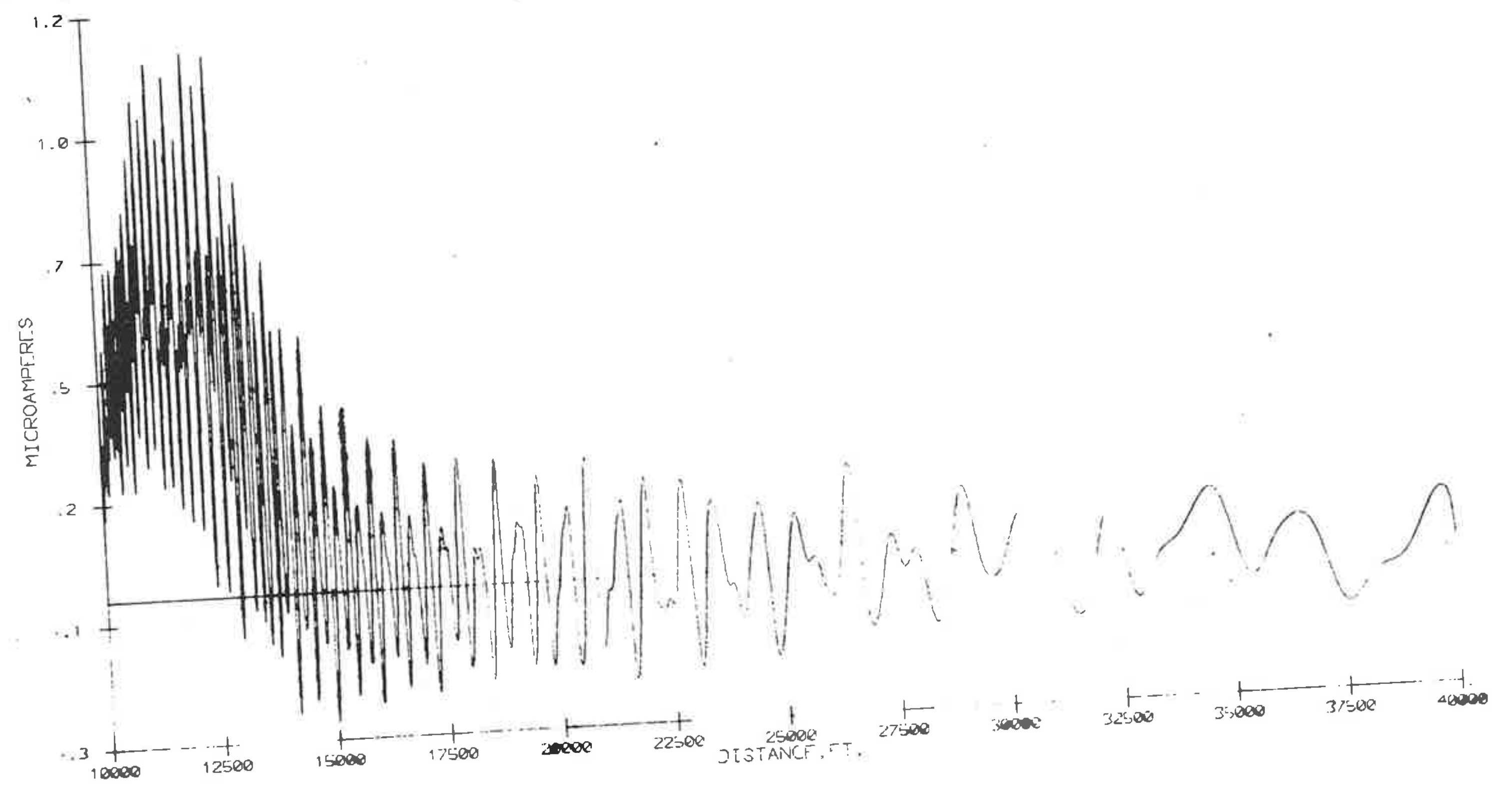


Figure 14i. Runway 35L - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (Alford Antenna Used)

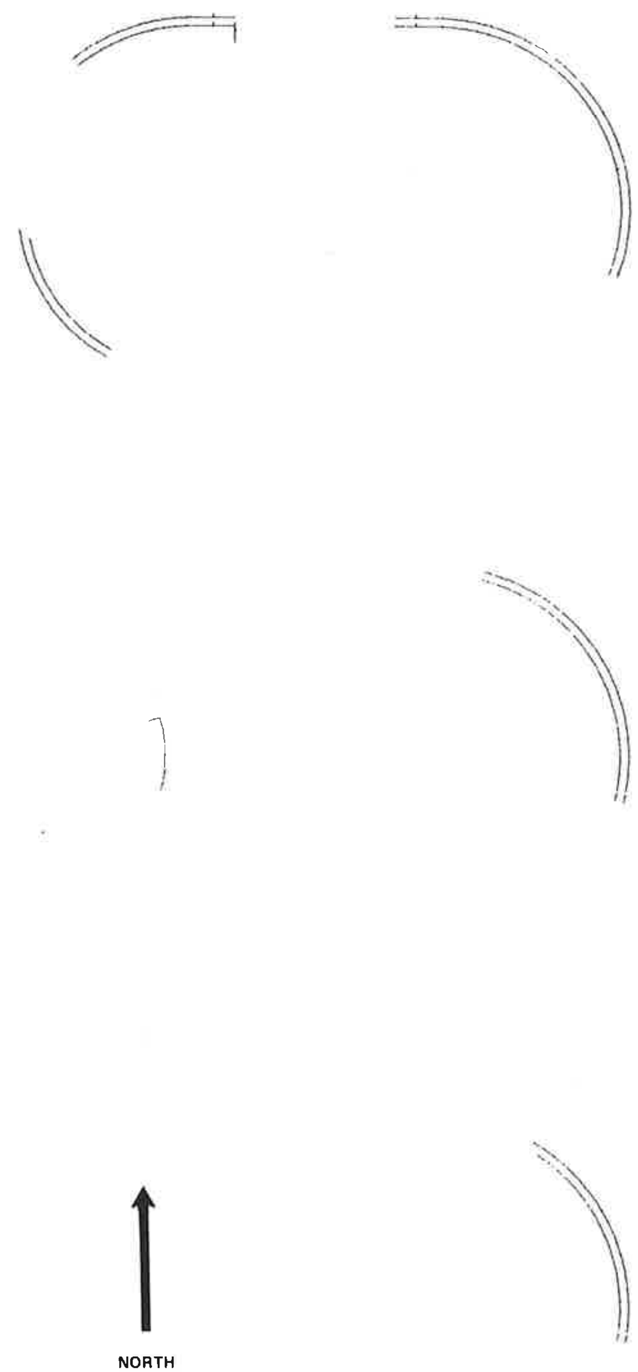


Figure 15a. Runway 35R - Illuminated Surfaces

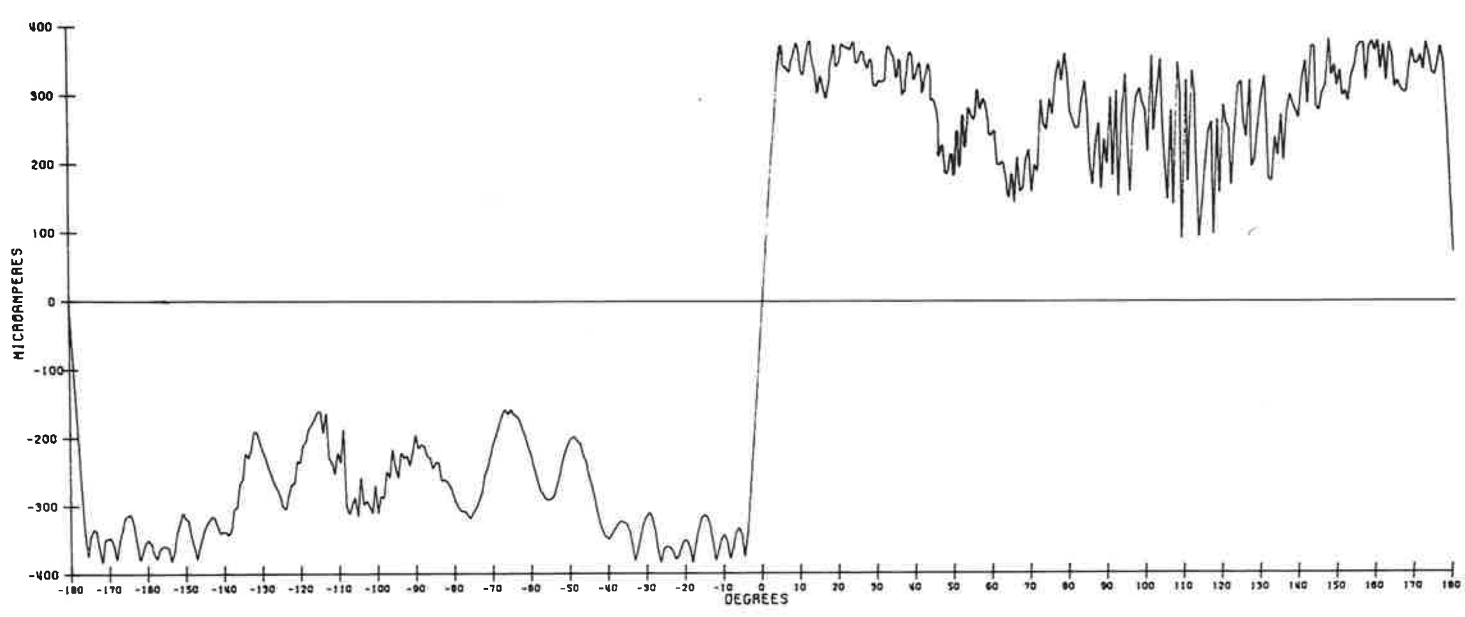


Figure 15b. Runway 35R - Clearance Orbit (V-Ring Antenna)

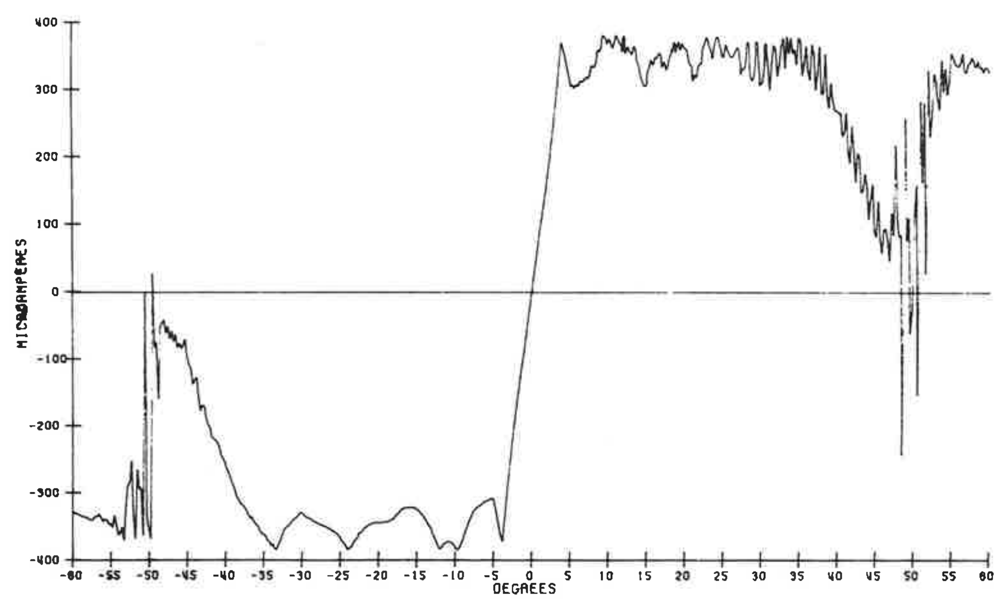


Figure 15c. Runway 35R - Clearance Orbit (Alford Antenna)

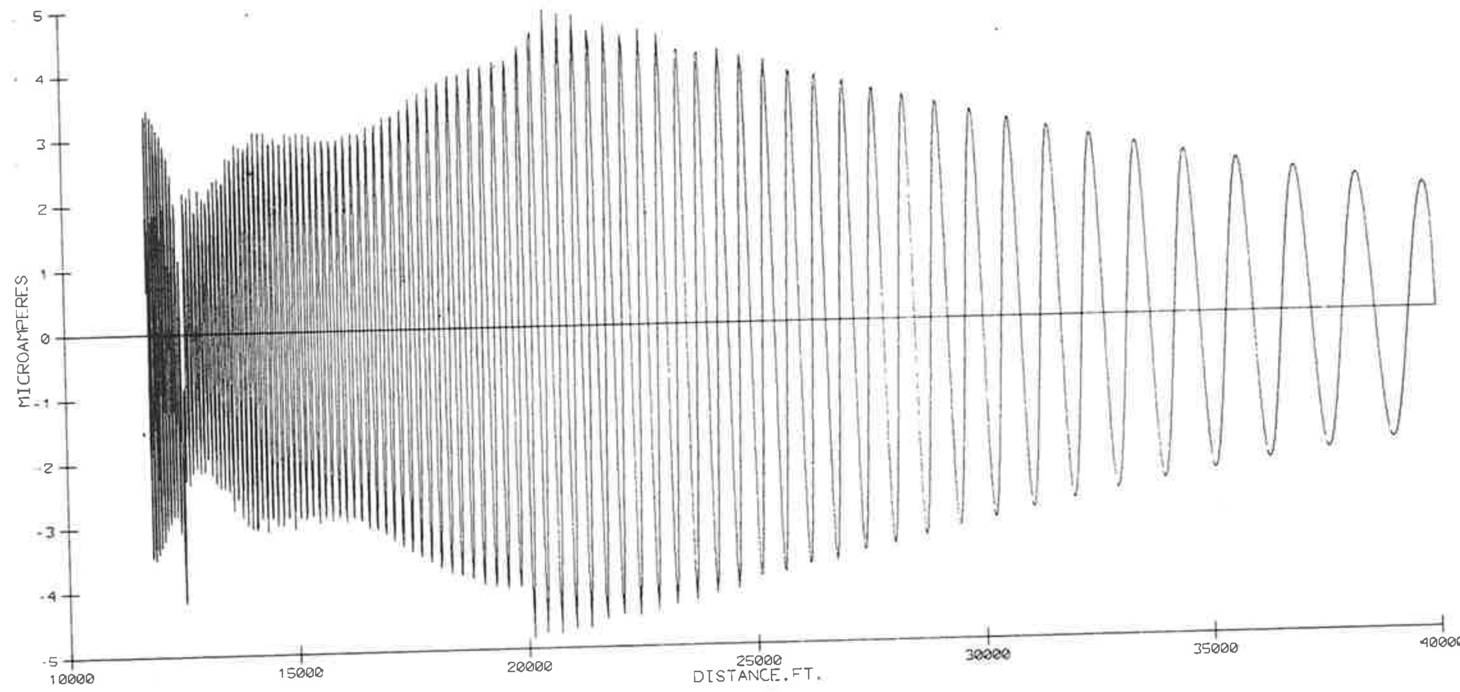


Figure 15d. Runway 35R - Detail of CDI Course Structure Due to Scattering from Hotel Alone, V-Ring Antenna Used.

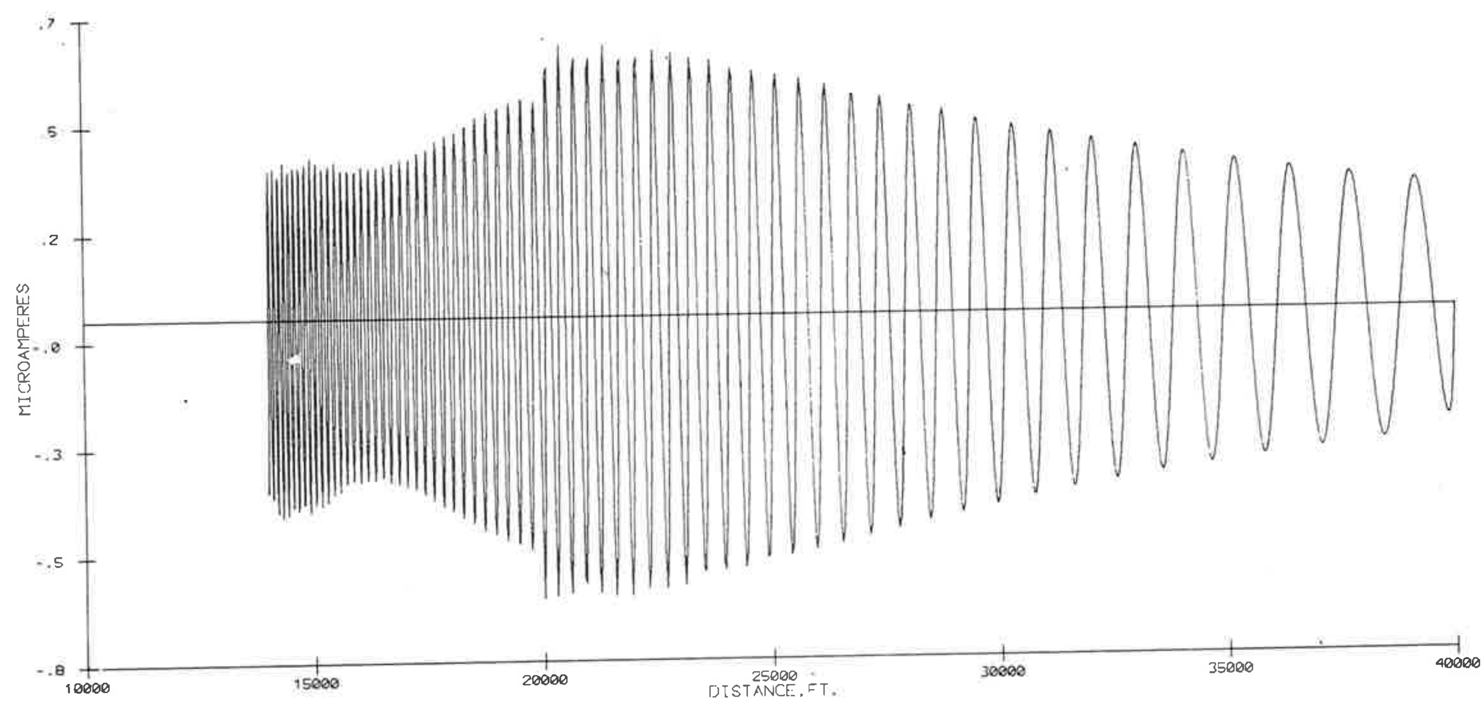


Figure 15e. Runway 35R - Detail of CDI Course Structure Due to Scattering from Hotel Alone, Alford Antenna Used (Note Different Scale)

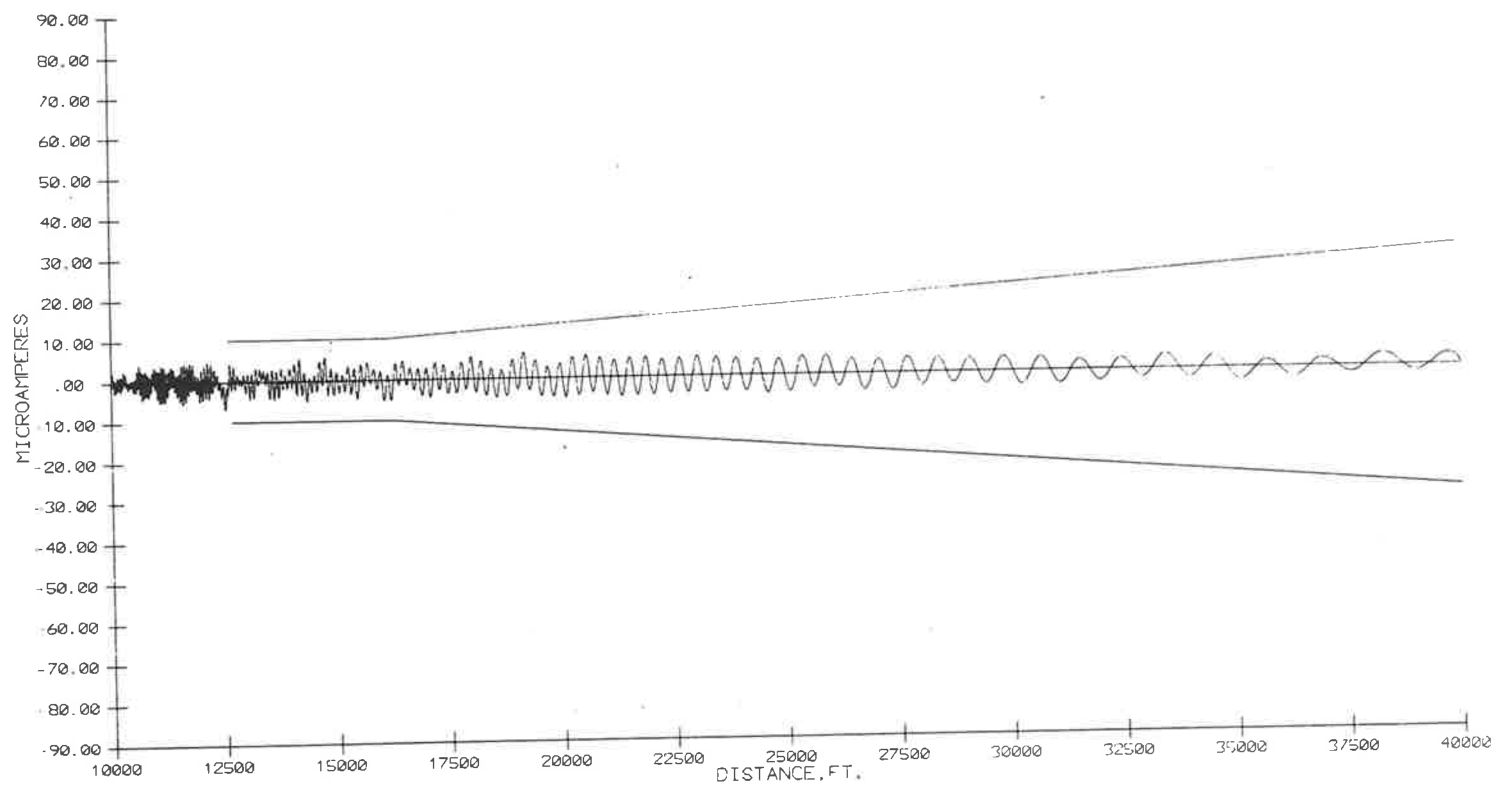


Figure 15f. Runway 35R - CDI Due to Scattering from All Modeled Structures (V-Ring Localizer Used)

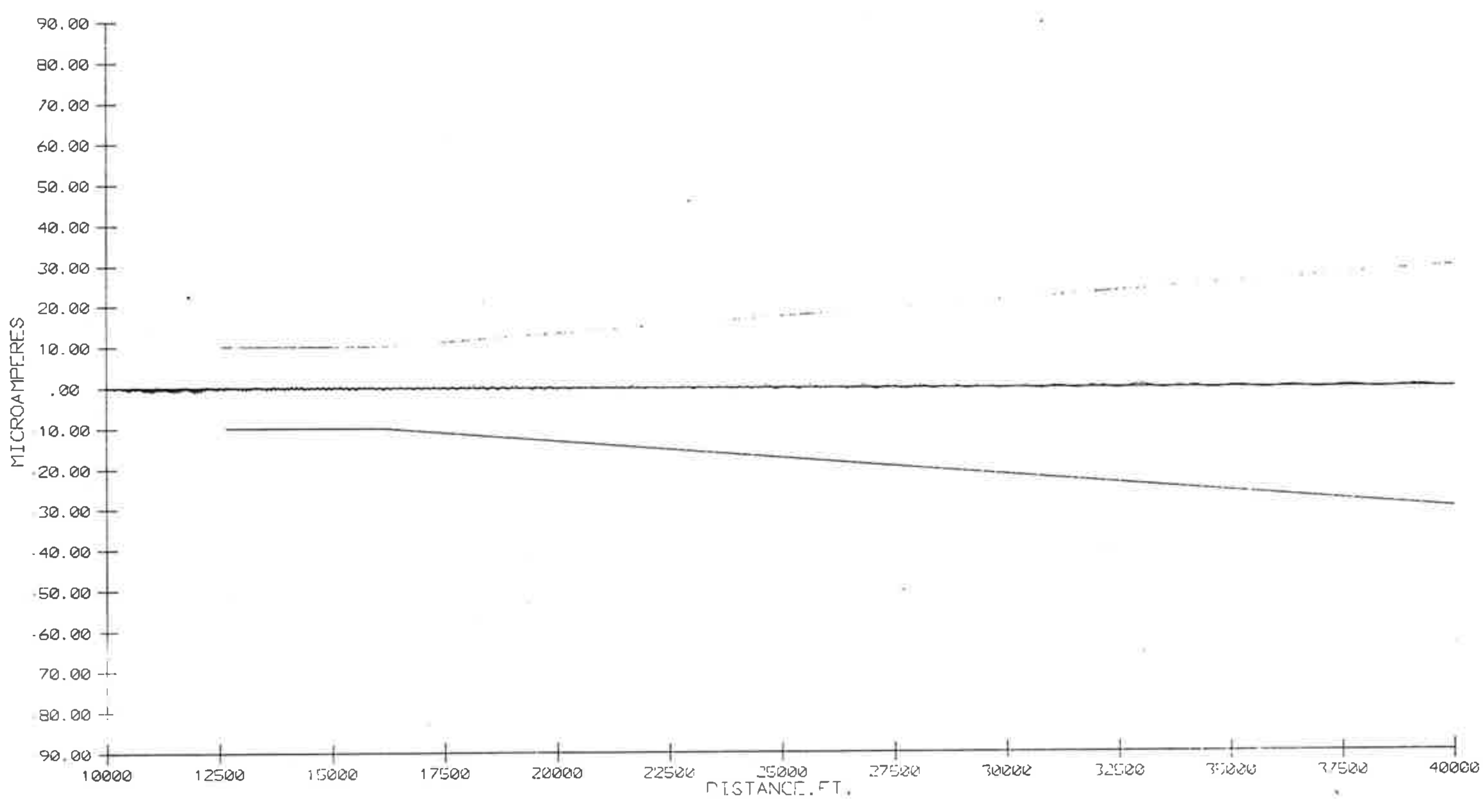


Figure 15g. Runway 35R - CDI Due to Scattering from All Modeled Structures (Alford Localizer Used)

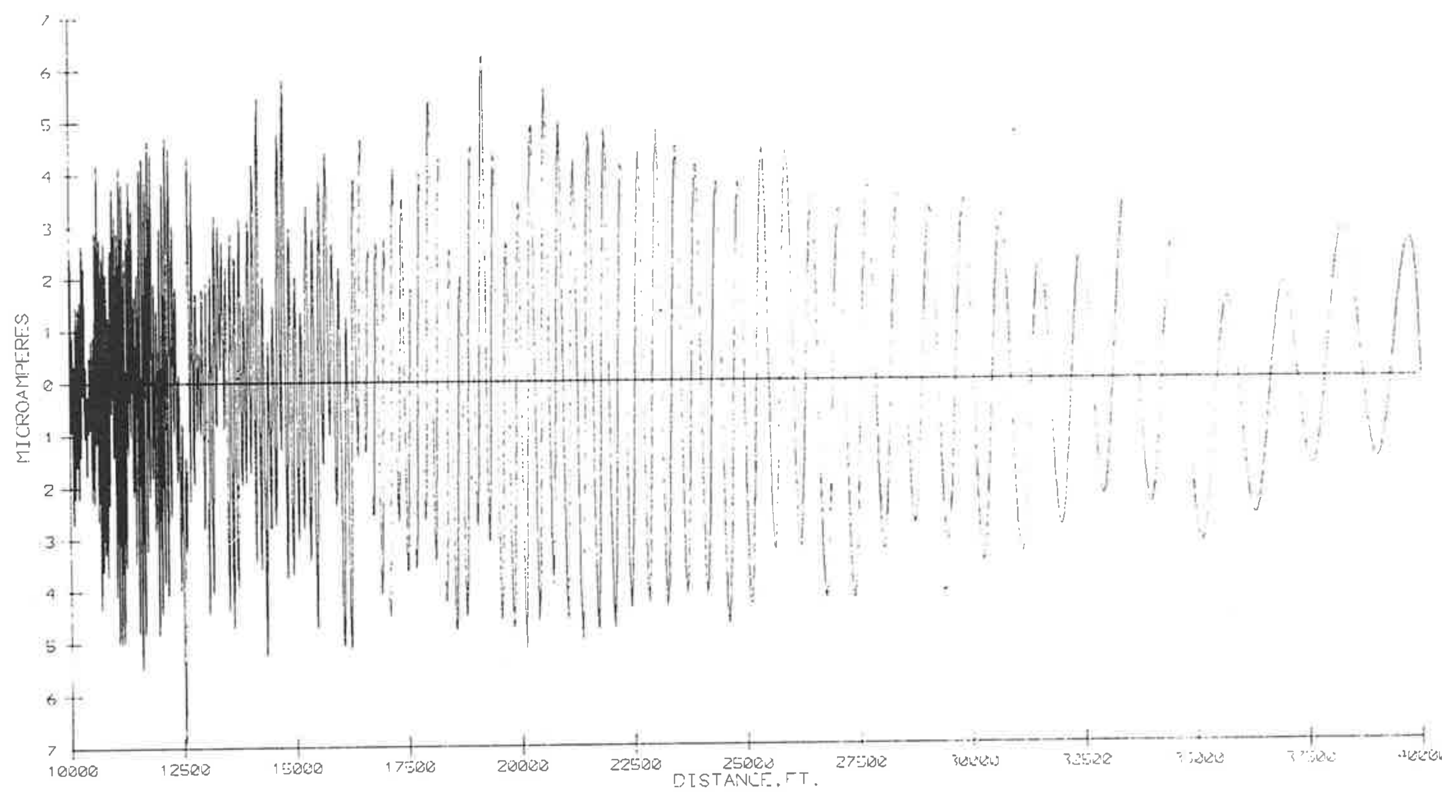


Figure 15h. Runway 35R - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (V-Ring Antenna Used)

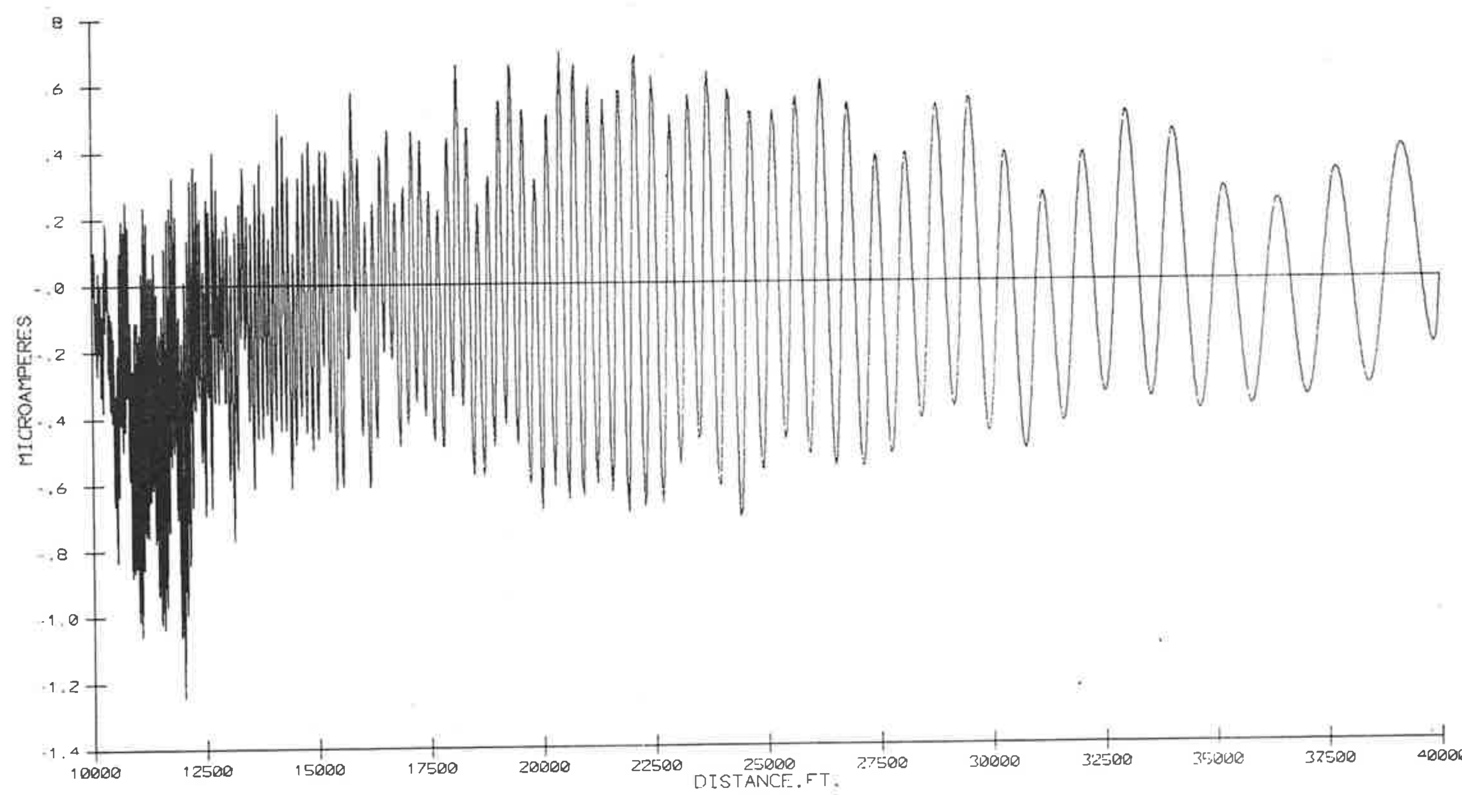


Figure 15i. Runway 35R - CDI Due to Scattering from All Modeled Structures Showing Course Structure Detail (Alford Antenna Used)

4.0 CONCLUSIONS

Electromagnetic scattering and the resulting course derogation due to the planned four terminals, hotel and tower at the Dallas Fort Worth Regional airport have been modeled using the TSC electromagnetic scattering model for two different ILS localizers, the standard V-Ring and the 14/6 element Alford Capture Effect array.

The results show that the course deviation indication (CDI) due to scattering from the modeled airport structures is typically less when the Alford antenna is used; that category II commissioning requirements for runway 17L are satisfied by the Alford array only, and that category I commissioning requirements for the other runway are only marginally satisfied by the V-Ring. It is recommended that the Alford array be used on all runways with the possible exception of runways 35R and 17R.

A closing cautionary statement should be noted. The reccommendations made in this report are based on the course derogation due to scattering only from the structures shown in Figures 5 or 6. Other structures will be built. It is important to determine the scattering from these structures, especially from any large jumbo jet hangars that may be constructed. It is recommended that, if possible, a final decision on which antenna is used not be made until such additional modeling is completed. If an early decision is, however, needed, it is recommended that the Alford antenna be used on all runways.

REFERENCES

1. Chin, G., Jordan, L., Kahn, D., and Morin, S., "The ILS Scattering Problem and Signal Detection Model," February 1972; DOT-TSC-FAA-72-7, Cambridge, Massachusetts. References to the other work may be found here. Also, see "ILS SCATTERING" by the same authors to be published July-August 1972.

APPENDIX A

COORDINATES AND SIZES OF SYRACUSE AIRPORT STRUCTURES USED IN THE TSC ELECTROMAGNETIC SCATTERING MODEL

APPENDIX A

COORDINATES AND SIZES OF SYRACUSE AIRPORT STRUCTURES USED IN THE TSC ELECTROMAGNETIC SCATTERING MODEL

The coordinates and sizes of the structures modeled at Hancock Syracuse Airport for insertion into the TSC model with the localizer position taken as origin, are given in the table below. The building number designation used on the airport layout, Figure 2, corresponds to the building numbers used in this Appendix. Based on the building sizes and locations as given in the following pages, Figure A-1 shows a computer generated layout of the buildings modeled.

TABLE A-1. BUILDING SIZES AND LOCATIONS MODELED AT HANCOCK SYRACUSE AIRPORT

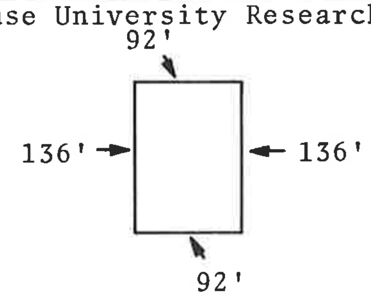
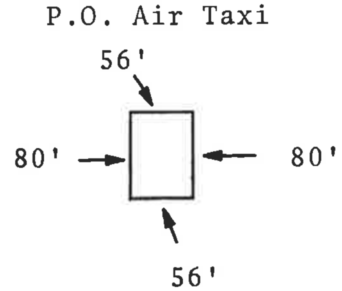
Bldg.	Coordinates	Shape	Height
1a	(2066, -916)'	Syracuse University Research Corp. 	25'
1b	(2142, -972)'	P.O. Air Taxi 	31'

TABLE A-1 (Cont.)

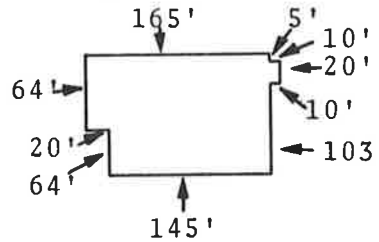
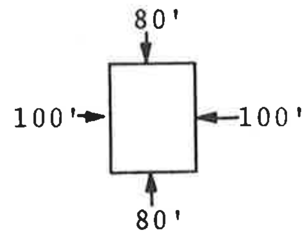
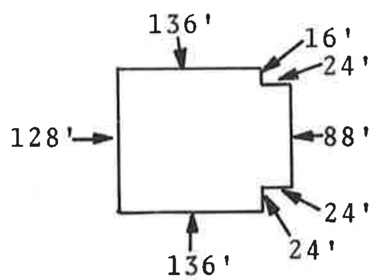
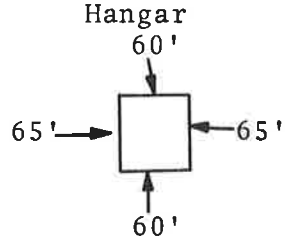
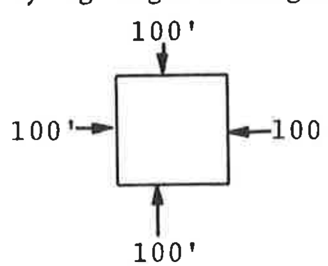
Bldg.	Coordinates	Shape	Height
2	(2322, -932)'	Niagara-Mohawk 	32'
3	(2560, -932)'	SAIR 	25'
4a	(2800, -920)'	Flight Service 	40'
4b	(2962, -908)'	Hangar 	20'
5	(3500, -846)'	Flying Tigers Hangar 	20'

TABLE A-1 (Cont.)

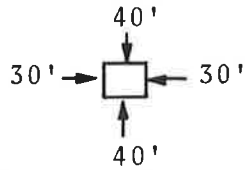
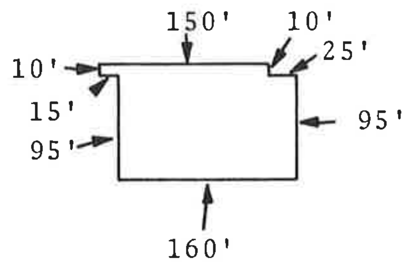
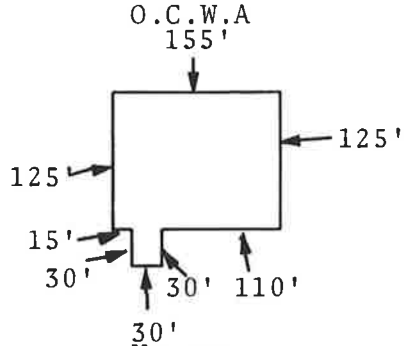
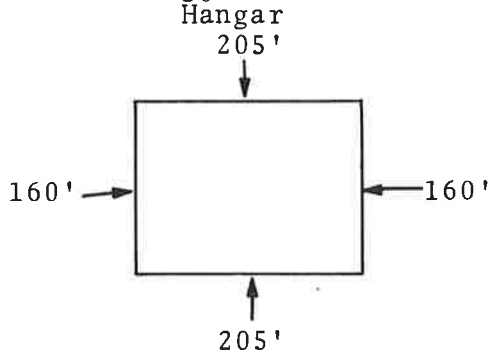
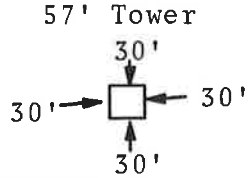
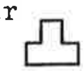
Bldg.	Correlates	Shape	Height
5a	(3700,-1012)'	Fire House 	18'
6	(4000,-830)'	Carrier Hangar 	30'
7	(4377, -825)'	O.C.W.A 	30'
8a	(4605, -775)'	Hangar 	30'
8b	(4722.5,-775)'	57' Tower 	57'
		J-Hangar 	

TABLE A-1 (Cont.)

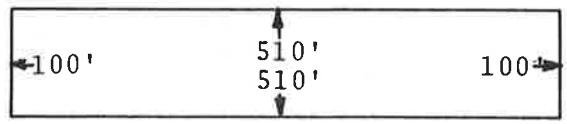
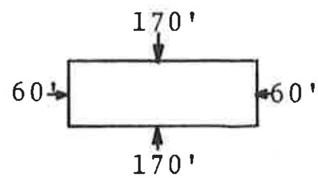
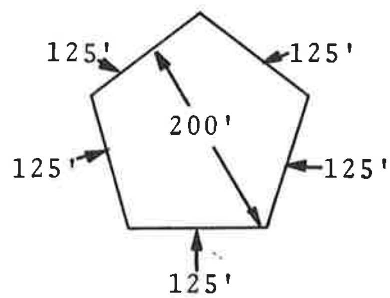
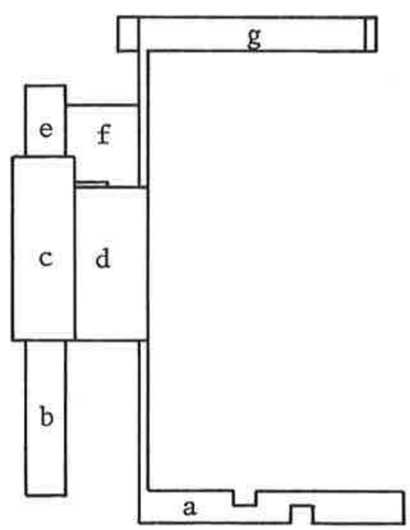
Bldg.	Coordinates	Shape	Height
10a	(3200,1185)'	Cargo Building A 	20'
10b	(3700,1225)'	Cargo Building B 	16'
11	Erected Jan. 1972 (4215,1620)'	Motel 	30'
12		Terminal Building 	

TABLE A-1 (Cont.)

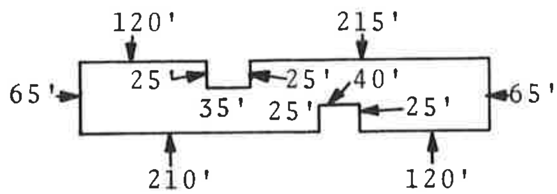
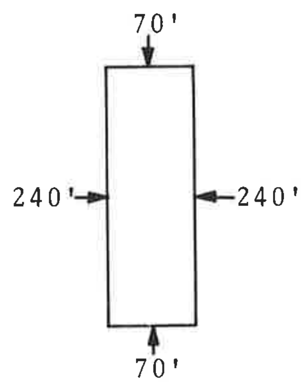
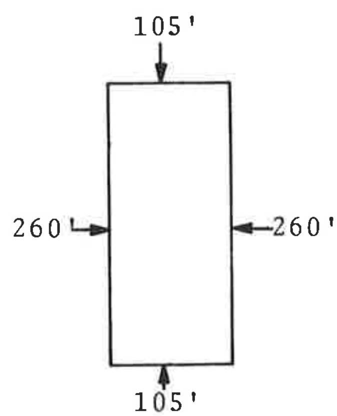
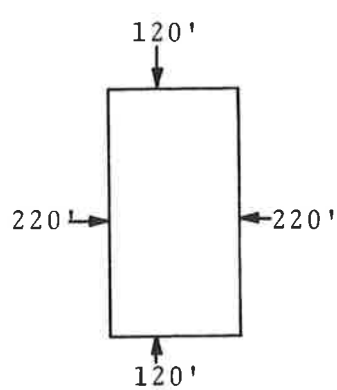
Bldg.	Coordinates	Shape	Height
12a	(6190,1507)'		22'
12b	(5935,1557)'		22'
12c	(5927.5,1797)'		37'
12d	(6032.5,1797)'		37'

TABLE A-1 (Cont.)

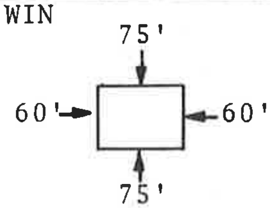
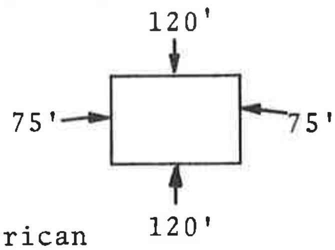
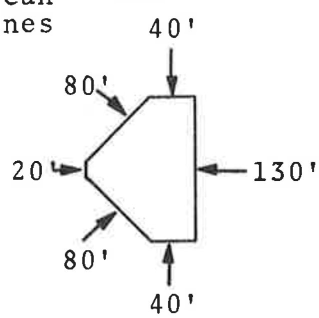
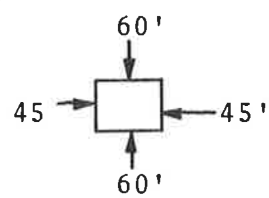
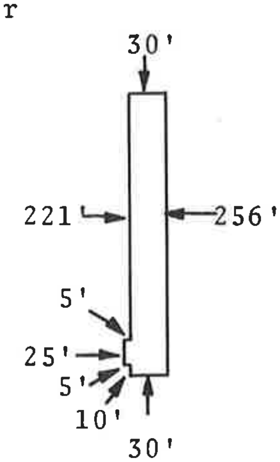
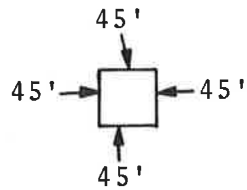
Bldg.	Coordinates	Shape	Height
13	(5015,-1235)'	WIN 	20'
14	(5115,-1295)'	Air Service 	30'
15	(5517,-1500)'	American Airlines 	40'
16	(1880,-818)'	Hangar 	20'
17	(1710,-812)'	Hangar 	20'

TABLE A-1 (Cont.)

Bldg.	Coordinates	Shape	Height
18	(5925,2410)'	Control Tower Beacon 	67'

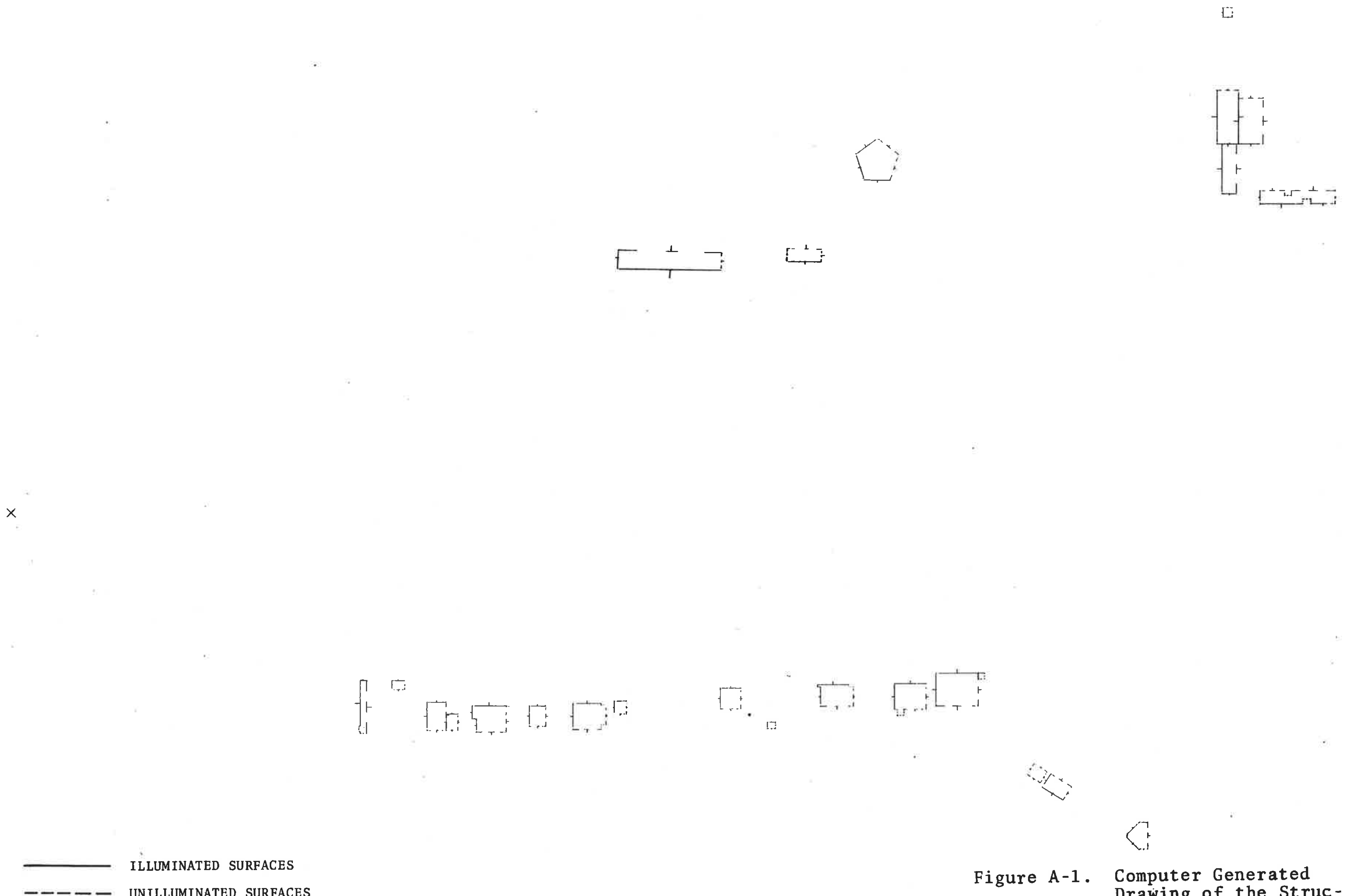


Figure A-1. Computer Generated Drawing of the Structures Modeled for Syracuse Airport. Only the Solid Lines in the Drawings of the Buildings Represent Illuminated Surfaces

APPENDIX B

COORDINATES AND SIZES OF THE TERMINAL BUILDINGS AT DALLAS FORT WORTH REGIONAL AIRPORT

APPENDIX B

The Dallas Fort Worth Regional Airport terminals as modeled for insertion into the TSC program are given in this Appendix. Internal reflections within the semicircle were neglected.

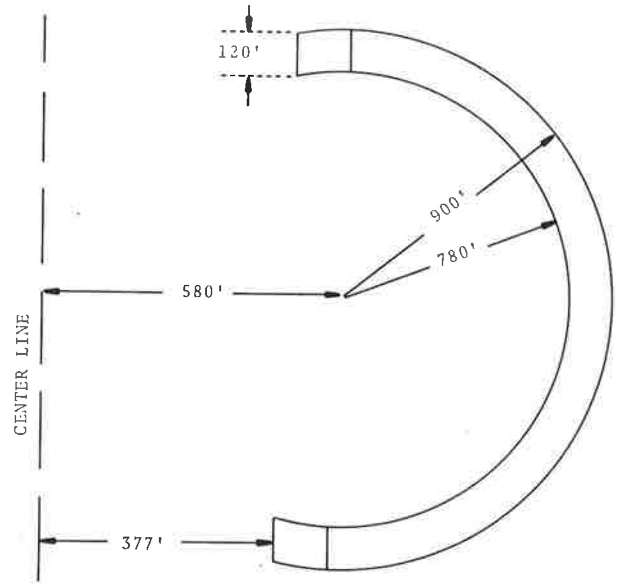


Figure B-1. Plan for Typical Terminal

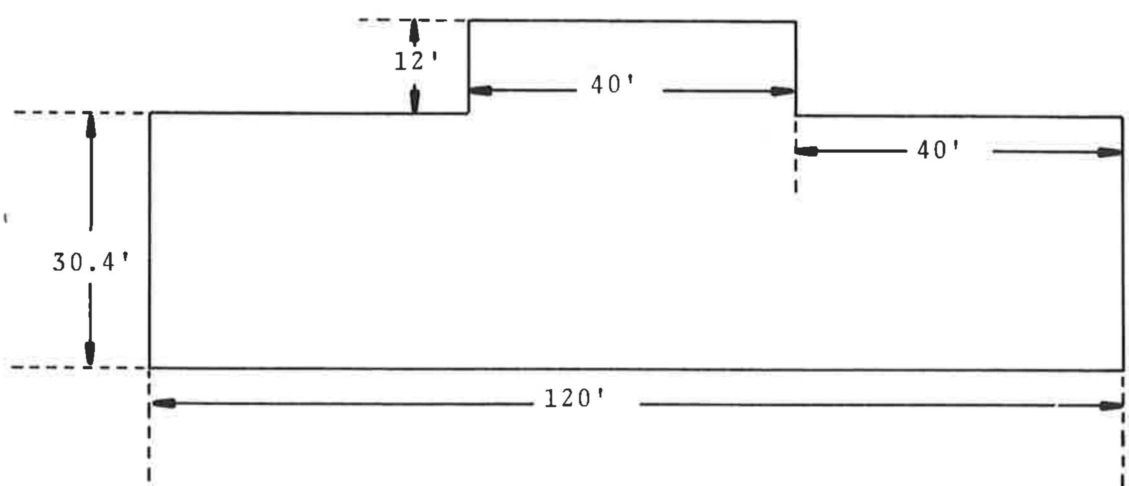


Figure B-2. Cross Section for Terminals in Areas 2W, 2E, and 4E

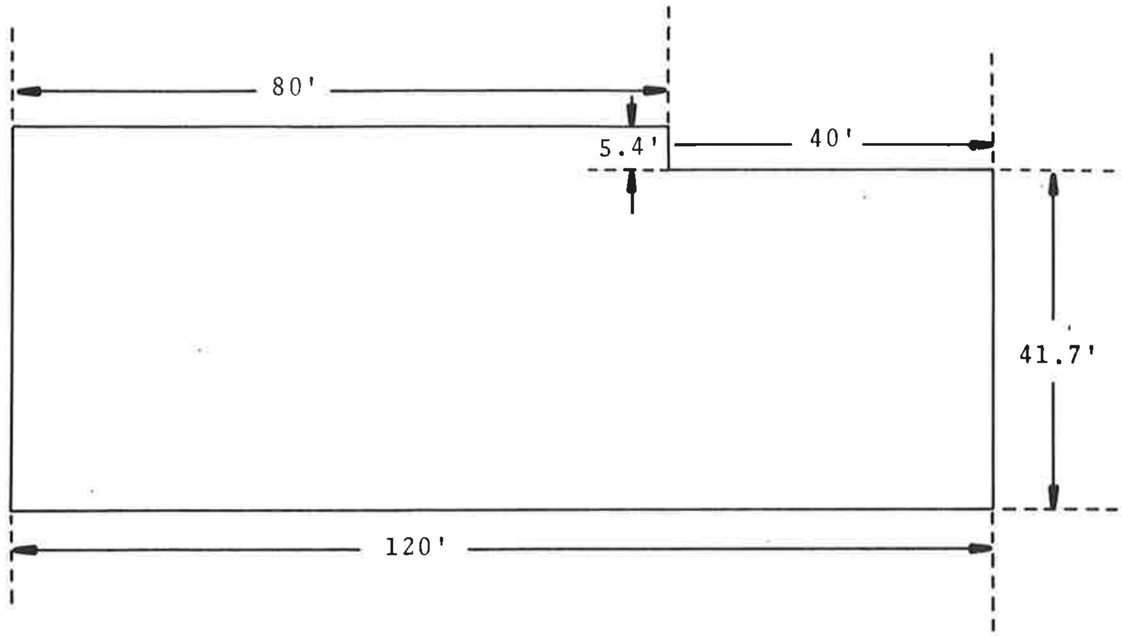


Figure B-3. Cross Section for Terminal in Area 3E

The coordinates of the foci of the terminals are as follows:

Terminal	Relative to localizer for runway 17R	Relative to localizer for runway 35L	Relative to localizer for runway 17L	Relative to localizer for runway 35R
2W	(10,374,-2620)	(3213,2620)	(10,374,3780)	(3013,-3780)
2E	(10,374,-3780)	(3213,3780)	(10,374,2620)	(3013,-2620)
3E	(7774,-3780)	(5813,3780)	(7774,2620)	(5613,-2620)
4E	(5174,-3780)	(8413,3780)	(5174,2620)	(8213,-2620)

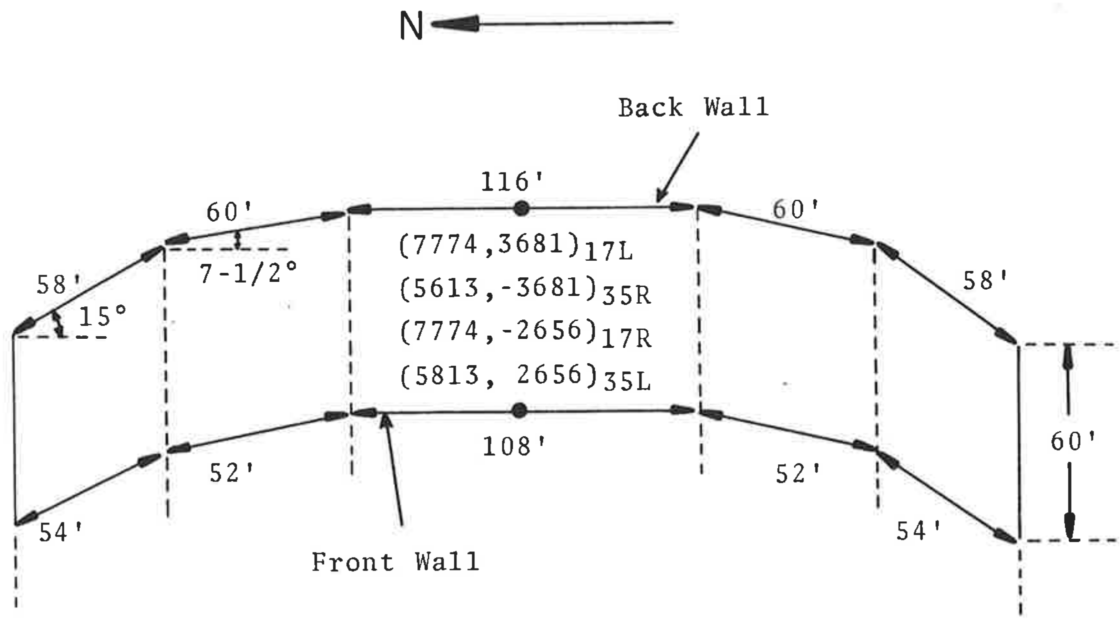
(All distances are in units of feet).

APPENDIX C

COORDINATES AND SIZE OF THE HOTEL AT DALLAS FORT WORTH REGIONAL AIRPORT AS USED IN THE TSC MODEL

APPENDIX C

The hotel is 124 feet high with the following plan layout:



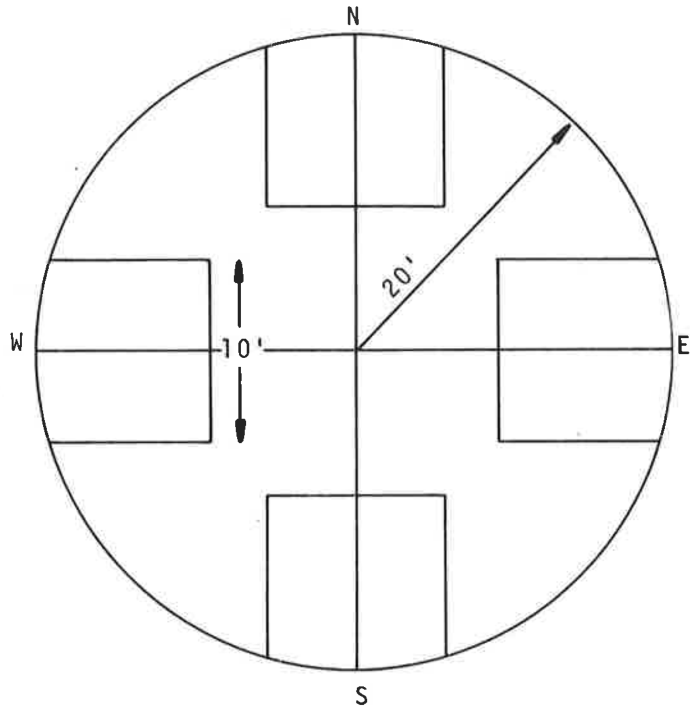
The lengths of the different wall sections of the hotel are shown in the figure above. The numbers in the parantheses represent the horizontal coordinates of the centers of the front and back walls relative to a localizer for the runway denoted by the subscript.

APPENDIX D

COORDINATES AND SIZE OF CONTROL TOWER AT THE DALLAS FORT WORTH REGIONAL AIRPORT

APPENDIX D

A drawing of the tower pillars is shown below. There are four columns of square cross section (which are rounded off at the perimeter of a 20 foot imaginary circle). The columns rise 174.5 feet.



An eleven sided cab, 16 feet high with walls that slope outwards at an angle of 15° is supported by the pillars. The horizontal coordinates of the tower relative to the different localizers are:

Relative to the localizer for runway 35R: (5878,-3200)'
Relative to the localizer for runway 17L: (7509,3200)'
Relative to the localizer for runway 35L: (6078,3200)'
Relative to the localizer for runway 17R: (7509,-3200)'

This control tower structure is the most difficult of all the Dallas Fort Worth structures to model precisely. The reason is that diffraction effects are important in the case of the tower because of the comparable sizes between pillar cross section and wavelength. While the TSC physical optics model does take into account diffraction effects, it does so only as part of an iterative solution, becoming less accurate as the wavelength of the radiation decreases to the size of the scattering object. However, because the whole tower structure comprises only a 20 foot radius, the amount of derogation due to the tower should not appreciably alter the total amount of derogation expected from all structures combined. Further, several different possible combinations of illuminated surfaces of the pillars were run and except for phase differences, little change in magnitude of the derogation was observed. Hence, while a more accurate treatment of diffraction effects would undoubtedly improve the accuracy of the results, it is believed that, in this case, the overall difference would be small.