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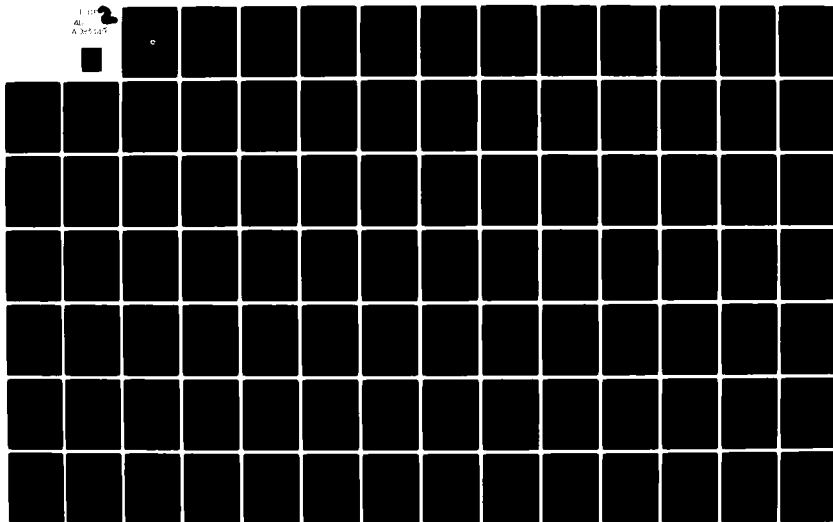
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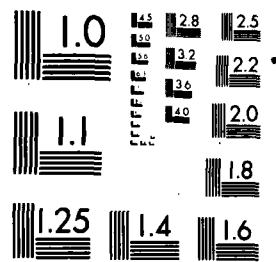
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MLS CHANNEL ASSIGNMENT MODEL

Thomas Hensler and Andrew Koshar
of
IIT Research Institute
Under Contract to
DEPARTMENT OF DEFENSE
Electromagnetic Compatibility Analysis Center
Annapolis, Maryland 21402



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Interim Report

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FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
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16 Abstract → An automated channel assignment model was constructed in response to an FAA need to assess the assignment feasibility of planned MLS angle-guidance equipment in C-band, and its associate L-band Precision Distance Measurement Equipment (PDME). The intersite interference analysis and channel-assignment algorithm capabilities are described. A trial assignment of MLS equipments was performed for a Southwest United States airport environment and the results are summarized. ↗					
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PREFACE

The Electromagnetic Compatibility Analysis Center (ECAC) is a Department of Defense facility, established to provide advice and assistance on electromagnetic compatibility matters to the Secretary of Defense, the Joint Chiefs of Staff, the military departments and other DoD components. The center, located at North Severn, Annapolis, Maryland 21402, is under policy control of the Assistant Secretary of Defense for Communication, Command, Control, and Intelligence and the Chairman, Joint Chiefs of Staff, or their designees, who jointly provide policy guidance, assign projects, and establish priorities. ECAC functions under the executive direction of the Secretary of the Air Force and the management and technical direction of the Center are provided by military and civil service personnel. The technical operations function is provided through an Air Force sponsored contract with the IIT Research Institute (IITRI).

This report was prepared for the Systems Research and Development Service of the Federal Aviation Administration in accordance with Interagency Agreement DOT-FA70WAI-175, as part of AF Project 649E under Contract F-19628-78-C-0006, by the staff of the IIT Research Institute at the Department of Defense Electromagnetic Compatibility Analysis Center.

To the extent possible, all abbreviations and symbols used in this report are taken from American Standards Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the USA Standards Institute.

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ENGLISH/METRIC CONVERSION FACTORS

LENGTH

From \ To	cm	m	km	in	ft	mi	nmi
cm	1	0.01	1×10^{-5}	0.3937	0.0328	6.21×10^{-6}	5.39×10^{-6}
m	100	1	0.001	39.37	3.281	0.0006	0.0005
km	100,000	1000	1	39370	3281	0.6214	0.5395
in	2.540	0.0254	2.54×10^{-5}	1	0.0833	1.58×10^{-5}	1.37×10^{-5}
ft	30.48	0.3048	3.05×10^{-4}	12	1	1.89×10^{-4}	1.64×10^{-4}
mi	160,900	1609	1.609	63360	5280	1	0.8688
nmi	185,200	1852	1.852	72930	6076	1.151	1

AREA

From \ To	cm ²	m ²	km ²	in ²	ft ²	mi ²	nmi ²
cm ²	1	0.0001	1×10^{-10}	0.1550	0.0011	3.86×10^{-11}	5.11×10^{-11}
m ²	10,000	1	1×10^{-6}	1550	10.76	3.86×10^{-7}	5.11×10^{-7}
km ²	1×10^{10}	1×10^6	1	1.55×10^3	1.08×10^7	0.3861	0.2914
in ²	6.452	0.0006	6.45×10^{-10}	1	0.0069	2.49×10^{-10}	1.68×10^{-10}
ft ²	929.0	0.0929	9.29×10^{-8}	144	1	3.59×10^{-8}	2.71×10^{-8}
mi ²	2.59×10^{10}	2.59×10^6	2.590	4.01×10^9	2.79×10^7	1	0.7548
nmi ²	5.43×10^{10}	5.43×10^6	5.432	5.31×10^9	3.70×10^7	1.325	1

VOLUME

From \ To	cm ³	liter	m ³	in ³	ft ³	yd ³	fl. oz.	fl. pt.	fl. qt.	gal.
cm ³	1	0.001	1×10^{-6}	0.0610	3.53×10^{-5}	1.31×10^{-6}	0.0338	0.0021	0.0010	0.0002
liter	1000	1	0.001	61.02	0.0353	0.0013	33.81	2.113	1.057	0.2642
m ³	1×10^6	1000	1	61,000	35.31	1.308	33,800	2113	1057	264.2
in ³	16.39	0.0163	1.64×10^{-5}	1	0.0006	2.14×10^{-5}	0.5541	0.0346	2115	0.0043
ft ³	28,300	28.32	0.0283	1728	1	0.0370	957.5	59.84	0.0173	7.481
yd ³	765,000	764.5	0.7646	46700	27	1	25900	1616	807.9	202.0
fl. oz.	29.57	0.2957	2.96×10^{-5}	1.805	0.0010	3.87×10^{-5}	1	0.0625	0.0312	0.0078
fl. pt.	473.2	0.4732	0.0005	28.88	0.0167	0.0006	16	1	0.5000	0.1250
fl. qt.	948.4	0.9463	0.0009	57.75	0.0334	0.0012	32	2	1	0.2500
gal.	3785	3.785	0.0038	231.0	0.1337	0.0050	128	8	4	1

MASS

From \ To	g	kg	oz	lb	ton
g	1	0.001	0.0353	0.0022	1.10×10^{-6}
kg	1000	1	35.27	2.205	0.0011
oz	28.35	0.0283	1	0.0625	3.12×10^{-5}
lb	453.6	0.4536	16	1	0.0005
ton	907,000	907.2	32,000	2000	1

TEMPERATURE

$$^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{F} = 9/5 (^{\circ}\text{C}) + 32$$

**FEDERAL AVIATION ADMINISTRATION
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STATEMENT OF MISSION

The mission of the Spectrum Management Staff is to assist the Department of State, Office of Telecommunications Policy, and the Federal Communications Commission in assuring the FAA's and the nation's aviation interests with sufficient protected electromagnetic telecommunications resources throughout the world to provide for the safe conduct of aeronautical flight by fostering effective and efficient use of a natural resource--the electromagnetic radio-frequency spectrum.

This objective is achieved through the following services:

- Planning and defending the acquisition and retention of sufficient radio-frequency spectrum to support the aeronautical interests of the nation, at home and abroad, and spectrum standardization for the world's aviation community.
- Providing research, analysis, engineering, and evaluation in the development of spectrum related policy, planning, standards, criteria, measurement equipment, and measurement techniques.
- Conducting electromagnetic compatibility analyses to determine intra/inter-system viability and design parameters, to assure certification of adequate spectrum to support system operational use and projected growth patterns, to defend the aeronautical services spectrum from encroachment by others, and to provide for the efficient use of the aeronautical spectrum.
- Developing automated frequency-selection computer programs/routines to provide frequency planning, frequency assignment, and spectrum analysis capabilities in the spectrum supporting the National Airspace System.
- Providing spectrum management consultation, assistance, and guidance to all aviation interests, users, and providers of equipment and services, both national and international.

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) has requested that the Electro-magnetic Compatibility Analysis Center (ECAC) provide a channel-assignment model capable of making channel assignments for the new Microwave Landing System (MLS). The MLS consists of angle-guidance equipments operating in C-band and its associated Precision Distance Measurement Equipment (PDME) operating in L-band. It was desired that the model be capable of using various channel-separation criteria and assignment environments input by the user. It was also necessary that the model should assign equipments according to a user-input channelization scheme and be capable of pairing MLS and PDME channel assignments with existing TACAN/DME and VOR/ILS channels. The results of an assignment will be a list of the airport runways in the environment, the channel assigned to each runway, and an indication of which equipment contributed most to the failure of any runway to get a channel assigned.

The channel-assignment model consists of an intersite analysis routine and a channel assignment routine. The intersite analysis routine calculates desired-to-undesired signal power ratios (D/U) within each equipment's protected service volume. It then constructs an array containing the worst-case D/U value which exists between each pair of equipments in the environment.

The channel-assignment routine converts the worst-case D/U values to channel separation between equipments, and makes channel assignments that satisfy these separation requirements. The channel assignments are performed using a dynamic assignment technique in which the most difficult assignments (those with the least number of available channels) are attempted first. This routine includes an option allowing the user to specify the order of equipment assignment as he wishes, as an alternative to the dynamic technique.

A trial channel assignment of a Southwest U.S. airport environment using the dynamic ordering technique was made to test both the model and channel plan capability. This trial assignment is documented in the results section of this report.

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SECTION 1

INTRODUCTION

BACKGROUND

A new non visual precision approach and landing guidance system has been accepted by the International Civil Aviation Organization (ICAO)¹ as the future international standard.

The federal Aviation Administration (FAA) proposed Microwave Landing System (MLS), is based on the Time Reference Scanning Beam (TRSB) technique in which time between successive scans of narrow fan beams provide elevation and azimuth information to aircraft within a designated service volume. Distance information is provided by existing Distance Measurement Equipment (DME) or by new Precision Distance Measurement Equipment (PDME), both operating in L-band (960 to 1215 MHz). Current proposals call for channel pairing^a between these L and C-band guidance functions. APPENDIX B contains a system description of the MLS angle-guidance and range-guidance equipments.

Early in the development of the MLS, the Electromagnetic Compatibility Analysis Center (ECAC) developed an automated channel assignment model that was capable of performing intersite analyses and making channel assignments for the MLS functions as they were envisioned in 1972². Subsequent refinements to the MLS system design and implementation plans have resulted in a requirement for a more complex channel-assignment model.

¹Time Reference Scanning Beam Microwave Landing System, DOT/FAA, December 1975.

²Frazier, R., *In-Band Compatibility Analysis of the RTCA-Proposed Microwave Landing Guidance System (LGS) and Interim System*, (FAA-RD-75-62), ECAC, Annapolis, MD., July 1972.

^aChannel pairing is when frequency assignments in different bands are inter-dependent. This enables a pilot to automatically use equipments of different bands by tuning to a single channel.

One of the major changes is that the PDME function has been moved from C-band (5.0-5.25 GHz) to L-band (960 to 1215 MHz). The current plan calls for possible assignment of the PDME function to existing L-band X and Y mode channels used by conventional DME systems. Additional L-band channels are expected to be created by defining new operating modes (i.e., multiplexing) on the present L-band frequency pairings.

The L-band TACAN/DME X and Y mode channels are currently channel paired to VHF (ILS Localizer and VOR) and UHF (ILS Glideslope) channels. Dependent upon the final implementation strategy, assigning the PDME functions to these L-band channels may result in channel-pairing of aeronautical radionavigation equipments in four bands: MLS angle-guidance equipment in C-band; TACAN, conventional DME and PDME equipments in L-band; ILS Localizer and VOR equipments in the VHF band; and ILS Glideslope equipments in the UHF band. Coupling between bands could therefore result in a need, when making MLS assignments, to check MLS C-band angle-guidance assignment criteria with potential assignment criteria in the L, VHF, and UHF bands.

In addition, the model reflects the FAA requirement that greater accuracy be provided in predicting the value and location point within the MLS protected service volume of the minimum desired-to-undesired signal power ratio (D/U).

OBJECTIVES

The objectives of this effort were to develop an automated channel-assignment model capable of providing frequency assignments of MLS equipments that operate either in C-band or L-band, and to provide a trial channel assignment predicated on a specific test environment and channelization scheme that utilizes existing VHF and UHF channels.

APPROACH

In developing an automated channel-assignment model (CAM), it was necessary that the CAM be capable of providing MLS frequency assignments that would allow operation on a non-interference basis of the new MLS equipments with the present

airport and enroute equipments³. These combined environments include MLS angle-guidance equipment to be assigned to C-band channels; DME, PDME and TACAN range-guidance equipment in L-band; ILS localizer and VOR equipment in the VHF band; and ILS glideslope equipment in the UHF band.

To satisfy the need for an intersite analysis, as well as to provide channel assignments, two routines were developed. The intersite analysis routine was designed to calculate the minimum desired-to-undesired signal power ratio (D/U) within a desired facility's service volume. This analysis can be performed for either/or the sector/circular service volumes associated with ILS and MLS as well as the sector/circular service volumes of TACAN/DME and associated VOR equipments. The D/U ratios are calculated using equipment location and equipment characteristics obtained from the user-specified airport environment. Propagation loss predictions are provided by a model developed for the FAA by the Institute for telecommunications Sciences (ITS).⁴ The intersite analysis results consist of predicted minimum D/U ratios for each equipment pair within the same frequency band.

The channel-assignment routine was designed to use the D/U values from the intersite analysis and convert them into minimum channel-separation requirements based on user-specified D/U protection criteria. Using these separation requirements and the frequency resources contained in a user-specified channel plan, a denied-channel array is generated. This array indicates those frequencies that are not available for use by each equipment to be assigned. If the user chooses the dynamic approach, a scan of the array determines the most constrained equipment, in terms of the remaining frequency resources available for its assignment.

³Analysis of MLS Channel Plans with L-Band DME, Inter-Agency Agreement, DOT-FA76WAI-6]2, Task Assignment.

⁴Gierhart, G.D. and Johnson, M.E., Propagation and Interference Analysis Computer Programs (0.1 to 20 GHz), Applications Guide, FAA-RD-77-60, ITS, Boulder, Colorado, March 1978.

The most constrained equipment is that which has the minimum number of available frequency resources. This equipment is assigned first. The denied-channel array is subsequently updated to include new constraints imposed by the channel just assigned, and the process is then repeated until all equipments are assigned or channel resources have been exhausted.

The channel-assignment model can assign equipments in each of the four bands (UHF, VHF, L-band, and C-band) and can make assignments for channel-paired equipments. Dependent upon user specified operating conditions it is also capable of reassigning existing preassigned^a equipment if their present operating frequencies cannot satisfy the channel-separation requirements of the new channel paired MLS functions.

In addition to the development of the intersite analysis routine and the channel-assignment routine, it was necessary to identify the types of data required to support those routines during their use. These data are documented as part of the assignment system.

A trial assignment was made to appraise the assignment model's performance in a working environment, as well as the performance of an FAA-proposed equipment channelization scheme.

The environment used to test the assignment model was an updated Southwest U.S. airport environment that had been developed by the FAA in support of the Radio Technical Commission for Aeronautics Special Committee 117 (RTCA in 1972). This environment included a four-state area and is listed in APPENDIX D.

The differences between the 1972 environment and the present version are:
1) addition of MLS-PDME requirements to L-band; 2) addition of existing preassigned

^a"Preassigned" refers to existing ILS/VOR or TACAN/DME equipments operating on a designated channel. When the new MLS and PDME systems are frequency paired to these existing equipments, their frequencies are predetermined in that the only MLS channel available for assignment is that which is hard-paired to the existing frequency assignment.

TACAN/DME and VOR enroute facilities, and existing preassigned ILS Localizer and Glideslope airport facilities to the UHF VHF-bands; and 3) addition of "dummy" equipments for the optional protection of paired frequencies where no associated equipments are physically installed.

The assignment was made using the channelization plan listed in APPENDIX E. The list of frequency resources that was used in this first trial channel assignment was derived by pairing the C-band Frequency Channel Plan with the L-band PDME Interim Channel Plan.⁵ The assumptions used to derive the specific list of frequencies and to define the potential interdependence between the C-, L-, VHF and UHF bands are as follows:

1. C-band channels used for MLS angle-guidance were hard-paired to specific L-band channels. For example, C-band channel 002 (5031.6 MHz) was paired with L-band channel 18X (979 MHz). If either one of these channels was assigned to a facility, both of them were protected. If both could not be protected during the assignment process, neither could be assigned to that facility. This is representative of intrasystem hard pairing.

2. The existing channel-pairing required by ICAO Annex 10 between certain L-band channels, VHF channels, and UHF channels became part of the MLS channel plan. For example, channel 18X now pairs C-band (5031.6 MHz) with L-band (979 MHz), VHF-band ILS Localizer (109.10 MHz) and UHF-band ILS Glideslope (334.7 MHz) frequencies. As in (1) above, the assignment of any one of these frequencies at a facility requires the protection of all related hard paired frequencies, even though some of the equipment was not actually required. This is representative of intersystem hard pairing.

The protection criteria used in this first trial assignment is presented in APPENDIX C. Included in this appendix are some qualifying statements, and a listing of the criteria for all four frequency bands, i.e., C-band, L-band, and the VHF and UHF bands. It should be noted that consistent with traditional FAA procedure, only ground-to-air L-band interference interactions were considered.

⁵MLS Signal Format and System Level Functional Requirements, FAA-ER-700-08C, 10 May 1979.

SECTION 2
MODEL DESCRIPTION

INTRODUCTION

The MLS channel-assignment system was designed to provide MLS frequency assignments compatible with existing airport and enroute environments. The system was constructed in three parts, an intersite analysis, a channel-assignment model, and a supporting data base. The overall program flow is illustrated in FIGURE 1.

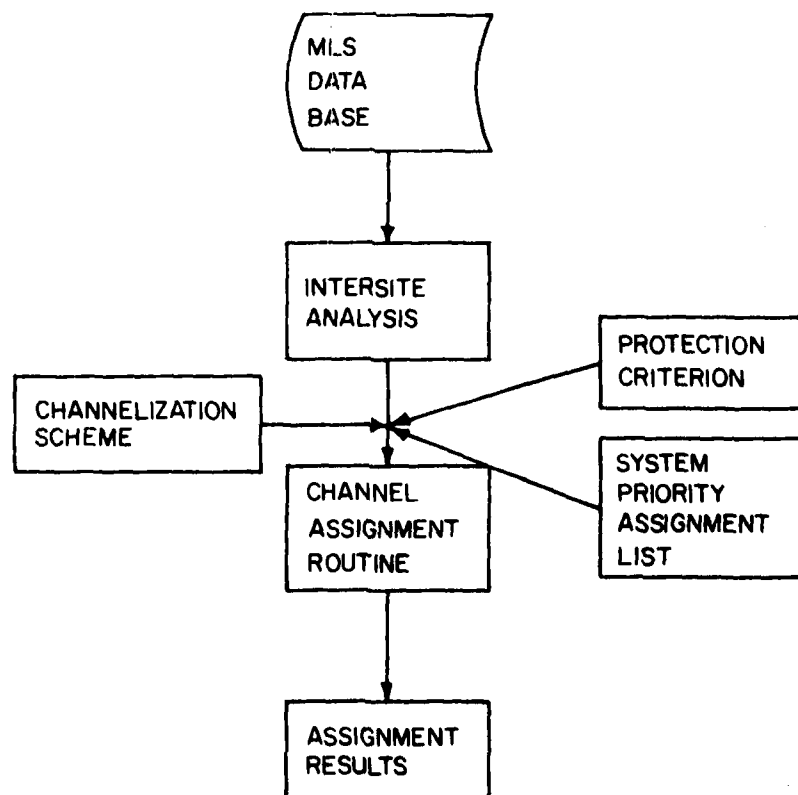


FIGURE 1. MLS CHANNEL ASSIGNMENT SYSTEM.

The system was designed so that the intersite routine and channel-assignment routine can be run independently. The results of the intersite analysis can be stored and reused for each assignment routine run. Hence it is generally not necessary to rerun the intersite analysis for each channel-assignment attempt.

A measure of the models usefulness during the MLS equipment development is its ability to accommodate various channelization schemes and assignment conditions that a user may wish to investigate. The flexibility to use varied schemes and conditions is accomplished through manipulating the model inputs (MLS data base, equipment protection criteria, channelization scheme, and equipment priority list) as well as selecting the use of several preprogrammed assignment options that control the internal assignment process. A discussion of the options and capabilities of the model that are available to the user is included in Section 3.

INTERSITE ANALYSIS

The intersite analysis routine examines the interference potential between two equipments and determines the minimum, i.e., worst-case, desired-to-undesired signal power ratio (D/U) at a receiver within the protected service volume of either equipment. The analysis is performed between equipments operating in the same frequency band.

The analysis has two parts, a distance culling procedure to identify those equipment pairs whose separation distance precludes interference, and a method for calculating the minimum D/U for the remaining equipment pairs. The intersite analysis program logic flow is shown in FIGURE 2.

Distance Cull

For each equipment pair, the model establishes two boundaries, a small circle defined by the victim service volume radius, and a larger circle representing the minimum distance separation for safe cochannel operation for the

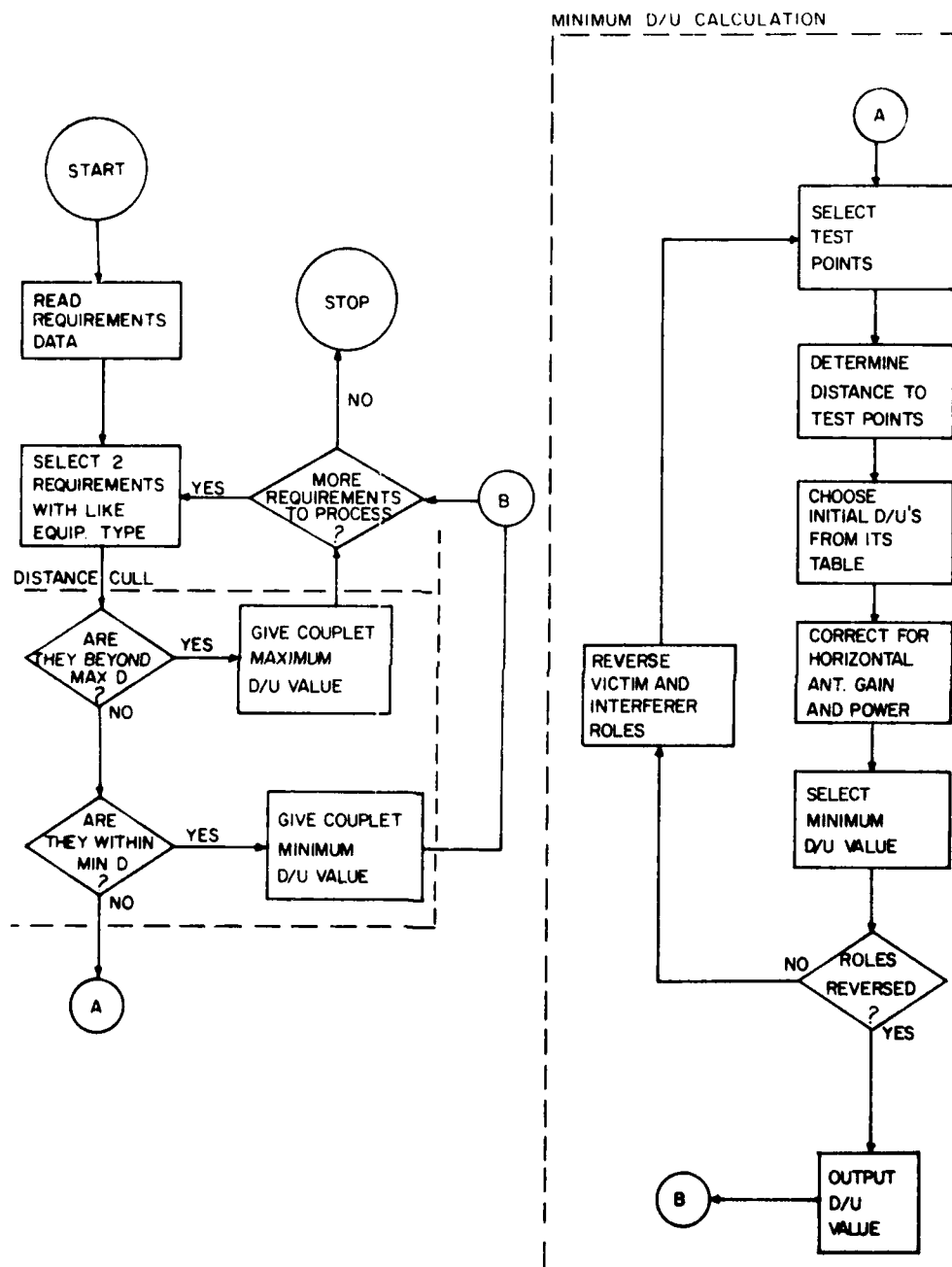


FIGURE 2. INTERSITE LOGIC FLOW.

two equipments (see FIGURE 3). An equipment pair separated by more than the cochannel distance boundary is assigned a cochannel D/U value. An equipment pair separated by less than the service volume distance boundary is assigned a worst-case D/U value, as defined by the protection criteria. The balance of the equipment pairs will require further analysis to determine the minimum D/U value, as shown in area B of FIGURE 3.

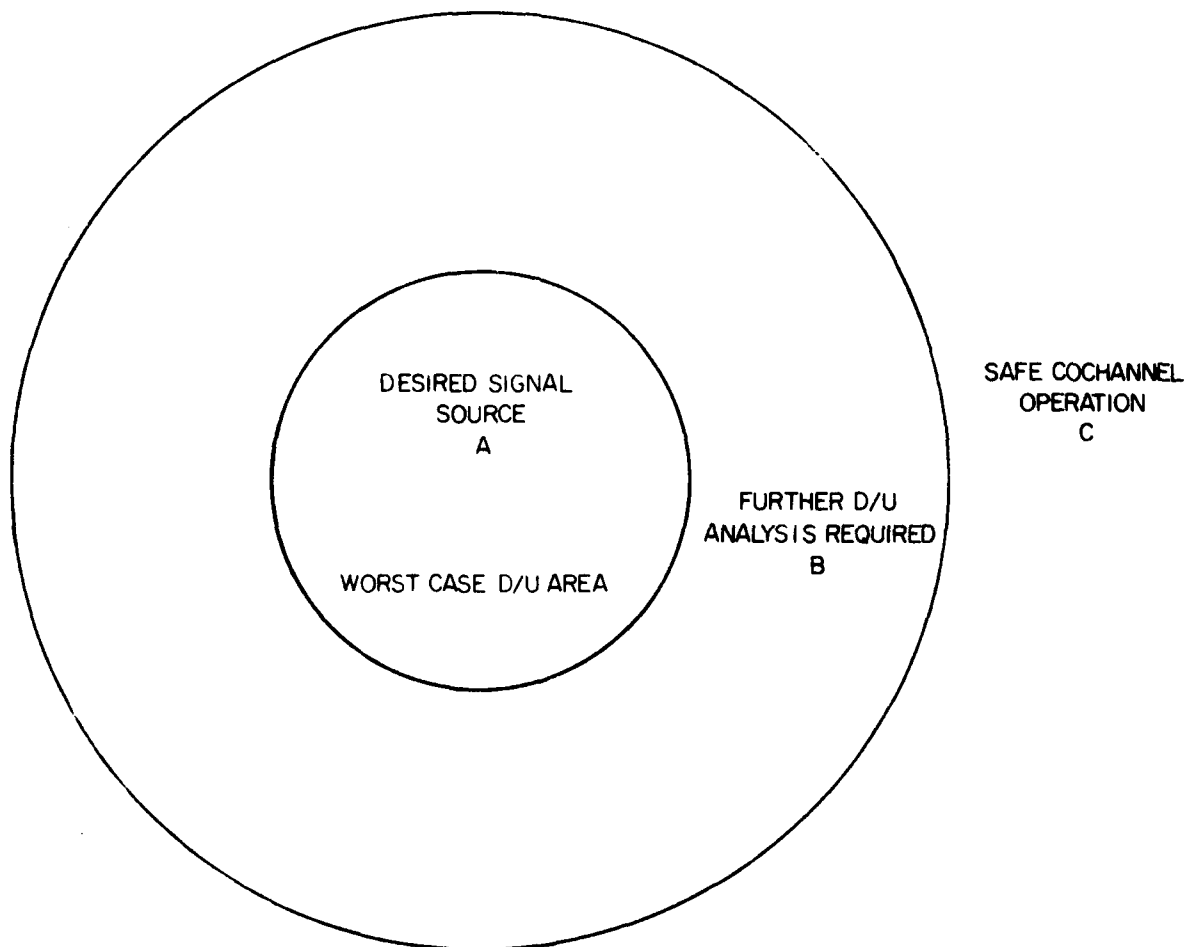


FIGURE 3. DISTANCE CULL BOUNDARIES

Minimum D/U Calculation

The minimum D/U is determined by calculating D/U ratios at critical test points (receiver locations) in the desired signal service volume and selecting the smallest value. The model is designed to analyze the circular service volumes associated with TACAN, VOR, conventional DME, and PDME equipments, as well as the various sector/circular service volumes associated with the ILS (Localizer and Glideslope) and MLS equipments. The location of the test points to be used was determined by an analysis described in APPENDIX A. In this analysis, it was shown that the minimum D/U value within the tailored service volumes associated with MLS and ILS equipment will occur at the maximum service volume range near one of three points. Those points, shown in FIGURE 4, are the corner points (B and D), and the intersection of the line connecting the desired and undesired equipments and the boundary of the desired equipments service volume, point (C).

The closest point may not have meaning when the non-circular tailored service volumes are used in the analysis. In a tailored service volume, if the undesired source is located within the angular limits of the desired service volume (case #1 in FIGURE 4), three points are selected, one at each corner of the service volume, and a third at the line connecting the desired and undesired source. When the undesired source is outside these angular limits, only the corner points are tested (case #2 in FIGURE 4). For circular service volumes, the angular limits are always considered to be $\pm 180^\circ$, making the undesired source always fall within the angular limits of the desired service volume. For that case, the model always uses the point on the line connecting the equipments, at the maximum service range.

The D/U calculation at each critical test point is performed by considering both the azimuth and elevation of the test point location with respect to the desired and undesired signal sources. A propagation model developed by ITS (Reference 4), which is based on a 95% time availability basis, has been integrated into this intersite analysis to calculate an initial D/U value for each test point based on the desired and undesired signal propagation losses and their vertical antenna gains in the direction of the victim receiver. These initial

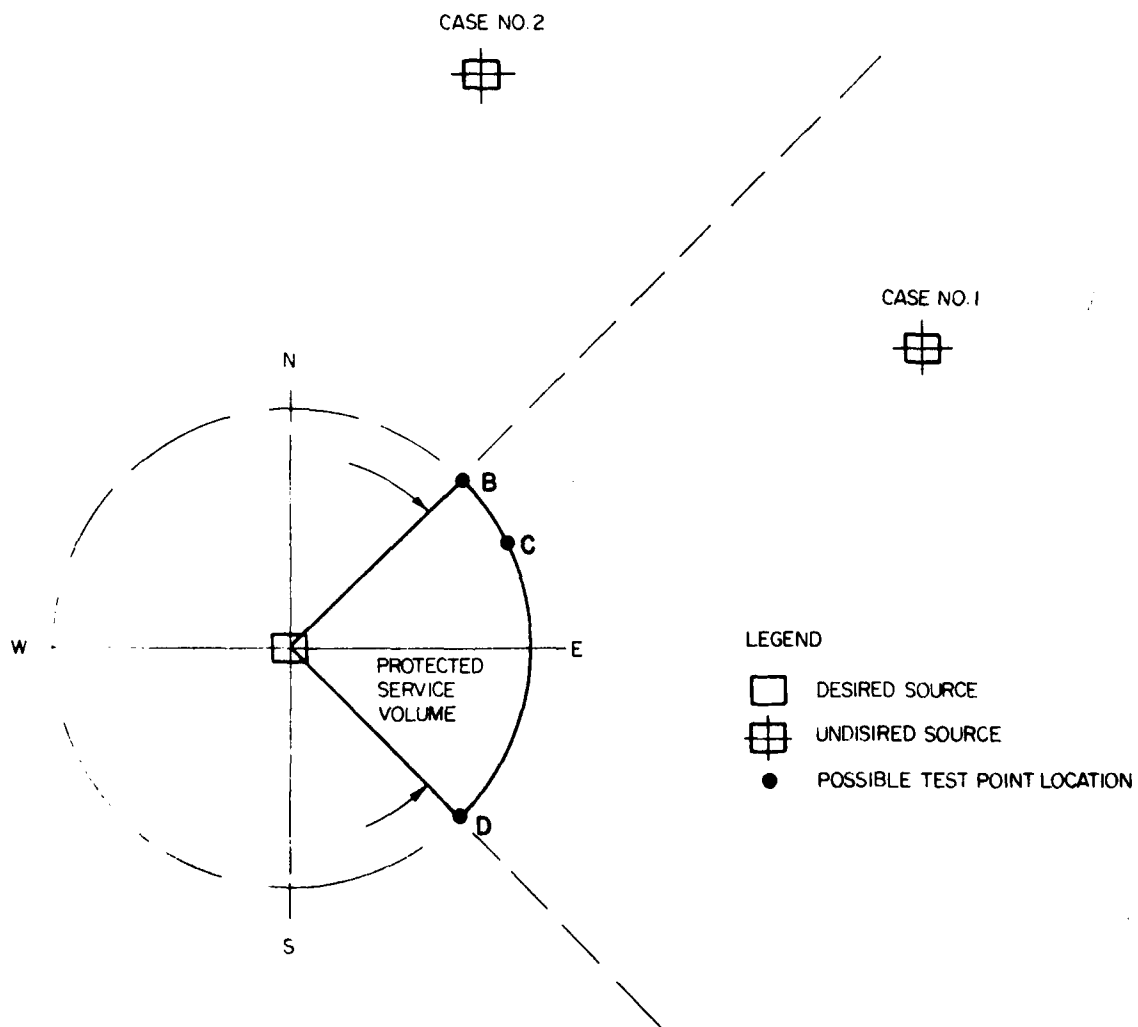


FIGURE 4. TEST POINT LOCATIONS IN A SECTOR SERVICE VOLUME.

D/U values are stored in a series of look-up tables prepared for each type of equipment. To obtain the final D/U values the initial D/U's are adjusted for transmitter power and horizontal antenna gain differences. The minimum D/U ratio is selected from this set of values.

The initial D/U ratio at each test point is determined by calculating the desired-to-undesired ground equipment separation distance^a, and interpolating from tabulated D/U curves prepared in advance. Every equipment service volume configuration (e.g., MLS, 20 nmi, and DME, 25 nmi, etc.) has a tabulated D/U curve to be used when that equipment undergoes analysis. FIGURE 5 shows the D/U curve prepared for an MLS 20 nmi service volume. Each curve has been constructed so that the D/U value at each site separation distance is the minimum that will occur at any altitude within the service volume limits.

The initial D/U values determined using the ITS curves are then adjusted by incorporating the difference between the desired and undesired signals, horizontal antenna gain in the direction of each test point, and the difference in transmitted power values between the desired and undesired signal sources, with the initial tabular D/U value.

The final D/U values calculated at the critical test points within the service volume of the desired source are then compared and the minimum D/U is stored. At this point, the model reverses the roles of the two equipments for the couplet being analyzed. The desired signal becomes the undesired signal and vice versa. The analysis is repeated using the same procedure described above, to calculate a second minimum D/U value. This second value is compared to the first value and the final minimum D/U is stored for use in the channel-assignment routine. The result is the smallest D/U value in the service volume of either equipment and its use assures the protection of both equipments.

The intersite analysis is performed for each individual equipment in an environment, with every other equipment in the same frequency band. At an

^aEquipment separation distance is the combination of the desired equipment-to-test point plus undesired equipment-to-test point distances.

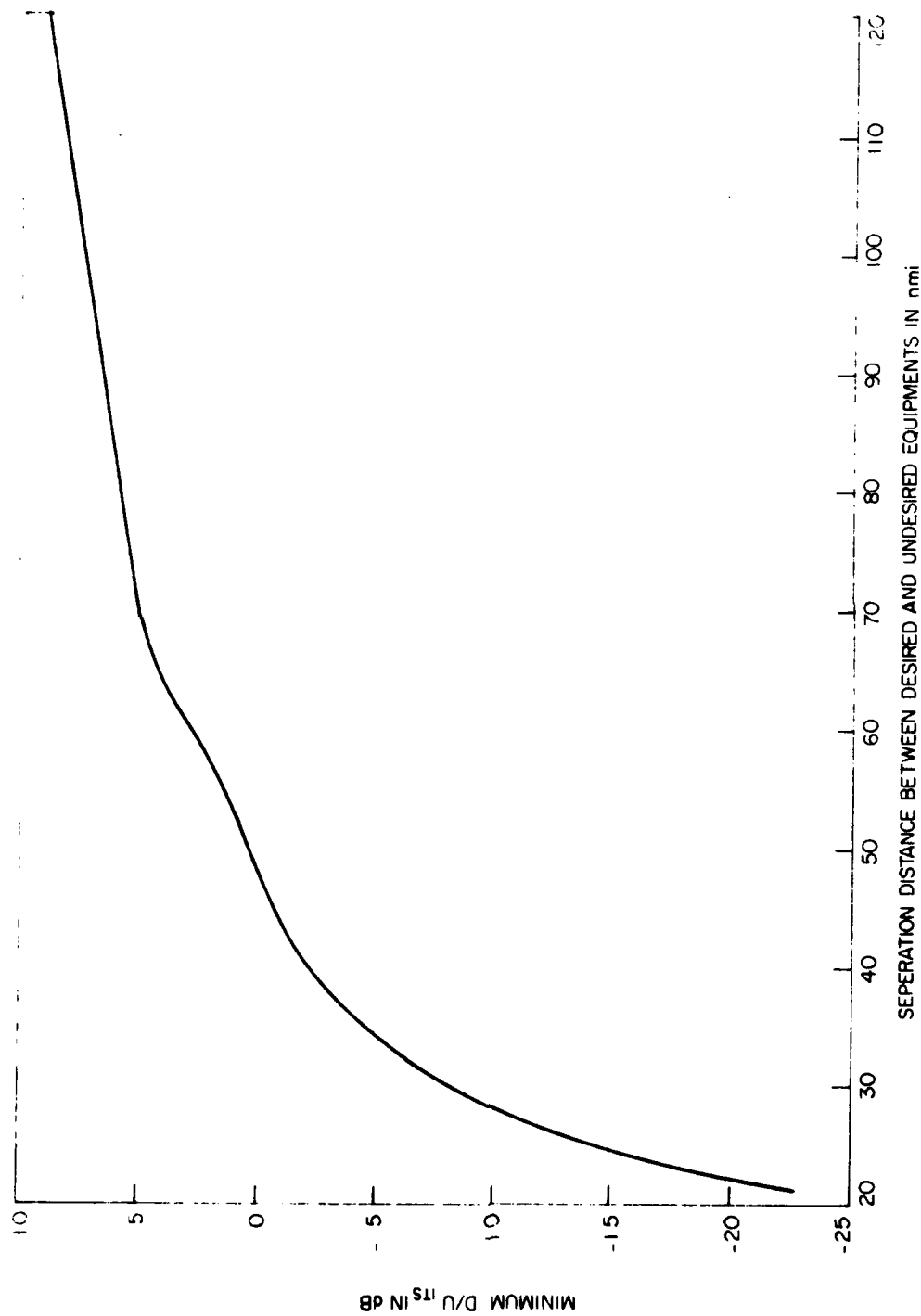


FIGURE 5. COMPOSITE D/U_{ITS} CURVES FOR 5,000, 10,000 AND 20,000 FEET ALTITUDE.

airport facility where several different equipments are operating and providing various services, there will be a set of minimum D/U values, one associated with each of the equipments.

CHANNEL ASSIGNMENT

The channel-assignment model examines the intersite constraints existing between the equipments in a working environment, and assigns channels providing the channel separation required by the protection criteria. The user specifies the inputs to the routine: 1) the channelization scheme; 2) the protection criteria; 3) the data base defining the equipment operational parameters; and 4) the method of determining the priority of equipment assignments.

In addition to specifying the above inputs the user may also select pre-programmed options: 1) alternate channel pairing schemes; 2) reassignment of existing equipment assignments to other channels, and; 3) a display of the percentage of channels denied to equipments that fail to be assigned. A description of the model options and capabilities is included in section 3.

The assignment routine will be discussed in two parts, the denied channel array construction, and the final assignment process. The program flow is illustrated in FIGURE 6.

Denied Channel Array

The denied channel array is constructed prior to the beginning of the assignment process. It shows the frequencies that are available to each system^a of equipments and does not initially reflect any of the intersite constraints between systems. This array is constructed in two steps: 1) listing the frequency resources available to each equipment type; and 2) entering a frequency resource list for each equipment into an array, according to the hard-pairing between equipments.

^aA system is a set of equipments providing landing guidance at a runway site, or navigational guidance at an enroute facility. Each equipment in the environment to be assigned is identified with a system.

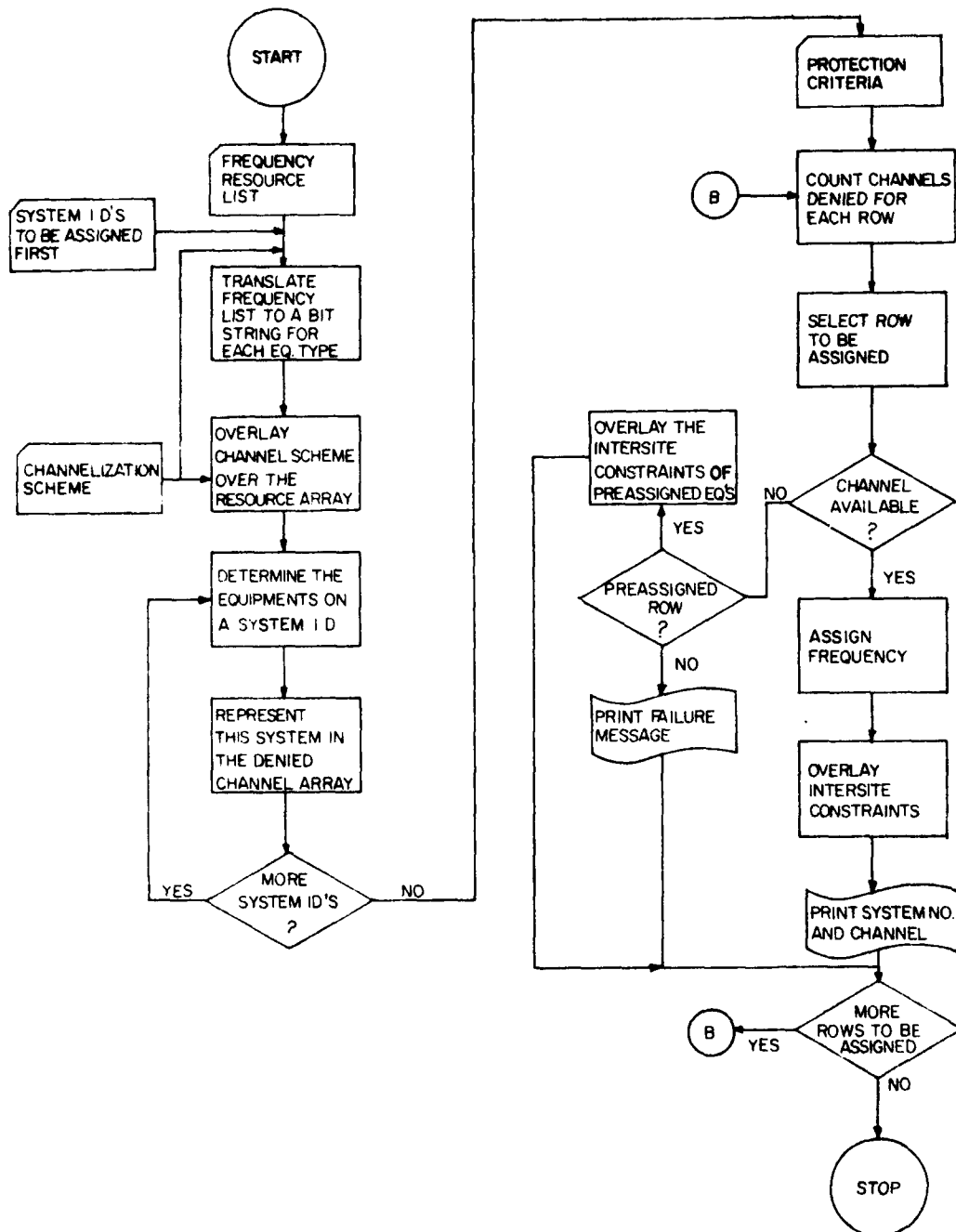


FIGURE 6. ASSIGNMENT ROUTINE LOGIC FLOW.

The first step is the creation of a frequency resource list for each equipment type to be considered in the assignment process. The channelization scheme defining the frequency resources available to each type of equipment is converted to a bit string, with "0's" indicating the available frequencies and "1's" indicating the denied frequencies. Step 1 of FIGURE 7 illustrates a frequency resource list constructed from the partial channel scheme listed.

The second step is to construct a denied channel array with columns representing frequency resources and rows representing the equipments to be assigned. Frequency resource lists for all equipments in a system are entered into the array according to equipment type and the required hard-pairing between equipments within each system. The model identifies the hard-paired equipments within a system and overlays their resource lists. Any frequency resource that is denied for one of the equipments results in the elimination of the corresponding resources on that channel for the entire hard-paired set. The result is an array showing the frequency resources available to each system of equipments.

Step 2 of FIGURE 7 illustrates the denied channel array row representing a hard-paired system of equipments composed of MLS, DME, ILS, and Glideslope. Four channels are available to their system: 18X, 18Y, 20X, and 20Y. In the event that no hard-pairing between equipments is desired, the denied channel array of FIGURE 7 would contain the four individual resource lists corresponding to the equipments that are listed, and no overlaying of these lists would occur.

When a system is preassigned (i.e., it is an existing system in the environment operating on a specific frequency), all channels except the preassigned one are denied to it. For example, if the system of FIGURE 7 were preassigned on channel 18X, all other channels would contain "1's" in the denied channel array shown. The user also has the optional capability to ignore the preassigned channel so that the system will be allowed assignment on any channel. Conversely, any system can be proposed for assignment on a specific channel by specifying for it a preassigned channel when the array is constructed.

Channel	MLS Angle	PDME	DME	VOR	ILS	Glideslope
17X			978	108.00		
17Y	5031.0	1,104	1,104	108.05		
17XZ	5031.3	978				
18X	5031.6	979	979		108.10	334.70
18Y	5031.9	1,105	1,105		108.15	334.55
18XZ	5032.2	979				
19X			980	108.20		
19Y	5032.5	1,106	1,106	108.25		
19XZ	5032.8	980				
20X	5033.1	981	981		108.30	334.10
20Y	5033.4	1,107	1,107		108.35	333.95
20XZ	5033.7	981				

Step 1

Frequency Resource List

	17	18	19	20
	X Y XZ	X Y XZ	X Y XZ	X Y XZ
MLS Angle	1 0 0	0 0 0	1 0 0	0 0 0
PDME	1 0 0	0 0 0	1 0 0	0 0 0
DME	0 0 1	0 0 1	0 0 1	0 0 1
VOR	0 0 1	1 1 1	0 0 1	1 1 1
ILS	1 1 1	0 0 1	1 1 1	0 0 1
Glideslope	1 1 1	0 0 1	1 1 1	0 0 1

Step 2

Denied Channel Array

	17	18	19	20
	X Y XZ	X Y XZ	X Y XZ	X Y XZ
MLS Angle DME ILS Glideslope	1 1 1	0 0 1	1 1 1	0 0 1

0 - channel available

1 - channel not available

FIGURE 7. DENIED CHANNEL ARRAY CONSTRUCTION.

Assignment

The assignment model uses the denied channel array to systematically assign each system in the environment to an available channel. After each successful assignment, the denied channel array is updated to reflect the intersite constraints between the most recently assigned system and all the remaining unassigned systems. The minimum D/U values between each system, calculated in the intersite analysis, have been translated into the channel separation required for safe operation as defined by the protection criteria listed in APPENDIX C. These channel separations determine the channel spacing required between systems when updating the denied channel array.

In normal operation, the model begins assigning systems by counting the frequency resources denied to each system (row) and first assigning those systems with the fewest remaining resources. As an option, the model may select the first system to be assigned from a list specified by the user. The row representing this first system to be assigned is searched for an available channel, and the first free channel is assigned^a. If no channel is available, the model prints a failure message and proceeds to the next assignment.

When an assignment is made, intersite constraints may be placed on some of the remaining unassigned systems. If necessary, the channel assigned, and some number of adjacent channels will be eliminated from the rows of potentially interfering systems. This process updates the denied channel array for the next assignment attempt.

FIGURE 8 illustrates the channel assignment process for three systems, beginning with the denied channel array. System one is assigned its first available channel, and the denied channel array is updated to reflect the channel separation required between the systems, as a result of this assignment. The process continues in the same manner, until assignment has been attempted for all systems.

^aThe sequence of channels as listed by the user represents an optional capability.

Begin - Denied Channel Array					
System	17 X Y XZ	18 X Y XZ	19 X Y XZ	20 X Y XZ	Protection Required
1. MLS Angle DME ILS Glideslope	1 1 1	0 0 1	1 1 1	0 0 1	1↔2 1 Channel 1↔3 1 channel 2↔3 2 channel
2. MLS Angle DME ILS	1 1 1	0 0 1	1 1 1	0 0 1	Assign System 1 Channel 18 X
3. MLS Angle PDME	1 0 0	0 0 0	1 0 0	0 0 0	
1ST - Updated Channel Array					
System	17 X Y XZ	18 X Y XZ	19 X Y XZ	20 X Y XZ	
2	1 1 1	1 0 1	1 1 1	0 0 1	Assign System 2 Channel 18 Y
5	1 0 0	1 0 0	1 0 0	0 0 0	
2ND - Updated Channel Array					
System	17 X Y XZ	18 X Y XZ	19 X Y XZ	20 X Y XZ	
5	1 0 0	1 1 1	1 0 0	0 0 0	7 Available Channels for Assignment

FIGURE 8. CHANNEL-ASSIGNMENT PROCESS.

It should be noted that for clarity purposes in this example, channels 17X, 17Y and 17XZ have been treated simplistically as adjacent channels. However, in reality this is dependent upon the channel plan definition. An examination of the channel plan defined in APPENDIX E reveals that the C-band frequencies contained in channels 17X, 17Y and 17XZ are adjacent frequencies, but that the L-band frequencies are not. L-band channels 17X and 18X contain adjacent frequencies. Therefore, when the denied channel array is updated by the channel assignment system to reflect the impact of a particular assignment on adjacent channels, each band is updated separately, and the results are combined (logical OR) to decide if a particular channel (paired set of frequencies) is available for future use.

Additional note should be made of the effect of using the APPENDIX E channel plan. Adjacent channel restrictions would usually affect separate L- and C-band channels, thus in some cases denying twice as many channel numbers as may be required for a more optimally defined plan.

A special situation arises when assigning systems containing preassigned equipments. In the assignment process, an existing preassigned system, hard-paired with a new MLS equipment, may be unable to use its existing "preassigned" channel because of intersite constraints placed on the MLS from prior assignments. In this case, a reassignment option is available to the user, and allows the assignment routine to search for any available channel to assign the entire system; planned plus existing. If this option fails, the hard-pairing requirement may be relaxed at the discretion of the user, thus allowing the planned MLS portion to be assigned separately from the existing equipment.

DATA BASE

The MLS data base consists of an individual data record for each equipment in the environment. Each equipment (subsystem) record contains a system identification number which links it with other equipments that form a system at the

same facility in the environment. A system is a set of equipments providing landing guidance at an airport, or navigational guidance at an enroute guidance site. An airport facility may contain many systems, associated with various runways.

A data record contains information for both the equipment, and the airport/enroute facility where its associated system is located. The equipment information includes the type and location, as well as the service and operational parameters. The facility information includes the identification, location, and service capability of the airport or enroute site.

A user wishing to create a new environment for use in the channel assignment model must provide the information needed to construct a data record for each individual equipment in that environment. Certain of the information contained on the data record is not crucial to the actual operation of the assignment model. The information that is necessary for the model operation and must be supplied, is identified by an asterisk in the description that follows. The information contained on each equipment record is as follows:

Equipment Data^a

1. Equipment Type* - Identifies the type of equipment contained on the record (e.g., TACAN, VOR, etc.).
2. Equipment Lat./Long.* (degrees, minutes, seconds) - Latitude and longitude of the equipment location.
3. Channel* - The designated channel of a preassigned L-band or VHF equipment.

^aAPPENDIX B defines equipment parameters and service options for each equipment type.

4. Frequency (MHz)* - The operating frequency of a preassigned L-band or VHF equipment.
5. Service Radius* (nmi) - The radius of the protected service volume.
6. Altitude (ft.)* - The maximum protected altitude within the service volume.
7. Service Volume* - Type of L-band or C-band service volume coverage (e.g., High, Low, Terminal, MLS Service Volume). This parameter should be specified when the service volume is of a standard type. The standard service volumes in use are listed in APPENDIX B.
8. Option* - Type of ILS service coverage. (Standard, Option 1, Option 2, Option 3). This parameter should be specified when a standard option, listed in APPENDIX B, is chosen.
9. Gain (dBi)* - Mainbeam antenna gain.
10. Power (kW)* - Effective power input to the antenna.
11. Antenna Pattern* - Type of vertical antenna pattern.
12. Height (ft.)* - Transmitter antenna height.

Facility Data

1. Airport/Enroute Facility Number* - This is the system identification number; it identifies the system, or group of equipments, providing guidance to a specific runway or enroute navigation site (i.e., all equipments associated with a runway/enroute site have the same facility number). Each equipment data record must have a facility number to insure that the equipments to be channel-paired at each site can be identified.
2. Location* - The city and state of an airport facility, or the state and location of an enroute site.
3. Airport Lat./Long. (degrees, minutes, seconds) - The latitude and longitude of airports (no entry for enroute facilities).
4. Bearing of Runway (degrees)* - The bearing of a runway associated with an airport facility.
5. Facility Call Number - Three alphanumeric characters identifying an airport facility or enroute site.

6. Airport Type - Categories designating the status and type of service for an airport facility.

New - not in existence

General Aviation - general air traffic

Air Carrier - all commercial aviation

V/STOL - special takeoff and landing facility

7. Tower Exist - Indicates whether a tower exists.

8. Runway Exist - Indicates whether a runway is in existence.

9. Frazier's Number - The number assigned to a system in the proposed environment developed in 1972.

10. Link Number* - A link number identifies those equipments which must operate on the same frequency. This situation arises when two like equipments are located at opposite ends of a runway, or on adjacent parallel runways, but do not operate simultaneously. By linking equipments, all guidance for a runway will be on the same frequency.

11. Runway length (ft.)

12. Runway Width (ft.)

SECTION 3

USER OPTIONS AND MODEL CAPABILITIES

GENERAL

The MLS Channel Assignment Model was constructed principally as a tool for evaluating the various channelization schemes proposed for the MLS angle guidance and range guidance equipments. In order for the model to handle a variety of channel plans, perhaps requiring special environmental assignment considerations, it was necessary to provide certain options that give the user sufficient flexibility to test particular ideas. User options are accomplished in two ways: (1) through the main inputs to the model and (2) by selecting internal system options that regulate the assignment process. By utilizing these options, the user may investigate assignment ideas in different airport environments, using various MLS characteristics and with specialized protection criteria. This section will describe these options and some example problems that can be investigated using this assignment model. The current use of this channel assignment model at ECAC is accomplished through the FAA Spectrum Support Office.

USER OPTIONS

The following is a description of the input options and model options available to the user.

Input Options

The main input options under user control are the equipment protection criteria, the channel plan, the data base including the environment description, and the assignment priority list. By controlling these key inputs, many options are available to the user.

Protection Criteria. The protection criteria places upper bounds on the undesired signal level (U) with respect to the desired signal level (D) that provide for interference-free operation of the potential victim equipment

within standard protected service volumes. Levels are specified as a D/U power ratio for cochannel and adjacent channel undesired signals. Different criteria are used in each frequency band as described in detail in APPENDIX C. The user has the option of specifying established protection criteria or updated criteria based on analytical or empirical results as equipment designs change.

The L-band protection criteria included in TABLE C-1 are consistent with current FAA frequency assignment methods found in the U.S. National Standard for the VORTAC System for X-mode channels. However, the planned use of multiple-modes for the MLS range guidance system and the planned revision of the national standard to consider the source/type of the undesired signal, have spawned the need for a more detailed specification of L-band protection criteria. In particular, the L-band protection matrix shown in TABLE 1 satisfies the structure needed to specify the required criteria. This matrix treats each combination of victim equipment and potentially interfering equipment on an individual basis, allowing the interference rejection advantage of the newer PDME equipments to be reflected in the assignment process. The user simply needs to provide the applicable inputs. As the MLS range guidance system matures or as older conventional TACAN/DME systems are deleted from the operational inventory, these criteria can be updated at the option of the user.

The C-band protection criteria included in TABLE C-2 were based on analytical work by ECAC and the Bendix Corporation, and substantiated by empirical testing at NAFEC. As with range guidance protection, these criteria are under user control and may be updated as the system matures.

The VHF and UHF protection criteria are contained in TABLES C-3 and C-4 respectively for the VOR, ILS Localizer and ILS Glideslope systems which are channel-paired to selected L-band frequencies as outlined in Section 1. The thresholds are planned for incorporation by the FAA into the revised national standard. Again, as with L- and C-bands, these criteria are under user control and can be updated as required.

TABLE 1
SAMPLE L-BAND PROTECTION MATRIX IN dB

Undesired Source Desired Source	TACAN		PDME ^b		DME (100W)		PDME ^b		TACAN		PDME	
	TACAN	DME	TACAN	DME	TACAN	DME	TACAN	DME	TACAN	DME	TACAN	DME
Cofrequency, Co-aperture	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8
Cofrequency Out-of-aperture	—	—	-50	—	—	—	-50	—	+8	+3	—	-50
First adjacent frequency, Co-aperture	-42	-46	-60	-29 ^a	-29 ^a	-29 ^a	-60	-29 ^a	-75	-25	-60	-60
First adjacent frequency, Out-of-aperture	—	—	-75	—	—	—	-75	—	-34	-34	-75	-75
Second adjacent frequency, Co-aperture	-50	-54	-75	-38	-38	-38	-75	-38	-34	-34	-75	-75
Second adjacent frequency, Out-of-aperture	—	—	-75	—	—	—	-75	—	-34	-34	-75	-75

^aFor an undesired IKW DME, these D/U become -39dB

^bIf PDME systems are assigned on conventional X or Y channels, the required protection criteria is the same as for conventional TACAN/DME equipment.

Channel Plan. The channelization scheme defines the frequencies that are available in each frequency band and identifies each set by a channel number. The MLS Channel Assignment System is capable of accepting channel plans with paired frequencies from four different bands for each channel number. A proposed channel plan is listed in APPENDIX E. Note that the L-band frequencies are in two sets, those available for conventional TACAN/DME equipment and those available for PDME equipment.

A channel plan may contain any number of channels with any subset of frequencies from the C-, L-, VHF-, and UHF-bands defined for each channel. The assignment model will accept any number of modes (pulse-pair spacings) within the L-band portion of the channel plan, and the channels may be listed in any order desired. TABLE 2 shows a sample channel plan containing 10 channels, each with paired frequencies from more than one band. Note some options available to the user in defining channels in the sample plan. Channel 18X contains frequencies from all four bands and allows MLS angle and range guidance, conventional TACAN/DME, and a complete IIS system to operate on that channel. However, channel 18B is an exclusive MLS channel for angle and range guidance only, and channel 19X is not available for MLS use but only for enroute VOR-DME facilities.

TABLE 3 shows this same plan with the channels listed in a different order. This ordering option gives the user the choice of defining a particular channel implementation sequence or "packing order". This determines the order in which the assignment model will search for an available channel during the dynamic assignment process. For a channel plan as listed in TABLE 3, the assignment model will search for an available channel starting with 18X for each assignment attempt and continue searching through 19X, 18Y, 19Y, etc., until an available channel is found or until the channel resources are exhausted. In this manner, successful facility channel assignments are "packed" on the left-most channels, thus saving those on the right for later implementation.

Data Base. The MLS Data Base contains the equipment operational parameter and facility information required by the assignment model when performing an assign-

TABLE 2
EXAMPLE CHANNEL PLAN

I	18X	18Y	18A	18B	18C	19X	19Y	19A	19B	19C
MLS	5031.60	5031.9	5032.2	5032.5	5032.8	--	5033.1	5033.4	5033.7	5034.0
PDME	979.0	1105.0	979.0	979.0	979.0	--	1106.0	980.0	980.0	980.0
TACAN/DME	979.0	1105.0	--	--	--	980.0	1106.0	--	--	--
ILS/VOR	108.1	108.15	--	--	--	108.2	108.2	--	--	--
Glideslope	334.7	334.55	--	--	--	--	--	--	--	--

TABLE 3
ALTERNATE PACKING ORDER

	18X	19X	18Y	19Y	18A	19A	18B	19B	18C	19C
MLS	5031.6	--	5031.9	5033.1	5032.1	5033.4	5032.5	5033.7	5032.8	5034.0
PDME	979.0	--	1105.0	1106.0	979.0	980.0	979.0	980.0	979.0	980.0
TACAN/DME	979.0	980.0	1105.0	1106.0	--	--	--	--	--	--
ILS/VOR	108.1	108.2	108.15	108.25	--	--	--	--	--	--
Glideslope	334.7	--	334.55	--	--	--	--	--	--	--

ment. Section 2 contains a listing of the information contained in the data base. This information is initially entered on data cards after which it is processed and organized onto record files containing all the required equipment data at a specific runway. FIGURE 9 shows the resulting compiled records for four ways in the Northeast United States.

Currently, there are three environments contained on MLS data base records. The first is a Southwest United States environment containing the existing and planned airport and enroute equipments in a four-state southwest region, including the Los Angeles basin. This environment was based on a predicted 1980 airport environment which included proposed new facilities as they were envisioned in 1972. A listing of this environment is contained in APPENDIX D. The second environment is a modification of the first made by deleting many of the proposed runways which were not built by 1980. The third environment consists of 20 states in the Northeast, East Central and Southeast United States region. All of these environments include high density airport regions that present conservative conditions from a channel assignment standpoint.

The MLS data base structure was intended to provide flexibility to the assignment model in that the key information needed for an assignment is contained in the data base record, which can be easily changed to suit a user's wishes. Equipment records can easily be added to or deleted from the data base through preprogrammed maintenance routines. In addition, records can be altered on an individual or environment-wide scale. This gives the user the capability of altering, for instance, the service volume coverage, transmitted power, antenna gain and radiation patterns of individual equipment records, or a specific type of equipment throughout the entire environment.

Equipment Assignment Priority. The normal operation of the channel assignment model uses a dynamic ordering technique to determine the order in which equipment will be assigned channels.

FACILITY LOCATION NUMBER STATE/CITY	FACILITY LATITUDE LONGITUDE	BEAR FAC CALL	AIRPORT TYPE	EXS AIR CARR	NO	YES	TOWER EXIST	FRAZIER NUMBER	LINK	RUNWAY LENGTH	RUNWAY WIDTH	AGENCY			
1 CT/BRIDGEPORT	41 09 49 N 073 07 35 W	110	80R	EXS	110	1000	10	1000	10	1000	10	FAA			
EQUIPMENT	LATITUDE	LONGITUDE	CHANNEL	FREQ	RAD	ALT	SERVICE	OPT	GAIN	POWER	PAT	HGT	1-1000	1-1000	1-1000
SMALL COMNTY	41 09 55 N	073 07 12 W	0	1000	20	2000	MLS	23.0	1.8	SM-CM	10	40	40	20.0	1.0
ILS-DME	41 09 30 N	073 07 44 W	44X	1005.000	25	12000	TERMIN	11.4	100.0	CARDIO	35	180	180	180	1.0
P-DME	41 09 30 N	073 07 44 W	0	1005.000	25	12000	TERMIN	8.5	50.0	POME	35	180	180	180	1.0
ILS 1	41 09 55 N	073 07 12 W	44X	111.700	10	4500	TERMIN	1	12.0	100.0	WILCOX	4	35	35	7.0
GLIDESLOPE-1	41 09 55 N	073 07 12 W	44X	330.300	10	1000	TERMIN	1	5.0	5.4	NULL	10	8	8	4.0
FACILITY LOCATION NUMBER STATE/CITY	FACILITY LATITUDE LONGITUDE	BEAR FAC CALL	AIRPORT TYPE	EXS AIR CARR	NO	YES	TOWER EXIST	FRAZIER NUMBER	LINK	RUNWAY LENGTH	RUNWAY WIDTH	AGENCY			
2 CT/BRIDGEPORT	41 09 49 N 073 07 35 W	290	80R	EXS	110	1000	10	1000	10	1000	10	FAA			
EQUIPMENT	LATITUDE	LONGITUDE	CHANNEL	FREQ	RAD	ALT	SERVICE	OPT	GAIN	POWER	PAT	HGT	1-1000	1-1000	1-1000
SMALL COMNTY	41 09 49 N	073 07 35 W	0	1000	20	2000	MLS	23.0	1.8	SM-CM	10	40	40	20.0	1.0
MARKER BECOM	41 09 49 N	073 07 35 W	0	75.000	25	12000	TERMIN	11.4	100.0	CARDIO	35	180	180	180	1.0
P-DME	41 09 49 N	073 07 35 W	0	1000	20	2000	TERMIN	8.5	50.0	POME	35	180	180	180	1.0
AVOR 2-A	41 09 49 N	073 07 35 W	0	1000	25	17000	TERMIN	2.2	50.0	COSINE	12	180	180	180	1.0
ILS 2	41 09 49 N	073 07 35 W	0	1000	17	6250	TERMIN	2	12.0	100.0	WILCOX	8	75	75	7.0
GLIDESLOPE-2	41 09 49 N	073 07 35 W	0	1000	10	1000	TERMIN	2	5.0	5.4	NULL	10	8	8	4.0
FACILITY LOCATION NUMBER STATE/CITY	FACILITY LATITUDE LONGITUDE	BEAR FAC CALL	AIRPORT TYPE	EXS GENERAL	YES	YES	TOWER EXIST	FRAZIER NUMBER	LINK	RUNWAY LENGTH	RUNWAY WIDTH	AGENCY			
3 CT/DANBURY	41 22 18 N 073 28 56 W	80	DXR	EXS	110	1000	10	1000	10	1000	10	FAA			
EQUIPMENT	LATITUDE	LONGITUDE	CHANNEL	FREQ	RAD	ALT	SERVICE	OPT	GAIN	POWER	PAT	HGT	1-1000	1-1000	1-1000
SMALL COMNTY	41 22 18 N	073 28 56 W	0	1000	20	2000	MLS	23.0	1.8	SM-CM	10	40	40	20.0	1.0
MARKER BECOM	41 22 18 N	073 28 56 W	0	75.000	25	12000	TERMIN	11.4	100.0	CARDIO	35	180	180	180	1.0
P-DME	41 22 18 N	073 28 56 W	0	1000	20	2000	TERMIN	8.5	50.0	POME	35	180	180	180	1.0
AVOR 2-A	41 22 18 N	073 28 56 W	0	1000	25	17000	TERMIN	2.2	50.0	COSINE	12	180	180	180	1.0
ILS 2	41 22 18 N	073 28 56 W	0	1000	17	6250	TERMIN	2	12.0	100.0	WILCOX	8	75	75	7.0
GLIDESLOPE-2	41 22 18 N	073 28 56 W	0	1000	10	1000	TERMIN	2	5.0	5.4	NULL	10	8	8	4.0
FACILITY LOCATION NUMBER STATE/CITY	FACILITY LATITUDE LONGITUDE	BEAR FAC CALL	AIRPORT TYPE	EXS GENERAL	YES	YES	TOWER EXIST	FRAZIER NUMBER	LINK	RUNWAY LENGTH	RUNWAY WIDTH	AGENCY			
4 CT/GROTON	41 19 47 N 072 02 49 W	50	GOM	EXS	110	1000	10	1000	10	1000	10	FAA			
EQUIPMENT	LATITUDE	LONGITUDE	CHANNEL	FREQ	RAD	ALT	SERVICE	OPT	GAIN	POWER	PAT	HGT	1-1000	1-1000	1-1000
SMALL COMNTY	41 20 16 N	072 02 14 W	0	1000	20	2000	MLS	23.0	1.8	SM-CM	10	40	40	20.0	1.0
ILS-DME	41 20 16 N	072 02 14 W	50X	1011.000	25	12000	TERMIN	11.4	100.0	CARDIO	35	180	180	180	1.0
P-DME	41 20 16 N	072 02 14 W	0	1011.000	25	12000	TERMIN	8.5	50.0	POME	35	180	180	180	1.0
ILS 1	41 20 16 N	072 02 14 W	50X	111.300	10	4500	TERMIN	2	12.0	100.0	WILCOX	8	35	35	7.0
GLIDESLOPE-1	41 20 16 N	072 02 14 W	50X	332.300	10	1000	TERMIN	2	5.0	5.4	NULL	10	8	8	4.0

FIGURE 9. DATA BASE RECORDS

This technique determines the equipment with the minimum number of available channels remaining in its list of channel resources, and attempts to assign that equipment next.

As an option, the assignment model is capable of accepting an assignment priority list specifying the order in which equipments will be assigned. Furthermore, the user may input an assignment order for only some of the equipments to be assigned; when this list is exhausted, the model will revert back to the dynamic technique for the remaining assignments.

The advantage of inputting a specific assignment order is that the user can simulate the actual order that equipment may be implemented. He may wish to place highest priority on the large metropolitan airports that require the newest equipment to meet their needs, and lower priority on the smaller, less congested facilities.

Model Options

The main model options under user control are frequency pairing options, reassignment options involving preassigned ILS and DME equipment, and the option to display certain diagnostic information regarding the most likely cause of an assignment failure at a particular facility.

Pairing Options. The MLS channel assignment model has the capability of "hard pairing" equipment assignments in different frequency bands. Hard pairing requires that the guidance equipment associated with a specific runway must all operate on the same channel even though they may be in different frequency bands. This requirement makes channel selection at runway interdependent between the various equipments; if one equipment cannot be assigned on a given channel, the remaining paired equipments cannot be assigned. The following degrees of pairing are available as an option to the user:

1. total pairing of all the equipments at a runway site, i.e., hard pairing of equipments in all four bands.

2. no pairing between frequency bands, allowing all equipments to be assigned independently of equipments in other bands.

3. pairing of various combinations of equipments, for instance pairing of MLS C-band equipments with PDME at a runway site. Any combination of equipments can be paired in this manner.

Reassignment Option. Any existing or proposed airport environment developed to exercise the channel assignment model will contain a significant number of existing equipments (i.e., ILS) operating on preassigned channels. In the assignment process, these equipments are automatically assigned to their present operating channel. However, if new MLS or PDME equipments are hard paired to the existing equipment at the same runway, the existing preassigned channel may not provide the necessary interference protection for the new equipment in a congested environment. When this occurs, the entire hard-paired set of equipments will fail, including the existing preassigned equipment. The model declares that channel (i.e., hard-paired set of frequencies) to be not available at that site. The channel assignment system then provides two options to the user:

1. When a preassigned set of equipments fails to retain its existing channel, the entire set may be reassigned to any open channel, providing that channel contains a sufficient set of frequencies, or

2. Carrying the above option one step further, if the entire set of equipments at a particular runway cannot be placed on an open channel, the paired set of equipments can be broken and the proposed MLS and PDME equipments may be assigned to any open channel while the preassigned ILS Localizer and Glideslope will be placed each on their original channel.

Display the Most Constrained Equipment. When a paired set of equipments at a runway fails to be assigned a channel, it is desirable to know which equipment was most likely to have caused the failure. The channel assignment system has the capability of listing the percentage of the channels that are denied to each equipment in the paired set to show exactly which equipment

was the most constrained at the time of failure. This capability is intended as a diagnostic aid in determining those aspects of a channelization scheme that may be unworkable or most constraining.

SECTION 4

RESULTS

A channel-assignment model was constructed that is capable of performing an intersite analysis between interfering equipments in a user-input environment and assigning channels based on user designated intersite protection requirements and channelization scheme. A trial assignment was made for the Southwest U.S. airport environment listed in APPENDIX D.

The results of the first MLS trial assignment are summarized in TABLE 4. APPENDIX D contains a listing of the specific channels assigned to each system in the environment.

TABLE 4
TRIAL ASSIGNMENT SUMMARY

MLS Requirements		Successful Assignments	
Preassigned ^a	103	60	(58%)
New Assignments	252	237	(94%)
Total	355	297	(84%)

^a"Preassigned" refers to new MLS systems which are frequency-paired to existing ILS-DME systems at the same runway. Therefore, their frequencies are pre-determined.

It should be noted that in attempting to assign a C-band frequency to a "pre-assigned" MLS requirement, if the assignment failed for the existing channel, no alternatives were attempted (i.e., existing assignments were not changed in this first trial assignment).

The following is a summary of the most significant qualifications that should be used to place this initial trial in the proper context:

1. It was assumed that the PDME interrogator receiver would operate in the "narrowband" mode outside a radius of 5 nmi. This assumption resulted in an optimistic L-band assignment. If, as currently planned, this receiver operates "wideband" all the time, a more stringent assignment criterion will need to be applied and a greater rate of assignment failure will result.

2. Only one test environment, the Southwest U.S., was used to exercise the assignment model. It is expected that upon exercising the Northeast U.S. environment, a higher rate of assignment failure will occur. This is anticipated due to the greater numbers (4X) of preassigned ILS facilities and a greater density of enroute TACAN and VOR facilities in that area.

3. The channel plan used to exercise this particular trial channel assignment contains rigid frequency-pairing requirements throughout the C, L, VHF, and UHF bands. Other channelization schemes may contain selective frequency-pairing options that could result in a higher rate of assignment success.

4. Consistent with traditional L-band channel assignment techniques, potential ground-to-ground interactions between Y-mode DME's and X/XZ mode DME's were not considered in this trial assignment.

5. The protection criteria necessary for wideband PDME transponder operations have not yet been determined nor applied in this model.

6. Refinements in the protection criteria being established by the revised (draft) VORTAC National Standard had not been incorporated into the model at the time of its initial exercise. These refinements could result in a greater rate of assignment failure for all types of L-band equipments with the exception of TACAN-to-TACAN interactions.

7. The present protection of the MLS angle-guidance 3° (small community) system is considered to be conservative. The protected service volume was extended from $\pm 10^\circ$ to $\pm 40^\circ$ in azimuth to afford protection for the fly-left/fly-right pulses. Refinement of this technique may result in a greater number of successful C-band assignments.

8. Experimentally determined C-band and L-band protection criteria will eventually replace the analytically determined values of APPENDIX C. This may alter the assignment results.

9. Propagation predictions for calculating D/U values were based on smooth-earth terrain. That is, terrain shielding effects were not considered. This represents a "worst case" propagation prediction.

10. The equipment operational parameters (power levels, antenna gains) and antenna patterns listed in the MLS data base were chosen to represent a conservative but realistic working environment. The actual working environment may contain a wider range of values than was exercised in this assignment.

APPENDIX A

ANALYSIS APPROACH FOR DETERMINING MINIMUM D/U VALUES

The MLS intersite analysis examines the interference potential between two equipments and determines the minimum, i.e., worst-case, desired-to-undesired signal power ratio, D/U, within the service volume of either equipment. Because of the tailored service volumes and directional antennas associated with MLS and ILS equipments, a more rigorous analysis technique is required to find the minimum D/U than has been developed for circular service volumes. The approach used is to calculate the D/U at predetermined test points/locations within the service volumes, and then choose the smallest value. The accuracy of this method depends on choosing the correct test points for consideration.

The following equation was used to calculate the desired-to-undesired signal power ratio (D/U) at a victim receiver:

$$\begin{aligned} D/U = & [G_D - VG_D - HG_D + EIRP_D - PL_D] \\ & - [G_U - VG_U - HG_U + EIRP_U - PL_U] \end{aligned} \quad (A-1)$$

where

D/U = desired-to-undesired power ratio, in dB

G = mainbeam antenna gain of the desired (D) or undesired (U) equipments, in dBi

VG, HG = the normalized vertical and horizontal antenna gains (desired or undesired) in the direction of the victim receiver, in dBi

EIRP = equivalent isotropically radiated power, in dBW

PL = propagation loss of a signal (desired or undesired) at the victim receiver, in dB.

The location of the minimum D/U value, in both azimuth and elevation, will depend upon the variation of both signals throughout the protected service volume (FIGURE A-1). From Equation A-1, it can be seen that the two main factors affecting those signal levels are propagation loss and antenna gain. Two simplifying assumptions were drawn from preliminary analysis of these variables: 1) when an undesired equipment is located outside the radius of the protected service volume, the minimum D/U location will occur at the farthest range (on the arc) of the service volume, near specific points on the arc; 2) when an undesired equipment is located within a service volume radius of the desired equipment, a conservative minimum D/U value is ensured by using the worst possible D/U value that could occur between those equipments.

The first assumption is based on the calculation of D/U values in the MLS service volume for many positions of the interfering equipments around the service volume. A subset of these D/U calculations is shown for interfering equipments positioned as in FIGURE A-2. The D/U value was calculated at eleven points on the MLS service volume. The azimuth scan beam antenna pattern of FIGURE A-3 was used for the desired signal horizontal antenna pattern, and the DPSK (Ident) pattern of FIGURE A-4 was used as the undesired signal horizontal antenna pattern. The resulting D/U values are documented in TABLE A-1. It can be seen that the minimum D/U value occurs on the service volume arc. In addition, the minimum value occurs near the corner points (1 and 9), or near the closest point to the undesired equipment, when that equipment is positioned within the angular limits of the desired service volume coverage.

To verify that these locations will yield a minimum D/U value for various equipment orientations, a second subset of calculations was performed with the same equipments oriented as shown in FIGURE A-5. The results of these calculations are shown in TABLE A-2. Again, the minimum D/U value occurs on the service volume arc, at either the corner points or the nearest point to the undesired equipment.

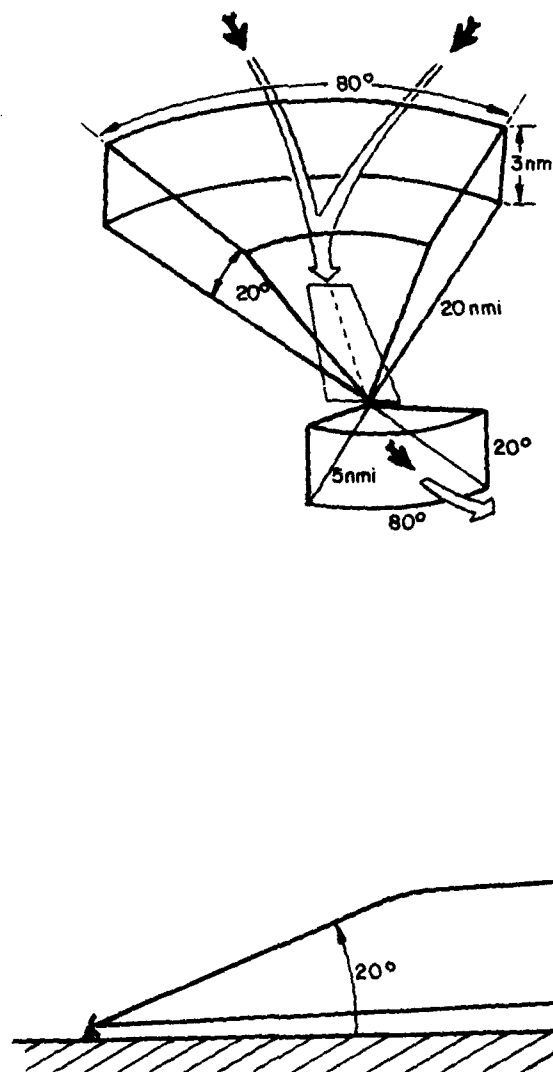


FIGURE A-1. MLS SERVICE COVERAGE.

⁶ICAO Submission by FAA, *Time Reference Scanning Beam Microwave Landing System*, DOT/FAA, December 1970.

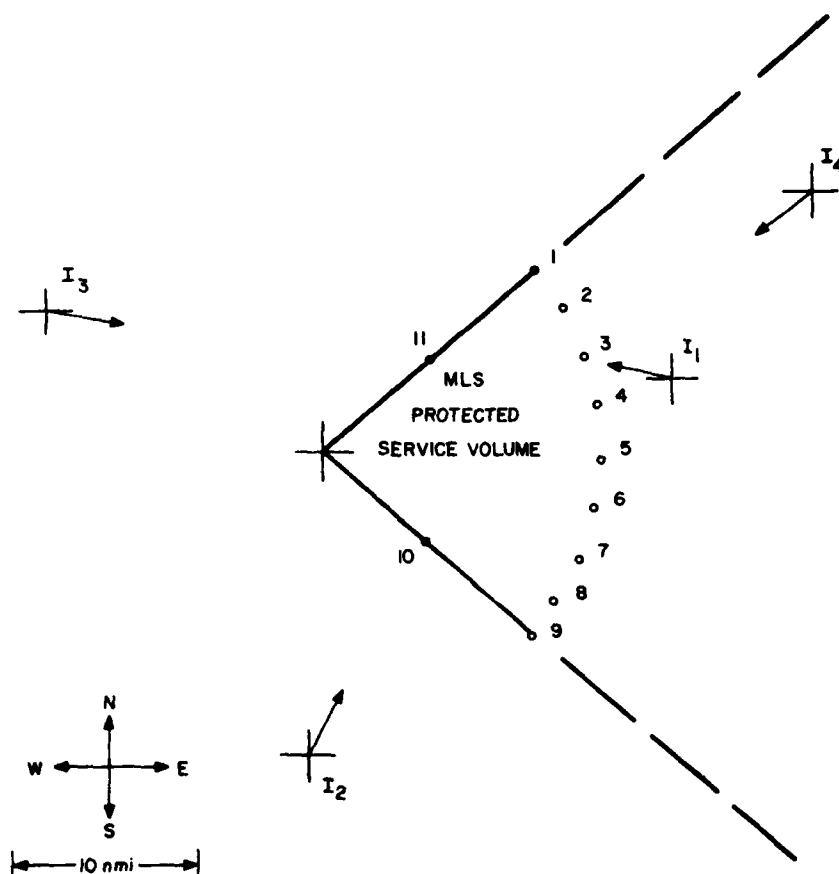


FIGURE A-2. TEST POINT LOCATIONS ON AN MLS SERVICE VOLUME.

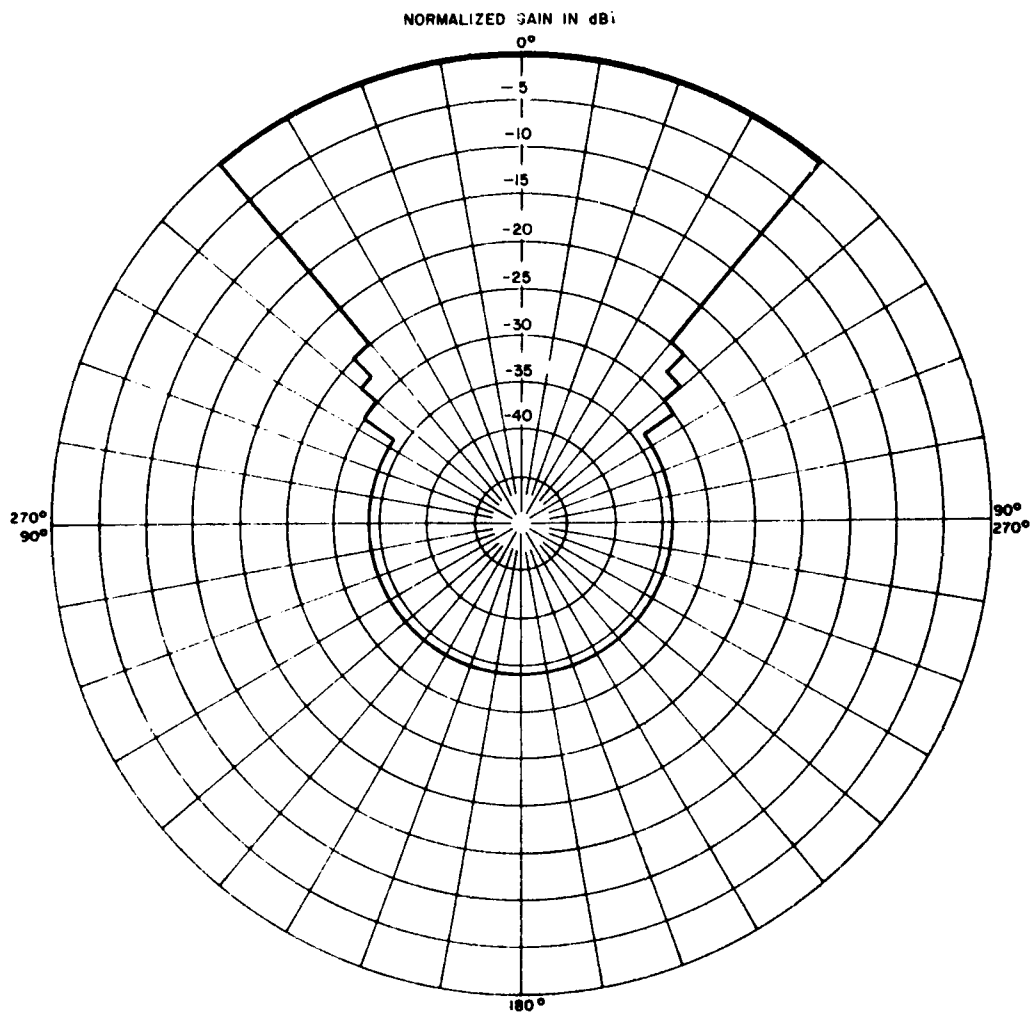


FIGURE A-3. AZIMUTH SCAN BEAM HORIZONTAL ANTENNA PATTERN.

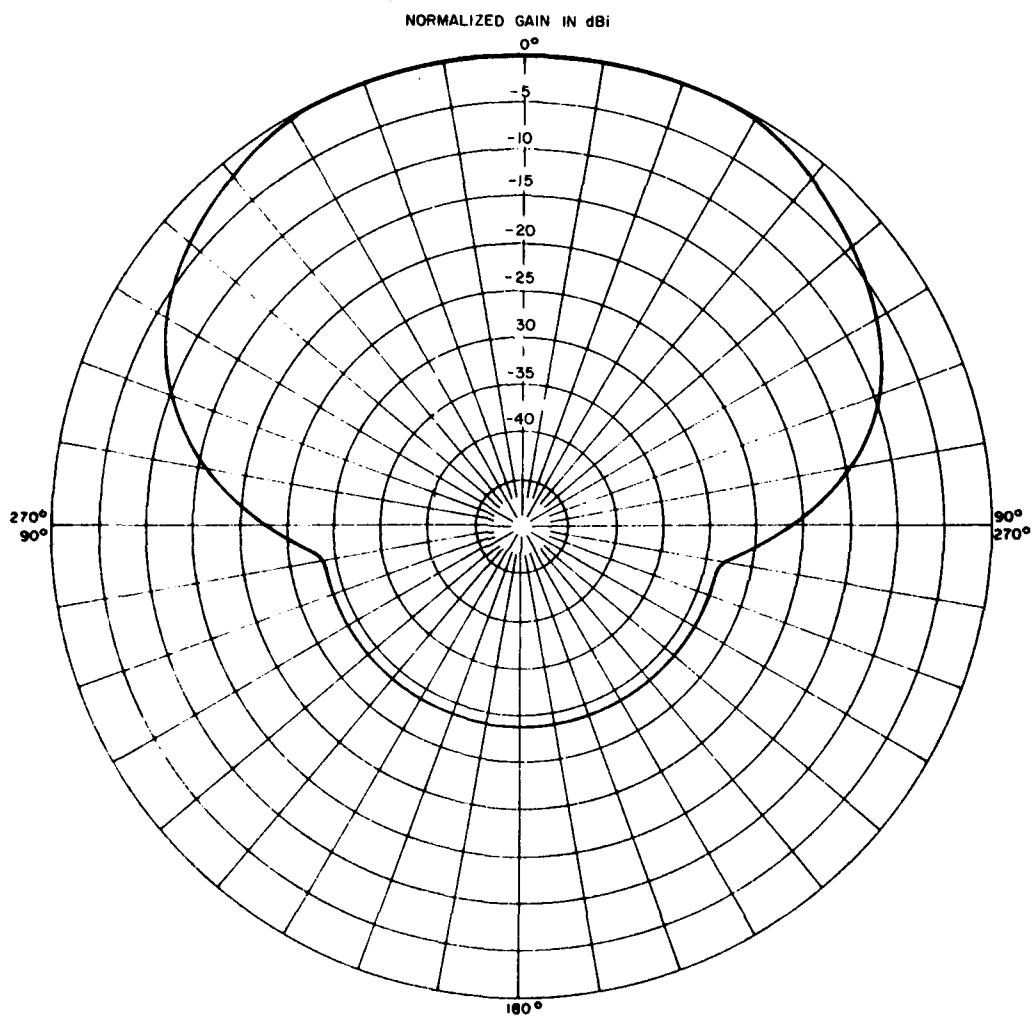


FIGURE A-4. IDENT HORIZONTAL ANTENNA PATTERN.

TABLE A-1
CALCULATED D/U VALUES

D/U e (dB)	Interferer			
	I ₁	I ₂	I ₃	I ₄
1	28.5	10.0	34.5	32.0
2	19.8	12.0	31.0	31.5
3	6.5	14.5	28.5	32.0
4	-5.8	17.0	26.0	32.0
5	-7.0	20.5	23.5	33.0
6	-4.2	24.5	20.5	33.5
7	-0.5	27.5	18.5	34.5
8	-1.5	28.5	16.5	35.0
9	-3.0	31.5	14.5	36.0
10	9.2	15.9	19.0	38.3
11	13.7	18.1	24.5	35.7

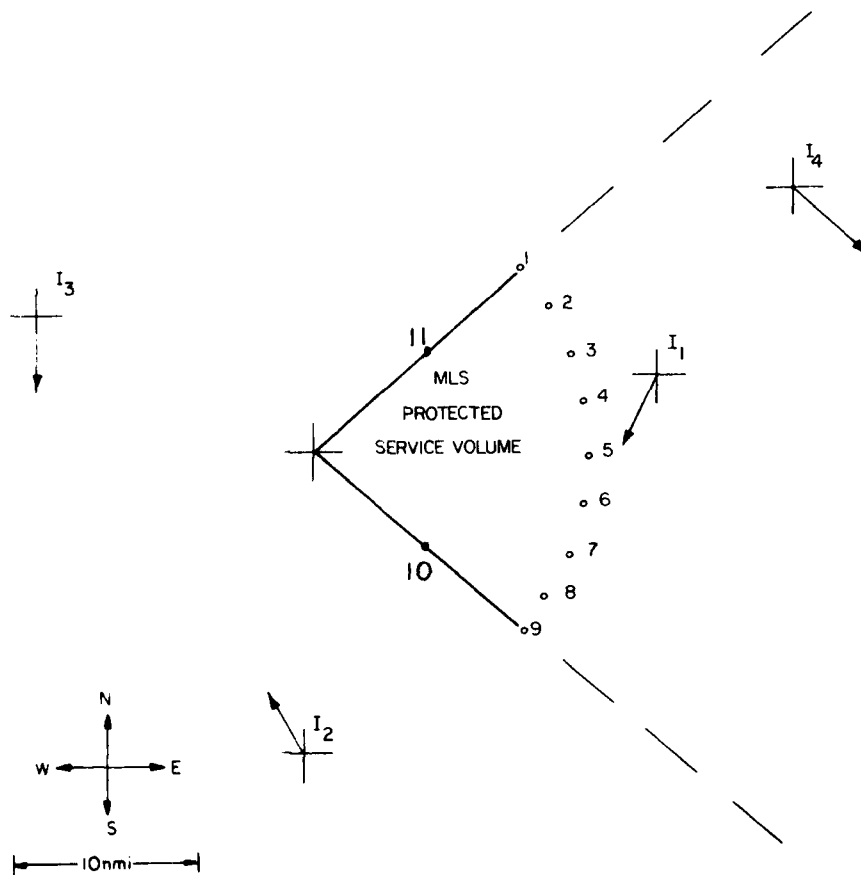


FIGURE A-5. ALTERNATE INTERFERING ORIENTATIONS.

TABLE A-2
CALCULATED D/U VALUES

D/U (dB)	Interferer			
	I ₁	I ₂	I ₃	I ₄
1	-0.5	7.8	6.5	3.0
2	-5.2	7.8	7.0	2.5
3	-7.5	6.5	7.5	3.0
4	-8.8	6.0	8.0	3.0
5	1.0	5.5	8.5	4.0
6	7.8	5.0	8.5	4.5
7	14.5	4.5	8.5	5.5
8	16.5	3.5	8.5	6.0
9	18.0	2.0	8.5	7.0
10	13.2	7.9	12.0	13.3
11	6.9	12.1	12.5	11.7

The approach used to calculate these D/U values takes into account the vertical as well as the horizontal antenna variations and propagation loss. This is done using a propagation model developed by the Institute for Telecommunication Sciences (ITS) (Reference 4). This model calculates a D/U value versus equipment separation distance^a on a 95% time availability basis, based on the propagation losses and normalized vertical antenna gains of the desired and undesired signals in the direction of the victim receiver. This D/U does not account for differences in the equipment power or the normalized horizontal antenna gains. The overall D/U value is determined by correcting the ITS-calculated D/U (D/U_{ITS}) for the differences in transmitter power and horizontal antenna gains of the desired and undesired signals. Rewriting Equation A-1 in terms of the D/U_{ITS} :

$$D/U = (G_D - HG_D + EIRP_D) - (G_U - HG_U + EIRP_U) + D/U_{ITS} \quad (A-2)$$

where

D/U_{ITS} = the ratio of desired to undesired signal propagation loss and vertical antenna gains, for a fixed desired-to-undesired separation distance and victim receiver altitude, in dB.

$$D/U_{ITS} = VG_U + PL_U - VG_D - PL_D$$

It can be seen that the D/U_{ITS} contains those variables, i.e., propagation loss and normalized vertical antenna gain, that vary with respect to the altitude of the victim receiver. To ensure that the overall D/U value is minimized with respect to altitude, the D/U_{ITS} is calculated at the worst-case altitude, for each value of separation distance, and these values are stored in look-up tables for use later in calculating the overall D/U.

^aThe separation distance is the ground distance from the undesired equipment to the victim receiver, plus the ground distance from the victim receiver to the desired equipment.

The process of creating these D/U_{ITS} look-up tables is based on producing a series of D/U_{ITS} curves for several altitudes within the limits of the victim's service volume, and combining these curves by taking the minimum value at each increment of separation distance.

FIGURE A-6 shows a series of D/U_{ITS} curves for a victim receiver at 20 nmi from the desired equipment and at various altitudes. It can be seen that the minimum D/U_{ITS} will occur at higher altitudes for increasing values of separation distance. By combining these curves, taking the minimum D/U for each value of separation distance, it is possible to produce a single curve that minimizes both the propagation loss and vertical antenna gain ratios for the desired and undesired signals (FIGURE A-7). Using this curve, in a tabulated form, the intersite model obtains a D/U_{ITS} value that reflects the minimized propagation losses and vertical antenna gains by calculating the separation distance through a point on the service volume arc, and obtaining the corresponding D/U_{ITS} value from the proper look-up table.

The second assumption is based on the premise that, by assuming that the worst-case interference will occur when an undesired equipment is located within the circle inscribed by the victim's service volume radius, a conservative minimum D/U value will be used for all those equipments. This worst-case interference is defined by the equipment protection criteria (Appendix C) as the lowest possible D/U value that can occur between interfering equipments. The considerations in determining this worst-case value are described in Reference 9 of Appendix C.

The overall intersite analysis approach developed as the complexity of the task involved. It was necessary to use an analysis that could universally handle all the service volumes and antenna patterns used in the assignment system, and be implemented in a reasonable time period. As the total assignment system is exercised, it may become apparent that the conservative approach used within the service volume radius restricts the assignment of equipments. Refinement of the intersite model to produce correct results for interfering equipments within the

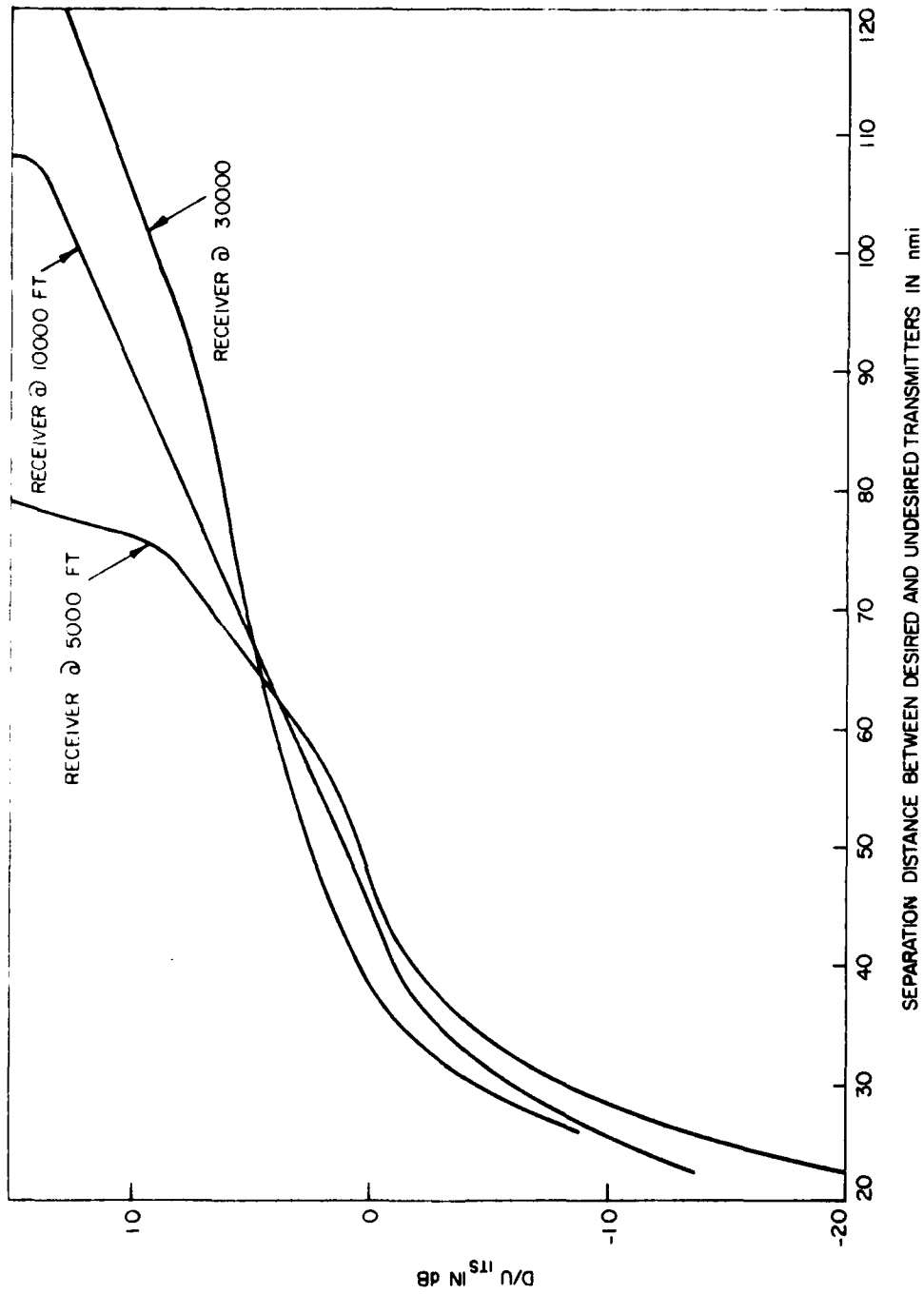


FIGURE A-6. D/U_{ITS} PLOTS AT VARIOUS RECEIVER ALTITUDES.

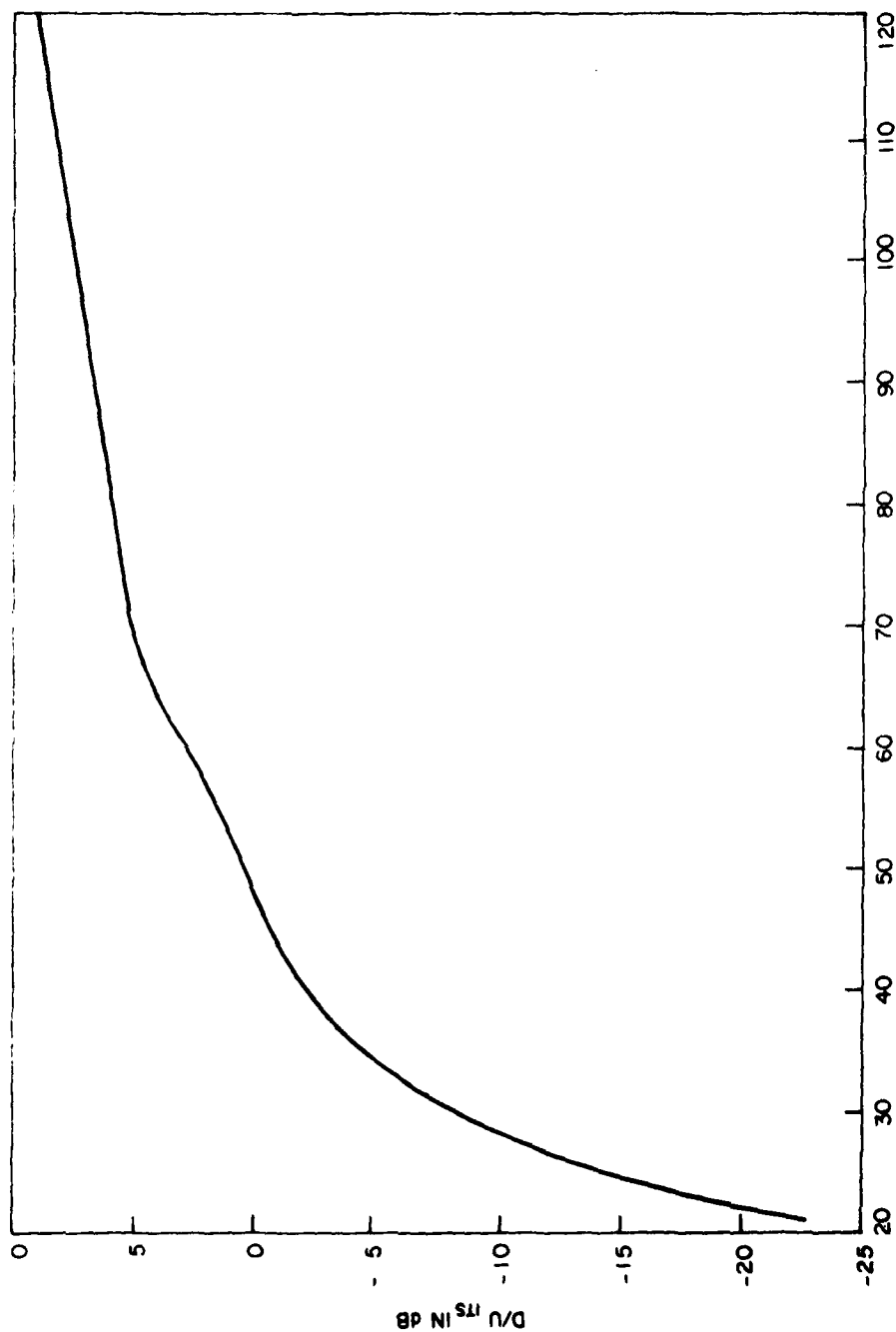


FIGURE A-7. COMPOSITE D/U_{ITS} CURVE FOR 5,000, 10,000, 20,000 FEET ALTITUDES

victim service volume radius would involve calculating D/U values at a greater number of points. The scheme would be similar to that shown in FIGURE A-8. For the interfering equipment (I) shown, a D/U calculation would be made at several points, A-G, along the service volume radius, in addition to the points used on the arc. The number of additional calculations necessary would depend on the directionality of the horizontal antenna pattern of the interfering equipment.

In its present form, the intersite routine contains the necessary capability to accommodate a variety of refinements. As it becomes clear that additional capabilities would be beneficial, the routine can be altered.

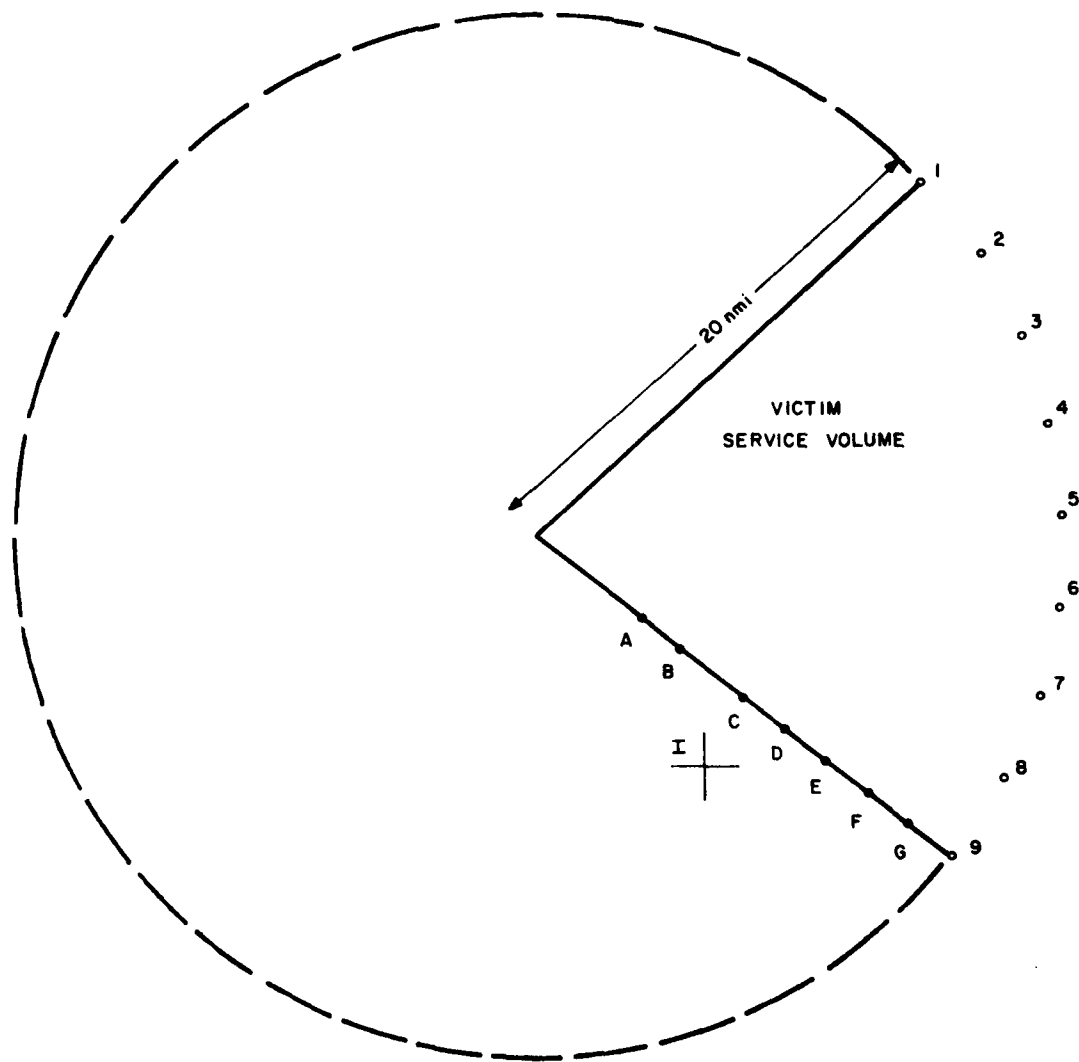


FIGURE A-8. REFINED INTERSITE ANALYSIS.

APPENDIX B
SYSTEM DESCRIPTIONS

This appendix contains a description of the Microwave Landing System (MLS) angle-guidance functions and associated Precision Distance Measuring Equipment. A section is included summarizing the functions, service options, and system parameters to be used for each equipment in the assignment model.

MLS ANGLE GUIDANCE

Angle Guidance (Reference 6)

The TRSB signal format is based on the TO-FRO scanning beam technique, in which narrow fan beams scan through the coverage volume in alternate directions. The beams are scanned at high speed and consist of a single, unmodulated, continuous radio frequency transmission. The scanning speed is uniform, starting from one extremity of the coverage sector and moving to the other and then back again to the starting point, thus producing a TO-FRO scan as shown in FIGURE B-1 for azimuth. The azimuth beam scans first counterclockwise and then clockwise, as viewed from above. The elevation beam scans first down and then up. In every scanning cycle, two pulses are received by the aircraft. The time interval between the TO and FRO pulses is proportional to the angular position of the aircraft with respect to the runway centerline. An important feature of the time reference encoded scanning beam system is the high data update rate, 13.5 Hz for azimuth and 40.5 Hz for elevation. These data rates make it possible to design simple airborne processors that can minimize multipath effects on guidance signals.

All angle and data functions are time-multiplexed on the assigned radio frequency so that a single receiver-processor channel may process all data. Since each function is an independent entity in the time-multiplexed function sequence, the receiver may decode functions in any sequence. This is accomplished by providing each function with a preamble that, upon reception, sets the receiver for the function which follows. The function identification preamble is radiated on

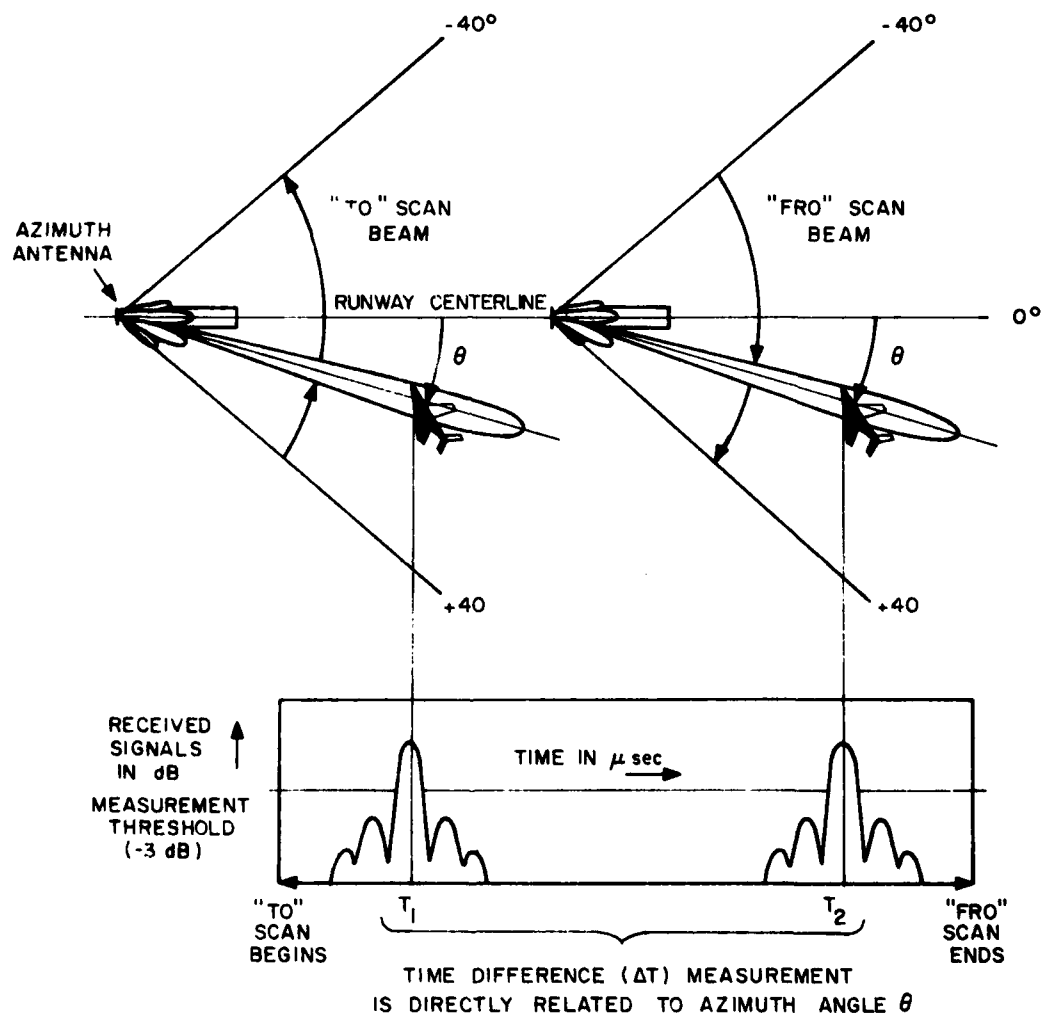


FIGURE B-1. TIME DIFFERENCE MEASUREMENT.

a sector antenna covering the function guidance volume. The scanning fan beam and the sector transmission are illustrated in FIGURE B-2.



FIGURE B-2. REPRESENTATION OF THE ANGLE AND PREAMBLE RADIATION CHARACTERISTICS.

All angular information is essentially linear throughout the volume of coverage. Precision azimuth angle guidance is provided to at least $\pm 40^\circ$, or a narrower sector if desired. For any installation, and particularly where proportional coverage is reduced for reasons of economy, left-right guidance information may be provided over a wider sector. Precision elevation angle guidance, referenced to a standard reference point, is provided from 1° to 20° in elevation, over the same sector that provides azimuth angle guidance. Precision missed-approach azimuth angle guidance, referenced to runway centerline, is provided to at least $\pm 20^\circ$.

The proposed standard signal format contains a time slot for the addition of 360° azimuth and missed-approach elevation guidance to meet potential future requirements, and the design concept is sufficiently flexible to permit the implementation of alternate means for providing a 360° azimuth capability for particular national requirements. Such an alternative could be implemented at C-band or Ku-band with either electronic or mechanically scanned antennas and could be made compatible with standard receivers by a simple processor augmentation.

Signal Format^a

The TRSB signal format defines details of the signals-in-space provided by MLS. The unique signal format concepts affecting operational and performance characteristics of TRSB are discussed below:

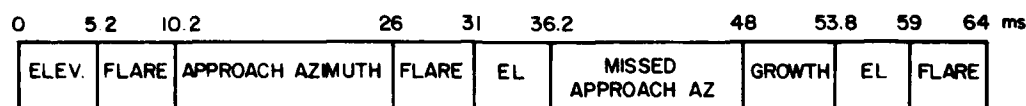
1. 200-independent-channel capability for angle and range.
2. Time Division Multiplex (TDM) operation of all TRSB functions per channel such that only one MLS transmitter is operational at any one time and only one receiver processor channel is required to decode angle guidance information.
3. A large number of samples per second to permit data averaging.

By employing the TDM format with a unique identification for each function, functions can be easily added to or deleted from the signal format to accommodate specific runway requirements. In this way the format provides a high degree of flexibility and growth capability to accommodate potential future requirements for additional MLS functions or auxiliary data messages. Functions provided by the signal format are:

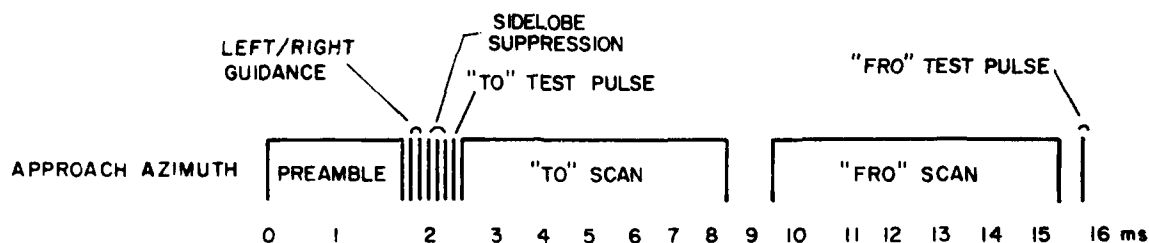
1. Function preamble including function identification.
2. Auxiliary data (e.g., Site Geometry, Status of Subsystems, etc.).
3. Approach azimuth angle guidance.
4. Elevation angle guidance.
5. Missed-approach azimuth angle guidance.
6. Missed-approach/departure elevation guidance.
7. Flare angle guidance.
8. 360° azimuth guidance.
9. left-right guidance.
10. Sidelobe suppression.
11. Ground test signal.
12. Independent range guidance.

^a pp 1-2.5 to 1-2.7 of Reference 6.

Part of a typical scan cycle is shown in FIGURE B-3. Each function is transmitted in time sequence and is differentiated from other functions by the function preamble preceding each function transmission. The preamble is radiated throughout the coverage volume on a sector antenna and contains function synchronization and identification information in the form of differentially phase-shift-keyed (DPSK) digital signals. This function preamble is followed by left-right guidance pulses, sidelobe suppression pulses, ground test pulses, and TO-FRO angle fan beams.



(a) Multiplexed Functions



(b) Sequence for Approach Azimuth Function

FIGURE B-3. TIME DIVISION MULTIPLEX OF FUNCTIONS

Angle guidance information is derived from narrow scanning fan beams. These beams sequentially encode all angles in the coverage sector. All other functions (function preamble, auxiliary data, etc.) are broadcast on wide-coverage sector antennas.

Another key feature of the signal format is the high data rates provided to permit data averaging. This averaging reduces the effect of in-beam multipath signals which cannot be eliminated by other forms of receiver processing. High sample rates are realized with electronically scanned antennas.

The signal format is designed such that at a runway providing maximum MLS service, all angle functions are combined on a single-frequency channel, while airports with more modest service requirements use the same signal format but radiate only selected functions. This flexibility provides for complete interoperability of all ground and airborne equipments, with the resulting service limited by the lesser capabilities of either the ground or airborne equipment.

Configurations

There are six MLS system configurations designed to provide a variety of performance levels to meet the needs of civil and military users. The three civil systems are the Small Community, the Basic and the Expanded. The remaining three systems are future military systems. At present the basic civilian system fulfills the requirements of fixed military bases. The performance capabilities of the civilian systems are shown in TABLE B-1.⁷

The Small Community configuration provides a minimum level of service, limited proportional or angle guidance, and less stringent accuracy requirements. The Basic configurations have several azimuth and elevation antenna beamwidth options. The wide aperture antenna configuration provides narrow beamwidths yielding higher accuracy. The narrow aperture antenna configuration provides broader beamwidths with lower accuracy. The Expanded configuration provides the complete range of angle coverage available including flare touchdown guidance, and missed approach or back azimuth.

⁷National Plan for Development of the Microwave Landing System, FAA-ED-07-2A, DOT/FAA, June 1978.

TABLE B-1
PERFORMANCE CAPABILITIES OF MLS CONFIGURATIONS
(FROM REFERENCE 7)

Configuration	Basic			
Function	Expanded	Wide Aperture	Narrow Aperture	Small Community
Azimuth	BW ^a 1° Coverage ±40° proportional guidance	BW 1° Coverage ±40° proportional guidance	BW 2° Coverage ±40° proportional guidance	BW 3° Coverage ±40° proportional guidance ±40° sector guidance
Elevation	1° 0° to 20° proportional guidance	1° 0° to 20° proportional guidance	1.5° 1° to 10° proportional guidance	2° 1° to 10° proportional guidance
Flare	0.5° 8 feet above runway to 8.5° proportional guidance	NA NA	NA NA	NA NA
Missed Approach Azimuth	3° proportional guidance	NA NA	NA NA	NA NA
Identification	NA ±40°	NA ±40°	NA ±40°	NA ±40°

^aAntenna - 3 dB beamwidth.

MLS PRECISION DISTANCE MEASURING EQUIPMENT

The MLS Precision Distance Measuring Equipment (PDME), operating in the 960-1215 MHz region, is an evolution of the conventional DME system. Increased accuracy is gained through pulse shape modification. As with conventional DME, the system consists of a transponder on the ground and an interrogator in the aircraft. Distance information is derived in a manner similar to that of the conventional TACAN/DME system.

The PDME is designed to be completely interoperable with conventional DME equipments and should meet the increased operational requirements that the MLS angle-guidance functions demand, which are an order of magnitude greater than those placed on the conventional DME.

To obtain the ± 100 feet range accuracy necessary during Category III^a landing, modification of the signal format and design of the conventional DME equipment was necessary. The signal format was modified by sharpening the leading edge of the first pulse of each pulse-pair. The cos/cos² pulse shape chosen has a cosine shape for the leading edge of the first pulse and a cos² or gaussian shape for the trailing edge.

The conventional DME equipment concept was modified to allow for the detection of the sharper rising pulse, to more closely control the system delay time, and to improve rejection to co- and adjacent channel signals.

The PDME is a multimode system capable of operating with various pulse-pair spacings for both the ground-to-air and air-to-ground transmissions. The PDME can be multiplexed onto available DME channels in X- and Y- modes.

SYSTEM PARAMETERS

This section summarizes the important equipment functions and operational parameters necessary to exercise the channel-assignment model. The actual

^a0 feet ceiling, 0 nmi visibility.

working environment may contain a much wider range of parameters than detailed here. The information in TABLE B-2 was chosen to represent a conservative but realistic working environment. The choice of functions and parameters to determine worst-case situations as well as the protection criterion is described in APPENDIX C.

TABLE B-2
EQUIPMENT PARAMETERS

Equipment	Function	Configuration Option	Service Volume Options	Frequency	Vertical Antenna Pattern	Horizontal Antenna Pattern	ERP (dBm)
MLS Angle Guidance	Ident.	Sm. Comm. Basic Expanded	Figure B-4	5.0-5.25 GHz	Ident. Elevation Figure B-5	Ident. Azimuth Figure B-6	49.0
	Azimuth Scan-Beam			5.0-5.25 GHz	Scan-Beam Elevation Figure B-5	Scan-Beam Azimuth Figure B-7	54.0
ILS	Localizer	Standard Option 1 Option 2 Option 3	Figure B-8	108-112 MHz	Cosine	Wilcox Figure B-9 or 8-Loop Figure B-10	62.0 or 54.0
	Glideslope			331-334 MHz		Null Figure B-11	42.5
VOR	NA ^a			108-112 MHz		Omni- direction	46.0 or 34.0
TACAN	NA	High Low Terminal	Figure B-12		RTA-2 Figure B-13		75.0
DME	VOR/DME			960-1215 MHz	CHU Figure B-14		41.4
	ILS/DME	Approach And Landing	Figure B-8				31.4
PDME	MLS/DME	Approach And Landing	Figure B-15		PDME Figure B-16	Omni/Sector	55.5

^aNA - not applicable.

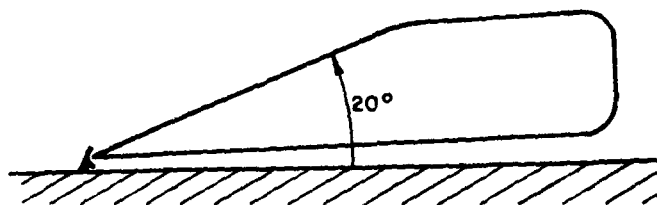
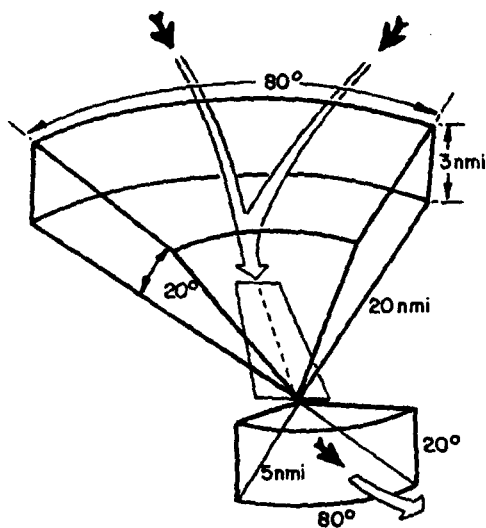


FIGURE B-4. MLS SERVICE VOLUME CONFIGURATIONS.

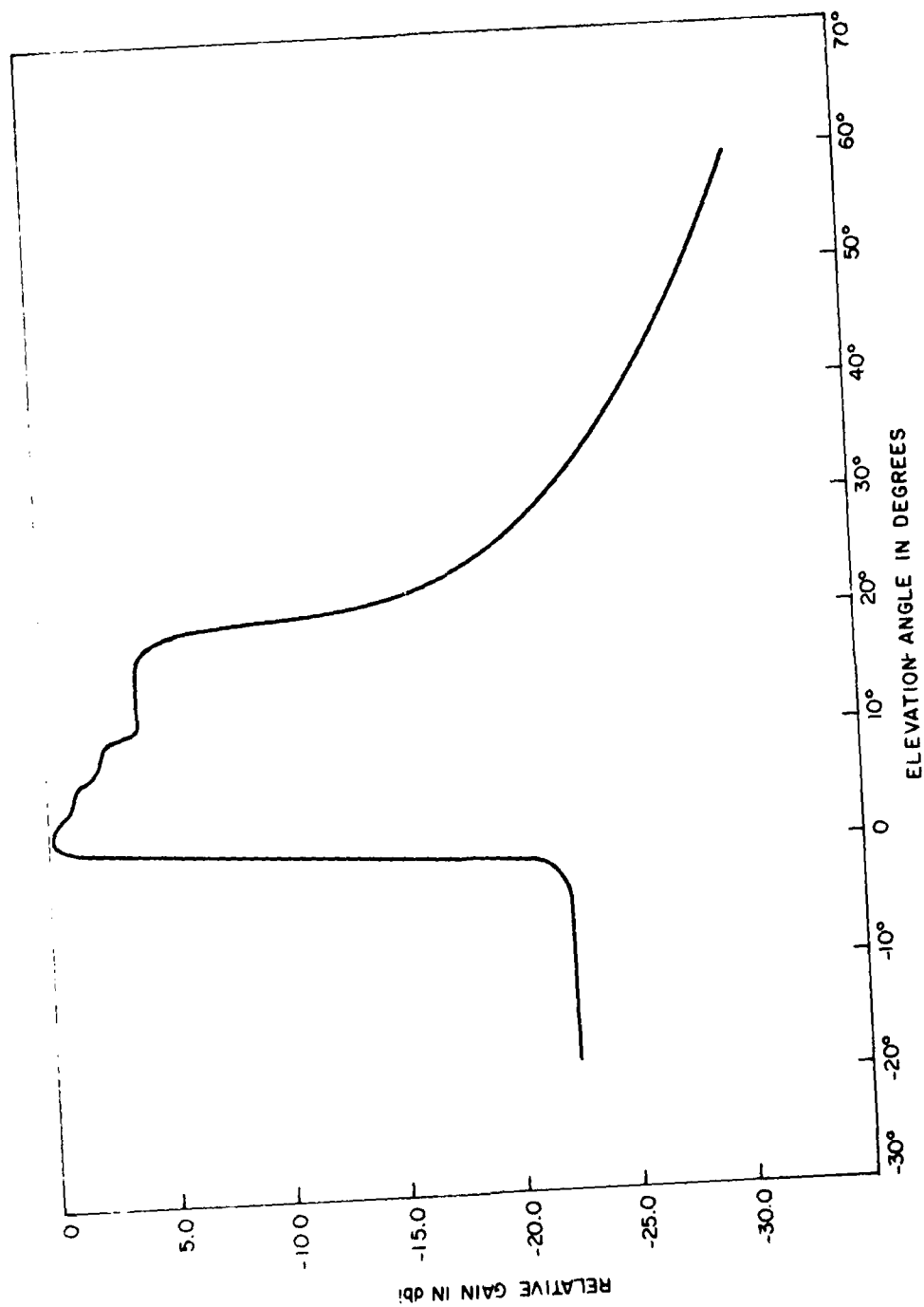


FIGURE B-5. MLS ANGLE GUIDANCE VERTICAL ANTENNA PATTERN.

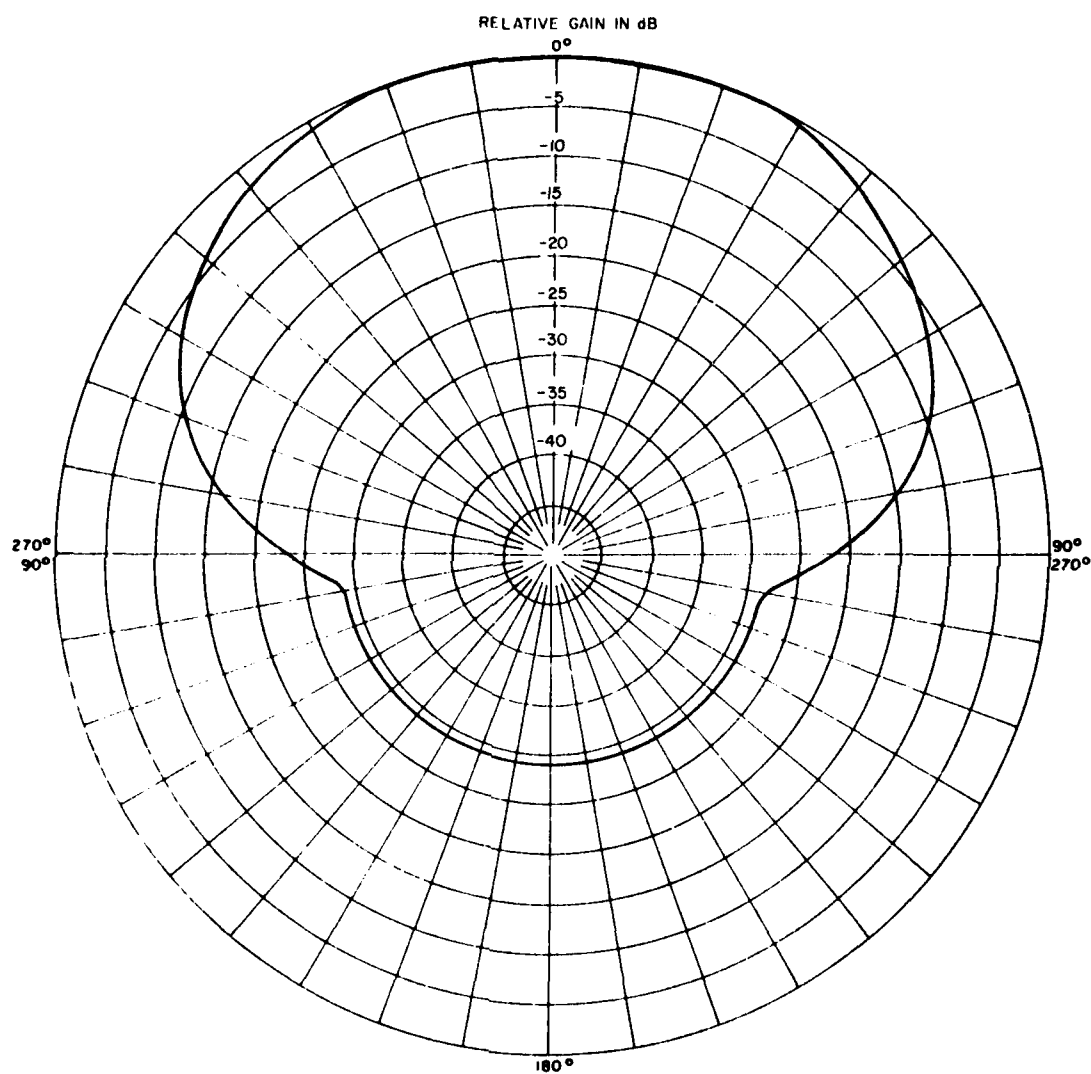


FIGURE B-6. IDENT HORIZONTAL ANTENNA PATTERN.

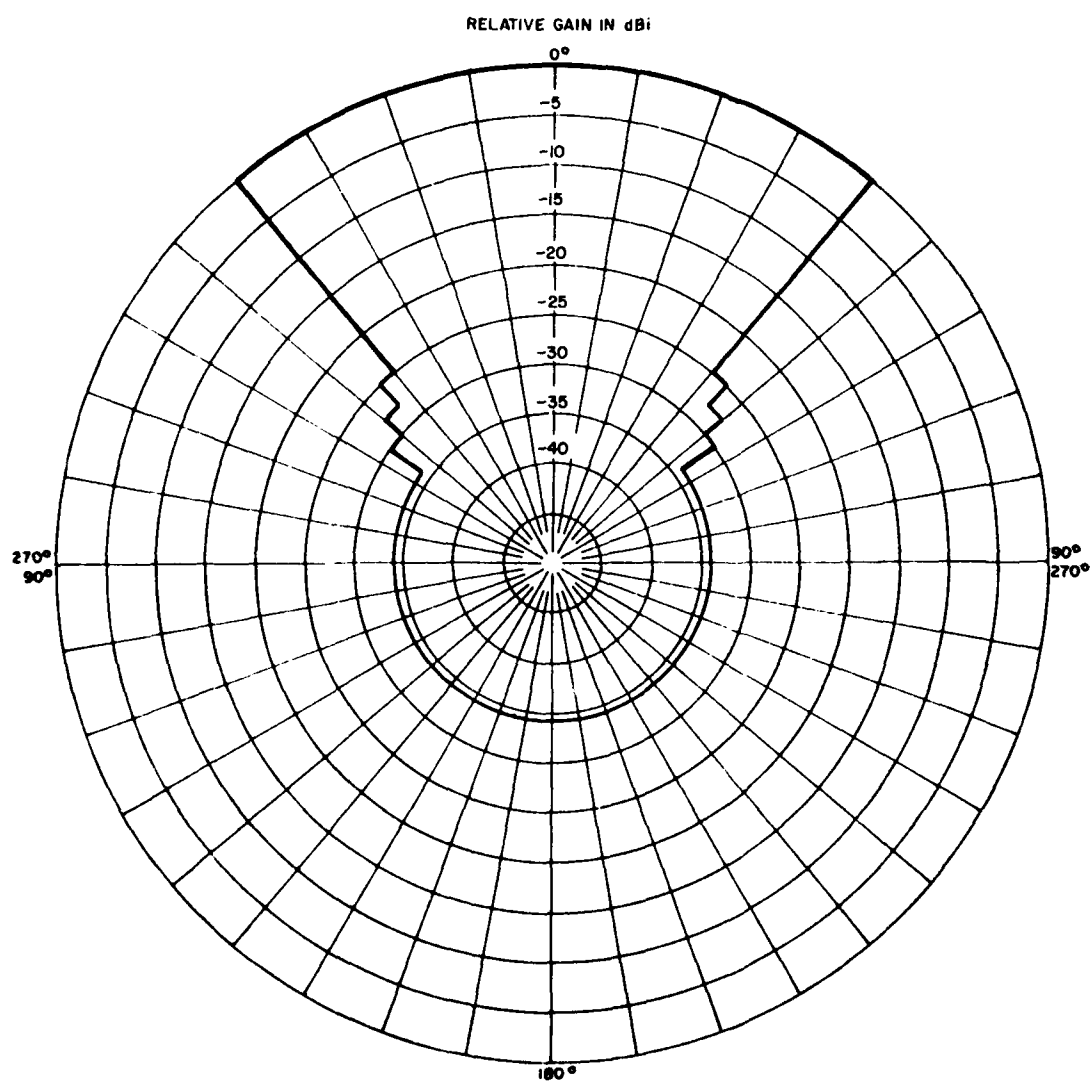
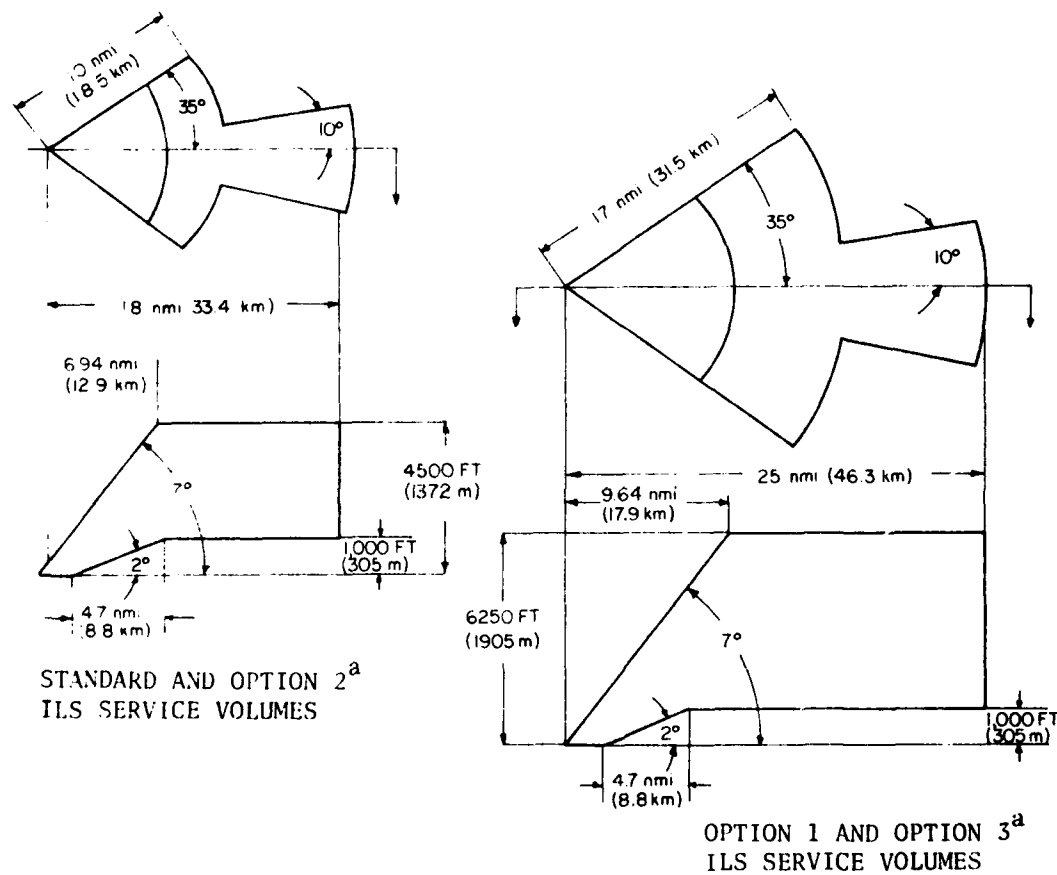


FIGURE B-7. AZIMUTH SCAN-BEAM HORIZONTAL ANTENNA PATTERN.



^a OPTION 2 PROVIDES THE FULL FRONT AND BACK COVERAGE SHOWN

FIGURE B-8. ILS SERVICE VOLUME OPTIONS.

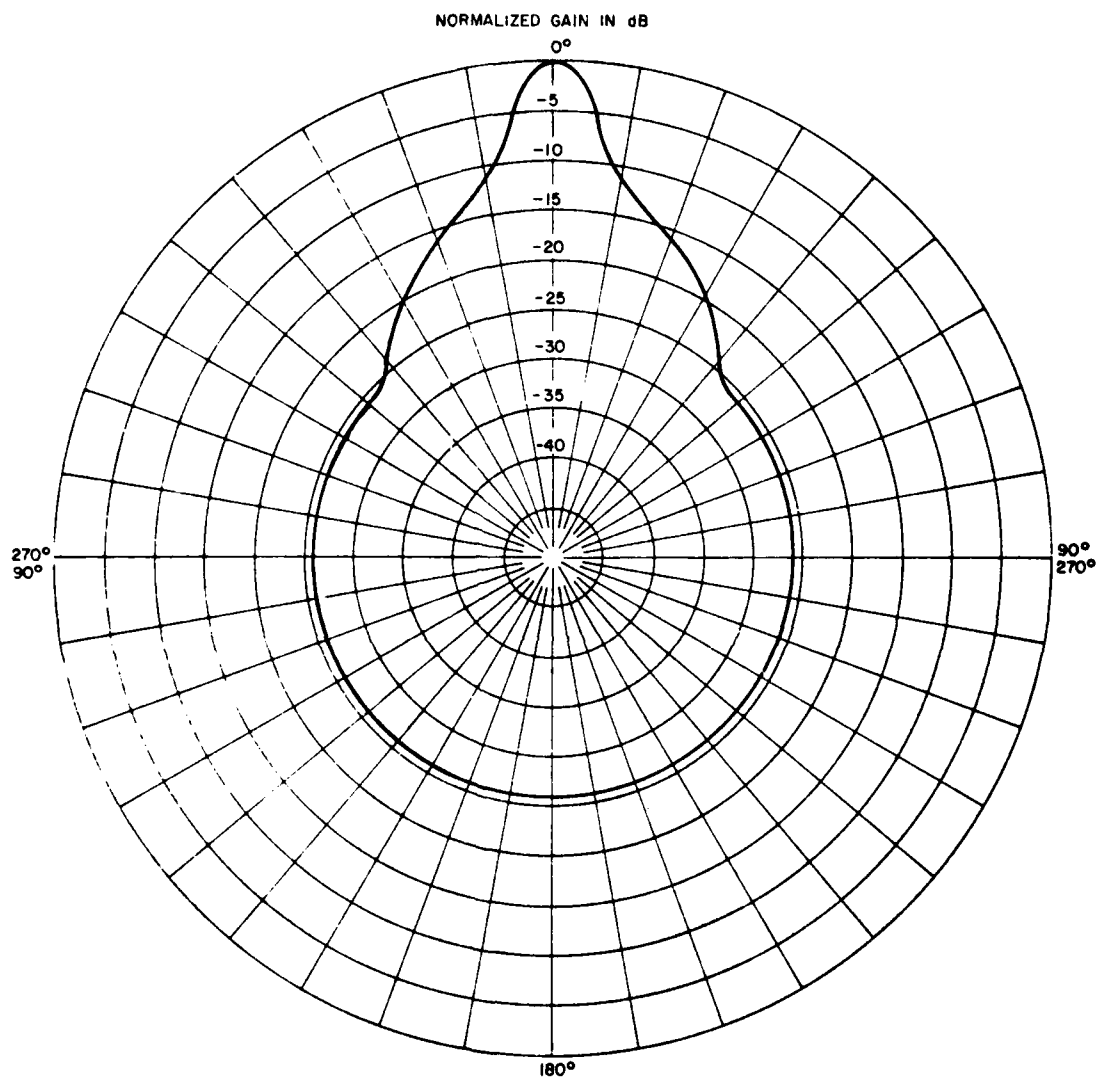


FIGURE B-9. ILS (WILCOX) HORIZONTAL ANTENNA PATTERN.

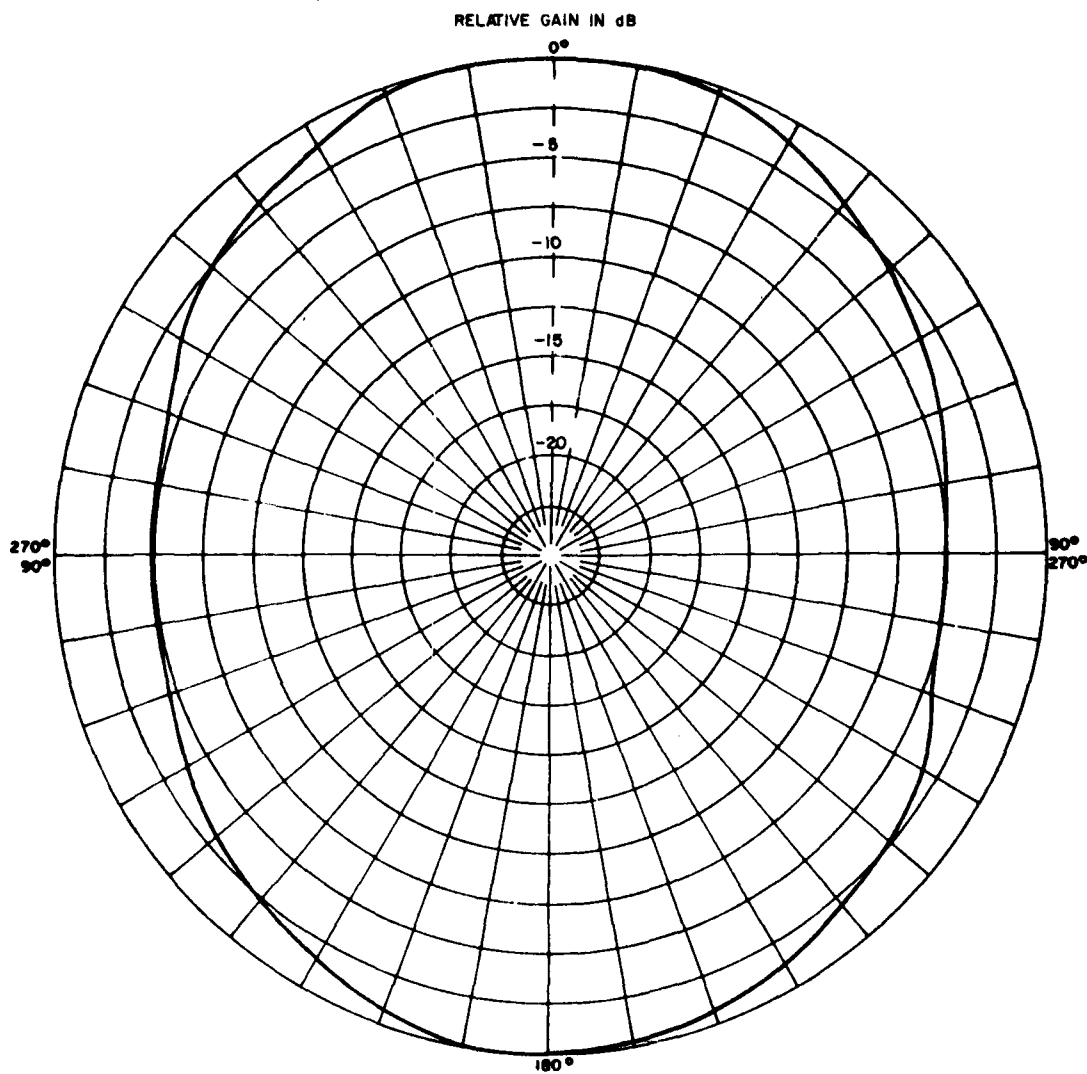


FIGURE B-10. ILS (8-LOOP) HORIZONTAL ANTENNA PATTERN.

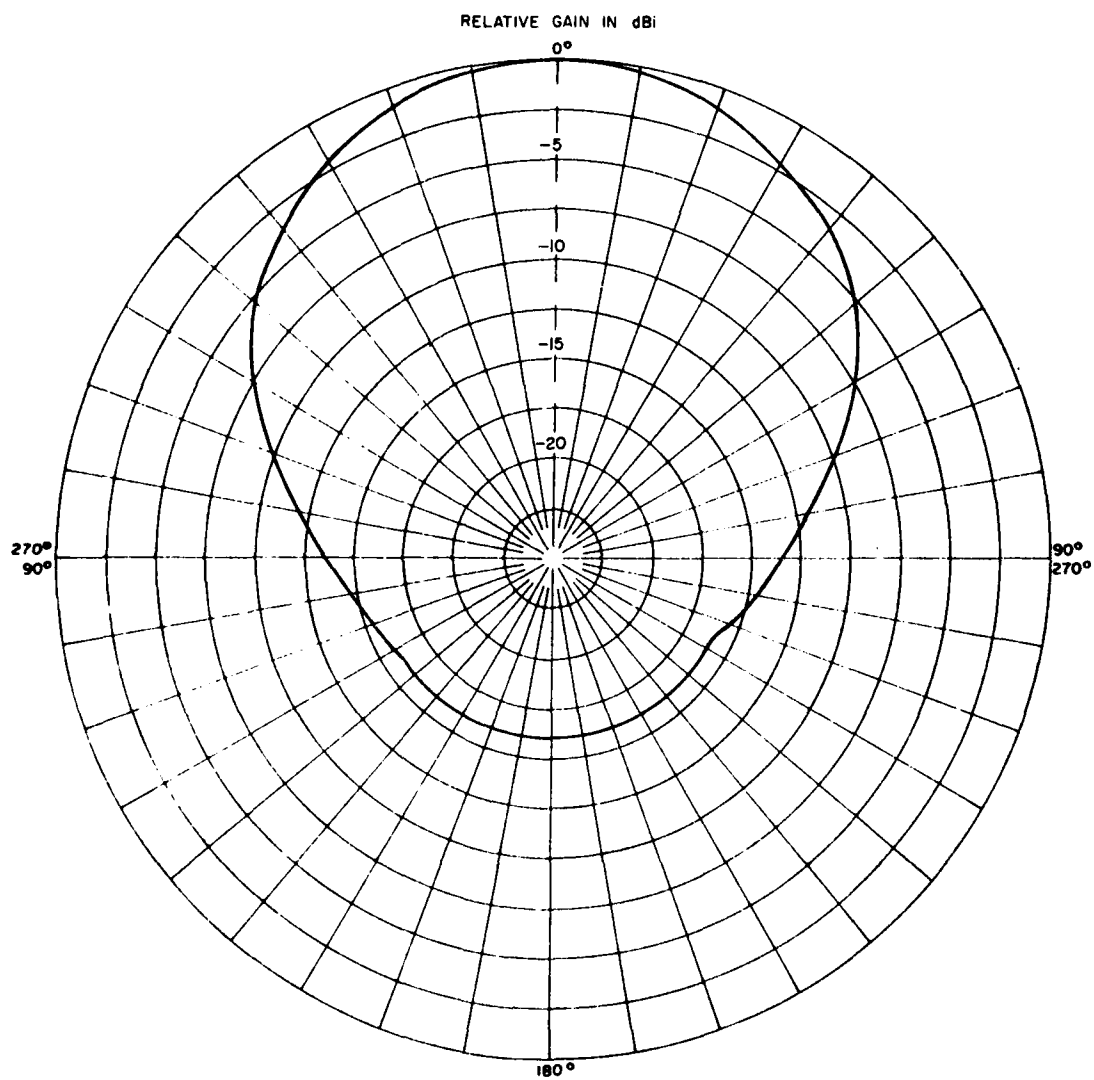


FIGURE 11. ILS GLIDESLOPE ANTENNA PATTERN.

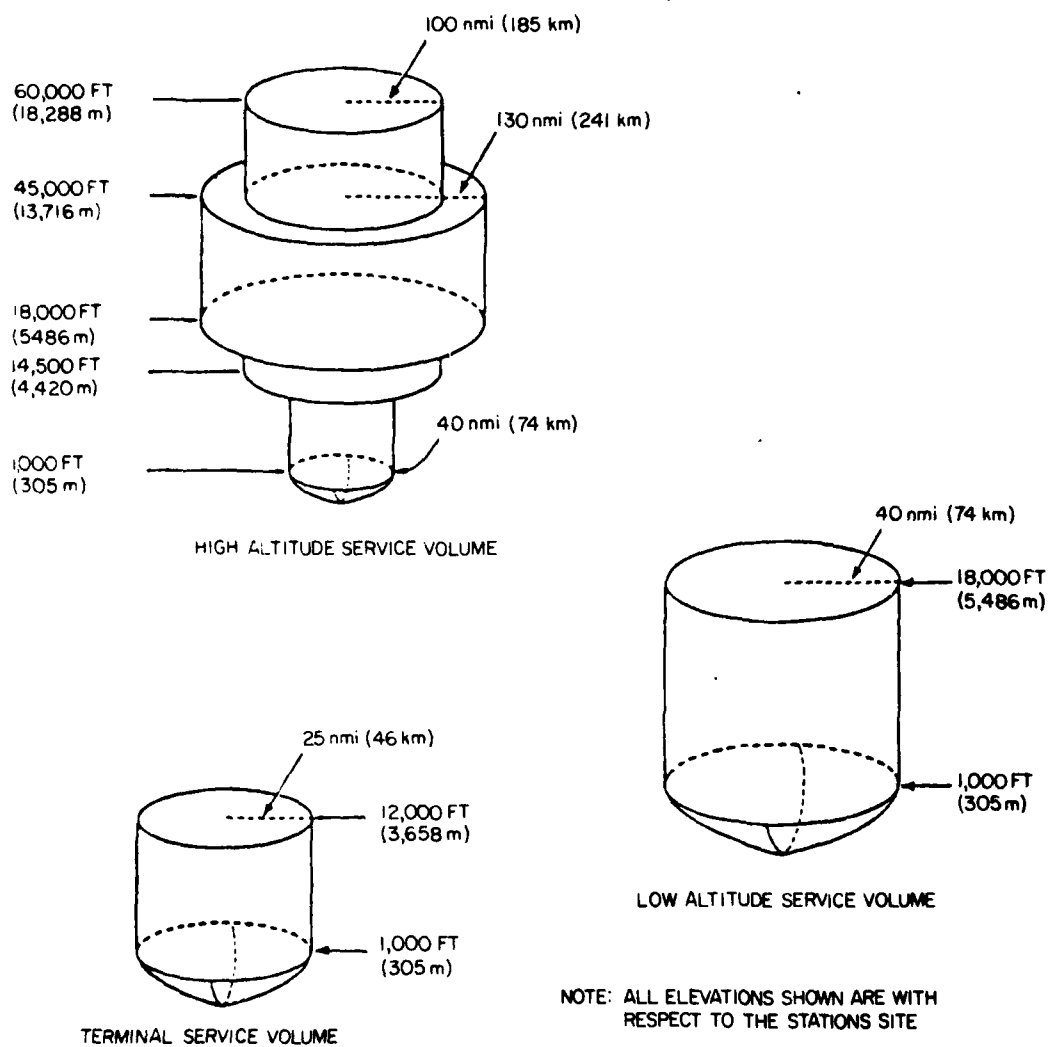


FIGURE B-12. L-BAND SERVICE VOLUME OPTIONS.

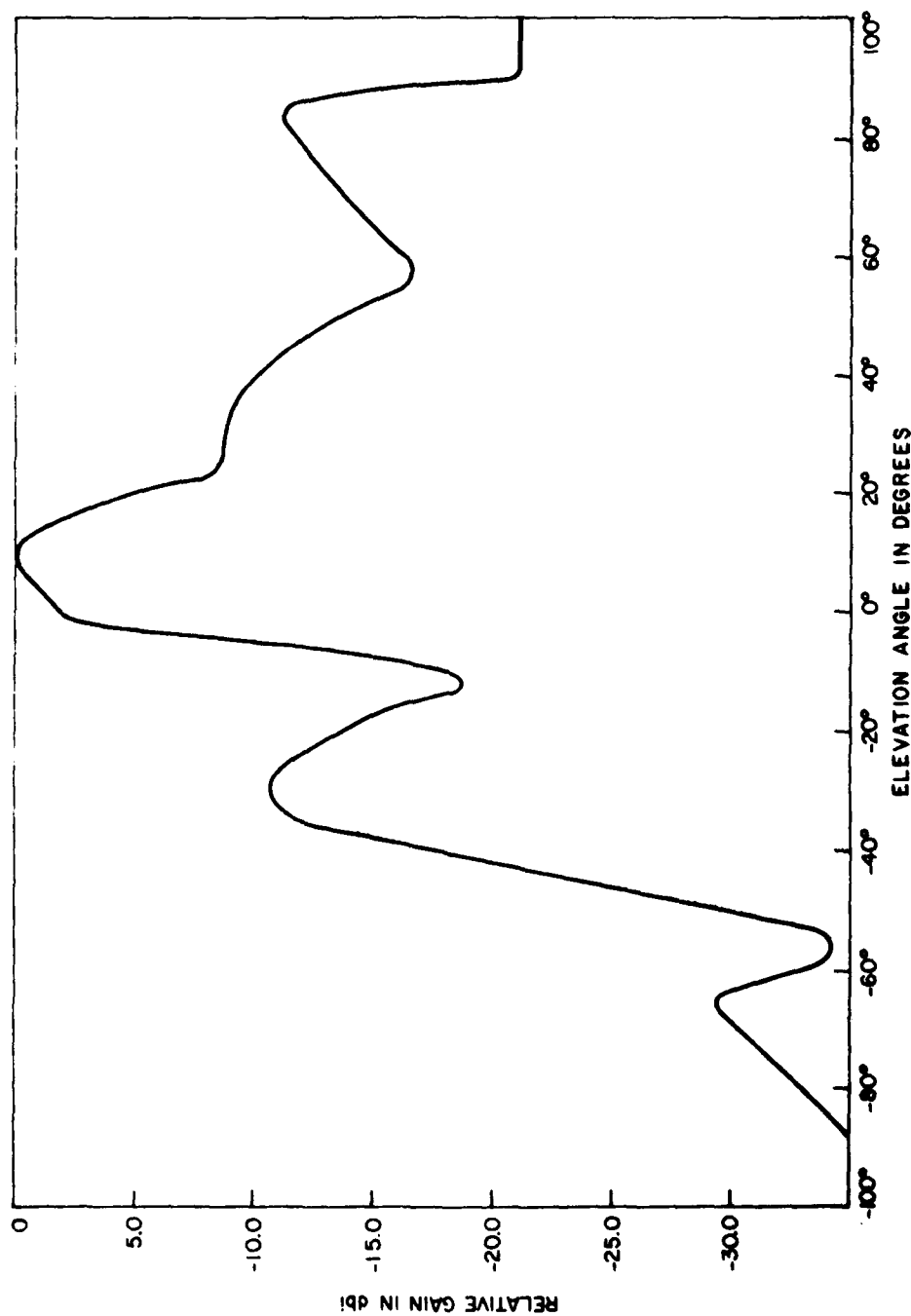


FIGURE B-13. RTA-2 VERTICAL ANTENNA GAIN.

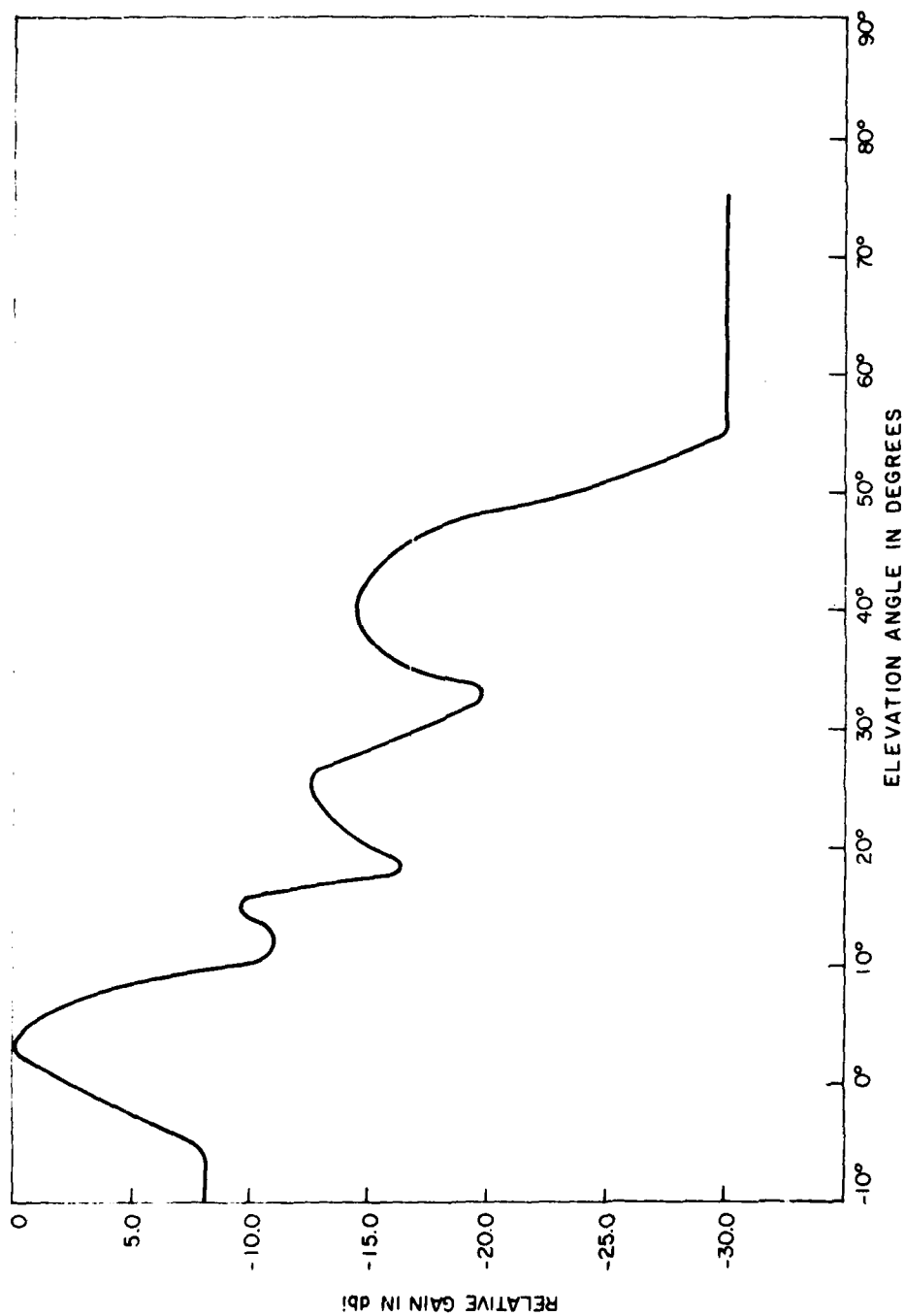


FIGURE B-14. CHU VERTICAL ANTENNA PATTERN.

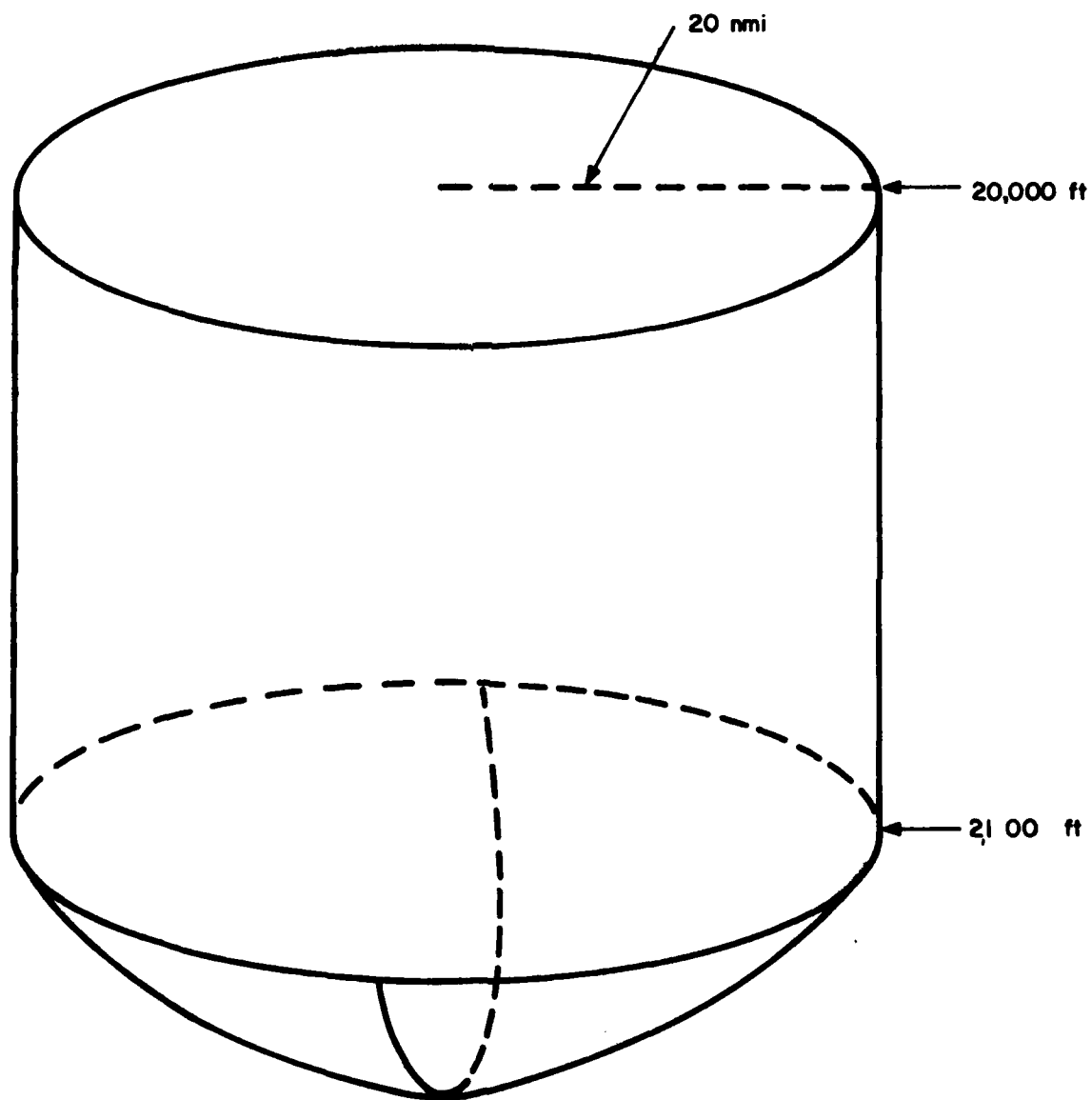


FIGURE B-15. PDME SERVICE COVERAGE.

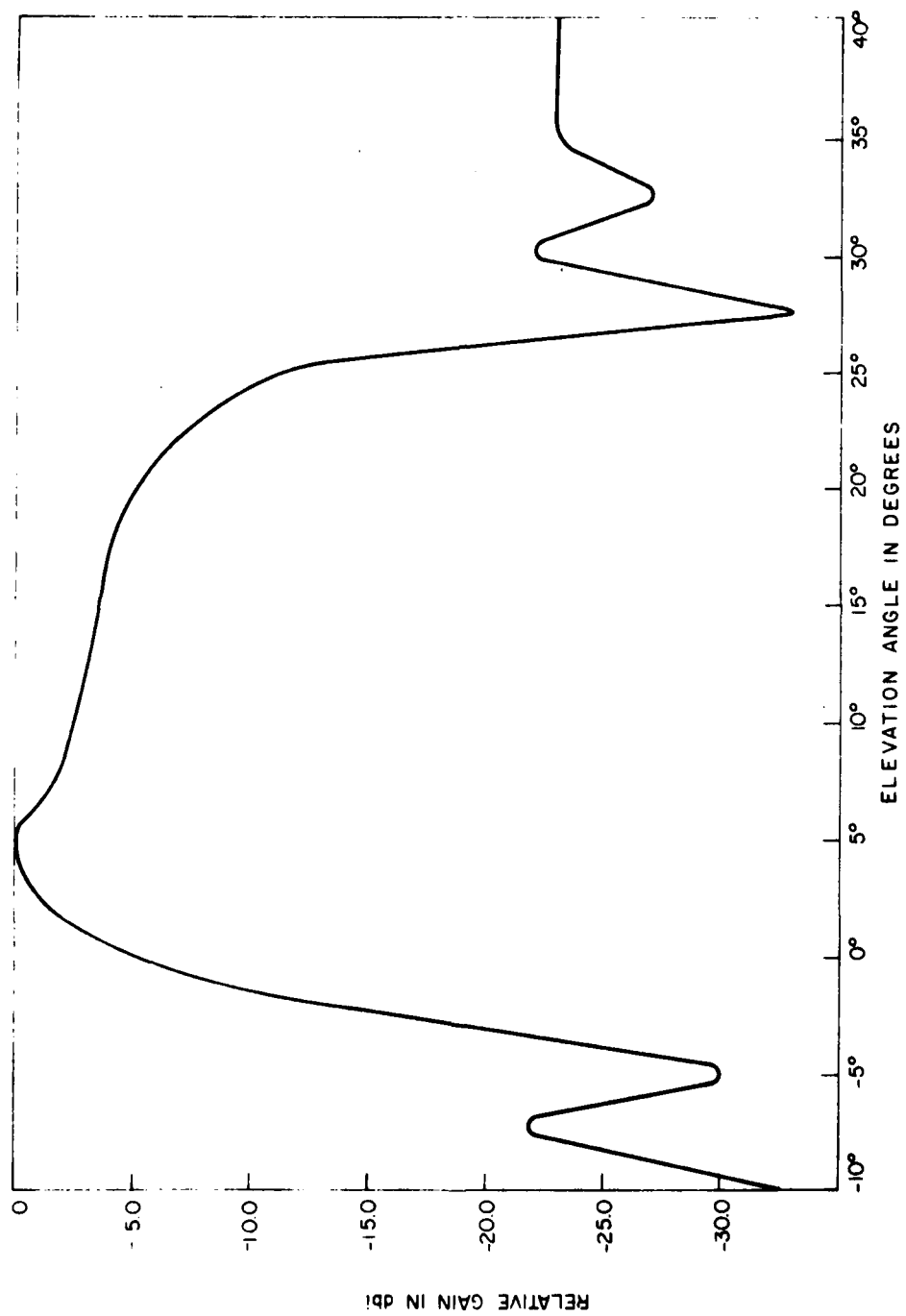


FIGURE B-16. PDME VERTICAL ANTENNA PATTERN.

APPENDIX C

EQUIPMENT PROTECTION CRITERIA

The MLS frequency-assignment model calculates the worst-case desired-to-undesired signal power ratio within the service volumes of each pair of equipments operating in the same band. It then determines the channel separation required for safe operation of each equipment pair based on the protection criteria input by the user. A different protection criterion is specified for each of the four bands to be assigned (C-band, L-band, VHF band and UHF band). In each case the criterion establishes the minimum D/U level allowed for the cochannel and adjacent-channel operation of equipments in these bands.

L-band contains three interacting types of equipments (DME, PDME, and TACAN). The operation of these equipments is such that D/U enhancement can be obtained by varying pulse-pair spacing, as well as by off-tuning. The L-band protection criteria reflects this added interference rejection by specifying D/U threshold levels for out-of-aperture (different pulse-pair spacing) interference as well as coaperture (like pulse-pair spacing) interference.

In C-band, MLS angle guidance is composed of many separate functions (elevation, azimuth, preamble, etc.) multiplexed onto a single frequency. In establishing a C-band protection criteria, it was necessary to determine which interaction of functions would cause the worst D/U degradation. It was found that for cochannel operation, the worst degradation was for a 3° azimuth scanning beam interfering with a 3° azimuth scanning beam. For adjacent-channel interactions, the worst degradation was for a preamble function interfering with a 3° azimuth scanning beam. This type of criterion requires that two worst-case D/U values be considered in the intersite analysis, scan beam-to-scan-beam for cochannel comparison and preamble-to-scan-beam for adjacent-channel comparison.

TABLES C-1 through C-4 list the protection criteria used in this particular trial assignment.

TABLE C-1
L-BAND PROTECTION CRITERIA⁹

Frequency and Pulse-Spacing Interaction	D/U Threshold (dB)
Cofrequency Coaperture	+ 8
Cofrequency Out-of-Aperture	+ 3
1st Adjacent Frequency Coaperture	-25
1st Adjacent Frequency Out-of-Aperture	-34
2nd Adjacent Frequency Coaperture	-34
2nd Adjacent Frequency Out-of-Aperture	-34

⁹Nanda, V. P., *Analytic Determination of Interference Thresholds for Microwave Landing System Equipment and TACAN/DME Equipment*, ECAC-PR-80-008, Annapolis, MD., to be published.

TABLE C-2

C-BAND PROTECTION CRITERIA⁹

	D/U Threshold
Cochannel	23.5 dB ^a
1st Adjacent Channel (± 300 kHz)	-19.4 dB
2nd Adjacent Channel	-26.0 dB

^aRecent tests at NAFFC have indicated that cochannel protection requires an absolute limit on the undesired signal of ≈ -103 dBm. The CAM will be revised to include this new type of protection criteria.

TABLE C-3

VHF BAND PROTECTION CRITERIA¹⁰

	D/U Threshold
Cochannel	20 dB
1st Adjacent Channel (± 50 kHz)	- 7 dB
2nd Adjacent Channel (± 100 kHz)	-46 dB
3rd Adjacent Channel (± 150 kHz)	-50 dB

TABLE C-4

UHF BAND PROTECTION CRITERIA¹⁰

	D/U Threshold
Cochannel	20 dB
1st Adjacent Channel (± 150 kHz)	0 dB
2nd Adjacent Channel (± 300 kHz)	-20 dB
3rd Adjacent Channel (± 450 kHz)	-40 dB
4th Adjacent Channel (± 600 kHz)	-40 dB

⁹Nanda, V. P., *Analytic Determination of Interference Thresholds for Microwave Landing System Equipment and TACAN/DME Equipment*, ECAC-PR-80-008, Annapolis, MD., to be published.

¹⁰Order 9840, Selection Order: U.S. National Aviation Standard for the VOR/DME/TACAN System, U.S. DOT/FAA undated.

APPENDIX D
TRIAL ENVIRONMENT

This appendix contains a listing of the airport and enroute environments used in the trial assignment. Listed along with each system is its present operating channel (if it is preassigned), and the channel assigned to it by the assignment model.

TABLE D-1 summarizes the number of individual equipments of each type included in the environments listed in TABLES D-2 and D-3.

TABLE D-1
TEST ENVIRONMENT SUMMARY

Facility	Existing Requirements	New Requirements ^a	Total
TACAN	118	0	118
DME	137	28	165
VOR	169	0	169
ILS	86	0	86
MLS Expanded	0	5	5
MLS Basic	0	136	136
MLS S. Com.	0	214	214
MLS PDME	0	66	66

^aNote that frequency-pairing requirements within a particular channel plan may necessitate the protection of new "dummy" DME, VOR and ILS equipments whenever MLS equipments are assigned which do not require the physical installation of associated equipments. These dummy equipments are not included in the tables.

TABLE D-2

AIRPORT ENVIRONMENT
(Page 1 of 8)

SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RWY	MLS SERVICE	DME EQUIPMENT	ILS EQUIP OFF CALL	LINK NUM	CHANNEL OLD/NEW
1	ANAHUIM /CA		NEW GENERAL	33 48 00 N	117 55 30 W	19	NO	SMALL COMNTY	MARKER BECN			/
2	ANAHUIM /CA		NEW GENERAL	33 48 00 N	117 55 00 W	14	NO	SMALL COMNTY	MARKER BECN			/
3	ANAHUIM /CA		NEW GENERAL	33 48 00 N	117 55 00 W	24	NO	SMALL COMNTY	MARKER BECN			/ 95Y
4	ANTIOCH /CA	Q12	FMS GENERAL	37 50 05 N	121 48 00 W	9	NO	SMALL COMNTY	MARKER BECN			/ 18X
5	ANTIOCH /CA	Q12	FMS GENERAL	37 50 05 N	121 48 00 W	3	NO	SMALL COMNTY	MARKER BECN			/ 41Y
6	APPLEVALE /CA	AVP	EXS AIR CARR	34 34 45 N	117 11 07 W	36	YES	SMALL COMNTY	ILS DME			/ 18Y
7	ARCATA /CA	ACV	EXS AIR CARR	40 53 00 N	124 06 30 W	31	YES	SMALL COMNTY	ILS DME	ACV		32X/ 32X
8	ARCATA /CA	ACV	EXS AIR CARR	40 53 00 N	124 06 30 W	31	YES	SMALL COMNTY	ILS DME			/ 24Y
9	AUBURN MUNI/CA	AUN	EXS GENERAL	38 57 10 N	121 04 51 W	1	YES	SMALL COMNTY	ILS DME			/ 18Y
10	AVALON /CA	AVX	EXS GENERAL	33 24 20 N	118 24 53 W	22	YES	SMALL COMNTY	MARKER BECN			/ 23Y
11	AVALON /CA	AVX	EXS GENERAL	33 24 20 N	118 24 53 W	13	NO	SMALL COMNTY	MARKER BECN			/ 28Y
12	CATALINA /CA		NEW VSTOL	32 26 00 N	118 14 00 W	27	NO	SMALL COMNTY	MARKER BECN			/ 52Y
13	BAKERSFIELD/CA	BFL	EXS AIR CARR	35 25 45 N	119 03 05 W	30R	YES	BASIC WIDE	P DME	R EFL	1	36X/ 36X
14	BAKERSFIELD/CA	BFL	EXS AIR CARR	35 25 45 N	119 03 05 W	12L	YES	BASIC WIDE	P DME	K EFL	1	36X/ 36X
15	BISHOP /CA	BIH	EXS GENERAL	37 22 24 N	118 21 54 W	30	YES	SMALL COMNTY	MARKER BECN			/ 28Y
16	BLITHC /CA	BLH	EXS GENERAL	33 37 15 N	114 43 08 W	26	YES	SMALL COMNTY	ILS DME			26X/ 26X
17	BREA /CA		NEW GENERAL	33 52 00 N	117 59 00 W	27	NO	SMALL COMNTY	ILS DME			/ 107Y
18	BREA /CA		NEW GENERAL	33 52 00 N	117 59 00 W	19	NO	SMALL COMNTY	MARKER BECN			32X/ 32X
19	BURBANK /CA	BUR	EXS AIR CARR	34 12 09 N	118 21 28 W	8	YES	BASIC WIDE	P DME	2 EUR		/ 272
20	BURBANK /CA	BUR	EXS AIR CARR	34 12 09 N	118 21 28 W	1	YES	BASIC WIDE	P DME			/ 23Y
21	CALISTO /CA	CLX	EXS GENERAL	33 42 00 N	115 30 45 W	26	YES	SMALL COMNTY	MARKER BECN			24X/ 24X
22	CARLSBAD /CA	CRS	EXS GENERAL	33 07 41 N	117 16 46 W	24	YES	BASIC WIDE	P DME			50X/ 50X
23	CHICO MUNI/CA	CIC	EXS AIR CARR	39 47 45 N	121 51 23 W	14L	YES	BASIC WIDE	P DME	2 CRO		/ 292
24	CHINO /CA	CHP	EXS GENERAL	33 56 15 N	117 38 29 W	21	YES	BASIC WIDE	P DME	3 C1C		/ 292
25	CHING /CA	CHG	EXS GENERAL	33 59 15 N	117 38 29 W	8	YES	SMALL COMNTY	MARKER BECN			/ 122Y
26	COLLINGA /CA	CLG	EXS GENERAL	36 00 36 N	120 21 34 W	30	YES	SMALL COMNTY	MARKER BECN			/ 32Y
27	COLUMBIA /CA	CLM	EXS GENERAL	38 01 45 N	120 24 45 W	17	YES	SMALL COMNTY	MARKER BECN			/ 85Y
28	COLUMBIA /CA	CLM	EXS GENERAL	38 01 45 N	120 24 45 W	11	YES	SMALL COMNTY	MARKER BECN			/ 37Y
29	COLUSA CTY/CA	COB	EXS GENERAL	39 10 45 N	121 50 29 W	13	YES	SMALL COMNTY	MARKER BECN			/ 78Y
30	COMPTON /CA	CPW	EXS GENERAL	33 53 24 N	118 14 34 W	25L	YES	SMALL COMNTY	MARKER BECN			/ 80Y
31	CORCORO /CA	CCR	EXS GENERAL	37 59 23 N	122 03 21 W	10R	YES	PASIC WIDE	P DME	3 CCR		22X/ 22X
32	CORONA MUNI/CA	LEB	EXS GENERAL	35 53 55 N	117 36 05 W	25	YES	SMALL COMNTY	MARKER BECN			/ 31Y
33	CRESCENT/CA	CEC	EXS AIR CARR	41 46 49 N	124 14 07 W	11	YES	SMALL COMNTY	ILS DME	3 CEC		24X/ 24X
34	DAVIS /CA	DCP	EXS GENERAL	36 31 55 N	121 47 17 W	16	YES	SMALL COMNTY	MARKER BECN			/ 35Y
35	EL MONTE /CA	EMT	EXS GENERAL	34 05 10 N	118 02 01 W	1	YES	BASIC WIDE	P DME			/ 472
36	EL MONTE /CA	EMT	NEW GENERAL	33 38 00 N	117 18 00 W	11	NO	SMALL COMNTY	MARKER BECN			/ 21Y
37	ESCONDIDO /CA	ESC	NEW GENERAL	33 12 00 N	117 10 30 W	17	NO	SMALL COMNTY	MARKER BECN			/ 20Y
38	EUREKA /CA	EKA	EXS GENERAL	40 48 18 N	124 06 52 W	11	YES	SMALL COMNTY	MARKER BECN			/ 28X
39	EUREKA /CA	EKA	EXS GENERAL	40 48 18 N	124 06 52 W	7	YES	SMALL COMNTY	MARKER BECN			/ 18Y
40	FAIR OAKS /CA	O11	EXS GENERAL	38 39 26 N	121 13 04 W	18	YES	SMALL COMNTY	ILS DME			/ 83Y
41	FAIR OAKS /CA	O11	EXS GENERAL	38 39 26 N	121 13 04 W	36	YES	SMALL COMNTY	MARKER BECN			/ 86Y
42	FORTUNA /CA	FOT	EXS GENERAL	40 33 15 N	124 07 45 W	11	YES	SMALL COMNTY	MARKER BECN			/ 32Y
43	FRANKLIN /CA	F53	EXS GENERAL	36 18 18 N	121 25 43 W	18	YES	SMALL COMNTY	MARKER BECN			/ 32Y
44	FREMONT /CA	F59	EXS GENERAL	37 27 30 N	121 55 45 W	13R	YES	SMALL COMNTY	ILS DME			/ 29Y
45	FREMONT /CA	F59	EXS GENERAL	37 27 30 N	121 55 45 W	5	NO	SMALL COMNTY	MARKER BECN			/ 42Y
46	FRESNO A /CA	FAT	EXS AIR CARR	36 46 28 N	119 42 57 W	29R	YES	BASIC WIDE	P DME	R FAT	2	40X/ 40X
47	FRESNO A /CA	FAT	EXS AIR CARR	36 46 28 N	119 42 57 W	11L	YES	BASIC WIDE	P DME	R FAT	2	40X/ 40X
48	FRESNO A /CA	FAT	EXS AIR CARR	36 46 28 N	119 42 57 W	7	NO	BASIC WIDE	P DME			/ 172
49	FRESNO CHD/CA	FCH	EXS GENERAL	36 43 57 N	119 49 07 W	30L	YES	BASIC WIDE	P DME			/ 272
50	FRESNO CHD/CA	FCH	EXS GENERAL	36 43 57 N	119 49 07 W	30R	YES	SMALL COMNTY	ILS DME			/ 26Y

TABLE D-2
(Page 2 of 8)

SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RWY	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL OLD/NEW
51	FRESNO CHD/CA	FCM	EXS GENERAL	36 43 57 N	119 49 07 W	21	NO	SMALL COMNTY	MARKER BECN				/ 20Y
52	FULLERTON /CA	FUL	EXS GENERAL	33 52 19 N	117 28 44 W	6	YES	BAS WIDE BAZ	P DME				/ 25Z
53	FULLERTON /CA	FUL	EXS GENERAL	33 52 19 N	117 28 44 W	24	YES	BAS WIDE BAZ	P DME				/ 35Z
54	GARBERVILLE/CA	016	EXS GENERAL	40 04 10 N	123 48 45 W	18	YES	SMALL COMNTY	MARKER BECN				/ 11Y
55	GRASS VLL /CA	017	EXS GENERAL	39 13 25 N	121 00 15 W	7	YES	SMALL COMNTY	MARKER BECN				/ 38Y
56	GRASS VLL /CA	017	EXS GENERAL	39 13 25 N	121 00 15 W	15	NO	SMALL COMNTY	MARKER BECN				/ 28Y
57	HALFMOONRY/CA	HAF	EXS GENERAL	37 33 50 N	122 30 03 W	30	YES	SMALL COMNTY	MARKER BECN				/ 40Y
58	HALFMOONRY/CA	HAF	EXS GENERAL	37 33 50 N	122 30 03 W	6	NO	SMALL COMNTY	MARKER BECN				/ 24X
59	HAYFORD MU/CA	018	EXS GENERAL	36 19 04 N	119 37 39 W	14	YES	SMALL COMNTY	MARKER BECN				/ 18Y
60	HAYFORD MU/CA	018	EXS GENERAL	36 19 04 N	119 37 39 W	6	NO	SMALL COMNTY	MARKER BECN				/ 44X/ 44X
61	HAYTHORN /CA	HHR	EXS GENERAL	33 55 23 N	118 20 03 W	25	YES	BASIC WIDE	P DME	2	MHR		/ 18Y
62	HAYTHORN /CA	HHR	EXS GENERAL	33 55 23 N	118 20 03 W	7	YES	SMALL COMNTY	MARKER BECN				/ 39Z
63	HAYWARD AT/CA	HWO	EXS GENERAL	37 39 34 N	122 07 18 W	109	YES	BASIC WIDE	P DME	3	HWD		52X/ 52X
64	HAYWARD AT/CA	HWO	EXS GENERAL	37 39 34 N	122 07 18 W	28	YES	SMALL COMNTY	MARKER BECN				/ 96Y
65	HEMET RYAN/CA	HAT	EXS GENERAL	36 43 06 N	117 01 14 W	23	YES	SMALL COMNTY	MARKER BECN				/ 54Y
66	HOLLIST MU/CA	307	EXS GENERAL	36 53 25 N	121 24 39 W	12	YES	SMALL COMNTY	MARKER BECN				/ 18Y
67	HUNTINGTON /CA	LIF	EXS GENERAL	33 43 08 N	118 32 13 W	1	YES	SMALL COMNTY	MARKER BECN				/ 21Y
68	IMPERIAL /CA	1PL	EXS AIR CARR	32 50 14 N	115 44 29 W	32	YES	SMALL COMNTY	MARKER BECN				/ 83Y
69	JACKSON /CA	072	EXS GENERAL	36 22 45 N	120 42 03 W	17	YES	SMALL COMNTY	MARKER BECN				/ 42X/ 42X
70	KING CITY /CA	KIC	EXS GENERAL	36 12 41 N	121 07 15 W	11	YES	SMALL COMNTY	MARKER BECN				/ 46Y
71	LA MESA /CA	LMA	NEW GENERAL	34 03 00 N	117 50 00 W	14	NO	SMALL COMNTY	MARKER BECN				/ 19Y
72	LA MESA /CA	LMA	NEW GENERAL	34 03 00 N	117 50 00 W	14	YES	BASIC WIDE	P DME	3	POC		40X/ 40X
73	LAVERNE /CA	POC	EXS GENERAL	34 05 30 N	117 46 59 W	26	YES	SMALL COMNTY	MARKER BECN				/ 46Y
74	LAVERNE /CA	POC	EXS GENERAL	34 05 30 N	117 46 59 W	24	YES	SMALL COMNTY	MARKER BECN				/ 21Z
75	LIVERMORE /CA	LJV	EXS GENERAL	37 41 41 N	121 49 02 W	7	YES	SMALL COMNTY	MARKER BECN				/ 82Y
76	LIVERMORE /CA	LJV	EXS GENERAL	37 41 41 N	121 49 02 W	25	YES	SMALL COMNTY	MARKER BECN				/ 36Y
77	LIVERMORE /CA	LVK	EXS GENERAL	37 41 41 N	121 49 02 W	5	YES	SMALL COMNTY	MARKER BECN				/ 46Y
78	LODI /CA	103	EXS GENERAL	36 12 11 N	121 16 33 W	12	YES	SMALL COMNTY	MARKER BECN				/ 19Y
79	LODI /CA	103	EXS GENERAL	36 12 11 N	121 16 33 W	25	YES	BASIC WIDE	P DME	2	LGP		40X/ 40X
80	LONG BEACH /CA	LSE	EXS AIR CARR	33 49 03 N	118 06 24 W	30	YES	BASIC WIDE	P DME				/ 31Z
81	LONG BEACH /CA	LSE	EXS AIR CARR	33 49 03 N	118 06 24 W	25R	YES	BAS WIDE BAZ	P DME				/ 51Z
82	LONG BEACH /CA	LSE	EXS AIR CARR	33 49 03 N	118 06 24 W	7L	YES	BAS WIDE BAZ	P DME				/ 86Y
83	LONG BEACH /CA	LSE	EXS AIR CARR	33 49 03 N	118 06 24 W	18	NO	SMALL COMNTY	MARKER BECN				/ 90Y
84	MANA MUYS /CA	VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	9	NO	SMALL COMNTY	MARKER BECN				50Y/ 50X
85	MANA MUYS /CA	VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	16R	YES	BASIC WIDE	P DME	2	VNY		/ 72Z
86	MANA MUYS /CA	VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	34L	NO	SMALL COMNTY	MARKER BECN				/ 97Y
87	MANA MUYS /CA	VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	27	NO	SMALL COMNTY	MARKER BECN				/ 38Y
88	LOS ANGELES/CA	LAX	EXS VSTOL	33 56 32 N	118 24 26 W	27	NO	SMALL COMNTY	MARKER BECN				/ 36X/
89	LOS ANGELES/CA	LAX	EXS VSTOL	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
90	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
91	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
92	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
93	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
94	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
95	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
96	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
97	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
98	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	BASIC WIDE	P DME	2	LAX		3 36X/
99	LOS ANGELES/CA	LSN	EXS GENERAL	37 03 43 N	120 52 05 W	14	YES	SMALL COMNTY	MARKER BECN				/ 80Y
100	PEARCE FLD/CA	204	EXS GENERAL	38 56 05 N	122 37 20 W	12	YES	SMALL COMNTY	MARKER BECN				/ 44Y

TABLE D-2
(Page 3 of 8)

SYSTEM ID	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN EXIST WAY	MLS SERVICE	DME EQUIPMENT	ILS EQUIP OPT CALL	LINK CHANNEL NUM OLD/NEW
101	MAJERA MUN/CA	MAE	EXS GENERAL	36 59 15 N	120 06 40 W	30	YES SMALL COMNTY	MARKER BECN		/ 23Y
102	MALIBU /CA		EXS GENERAL	34 02 00 N	118 41 00 W	25	NO SMALL COMNTY	MARKER BECN		/ 23Y
103	MAMMOTH LA/CA	MWH	EXS GENERAL	37 37 40 N	118 50 35 W	4	YES SMALL COMNTY	MARKER BECN		/ 19Y
104	MERCED MUN/CA	MCE	EXS AIR CARR	37 17 06 N	120 30 34 W	30	YES SMALL COMNTY	MARKER BECN	R MCE	7 30X/ 30X
105	MERCED MUN/CA	MCE	EXS AIR CARR	37 17 06 N	120 30 34 W	12	YES SMALL COMNTY	MARKER BECN	R MCE	7 30X/ 30X
106	MARYSVILLE/CA	MVY	EXS AIR CARR	39 25 51 N	121 34 05 W	14	YES BASIC WIDE	P DME		/ 23Z
107	MOJAVE /CA	MOC	EXS AIR CARR	37 37 34 N	120 57 13 W	28R	YES BASIC WIDE	P DME		/ 23Z
108	MOJAVE /CA	MVY	EXS GENERAL	35 04 00 N	118 00 00 W	14	YES SMALL COMNTY	MARKER BECN	MOD	56X/ 56X
109	MONROVIA /CA		EXS GENERAL	34 08 00 N	117 56 00 W	30	NO SMALL COMNTY	ILS DME		/ 24Y
110	MONROVIA /CA		EXS GENERAL	34 08 00 N	117 56 00 W	12	NO SMALL COMNTY	ILS DME		/ 18X
111	MONTAGUE /CA	STY	EXS GENERAL	41 46 54 N	122 28 31 W	35	YES SMALL COMNTY	MARKER BECN		/ 102Y
112	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	30	NO SMALL COMNTY	MARKER BECN		/ 28X
113	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
114	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
115	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
116	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
117	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
118	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
119	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
120	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
121	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
122	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
123	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
124	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
125	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
126	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
127	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
128	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
129	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
130	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
131	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
132	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
133	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
134	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
135	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
136	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
137	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
138	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
139	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
140	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
141	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
142	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
143	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
144	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
145	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
146	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
147	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
148	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
149	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y
150	MONTESSELLO/CA		EXS GENERAL	34 00 00 N	118 06 30 W	12	NO SMALL COMNTY	MARKER BECN		/ 28Y

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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN EXIST WAY RUNY	MLS SERVICE	DME EQUIPMENT	ILS EQUIP OPT CALL	LINK NUM	CHANNEL OLD/NEW
151	RICHMOND /CA	L67	NEW GENERAL	37 55 00 N	122 20 00 W	29	NO SMALL COMNTY	MARKER BECN			/ 43Y
152	RISHTO /CA	L67	EXS GENERAL	34 07 45 N	117 23 30 W	24	YES SMALL COMNTY	MARKER BECN			/ 87Y
153	RIVERSIDE /CA	RAL	EXS AIR CARR	33 57 06 N	117 26 32 W	9R	YES BAS WIDE BAZ	P DME	1 RAL		46X/ 46X
154	RIVERSIDE /CA	RAL	EXS AIR CARR	33 57 06 N	117 26 32 W	34	YES SMALL COMNTY	MARKER BECN			/ 48Y
155	SACRAMENTO/CA	SMF	EXS AIR CARR	38 41 44 N	121 36 01 W	16L	YES BAS WIDE BAZ	P DME	2 SMF		20X/ 20X
156	SACRAMENTO/CA	SMF	EXS AIR CARR	38 41 44 N	121 36 01 W	34R	YES BAS WIDE BAZ	P DME	3 MUX		48X/ 48X
157	SACRAMENTO/CA	SMF	EXS AIR CARR	38 41 44 N	121 36 01 W	6	NO SMALL COMNTY	MARKER BECN			/ 56Y
158	SACRAMENTO/CA	SAC	EXS GENERAL	38 30 47 N	121 29 32 W	2	YES BAS WIDE BAZ	P DME	R SAC	10	40X/ 40X
159	SACRAMENTO/CA	SAC	EXS GENERAL	38 30 47 N	121 29 32 W	20	YES BAS WIDE BAZ	P DME	R SAC	10	48Y/ 48Y
160	SALINAS /CA	SNS	EXS GENERAL	36 39 45 N	121 36 20 W	31	YES BAS WIDE BAZ	P DME	3 SNS		22X/ 22X
161	SALINAS /CA	SNS	EXS GENERAL	36 39 45 N	121 36 20 W	R	YES SMALL COMNTY	MARKER BECN			/ 50X
162	SANBERNARDI/CA	SST	EXS GENERAL	34 04 03 N	117 16 26 W	25	YES SMALL COMNTY	MARKER BECN			/ 84Y
163	SANBERNARDI/CA	SST	EXS GENERAL	34 04 03 N	117 16 26 W	74	YES SMALL COMNTY	MARKER BECN			/ 20Z
164	SAN CARLOS/CA	SCL	EXS GENERAL	37 30 40 N	122 14 55 W	12	YES BAS WIDE BAZ	P DME			/ 26X
165	INYOKERN /CA	IVK	EXS AIR CARR	35 39 32 N	117 49 43 W	2	YES SMALL COMNTY	MARKER BECN	R SAN	11	46X/ 46X
166	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	27	YES BAS WIDE BAZ	P DME	R SAN	11	46X/ 46X
167	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	27	YES BAS WIDE BAZ	P DME			/ 81Y
168	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	13	YES BAS WIDE BAZ	P DME			/ 22Y
169	SAN DIEGO /CA	SCP	EXS GENERAL	32 34 20 N	116 58 47 W	8L	YES SMALL COMNTY	MARKER BECN			/ 39Y
170	SAN DIEGO /CA	SCP	EXS GENERAL	32 34 20 N	116 58 47 W	26R	YES SMALL COMNTY	MARKER BECN			/ 30Y
171	SAN DIEGO /CA	SCP	EXS GENERAL	33 00 00 N	117 00 00 W	25	NO SMALL COMNTY	ILS DME			/ 37Y
172	SAN DIEGO /CA	SCP	EXS GENERAL	33 00 00 N	117 00 00 W	7	NO SMALL COMNTY	ILS DME			/ 42X/ 42X
173	SAN DIEGO /CA	SEE	EXS GENERAL	32 49 33 N	116 58 19 W	27R	YES BAS WIDE BAZ	P DME	1 SEE	12	42X/ 42X
174	SAN DIEGO /CA	SEE	EXS GENERAL	32 49 33 N	116 58 19 W	9L	YES BAS WIDE BAZ	P DME	1 SEE	12	42X/ 42X
175	SAN DIEGO /CA	MYF	EXS GENERAL	32 48 58 N	117 08 24 W	10L	YES BAS WIDE BAZ	P DME	1 MYF		54X/ 54X
176	SAN DIEGO /CA	MYF	EXS GENERAL	32 48 58 N	117 08 24 W	28R	YES BAS WIDE BAZ	P DME			/ 19Z
177	SAN FERNAD/CA	SFF	EXS GENERAL	34 17 25 N	118 25 15 W	19	YES SMALL COMNTY	MARKER BECN			/ 112Y
178	SAYRN /CA	SFF	NEW VSTOL	37 37 00 N	122 23 00 W	27	YES SMALL COMNTY	MARKER BECN			/ 19Y
179	SAN FRANCISCO	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	28R	YES 360 EXPN BAZ	P DME	2 GWG		54X/ 54X
180	SAN FRANCISCO	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	28R	YES 360 EXPN BAZ	P DME	3 SFO		32X/ 32X
181	SAN FRANCISCO	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	28L	YES 360 EXPN BAZ	P DME	2 SIA		26X/ 26X
182	SAN FRANCISCO	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	28L	YES 360 EXPN BAZ	P DME			/ 44Z
183	SAN JOSE /CA	RHV	EXS GENERAL	37 45 00 N	122 25 00 W	2P	NO BASIC WIDE	P DME			/ 35Z
184	SAN JOSE /CA	RHV	EXS GENERAL	37 45 00 N	122 25 00 W	30	NO BASIC WIDE	P DME			/ 40Z
185	SAN JOSE /CA	SJC	EXS GENERAL	37 19 59 N	121 49 37 W	31R	YES BAS WIDE BAZ	P DME	3 SVL		46X/ 46X
186	SAN JOSE /CA	SJC	EXS AIR CARR	37 21 41 N	121 55 39 W	12R	YES BAS WIDE BAZ	P DME	2 SJC		46X/ 46X
187	SAN JOSE /CA	SJC	EXS AIR CARR	37 21 41 N	121 55 39 W	30L	YES BAS WIDE BAZ	P DME			/ 27Y
188	SAN JUAN /CA	SJC	EXS GENERAL	33 33 00 N	117 40 00 W	?	NO SMALL COMNTY	MARKER BECN			/ 35Y
189	SAN JUAN /CA	SJC	EXS GENERAL	33 33 00 N	117 40 00 W	13	NO SMALL COMNTY	MARKER BECN			/ 24Y
190	SAN MARTIN/CA	SBP	EXS GENERAL	35 14 11 N	120 38 26 W	11	YES SMALL COMNTY	MARKER BECN	3 SBP		/ 38Y
191	SAN MARTIN/CA	SBP	EXS AIR CARR	37 04 55 N	121 35 45 W	27	YES SMALL COMNTY	MARKER BECN			/ 23Y
192	SAN PEDRO /CA	099	EXS AIR CARR	37 04 55 N	121 35 45 W	14	YES SMALL COMNTY	MARKER BECN			/ 23Y
193	SAN PEDRO /CA	099	EXS AIR CARR	37 04 55 N	121 35 45 W	30	YES SMALL COMNTY	MARKER BECN			/ 23Y
194	SANTA ANA /CA	SNA	EXS GENERAL	35 39 00 N	112 12 00 W	30	NO SMALL COMNTY	MARKER BECN			/ 23Y
195	SANTA ANA /CA	SNA	EXS AIR CARR	35 40 32 N	117 52 01 W	19R	YES BAS WIDE BAZ	P DME	R SNA	13	20X/ 20X
196	SANTA ANA /CA	SNA	EXS AIR CARR	35 40 32 N	117 52 01 W	1L	YES BAS WIDE BAZ	P DME	R SNA	13	20X/ 20X
197	SANTA ANA /CA	SNA	EXS AIR CARR	35 40 32 N	117 52 01 W	13	NO SMALL COMNTY	MARKER BECN			/ 23Y
198	SANTA ANA /CA	SNA	EXS AIR CARR	35 40 32 N	117 52 01 W	19	NO SMALL COMNTY	MARKER BECN			/ 23Y
199	SANTA ANA /CA	SNA	EXS AIR CARR	35 40 32 N	117 52 01 W	19	NO SMALL COMNTY	MARKER BECN			/ 23Y
200	SANTA BARB/CA	SBA	EXS AIR CARR	34 25 39 N	119 50 17 W	15R	YES BAS WIDE BAZ	P DME	2 SBA		40X/ 40X

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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RWY.	MLS SERVICE	DME EQUIPMENT	ILS OPT	EQUIP CALL	LINK NUM	CHANNEL QLO/NEU
201	SANTA CRUZ/CA	SRV	EXS GENERAL	37 03 03 N	122 01 50 W	15	YES	SMALL COMNTY	MARKER BECN				/ 33V
202	SANTA MARIA/CA	SMX	EXS AIR CARR	39 53 56 N	120 27 23 W	12	YES	BAS WIDE BAZ	P DME	R	SMX	14	26X/
203	SANTA MARIA/CA	SMX	EXS AIR CARR	39 53 56 N	120 27 23 W	30	YES	BAS WIDE BAZ	P DME	R	SMX	14	26X/
204	SANTA MARIA/CA	SMX	EXS AIR CARR	39 53 56 N	120 27 23 W	20	YES	SMALL COMNTY	MARKER BECN				/ 30V
205	SANTA MONI/CA	SMO	EXS GENERAL	34 00 58 N	118 27 03 W	3	YES	BAS WIDE BAZ	P DME				/ 172
206	SANTA MONI/CA	SPG	EXS GENERAL	34 00 58 N	118 27 03 W	21	YES	BAS WIDE BAZ	P DME				/ 572
207	SANTA PAULA/CA	SPF	EXS GENERAL	34 20 50 N	119 03 37 W	22	YES	SMALL COMNTY	MARKER BECN				/ 30V
208	SANTA ROSA/CA	STS	EXS AIR CARR	38 50 32 N	122 48 42 W	32	YES	BASIC WIDE	P DME	3	STS		50X/
209	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 42X/
210	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	34	YES	SMALL COMNTY	MARKER BECN				/ 23V
211	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 42V
212	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 35V
213	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 31V
214	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
215	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 26X/
216	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 31V
217	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
218	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 31V
219	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
220	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
221	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
222	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
223	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
224	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
225	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
226	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
227	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
228	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
229	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
230	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
231	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
232	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
233	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
234	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
235	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
236	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
237	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
238	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
239	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
240	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
241	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
242	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
243	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
244	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
245	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
246	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
247	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
248	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
249	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V
250	SANTA ROSA/CA	001	EXS GENERAL	38 24 52 N	122 45 25 W	16	YES	SMALL COMNTY	MARKER BECN				/ 20V

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SYSTEM ID	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RWY	MLS SERVICE	DME EQUIPMENT	ILS EQUIP OPT CALL	LINK CHANNEL NUM OLD/NEW
251	ELY /NV	ELY	EXS AIR CARR	39 14 07 N	114 50 31 W	19	YES	SMALL COMNTY	PARKER BECN		/ 18X
252	ELY /NV	ELY	EXS GENERAL	39 14 07 N	114 50 31 W	19	YES	SMALL COMNTY	PARKER BECN		/ 18X
253	LAS VEGAS /NV	VGT	EXS GENERAL	36 12 45 N	115 11 46 W	12	YES	SMALL COMNTY	PARKER BECN		/ 18X
254	LAS VEGAS /NV	VGT	EXS GENERAL	36 12 45 N	115 11 46 W	12	YES	SMALL COMNTY	PARKER BECN		/ 18X
255	LAS VEGAS /NV	VGT	EXS AIR CARR	36 04 48 N	115 09 04 W	19L	YES	BAS WIDE BAZ	ILS DME		/ 22X
256	LAS VEGAS /NV	LAS	EXS AIR CARR	36 04 48 N	115 09 04 W	19L	YES	BAS WIDE BAZ	P DME		/ 252
257	LAS VEGAS /NV	LAS	EXS AIR CARR	36 04 48 N	115 09 04 W	19L	YES	BAS WIDE BAZ	P DME		/ 192
258	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	16	YES	PASIC WIDE	P DME	2 LAS	32X/ 32X
259	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	16	YES	BAS WIDE BAZ	P DME	P RNO	18 52X/ 18
260	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	16	YES	BAS WIDE BAZ	P DME	R RNO	18 52X/ 18
261	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	16	YES	PASIC WIDE	P DME		/ 24Z
262	PRITCHAM /UT	PRC	EXS GENERAL	41 52 36 N	112 02 41 W	34	YES	SMALL COMNTY	PARKER BECN		/ 20Y
263	CATONLAND/UT	CTC	EXS GENERAL	38 11 00 N	109 44 00 W	27	YES	SMALL COMNTY	PARKER BECN		/ 18X
264	CEGAR CITY/UT	CCG	EXS AIR CARR	37 42 06 N	113 08 53 W	20	YES	SMALL COMNTY	PARKER BECN		/ 18X
265	GLENCANYON/UT	UG7	EXS GENERAL	37 32 45 N	110 42 45 W	17	YES	SMALL COMNTY	PARKER BECN		/ 20X
266	LOSCANCACHE/UT	LGL	EXS GENERAL	41 47 14 N	111 51 12 W	1	YES	SMALL COMNTY	PARKER BECN		/ 20Y
267	PO43 /UT	CNY	EXS AIR CARR	38 45 34 N	109 44 46 W	15	YES	SMALL COMNTY	PARKER BECN		/ 18X
268	OSSEN MUNI/UT	OGC	EXS GENERAL	41 11 47 N	112 00 39 W	3	YES	SMALL COMNTY	PARKER BECN		/ 18X
269	PRIMO MUNI/UT	PVG	EXS GENERAL	40 12 56 N	111 43 15 W	13	YES	SMALL COMNTY	PARKER BECN		/ 20X
270	PRIMO MUNI/UT	PVG	EXS GENERAL	40 12 56 N	111 43 15 W	13	YES	SMALL COMNTY	PARKER BECN		/ 18Y
271	SALT LAKE /UT	SLC	EXS AIR CARR	40 47 03 N	111 58 31 W	16L	YES	BAS WIDE BAZ	P DME	2 SLC	32X/ 32X
272	SALT LAKE /UT	SLC	EXS AIR CARR	40 47 03 N	111 58 31 W	16L	YES	BAS WIDE BAZ	P DME	2 ENT	52X/ 52X
273	SALT LAKE /UT	SLC	EXS AIR CARR	40 47 03 N	111 58 31 W	16L	YES	SMALL COMNTY	PARKER BECN		/ 22X
274	SALT LAKE /UT	SLC	EXS AIR CARR	40 47 03 N	111 58 31 W	16L	YES	SMALL COMNTY	PARKER BECN		/ 19Y
275	VERNAL /UT	VEL	EXS GENERAL	40 37 15 N	111 56 37 W	34	YES	SMALL COMNTY	PARKER BECN		/ 21Y
276	CLSA GRAND/UT	CGC	EXS GENERAL	40 26 20 N	109 30 37 W	34	YES	SMALL COMNTY	PARKER BECN		/ 18X
277	CHANDLER /AZ	PLG	EXS GENERAL	33 57 12 N	111 45 45 W	23	YES	SMALL COMNTY	PARKER BECN		/ 33Y
278	COUGLAS /AZ	ZUG	EXS GENERAL	33 16 10 N	111 46 45 W	4	YES	SMALL COMNTY	PARKER BECN		/ 20Y
279	FLAISTAFF /AZ	FLG	EXS AIR CARR	35 08 16 N	111 40 12 W	4	YES	SMALL COMNTY	ILS DME		/ 20Y
280	GLIBESANCA/AZ	PLI	EXS GENERAL	35 21 10 N	110 39 45 W	9	YES	SMALL COMNTY	PARKER BECN		/ 21Y
281	GRAND CANYON/AZ	GCA	EXS AIR CARR	35 57 06 N	112 08 46 W	3	YES	SMALL COMNTY	ILS DME	2 GCA	26X/ 26X
282	GRAND CANYON/AZ	GCA	EXS AIR CARR	35 57 06 N	112 08 46 W	3	YES	SMALL COMNTY	PARKER BECN		/ 19Y
283	KINGMAN /AZ	TOM	EXS AIR CARR	35 15 24 N	113 56 25 W	19	NO	SMALL COMNTY	PARKER BECN		/ 28Y
284	LAKEHAVASU/AZ	LHU	EXS GENERAL	34 27 40 N	114 21 42 W	23	YES	SMALL COMNTY	PARKER BECN		/ 18X
285	LAKEHAVASU/AZ	LHU	EXS GENERAL	34 27 40 N	114 21 42 W	23	YES	SMALL COMNTY	PARKER BECN		/ 18X
286	PHOENIX /AZ	PHX	EXS GENERAL	33 26 07 N	112 02 31 W	3	YES	SMALL COMNTY	PARKER BECN		/ 20Y
287	PHOENIX /AZ	PHX	EXS GENERAL	33 26 07 N	112 02 31 W	3	YES	SMALL COMNTY	ILS DME		/ 38X
288	PHOENIX /AZ	PHX	EXS GENERAL	33 26 07 N	112 02 31 W	3	YES	SMALL COMNTY	PARKER BECN		/ 22Y
289	NOGALES /AZ	GLS	EXS GENERAL	31 25 00 N	111 43 19 W	12	NO	SMALL COMNTY	PARKER BECN		/ 45Y
290	PAGE MUNI /AZ	P6A	EXS GENERAL	31 25 00 N	111 43 19 W	12	NO	SMALL COMNTY	PARKER BECN		/ 26Y
291	PARKER MUNI/AZ	P20	EXS GENERAL	34 09 15 N	114 16 10 W	15	YES	SMALL COMNTY	PARKER BECN		/ 18Y
292	PARKER MUNI/AZ	P20	EXS GENERAL	34 09 15 N	114 16 10 W	15	YES	SMALL COMNTY	PARKER BECN		/ 27Y
293	PHOENIX /AZ	PHX	EXS GENERAL	33 26 07 N	112 02 31 W	3	YES	SMALL COMNTY	PARKER BECN		/ 38Y
294	PHOENIX /AZ	PHX	EXS AIR CARR	33 26 07 N	112 02 31 W	3	YES	BAS WIDE BAZ	P DME	2 PHX	20X/ 20X
295	PHOENIX /AZ	PHX	EXS AIR CARR	33 26 07 N	112 02 31 W	3	YES	BAS WIDE BAZ	P DME		/ 17Z
296	PHOENIX /AZ	PHX	EXS GENERAL	33 26 07 N	112 02 31 W	3	YES	SMALL COMNTY	PARKER BECN		/ 26Y
297	PHOENIX /AZ	PHX	EXS GENERAL	33 26 07 N	112 02 31 W	3	YES	SMALL COMNTY	PARKER BECN		/ 29Y
298	PHOENIX /AZ	PHX	EXS GENERAL	33 26 07 N	112 02 31 W	3	YES	SMALL COMNTY	PARKER BECN		/ 32Y
299	PRESCOTT /AZ	PRC	EXS GENERAL	34 39 05 N	112 25 15 W	3	YES	SMALL COMNTY	PARKER BECN		/ 33Y
300	SAFFORD /AZ	SAC	EXS GENERAL	32 51 17 N	109 38 05 W	8	YES	SMALL COMNTY	PARKER BECN		/ 21Y

TABLE D-2
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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN EXIST WAY RMY	MLS SERVICE	DME EQUIPMENT	ILS EQUIP OPT CALL	LINK NUM	CHANNEL OLD/NEW
301	SCOTTSDALE/AZ	SOL	EXS GENERAL	33 37 10 N	111 54 50 W	3	YES SMALL COMNTY	MARKER BECN	Y TUS	19	22X/ 22X
302	TUCSON	/AZ	EXS AIR CARR	32 07 06 N	110 56 35 W	11L	YES BAS WIDE BAZ	P DME	R TUS	19	22X/ 22X
303	TUCSON	/AZ	EXS AIR CARR	32 07 06 N	110 56 35 W	29L	YES BAS WIDE BAZ	P DME			/ 25Y
304	TUCSON	/AZ	EXS AIR CARR	32 07 06 N	110 56 35 W	3	YES SMALL COMNTY	MARKER BECN			/ 25Y
305	TUCSON	/AZ	EXS GENERAL	32 08 29 N	111 10 00 W	6L	YES SMALL COMNTY	MARKER BECN			/ 36X
306	TUCSON	/AZ	EXS GENERAL	32 16 40 N	111 00 30 W	12	YES SMALL COMNTY	MARKER BECN			/ 18Y
307	TUCSON	/AZ	EXS GENERAL	32 16 40 N	111 00 30 W	3	NO SMALL COMNTY	P DME			/ 19Z
308	TUCSON	/AZ	EXS GENERAL	32 11 00 N	110 57 00 W	11	YES SMALL COMNTY	MARKER BECN			/ 19Z
309	WILCOX	/AZ	EXS GENERAL	32 14 39 N	109 53 36 W	3	YES SMALL COMNTY	MARKER BECN			/ 22X
310	WINSLOW	/AZ	EXS AIR CARR	35 01 20 N	110 43 20 W	11	YES BAS WIDE BAZ	P DME			/ 22X
311	YUMA	/AZ	EXS AIR CARR	32 39 24 N	114 36 18 W	3L	YES BAS WIDE BAZ	P DME			/ 24Y
312	YUMA	/AZ	EXS AIR CARR	32 39 24 N	114 36 18 W	21R	YES BAS WIDE BAZ	P DME			/ 24Y
313	YUMA	/AZ	EXS AIR CARR	32 39 24 N	114 36 18 W	8	YES BAS WIDE BAZ	P DME			/ 24Y
314	SCALE AFB/CA	BAR	EXS MILITARY	35 08 00 N	121 26 00 W	14	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
315	CASTLE AFB/CA	MER	EXS MILITARY	37 23 00 N	120 34 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
316	CASTLE AFB/CA	MER	EXS MILITARY	37 23 00 N	120 34 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
317	TRAVIS AFB/CA	SUU	EXS MILITARY	38 16 00 N	121 56 00 W	21	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
318	TRAVIS AFB/CA	SUU	EXS MILITARY	38 16 00 N	121 56 00 W	3	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
319	VANDENBURG/CA	VEG	EXS MILITARY	34 43 00 N	120 34 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
320	EDWARDS AFB/CA	EDW	EXS MILITARY	34 54 00 N	117 52 00 W	22	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
321	MARCH AFB/CA	MXX	EXS MILITARY	35 53 00 N	117 16 00 W	31	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
322	MC CLELLAN/CA	MCC	EXS MILITARY	38 40 00 N	121 24 00 W	16	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
323	MC CLELLAN/CA	MCC	EXS MILITARY	38 40 00 N	121 24 00 W	34	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
324	WATHER AFB/CA	MHR	EXS MILITARY	38 34 00 N	121 18 00 W	22	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
325	WATHER AFB/CA	MHR	EXS MILITARY	38 34 00 N	121 18 00 W	4	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
326	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	6	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
327	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
328	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
329	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
330	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
331	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
332	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
333	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
334	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
335	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
336	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
337	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
338	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
339	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
340	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
341	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
342	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
343	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
344	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
345	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
346	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
347	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
348	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
349	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X
350	WATSON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	30	YES BAS WIDE BAZ	P DME	YUM	20	32X/ 32X

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SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN EXIST	MLS SERVICE	DME EQUIPMENT	ILS EQUIP OPT CALL	LINK NUM	CHANNEL OLD/NEW
351	JUGWAY	/UT DPG	EXS MILITARY	40 12 00 N	112 56 00 W	25	YES BAS WIDE BAZ	P DME			/ 17Z
352	PALMDALE	/CA PMD	EXS AIR CARR	34 37 46 N	118 05 01 W	25	YES 360 EXPN BAZ	P DME	2	PMO	28K / 28K
353	PALMDALE	/CA PMD	EXS AIR CARR	34 37 46 N	118 05 01 W	7	YES BAS WIDE BAZ	P DME			/ 21Z
354	PALMDALE	/CA PMD	EXS AIR CARR	34 37 46 N	118 05 01 W	22	YES BAS WIDE BAZ	P DME			/ 35Z
355	PALMDALE	/CA PMD	EXS AIR CARR	34 37 46 N	118 05 01 W	4	YES BASIC WIDE	P DME			/ 33Z

TABLE D-3
ENROUTE ENVIRONMENT
(Page 1 of 4)

SYSTEM ID	LOCATION CITY STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	CHANNEL OLD/NEW	LINK NUM
80001	GEORGEAB	CA 34 35 41 N	117 23 21 W	TACAN	LOW	VCV	23X/ 23X	
80002	BEALE	CA 39 08 06 N	121 26 23 W	TACAN	LOW	BAB	23X/ 23X	
80003	IMP BHM	CA 32 33 51 N	117 06 32 W	TACAN	LOW	NRS	29X/ 29X	
80004	MIRANAR	CA 37 52 11 N	117 09 14 W	TACAN	LOW	NKX	33X/ 33X	
80005	EL TORO	CA 33 40 28 N	117 43 54 W	TACAN	LOW	NZJ	39X/ 39X	
80006	CMS LND	CA 37 24 25 N	121 06 44 W	TACAN	LOW	NR2	39X/ 39X	
80007	SNWICLIS	CA 33 14 06 N	119 27 27 W	TACAN	LOW	NSI	43X/ 43X	
80008	PT HUGU	CA 34 07 24 N	119 07 16 W	TACAN	LOW	NTD	43X/ 43X	
80009	HILL AFB	UT 41 07 14 N	111 57 46 W	TACAN	LOW	HIF	49X/ 49X	
80010	SEAL BHM	CA 33 43 50 N	118 05 10 W	TACAN	TERMINAL			
80011	CRAWLNDG	CA 37 24 40 N	121 06 33 W	TACAN	LOW	NID	49X/ 53X	
80012	CHIVA LK	CA 35 41 17 N	117 41 23 W	TACAN	LOW	CCS	53X/ 53X	
80013	CPNDLTN	CA 34 43 57 N	120 34 55 W	TACAN	TERMINAL	VRG	58X/ 58X	
80014	VANDENBG	CA 34 43 57 N	120 34 55 W	TACAN	LOW	NUC	73X/ 73X	
80015	SNCLEWNT	CA 33 01 37 N	118 34 43 W	TACAN	LOW	SRF	75X/ 75X	
80016	HAMILTON	CA 38 03 35 N	122 50 14 W	TACAN	LOW	LUF	77X/ 77X	
80017	LUKE	AZ 33 32 41 N	112 22 52 W	TACAN	LOW	RIV	77X/ 77X	
80018	MARCHAFB	CA 33 54 25 N	117 16 26 W	TACAN	LOW	NG7	78X/ 78X	
80019	ALAMEDA	CA 38 32 04 N	121 17 44 W	TACAN	LOW	MHR	81X/ 81X	
80020	MATHERAB	CA 38 32 04 N	121 17 44 W	TACAN	LOW	NFL	82X/ 82X	
80021	FALLON	NE 39 24 59 N	218 42 10 W	TACAN	HIGH	NYL	84X/ 84X	
80022	YUNA	AZ 32 38 48 N	114 36 46 W	TACAN	LOW	DMA	111X/ 111X	
80023	DVSMITHN	AZ 32 09 36 N	116 52 49 W	TACAN	LOW	SUU	113X/ 113X	
80024	TRAVISAB	CA 36 14 44 N	121 56 38 W	TACAN	LOW	NZY	117X/ 117X	
80025	MTISLO	CA 32 41 53 N	117 14 05 W	TACAN	LOW	NUC	123X/ 123X	
80026	SNCLWNTI	CA 33 01 37 N	118 34 43 W	TACAN	LOW	NUG	123X/ 123X	
80027	MOFTFLD	CA 37 25 57 N	122 03 23 W	TACAN	LOW	VEL	19X/ 19X	
9001	VERNAL	UT 40 22 44 N	109 29 33 W	VOR 1-A	LOW	FLG	19X/ 19X	
9001	LGSTAFF	AZ 34 36 00 N	111 40 24 W	VOR 1-A	LOW	OLS	19X/ 19X	
90015	NOGALES	AZ 31 24 54 N	110 50 54 W	VOR 1-A	LOW	VTU	19X/ 19X	
90016	VENTURA	CA 34 06 54 N	119 02 55 W	VOR 1-A	LOW	LMS	21X/ 21X	
90017	LAK HUGU	CA 34 43 59 N	118 34 34 W	VOR 1-A	LOW	PVU	21X/ 21X	
90018	PROV MUN	UT 40 12 54 N	111 43 14 W	VOR 1-A	LOW	GOE	21X/ 21X	
90019	GLOBE	AZ 33 22 38 N	110 43 53 W	VOR 1-A	LOW	RDD	21X/ 21X	
90020	RETN MUN	CA 40 30 17 N	122 17 26 W	VOR 1-A	LOW	CDC	23X/ 23X	
90021	CIOR MUN	UT 37 47 15 N	113 04 03 W	VOR 1-A	LOW	SNA	25X/ 25X	
90022	SANT AN	CA 33 40 61 N	117 51 43 W	VOR 1-A	LOW	IGH	25X/ 25X	
90023	KINGMAN	AZ 35 15 38 N	113 56 00 W	VOR 1-A	LOW	DUG	25X/ 25X	
90024	DOUGLAS	AZ 31 28 21 N	109 36 05 W	VOR 1-A	LOW	PUC	27X/ 27X	
90025	PRICE	UT 39 36 50 N	110 44 56 W	VOR 1-A	TERMINAL	CEC	27X/ 27X	
90026	SANT MAR	CA 34 57 09 N	120 31 14 W	VOR 1-A	LOW	PTV	29X/ 29X	
90027	CRESCENT	CA 41 46 47 N	124 14 23 W	VOR 1-3	LOW	VIS	31X/ 31X	
90028	FORTAVIL	CA 35 54 47 N	119 01 12 W	VOR 1-A	TERMINAL	SXC	33X/ 33X	
90029	VICALIA	CA 36 22 03 N	119 28 52 W	VOR 1-A	LOW	STS	33X/ 33X	
90030	SNT CALA	CA 33 22 30 N	118 25 08 W	VOR 1-A	LOW	B1H	33X/ 33X	
90031	SNT ROS	CA 38 30 30 N	122 48 34 W	VOR 1-A	LOW	FJS	33X/ 33X	
90032	BISHOP	CA 37 22 37 N	118 21 56 W	VOR 1-A	LOW	LGU	35X/ 35X	
90033	FT JONES	CA 41 26 59 N	122 48 19 W	VOR 1-A	TERMINAL	OAB	35X/ 35X	
90034	LOGAN	UT 41 50 39 N	111 51 53 W	VOR 1-A	TERMINAL			
90035	MOAB	UT 38 45 23 N	109 44 55 W	VOR 1-A	TERMINAL			

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IIT RESEARCH INST ANNAPOLIS MD
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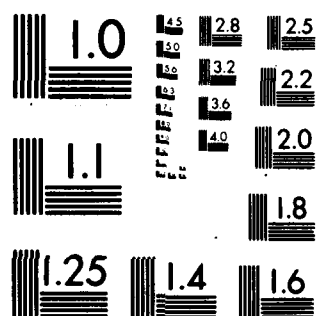
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MICROCOPY RESOLUTION TEST CHART
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TABLE D-3
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SYSTEM ID	LOCATION CITY STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	CHANNEL OLD/NEW	LINK MUP
90036	SNT GEORGE	UT 17 05 17 N	113 55 30 W	VOR 1-A	TERMINAL	OZN	35X/ 35X	
90037	CHCO RUN	CA 39 47 24 N	121 50 46 W	VOR 1-A	TERMINAL	CIC	35X/ 35X	
90038	MARWELL	CA 39 19 04 N	122 13 14 W	VOR 1-A	LOW	MXV	37X/ 37X	
90039	PRICST	CA 36 08 26 N	120 39 50 W	VOR 1-A	LOW	ROH	39X/ 39X	
90040	ARCATA	CA 40 58 54 N	124 06 26 W	VOR 1-A	LOW	ACV	43X/ 43X	
90041	BUCKEYE	CA 33 27 12 N	112 49 26 W	VOR 1-A	LOW	BKX	43X/ 43X	
90042	ELY	AV 39 17 54 N	114 50 51 W	VOR 1-A	LOW	ELY	45X/ 45X	
90043	SNT MONC	CA 34 00 37 N	118 27 21 W	VOR 1-A	LOW	SHQ	45X/ 45X	
90044	MARYSVIL	CA 39 05 56 N	121 34 19 W	VOR 1-A	TERMINAL	MYV	45X/ 45X	
90045	MONTAGUE	CA 41 47 10 N	122 27 50 W	VOR 1-A	TERMINAL	STV	45X/ 45X	
90046	SNT MONC	CA 34 00 37 N	118 27 21 W	VOR 1-A	LOW	SHQ	45X/ 45X	
90047	RIVERSID	CA 33 57 07 N	117 26 54 W	VOR 1-A	LOW	RAL	51X/ 51X	
90048	POMONA	CA 34 04 42 N	117 47 10 W	VOR 1-A	LOW	POH	41X/ 41X	
90049	FORT HUA	AZ 31 35 26 N	110 20 32 W	VOR 1-A	TERMINAL	FNU	53X/ 53X	
90050	VANDENBE	CA 34 42 56 N	120 33 30 W	VOR 1-A	LOW	VBG	55X/ 55X	
90051	PEACH SP	AZ 35 37 29 N	113 32 37 W	VOR 1-A	HIGH	PSS	57X/ 57X	
90052	WILFORD	UT 28 21 37 N	113 00 45 W	VOR 1-A	HIGH	MLF	58X/ 58X	
90053	NAPA CO	CA 38 10 44 N	122 22 19 W	VOR 1-A	LOW	APC	58X/ 58X	
90054	ONTARIO	CA 33 53 06 N	117 31 44 W	VOR 1-A	HIGH	ONT	59X/ 59X	
90055	847 MOON	NY 41 34 04 N	116 55 17 W	VOR 1-A	HIGH	BAM	59X/ 59X	
90056	SUNNEVIL	UT 40 43 34 N	113 45 24 W	VOR 1-A	HIGH	BVL	70X/ 70X	
90057	ST JOHNS	AZ 34 25 26 N	109 08 34 W	VOR 1-A	HIGH	SJN	70X/ 70X	
90058	UKIAH PU	CA 39 03 12 N	123 16 23 W	VOR 1-A	HIGH	UKI	70X/ 70X	
90059	SAN LUIS	CA 35 15 08 N	120 45 31 W	VOR 1-A	LOW	SBP	71X/ 71X	
90060	FILLMORE	CA 34 21 24 N	118 52 49 W	VOR 1-A	LOW	FIM	72X/ 72X	
90061	JAYSLON	AZ 35 03 42 N	110 47 40 W	VOR 1-A	HIGH	INW	73X/ 73X	
90062	LOS BANG	CA 36 42 56 N	120 46 40 W	VOR 1-A	LOW	PYN	73X/ 73X	
90063	NECTOR	CA 39 47 59 N	116 27 43 W	VOR 1-A	HIGH	NEC	74X/ 74X	
90064	ENTEE CT	UT 37 41 21 N	112 18 11 W	VOR 1-A	HIGH	BCE	75X/ 75X	
90065	RESNA T	CA 36 53 12 N	119 48 11 W	VOR 1-A	HIGH	FAT	76X/ 76X	
90066	GRD CYN	AZ 35 57 37 N	112 08 43 W	VOR 1-A	LOW	GCN	78X/ 78X	
90067	VA NUYS	CA 34 13 24 N	118 29 27 W	VOR 1-A	LOW	VNY	78X/ 78X	
90068	DAGECTY	CA 34 57 45 N	116 34 38 W	VOR 1-A	HIGH	DAG	79X/ 79X	
90069	LAK TANO	CA 39 10 50 N	120 16 07 W	VOR 1-A	LOW	LTA	79X/ 79X	
90070	CHANDLER	AZ 32 18 11 N	111 39 03 W	VOR 1-A	LOW	CHD	80X/ 80X	
90071	MARCH AF	CA 33 45 31 N	117 11 17 W	VOR 1-A	LOW	RIV	81X/ 81X	
90072	TUSA CIT	AZ 36 07 17 N	111 16 08 W	VOR 1-A	TERMINAL	78C	82X/ 82X	
90073	L A INTL	CA 33 55 59 N	118 25 52 W	VOR 1-A	HIGH	LAX	83X/ 83X	
90074	LUCIN	UT 41 21 47 N	113 50 23 W	VOR 1-A	HIGH	LCU	83X/ 83X	
90075	PT REYES	CA 38 04 47 N	122 52 00 W	VOR 1-A	LOW	PYE	84X/ 84X	
90076	WOODSIDE	CA 37 23 33 N	122 16 49 W	VOR 1-A	LOW	OSI	86X/ 86X	
90077	JULIAN	CA 33 08 26 N	116 35 06 W	VOR 1-A	LOW	JLI	87X/ 87X	
90078	BIS SUR	CA 34 10 53 N	121 38 28 W	VOR 1-A	LOW	BSR	87X/ 87X	
90079	PONTOMA	CA 40 40 17 N	124 14 00 W	VOR 1-A	LOW	FOT	87X/ 87X	
90080	PSCOT MU	AZ 34 42 09 N	112 28 46 W	VOR 1-A	HIGH	PSC	88X/ 88X	
90081	HAZEN	NV 39 30 59 N	118 59 48 W	VOR 1-A	LOW	HZN	88X/ 88X	
90082	SN JOS M	CA 37 21 53 N	121 55 45 W	VOR 1-A	LOW	SJC	89X/ 89X	
90083	TWIN PLM	CA 34 06 44 N	115 46 09 W	VOR 1-A	LOW	TNP	89X/ 89X	
90084	BELLS	NV 41 06 42 N	114 58 36 W	VOR 1-A	LOW	LWL	89X/ 89X	
90085	MERCED	CA 37 13 10 N	120 23 57 W	VOR 1-A	LOW	MCE	89X/ 89X	

TABLE D-3
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SYSTEM ID	LOCATION CITY STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	CHANNEL OLD/NEW	LINK AUP
90086	SOC MOUS	NV 41 24 34 N	118 01 56 W	VOR 1-A	LOW	SDD	90X/ 90X	
90087	MORAN MS	NV 38 46 14 N	114 16 36 W	VOR 1-A	LOW	MMH	90X/ 90X	
90088	PASO R M	CA 35 40 21 N	120 37 34 W	VOR 1-A	LOW	PRB	90X/ 90X	
90089	GOFFS	CA 35 07 57 N	115 10 32 W	VOR 1-A	LOW	GFS	91X/ 91X	
90090	WILLIAMS	CA 35 04 16 N	122 01 36 W	VOR 1-A	LOW	ILA	91X/ 91X	
90091	PALMDALE	CA 34 37 53 N	118 03 47 W	VOR 1-A	HIGH	PMC	92X/ 92X	
90092	CLVO MUN	NV 40 42 35 N	115 45 38 W	VOR 1-A	LOW	EKO	92X/ 92X	
90093	WESI-C-C	CA 37 37 75 N	126 57 24 W	VOR 1-A	HIGH	MOO	93X/ 93X	
90094	BEATTY	NV 36 44 02 N	116 44 48 W	VOR 1-A	HIGH	ETV	94X/ 94X	
90095	CAS GRND	AZ 32 53 09 N	111 54 29 W	VOR 1-A	HIGH	CZG	95X/ 95X	
90096	LINDED	CA 36 04 29 N	121 00 10 W	VOR 1-A	HIGH	LIN	95X/ 95X	
90097	SNT BA M	CA 36 30 35 N	119 46 12 W	VOR 1-A	HIGH	SRA	96X/ 96X	
90098	MINA	NV 38 33 35 N	115 01 55 W	VOR 1-A	HIGH	WVA	98X/ 98X	
90099	SACRAM X	CA 38 26 15 N	121 33 02 W	VOR 1-A	HIGH	SAC	90X/ 99X	
90100	NEEDLE M	CA 34 45 53 N	114 28 24 W	VOR 1-A	HIGH	EED	99X/ 99X	
90101	OCEANSIC	CA 33 14 24 N	117 25 01 W	VOR 1-A	HIGH	OCN	100X/100X	
90102	SAN SINO	AZ 32 16 09 N	109 15 45 W	VOR 1-A	HIGH	SSO	110X/110X	
90103	BAKERFLC	CA 32 23 05 N	118 05 47 W	VOR 1-A	HIGH	EFL	120X/120X	
90104	PLN SPR	CA 32 52 12 N	115 25 44 W	VOR 1-A	LOW	PSP	120X/120X	
90105	FRIANT	CA 37 36 16 N	118 35 40 W	VOR 1-A	HIGH	FRA	120X/120X	
90106	PHX S MB	AZ 33 25 53 N	111 53 17 W	VOR 1-A	HIGH	PHX	103X/103X	
90107	SEAL BCH	CA 33 47 00 N	118 03 14 W	VOR 1-A	LOW	SLI	104X/104X	
90108	OGDEN MU	UT 41 13 27 N	112 35 51 W	VOR 1-A	LOW	OGO	104X/104X	
90109	RED BUF	CA 40 05 57 N	122 14 07 W	VOR 1-A	HIGH	RBL	104X/104X	
90110	S F INTL	CA 37 36 50 N	122 21 23 W	VOR 1-A	LOW	SFO	105X/105X	
90111	COCHISE	AZ 32 02 00 N	105 45 27 W	VOR 1-A	HIGH	CIE	105X/105X	
90112	S F INTL	CA 37 37 10 N	122 22 22 W	VOR 1-A	HIGH	SFO	105X/105X	
90113	CANARILLO	CA 34 12 45 N	119 35 36 W	VOR 1-A	LOW	CMA	105X/105X	
90114	IMPERIAL	CA 32 44 56 N	115 20 28 W	VOR 1-A	HIGH	IPL	106X/106X	
90115	MANASVIL	UT 38 25 01 N	110 41 56 W	VOR 1-A	HIGH	HVE	106X/106X	
90116	STRTN ME	CA 37 50 01 N	121 10 13 W	VOR 1-A	HIGH	SCX	107X/107X	
90117	GORMAN	CA 34 46 10 N	118 51 38 W	VOR 1-A	LOW	GMA	106X/106X	
90118	DELTA MU	UT 39 18 05 N	112 30 17 W	VOR 1-A	HIGH	DTA	108X/108X	
90119	THERMAL	CA 33 37 41 N	116 09 34 W	VOR 1-A	HIGH	TRP	108X/108X	
90120	SAUSALIT	CA 37 51 15 N	122 31 18 W	VOR 1-A	LOW	SAU	109X/109X	
90121	WILSON CK	NV 38 15 01 N	114 23 36 W	VOR 1-A	HIGH	ILC	110X/110X	
90122	EDR AFS	CA 34 58 57 N	117 43 54 W	VOR 1-A	LOW	EDW	110X/110X	
90123	TRAVIS A	CA 38 20 47 N	121 48 35 W	VOR 1-A	LOW	SUU	111X/111X	
90124	LOVELOCK	NV 40 04 00 N	118 33 36 W	VOR 1-A	LOW	LLO	112X/112X	
90125	CAVITO A	CA 34 31 53 N	120 45 24 W	VOR 1-A	LOW	GVO	112X/112X	
90126	FAIRFIELD	UT 40 16 30 N	111 56 23 W	VOR 1-A	LOW	FFU	113X/113X	
90127	GILA BEN	AZ 32 57 22 N	112 40 25 W	VOR 1-A	HIGH	GBN	113X/113X	
90128	BOLDR CI	NV 35 55 45 N	114 51 46 W	VOR 1-A	HIGH	CLD	114X/114X	
90129	YUCA	AZ 32 45 05 N	114 56 08 W	VOR 1-A	HIGH	YCU	115X/115X	
90130	S LAK CI	UT 40 51 01 N	111 58 52 W	VOR 1-A	HIGH	SLC	115X/115X	
90131	OAKLAND	CA 37 42 34 N	122 13 21 W	VOR 1-A	HIGH	OAK	115X/115X	
90132	LAS BEGA	NV 36 04 47 N	115 09 32 W	VOR 1-A	HIGH	LAS	116X/116X	
90133	COS-CORO	CA 38 12 42 N	122 02 39 W	VOR 1-A	TERMINAL	CCR	117X/117X	
90134	TUSON IM	AZ 32 07 21 N	110 49 12 W	VOR 1-A	HIGH	TUS	118X/118X	
90135	AVENAL	CA 35 36 49 N	119 56 39 W	VOR 1-A	HIGH	AVE	118X/118X	

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SYSTEM DB	LOCATION CITY STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	CHANNEL OLD/NEW	LINK NUM
90136	TONGAH	NV 38 01 51 N	117 01 57 W	VOR 1-A	LOW	TPH	119X/119X	
90137	EL TORO	CA 33 40 03 N	117 43 50 W	VOR 1-A	LOW	NZJ	119X/119X	
90138	SALIN HU	CA 36 39 50 N	121 36 08 W	VOR 1-A	HIGH	SNS	120X/120X	
90139	BLVINE	CA 33 35 46 N	114 45 37 W	VOR 1-A	HIGH	BLM	121X/121X	
90140	FELLOWS	CA 35 05 35 N	119 51 53 W	VOR 1-A	LOW	FLW	122X/122X	
90141	PAGE	AZ 36 55 41 N	111 27 00 W	VOR 1-A	TERMINAL	PGA	123X/123X	
90142	COALDALE	NV 38 00 12 N	117 46 10 W	VOR 1-A	HIGH	OAL	124X/124X	
90143	MISN BAY	CA 32 46 56 N	117 13 28 W	VOR 1-A	HIGH	M78	125X/125X	
90144	MYTON	UT 40 08 40 N	110 07 37 W	VOR 1-A	HIGH	MTU	126X/126X	
90145	PARKER	CA 39 06 07 N	114 40 52 W	VOR 1-A	HIGH	PKE	126X/126X	
90146	RENO INT	NV 39 31 53 N	119 39 18 W	VOR 1-A	HIGH	RNO	126X/126X	
90147	SCALE	CA 39 17 46 N	121 30 32 W	VOR 1-A	LOW	EAE	27X/ 27X	
90148	SIERRA DPT	CA 40 15 00 N	120 39 00 W	VOR 1-A	LOW	PCC	29X/ 29X	
90149	MCCLELLN	CA 36 40 03 N	121 24 12 W	VOR 1-A	LOW	VIS	31X/ 31X	
90150	VISCALIA	CA 36 22 03 N	119 28 52 W	VOR 1-A	TERMINAL	SMX	47X/ 47X	
90151	SANTAMAR	CA 34 27 09 N	120 31 14 W	VOR 1-A	TERMINAL	FTQ	72X/ 72X	
90152	FT ORD	CA 36 41 00 N	121 46 00 W	VOR 1-A	LOW	STS	77X/ 77X	
90153	SANTAROS	CA 38 30 30 N	122 48 34 W	VOR 1-A	LOW	MLC	80X/ 80X	
90154	LEWDORE	CA 36 02 39 N	119 57 55 W	VOR 1-A	LOW	PLC	102X/102X	
90155	PLACRVLL	CA 36 42 27 N	120 44 57 W	VOR 1-A	LOW			

APPENDIX E
CHANNEL PLAN

This appendix contains a listing of the channel plan used in the initial assignment attempt.

TABLE E-1
CHANNEL PLAN
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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
17X	-	-	978	108.00	-
17Y	5031.0	1104	1104	108.05	-
17XZ	5031.3	978	-	-	-
18X	5031.6	979	979	108.10	334.10
18Y	5031.9	1105	1105	108.15	334.55
18XZ	5032.2	979	-	-	-
19X	-	-	980	108.20	-
19Y	5032.5	1106	1106	108.25	-
19XZ	5032.8	980	-	-	-
20X	5033.1	981	981	108.30	334.10
20Y	5033.4	1107	1107	108.35	334.95
20XZ	5033.7	981	-	-	-
21X	-	-	982	108.40	-
21Y	5034.0	1108	1108	108.45	-
21XZ	5034.3	982	-	-	-
22X	5034.6	983	983	108.50	329.90
22Y	5034.9	1109	1109	108.55	329.75
22XZ	5035.2	983	-	-	-
23X	-	-	984	108.66	-
23Y	5035.5	1110	1110	108.65	-
23XZ	5035.8	984	-	-	-
24X	5036.1	985	985	108.70	330.50
24Y	5036.4	1111	1111	108.75	330.35
24XZ	5036.7	985	-	-	-
25X	-	-	986	108.80	-
25Y	5037.0	1112	1112	108.85	-
25XZ	5037.3	986	-	-	-
26X	5037.6	987	987	108.90	329.30
26Y	5037.9	1113	1113	108.95	329.15
26XZ	5038.2	987	-	-	-
27X	-	-	988	109.00	-
27Y	5038.5	1114	1114	109.05	-
27XZ	5038.8	988	-	-	-
28X	5039.1	989	989	109.10	331.40
28Y	5039.4	1115	1115	109.15	331.25
28XZ	5039.7	989	-	-	-
29X	-	-	990	109.20	-
29Y	5040.0	1116	1116	109.25	-
29XZ	5040.3	990	-	-	-
30X	5040.6	991	991	109.30	332.00
30Y	5040.9	1117	1117	109.35	331.85
30XZ	5041.2	991	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
31X	-	-	992	109.40	-
31Y	5041.5	1118	1118	109.45	-
31XZ	5041.8	992	-	-	-
32X	5042.1	993	993	109.50	332.60
32Y	5042.4	1119	1119	109.55	332.45
32XZ	5042.7	993	-	-	-
33X	-	-	994	109.60	-
33Y	5043.0	1120	1120	109.65	-
33XZ	5043.3	994	-	-	-
34X	5043.6	995	995	109.70	333.20
34Y	5043.9	1121	1121	109.75	333.05
34XZ	5044.2	995	-	-	-
35X	-	-	996	109.80	-
35Y	5044.5	1122	1122	109.85	-
35XZ	5044.8	991	-	-	-
36X	5045.1	997	997	109.90	333.80
36Y	5045.4	1123	1123	109.95	333.65
36XZ	5045.7	997	-	-	-
37X	-	-	998	110.00	-
37Y	5046.0	1124	1124	110.05	-
37XZ	5046.3	998	-	-	-
38X	5046.6	999	999	110.10	334.40
38Y	5046.9	1125	1125	110.15	334.25
38XZ	5047.2	999	-	-	-
39X	-	-	1000	110.20	-
39Y	5047.5	1126	1126	110.25	-
39XZ	5047.8	1000	-	-	-
40X	5048.1	1001	1001	110.30	335.00
40Y	5048.4	1127	1127	110.35	334.85
40XZ	5048.4	1001	-	-	-
41X	-	-	1002	110.40	-
41Y	5049.0	1128	1128	110.45	-
41XZ	5049.3	1002	-	-	-
42X	5049.6	1003	1003	110.50	329.60
42Y	5049.9	1129	1129	110.55	329.45
42XZ	5050.2	1003	-	-	-
43X	-	-	1004	110.60	-
43Y	5050.5	1130	1130	110.65	-
43XZ	5050.8	1004	-	-	-
44X	5051.1	1005	1005	110.70	330.20
44Y	5051.4	1131	1131	110.75	330.05
44XZ	5051.7	1005	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
45X	-	-	1006	110.80	-
45Y	5052.0	1132	1132	110.85	-
45XZ	5052.3	1006	-	-	-
46X	5052.6	1007	1007	110.90	330.80
46Y	5052.9	1133	1133	110.95	330.65
46XZ	5053.2	1007	-	-	-
47X	-	-	1008	111.00	-
47Y	-	-	1134	111.05	-
47XZ	5053.5	1008	-	-	-
48X	5053.8	1009	1009	111.10	331.70
48Y	5054.1	1135	1135	111.15	331.55
48XZ	5054.4	1009	-	-	-
49X	-	-	1010	111.20	-
49Y	-	-	1136	111.25	-
49XZ	5054.7	1010	-	-	-
50X	5055.0	1011	1011	111.30	332.30
50Y	5055.3	1137	1137	111.35	332.15
50XZ	5055.6	1011	-	-	-
51X	-	-	1012	111.40	-
51Y	-	-	1138	111.45	-
51XZ	5055.9	1012	-	-	-
52X	5056.2	1013	1013	111.50	332.90
52Y	5056.5	1139	1139	111.55	332.75
52XZ	5056.8	1013	-	-	-
53X	-	-	1014	111.60	-
53Y	-	-	1014	111.65	-
53XZ	5057.1	1014	-	-	-
54X	5057.4	1015	1015	111.70	333.50
54Y	5057.7	1141	1141	111.75	333.35
54XZ	5058.0	1015	-	-	-
55X	-	-	1016	111.80	-
55Y	-	-	1142	111.85	-
55XZ	5058.3	1016	-	-	-
56X	5058.6	1017	1017	111.90	331.90
56Y	5058.9	1143	1143	111.95	330.95
56XZ	5059.2	1017	-	-	-
57X	-	-	1018	112.00	-
57Y	-	-	1144	112.05	-
57XZ	5059.5	1018	-	-	-
58X	-	-	1019	112.10	-
58Y	-	-	1145	112.15	-
58XZ	5059.8	1019	-	-	-
59X	-	-	1020	112.20	-
59Y	-	-	1146	112.25	-
59XZ	5060.1	1020	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
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70X	-	-	1157	112.30	-
70Y	-	-	1031	112.35	-
71X	-	-	1158	112.40	-
71Y	-	-	1032	112.45	-
72X	-	-	1159	112.50	-
72Y	-	-	1033	112.55	-
72XZ	5060.4	1159	-	-	-
73X	-	-	1160	112.60	-
73Y	-	-	1034	112.65	-
73XZ	5060.7	1160	-	-	-
74X	-	-	1161	112.70	-
74Y	-	-	1035	112.75	-
74XZ	5061.0	1161	-	-	-
75X	-	-	1162	112.80	-
75Y	-	-	1036	112.85	-
75XZ	5061.3	1162	-	-	-
76X	-	-	1163	112.90	-
76Y	-	-	1037	112.95	-
76XZ	5061.6	1163	-	-	-
77X	-	-	1164	113.00	-
77Y	-	-	1038	113.05	-
77XZ	5061.9	1164	-	-	-
78X	-	-	1165	113.10	-
78Y	5062.2	1039	1039	113.15	-
78XZ	5062.5	1165	-	-	-
79X	-	-	1166	113.20	-
79Y	5062.8	1040	1166	113.20	-
79XZ	5063.1	1166	-	-	-
80X	-	-	1167	113.30	-
80Y	5063.4	1041	1041	113.35	-
80XZ	5063.7	1167	-	-	-
81X	-	-	1168	113.40	-
81Y	5064.0	1042	1042	113.45	-
81XZ	5064.3	1168	-	-	-
82X	-	-	1169	113.50	-
82Y	5064.6	1043	1043	113.55	-
82XZ	5064.9	1169	-	-	-
83X	-	-	1170	113.60	-
83Y	5065.2	1044	1044	113.65	-
83XZ	5065.5	1170	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UIIF (MHz)
84X	-	-	1171	113.70	-
84Y	5065.8	1045	1045	113.75	-
84XZ	5066.1	1171	-	-	-
85X	-	-	1172	113.80	-
85Y	5066.4	1046	1046	113.85	-
85XZ	5066.7	1172	-	-	-
86X	-	-	1173	113.90	-
86Y	5067.0	1047	1047	113.95	-
86XZ	5067.3	1173	-	-	-
87X	-	-	1174	114.00	-
87Y	5067.6	1048	1048	114.05	-
87XZ	5067.9	1174	-	-	-
88X	-	-	1175	114.10	-
88Y	5068.2	1049	1049	114.15	-
88XZ	5068.5	1175	-	-	-
89X	-	-	1176	114.20	-
89Y	5068.8	1050	1050	114.25	-
89XZ	5069.1	1176	-	-	-
90X	-	-	1177	114.30	-
90Y	5069.4	1051	1051	114.35	-
90XZ	5069.7	1177	-	-	-
91X	-	-	1178	114.40	-
91Y	5070.0	1052	1052	114.45	-
91XZ	5070.3	1178	-	-	-
92X	-	-	1179	114.50	-
92Y	5070.6	1053	1053	114.55	-
92XZ	5070.9	1179	-	-	-
93X	-	-	1180	114.60	-
93Y	5070.2	1054	1054	114.65	-
93XZ	5070.5	1180	-	-	-
94X	-	-	1181	114.70	-
94Y	5071.8	1055	1055	114.75	-
94XZ	5072.1	1181	-	-	-
95X	-	-	1182	114.80	-
95Y	5072.4	1056	1056	114.85	-
95XZ	5072.7	1182	-	-	-
96X	-	-	1183	114.90	-
96Y	5073.0	1057	1057	114.90	-
96XZ	5073.3	1183	-	-	-
97X	-	-	1184	115.00	-
97Y	5073.6	1058	1058	115.05	-
97XZ	5073.9	1184	-	-	-
98X	-	-	1185	115.10	-
98Y	5074.2	1059	1059	115.15	-
98XZ	5074.5	1185	-	-	-

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
99X	-	-	1186	115.20	-
99Y	5074.8	1060	1060	115.25	-
99XZ	5075.1	1186	-	-	-
100X	-	-	1187	115.30	-
100Y	5075.4	1061	1061	115.35	-
100XZ	5075.7	1187	-	-	-
101X	-	-	1188	115.40	-
101Y	5076.0	1062	1062	115.45	-
101XZ	5076.3	1188	-	-	-
102X	-	-	1189	115.50	-
102Y	5076.6	1063	1063	115.55	-
102XZ	5076.9	1189	-	-	-
103X	-	-	1190	115.60	-
103Y	5077.2	1064	1064	115.65	-
103XZ	5077.5	1190	-	-	-
104X	-	-	1191	115.70	-
104Y	5077.8	1065	1065	115.75	-
104XZ	5078.1	1191	-	-	-
105X	-	-	1192	115.80	-
105Y	5078.4	1066	1066	115.85	-
105XZ	5078.7	1192	-	-	-
106X	-	-	1193	115.90	-
106Y	5079.0	1067	1067	115.95	-
106XZ	5079.3	1193	-	-	-
107X	-	-	1194	116.00	-
107Y	5079.6	1068	1068	116.05	-
107XZ	5079.9	1194	-	-	-
108X	-	-	1195	116.10	-
108Y	5080.2	1069	1069	116.15	-
108XZ	5080.5	1195	-	-	-
109X	-	-	1196	116.20	-
109Y	5080.8	1070	1070	116.20	-
109XZ	5081.1	1196	-	-	-
110X	-	-	1197	116.30	-
110Y	5081.4	1071	1071	116.35	-
110XZ	5081.7	1197	-	-	-
111X	-	-	1198	116.40	-
111Y	5082.0	1072	1072	116.45	-
111XZ	5082.3	1198	-	-	-
112X	-	-	1199	116.50	-
112Y	5082.6	1073	1073	116.55	-
112XZ	5082.9	1199	-	-	-

TABLE E-1

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Channel	C-Band (MHz)	L-Band (MHz)	L-Band (MHz)	VHF (MHz)	UHF (MHz)
113X	-	-	1200	116.60	-
113Y	5083.2	1074	1074	116.65	-
113XZ	5083.5	1200	-	-	-
114X	-	-	1201	116.70	-
114Y	5083.8	1075	1075	116.75	-
114XZ	5084.1	1201	-	-	-
115X	-	-	1202	116.80	-
115Y	5084.4	1076	1076	116.85	-
115XZ	5084.7	1202	-	-	-
116X	-	-	1203	116.90	-
116Y	5085.0	1077	1077	116.95	-
116XZ	5085.3	1203	-	-	-
117X	-	-	1204	117.00	-
117Y	5085.6	1078	1078	117.05	-
117XZ	5085.9	1204	-	-	-
118X	-	-	1205	117.10	-
118Y	5086.2	1079	1079	117.15	-
118XZ	5086.5	1205	-	-	-
119X	-	-	1206	117.20	-
119Y	5086.8	1080	1080	117.25	-
119XZ	5087.1	1206	-	-	-
120X	-	-	1207	117.30	-
120Y	5087.4	1081	1081	117.35	-
120XZ	5087.7	1207	-	-	-
121X	-	-	1208	117.40	-
121Y	5088.0	1082	1082	117.45	-
121XZ	5088.3	1208	-	-	-
122X	-	-	1209	117.50	-
122Y	5088.6	1083	1083	117.55	-
122XZ	5088.9	1209	-	-	-
123X	-	-	1210	117.60	-
123Y	5089.2	1084	1084	117.65	-
123XZ	5089.5	1210	-	-	-
124X	-	-	1211	117.70	-
124Y	5089.8	1085	1085	117.75	-
124XZ	5090.1	1211	-	-	-
125X	-	-	1212	117.80	-
125Y	-	-	1086	117.85	-
125XZ	5090.4	1212	-	-	-
126X	-	-	1213	117.90	-
126Y	-	-	1087	117.95	-
126XZ	5090.7	1213	-	-	-

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