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DEPARTMENT OF DEFENSE

ELECTROMAGNETIC COMPATIBILITY ANALYSIS CENTER

VALIDATION OF THE COSITE ANALYSIS MODEL (COSAM) FOR SELECTED VHF FM EQUIPMENTS

Prepared by D. J. Hughes and M. N. Lustgarten
of the IIT Research Institute

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FOREWORD

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This report was prepared as part of AF Project 649E under Contract F-19628-73-C-0031 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 Standard Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the United States of America Standards Institute.

Users of this report are invited to submit comments which would be useful in revising or adding to this material to the Director, ECAC, North Severn, Annapolis, Maryland 21402, Attention ACL.

Reviewed by:

DOUGLAS J. HUGHES
Project Engineer, IITRI

J. M. DETERDING
Director of Contractor Operations

Approved by:

GUSTAV J. AKERLAND
Colonel, USAF
Director, DOD ECAC

RICHARD H. DE WITT
Chief, Plans and Resource Mgt.

ABSTRACT

Measurements were made of numerous interactions at a typical cosite installation; results were compared with predictions made by the Cosite Analysis Model (COSAM) developed by the DoD Electromagnetic Compatibility Analysis Center (ECAC). Tests involved six FM voice communications transceivers operating in the 30-76 MHz VHF range. Twenty-five frequency assignments were tested, with several desired signal levels. Types of interactions included adjacent signals, spurious responses, spurious emissions, receiver and transmitter intermodulation (2 and 3-signal mixes; 2nd, 3rd, 5th and 7th orders).

Results show that model accuracy is adequate for predicting the operational performance of collocated VHF-FM tactical communications equipment. Confidence levels are presented.

KEYWORDS

FM
VHF
COSITE
VALIDATION
MEASUREMENTS
ADJACENT SIGNAL
INTERMODULATION
SPURIOUS EMISSIONS
SPURIOUS RESPONSES
FREQUENCY ASSIGNMENT
ELECTROMAGNETIC COMPATIBILITY

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INTRODUCTION

BACKGROUND

Reference 1 describes a cosite analysis model (COSAM) designed to statistically evaluate interactions between communications equipment. The first phase of model development dealt primarily with conventional UHF-AM transmitter/receiver systems which employ single channel voice modulation. Validation of this portion of the model is documented in References 2 and 3.

The second development phase dealt with single channel and multiplexed FM transmitter/receiver systems at VHF. Transmitter and receiver equipment models were derived from spectrum signature measured data. A coupling model was developed from measured VHF coupling data (Reference 6).

Although the model components were based, primarily, on equipment and coupling measured data, a full scale validation program, conducted in several phases was desirable to determine how well the overall COSAM system could predict cosite situations.

Consequently, a measurement program involving VHF equipments was conducted by the U.S. Army Electronic Proving Grounds (USAEPG), Fort Huachuca, Arizona (Reference 4). Supplemental tests were conducted at the Naval Electronic Systems Test and Evaluation Facility (Reference 5). This report compares the measurements obtained during this program with predictions made using COSAM.

The original intent of the effort was to validate the COSAM program for simulated operational configurations of equipments for which no spectrum signature data were available. If this were possible, the desired independence of model development from measured equipment data could have been determined. All tactical VHF equipments fall into one of three or four basic designs. Equipments of each design have been measured in the spectrum signature program. Attempts to obtain equipments of different design, such as commercial land mobile VHF-FM equipments, for this validation program were not successful. Consequently, the effort was necessarily limited to validation of the prediction program relative to equipments for which measured data were previously available. Three-signal intermodulation measured data were not available from the spectrum signature program, so that, for this type of interaction, results obtained represent a test of capability to estimate performance with no measurements.

Most available measured data are, at best, small samples of equipment performance. In general, spectrum signatures involve limited ranges of frequency separation and input power levels for adjacent signal, transmitter and receiver intermodulation, and spurious response and spurious emission tests. They also involve limited samples of equipments of the same nomenclature. The data do not necessarily represent the behavior of all the receivers and transmitters at all frequencies in the tuning range.

OBJECTIVE

The objective of this study was to compare measured data with predictions made by the ECAC COSAM VHF-FM prediction program for the purpose of validating the predictive technique, and to provide quantitative descriptions of confidence in the model and its various components. The objective was necessarily limited to a consideration of equipment for which measured spectrum signature data was available.

APPROACH

The major findings of the measurement program were described and compared with COSAM predictions. Several measures were used to indicate how well the analysis results compared with the measurements.

Measured coupling data were compared with results of the COSAM coupling model. The average difference between the measured and predicted mean values was noted; the standard deviation of the differences was calculated.

The overall model bias and the associated standard deviation were also provided. Model bias is defined as the average value of the differences between the measured SINAD output values and the associated predicted mean values. (The term SINAD represents the signal-plus-interference-plus-noise to interference-plus-noise ratio, or (S+I+N)/(I+N), where S refers to the desired signal power, I is the effective sum of all interference and distortion effects and N refers to noise.) The summation is made in watts; the ratio is in dB.

It was determined that every interaction could be identified as being due, primarily, to a specific mechanism, that is, adjacent signal, noise effects, two- or three-signal intermodulation (2nd, 3rd, 5th and 7th orders), receiver spurious responses or transmitter spurious emissions. Bias and associated standard deviation values were calculated for data groups corresponding to each mechanism.

Two measures were provided to compare predicted System Performance Scores (SPS) with measured SINAD values. The first, using the "Bin method" applicable to overall results, provides a confidence level, in terms of SPS. SPS, for this report, is defined as the probability of exceeding a SINAD of 10 dB. The method involves placing predicted SPS values in bins or groupings and determining the average SPS per bin. These averages were then compared with the percentages obtained by dividing the number of measured values exceeding 10 dB by the number of samples per bin.

A somewhat coarser measure, using the "Interference Condition method", was also used to compare the measured SINAD values with predicted SPS values for all interactions and identifiable mechanisms noted above. The measure provides a confidence level in terms of the magnitude of the error relative to a 5-condition scale based on operational degradation considerations.

The text summarizes major aspects of the study. Results are summarized in Section 2 and are given in detail along with the analysis methods in Section 3. APPENDIX I contains a detailed description of the measurement procedure and a tabulation of the measured data considered in the analysis. APPENDIX II contains a detailed description of the analysis used in the comparison of predicted and measured values. APPENDIX III is a brief description of COSAM. APPENDIX IV contains an analysis of the antenna AT-912/VRC and the antenna coupler MX-2799 and their associated selectivity characteristics.

SECTION 2

RESULTS

The VHF-FM COSAM system predicts operational degradation accurately in spite of the large number and the magnitude of the uncertainties involved. The major results, in terms of agreement between measurements and predictions, were as follows:

1. A comparison of 460 measured coupling values and associated predicted mean values resulted in an average difference of 1.4 dB, with a standard deviation of 8.1 dB.
2. The system model bias for 561 SINAD distribution predictions was -1.72 dB, implying a small tendency toward prediction of too little interference. The standard deviation was 5.6 dB.
3. An evaluation of the interactions identified as being due to each of the specified mechanisms indicated that, for 86% of the cases, the bias value magnitudes for each mechanism were less than 2.4 dB and that standard deviation values were less than 6.3 dB. The bias value magnitudes were less than 6.2 dB for 94% of the cases.
4. As shown in Figure 2-1, 90% of all of the cases resulted in differences between measured SINAD values (S_m) and associated predicted mean values ($\bar{S}_p$) of less than 10 dB.
5. Results of the Bin Method, depicted in Figure 2-2, indicated that, for example, a confidence level of 90% can be assigned to a prediction of SPS ± 0.225. $\overline{SPS}$ is the average SPS value for a specified bin and SPS_m is the measured SPS value associated with the same bin.
6. Results of the Interference Condition method, using a 5-condition scale, indicated that COSAM results were within one condition for 76% of the cases and within two conditions for 92% of the cases.
7. Using the results of the coarser Interference Condition method, the probability of a COSAM prediction resulting in a gross error is less than 0.08. (A gross error is defined as a situation where a prediction will indicate acceptable or better performance when a measurement indicates intolerable degradation, or the converse situation.)

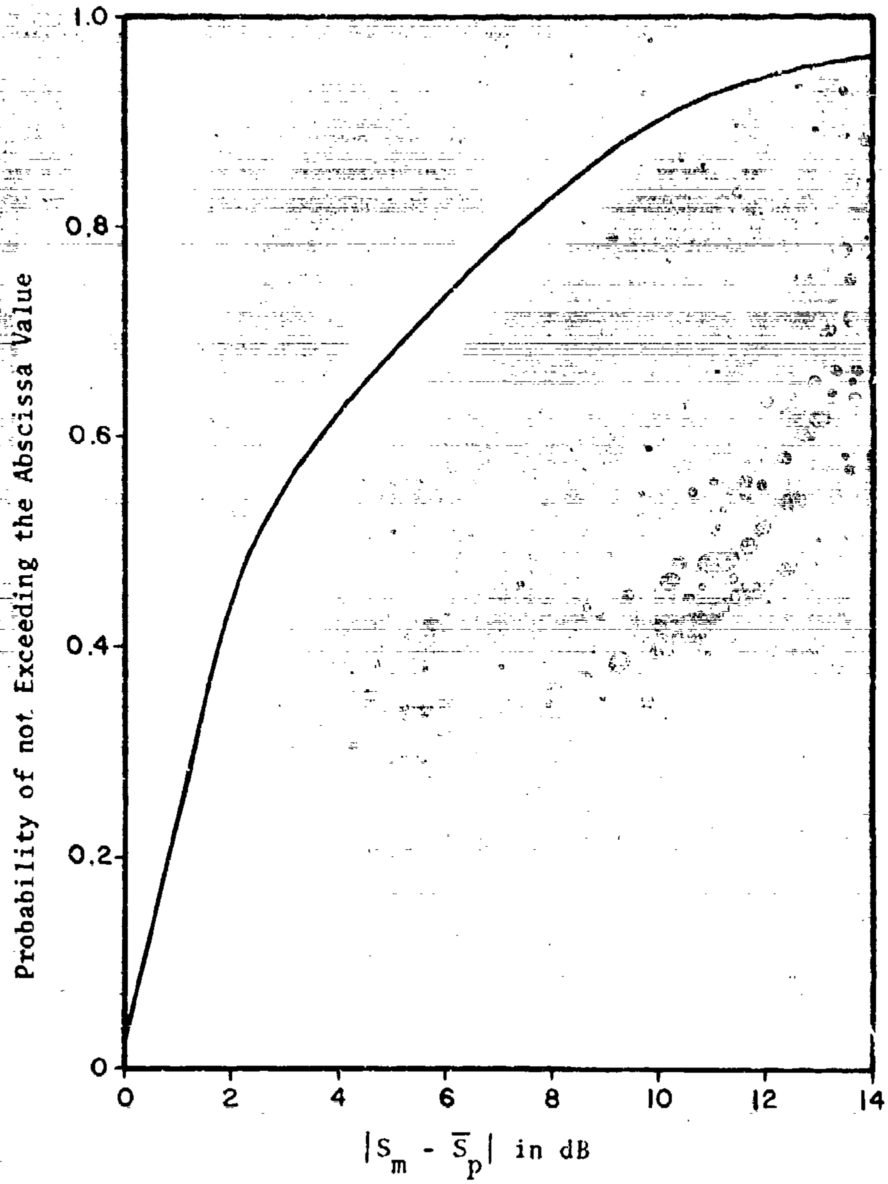

Figure 2-1. Cumulative Probability Distribution of $|S_m - \overline{S}_p|$

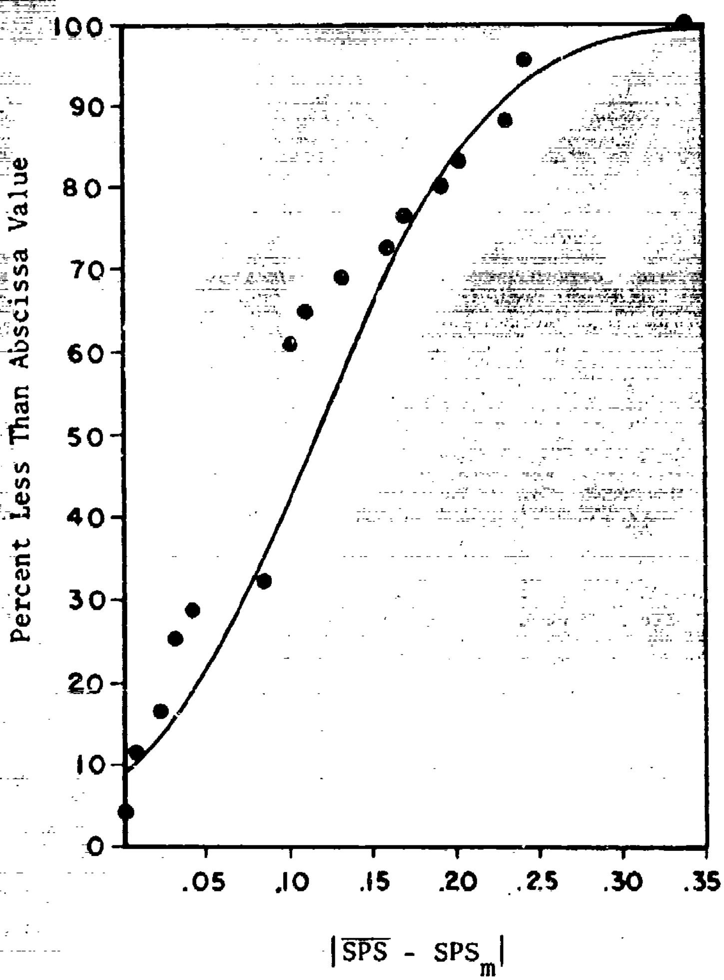

Figure 2-2. Cumulative Probability Distribution of |$\overline{SPS} - SPS_m$|

SECTION 3

ANALYSIS

INTRODUCTION

This section contains an outline of the measurement program and a description of the methods employed to design the experiment. The various measures of comparison between measurements and predictions are also described. Finally, major results of the comparisons are provided.

MEASUREMENT PROGRAM

Reference 4 contains measured bench test information, of the type obtained in the spectrum signature program, for four equipments, namely, the AN/PRC-25, the AN/PRC-77, the AN/VRC-49, (two AN/VRC-12 transceivers) and the AN/GRC-163 (two AN/VRC-12 MUX transceivers). All of these equipments are FM transceivers, using the 30-76 MHz portion of the VHF band. The first three are designed for single-channel voice communications and the last is designed for frequency division multiplexing (MUX) of four voice channels, four teletype channels, and one administrative voice channel.

Also included in the data are coupling loss measurements for a specific configuration of six closely-spaced VHF antennas, and an extensive compilation of information obtained when each of six receivers was individually exposed to simultaneous radiations from five transmitters operating at various frequencies in the 30-76 MHz band.

A complete description of the field measurements is contained in APPENDIX I. Briefly, 25 frequency assignments were provided to the measurement agency. The six transceivers were assigned to the six antennas. For each assignment, a specified tone-modulated desired signal was inserted into the first receiver and the output (S+N)/N ratio was recorded. The five interfering transmitters were activated, using noise modulation. The output (S+I+N)/(I+N) ratio (designated SINAD), was recorded for that assignment. The transmitters were tuned on and off during certain tests to determine which of them contributed to the noted interference.

For a number of tests, the desired signal was modulated with a voice message and the undesired transmitters were modulated with a different voice message. A tape recording was then made.

The procedure was repeated for the other five receivers for the first assignment and then re-run for the other 24 assignments. Then, the total procedure was repeated for different desired signal levels.

In effect, a total of 450 receiver measurements were called for initially [6 receivers x 25 assignments x 3 desired signal levels (-85, -95, -105 dBm)]. Because additional tests were specified after the measurement effort started, the total number of measurements actually recorded was 561.

TABLE II-1, in APPENDIX II, contains a summary of the pertinent measured data, including the interaction identification, the desired signal level, the output (S+N)/N ratio and the output SINAD ratio. Other pertinent data, noting the power levels of the various transmitters and the identification of transmitters causing significant interactions, are given in APPENDIX I.

PREDICTION PROGRAM

Most of the predictions were made, using COSAM, prior to obtaining the measured data. The arrangement of antennas was originally intended to resemble an Army or Marine Corps tactical command post, but practical considerations resulted in the configuration described in APPENDIX I.

Of more concern was the pattern of frequency assignments. It was deemed desirable to subject each equipment to an equal number of each of the interactions considered by COSAM, namely: adjacent signal, spurious responses, spurious emissions, and transmitter and receiver intermodulation (IM). Further, it was desired to check both two- and three-signal IM mixes of various orders. Various frequency separation ranges were included for each interaction type.

It would also have been desirable to secure output SINAD values, ranging from zero to the maximum, in an approximately uniform manner, for all nomenclatures. If all of these conditions could have been met, one could state with confidence that a complete, homogeneous population had been available for analysis. Unfortunately, even with the 25 assignments, it was not possible to generate a homogeneous population. Later sections will describe the spreads involved, the number of each type of interaction, etc.

TABLE II-1, in APPENDIX II, contains, for each interaction, the predicted values of mean SINAD output and the System Performance Score (SPS). These scores are used, as discussed below, to provide a measure of confidence for the model.

The interaction identifications provided in TABLE II-1 refer only to the major mechanisms predicted by COSAM. In many cases, SPS values are influenced by more than one mechanism and more than one transmitter. Consequently, even though, for example, an adjacent signal or a spurious response is identified, the score may reflect the effects of other transmitters and other mechanisms.

MODEL VALIDATION

Evaluation of Coupling Predictions

As noted in APPENDIX I, 460 coupling measurements were made among the 6 antennas. Four of the antennas were connected to MX-2799 antenna couplers, which provide 10 tuning positions. Four tuned frequencies were used in conjunction with four tuning positions of the couplers. The bias was approximately 1.4 dB; i.e., measured values, on the average, exceeded predicted values by this amount. The standard deviation was approximately 8.1 dB.*

Note that the coupling values for a large majority of the measurements included the attenuating effects of the couplers. The coupler selectivity model was based on a single set of measurements made at Fort Huachuca several years ago (Reference 7). The instruction manual for the coupler (Reference 12) indicates that the device is matched to the antenna and the transceiver by ensuring that an input VSWR of 3:1 is not exceeded. The matching procedure involves adjustment of one or two capacitors in each of the ten networks.

For a large majority of the coupling measurements, both couplers were in off-tune positions relative to the measurement frequency. APPENDIX IV indicates that the matching procedure can result in circuits which can have considerably different off-frequency rejection characteristics from one coupler to another. Transmission line length can also have a significant effect. Variations up to 12 dB are possible.

Evaluation of the coupling data suggests that prediction errors can be attributed to the combined effects of antenna-to-antenna coupling and antenna coupler selectivity. Eighty percent of the total sample involved errors less than 10 dB; approximately 94% of the sample involved errors less than 15 dB.

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* The predicted mean values have not been tabulated with the measured values. If desired, one can perform this comparison, using the data supplied in APPENDIX I, Equation III-7 in APPENDIX III, and the curves provided in APPENDIX IV, labelled USAEPG data. The mean antenna gains used in the equation were -1.6 dB for the whip and -6.9 dB for the LPA.

Reference 6 indicates that a standard deviation (σ) of 6 or 7 dB can be expected for the antenna-to-antenna coupling model. The uncertainties involved in coupler tuning can be expected to increase this value to at least 8.1 dB, which was the computed standard deviation.

It is of interest that the path between antennas #1 and #4 consistently indicated errors involving too little loss as compared with predictions. The orientation of the antennas (including the effects of antenna #3 on the jeep; see Figure I-1) evidently resulted in increased gains over this path.

Conversely, combinations 1-2 and 3-4 (on the jeep) exhibited more loss than was predicted.

However, the uncertainties involved with coupler selectivity suggest that there is no justification for modifying the coupling model. A revised statistical coupler loss model which will provide slightly more accuracy, is presented (Figure IV-19 to IV-23), but it appears that no generalized model for the configuration in question could be devised which could reduce the overall σ to a value of less than 7 dB.

In general, the small bias value suggests that the models of path loss and coupler selectivity are predicting average values adequately. Some improvement in the coupler model (involving transmission line length and average values of the tuning capacitors) will be achieved by incorporating the revised statistical model. Construction of improved coupling models for specific configurations (i.e., different orientations relative to a jeep or some other obstacle) does not appear to be warranted.

Evaluation of dB Variations

As indicated, 561 SINAD output distributions were predicted and compared with the same number of measured SINAD output values. Each measurement is said to be a sample of each distribution.

We wish to determine how well the distributions represent the measured values. This is a rather unusual problem in statistical analysis, for which no standard procedure is known. Instead of having one distribution to evaluate, we have a family of distributions. The methods applied in the following subsections were developed in Reference 2.

The model bias (B) is defined as follows:

$$B = \frac{1}{N} \sum_{i=1}^{N} \Delta i \qquad (3\text{-}1)$$

where:

Δi = the ith value of S_M minus the ith value of $\overline{S}_p$, in dB

S_M = the measured output SINAD value, in dB

$\overline{S}_p$ = the predicted output SINAD mean value, in dB

N = the number of samples

B, therefore, represents the mean deviation, or the average difference between the measured values and the associated predicted mean values, in dB. A positive value will indicate, on the average, that the model is predicting too much interference. A value close to zero would be desirable.

The second test performed was the computation of $\sigma(\Delta)$, defined as follows:

$$\sigma(\Delta) = \sum_{i=1}^{N} [(B - \Delta_i)^2/N]^{1/2} \qquad (3\text{-}2)$$

$\sigma(\Delta)$ is defined as the standard deviation of the $S_M - \overline{S}_p$ distribution and provides a measure of the spread of the deviations from the mean. A plot of the cumulative distribution is given in Figure 2-1. Examination of the plot provides the percentage of the total which is less than any specified dB level.

The values of B and $\sigma(\Delta)$, for all of the measurements and the various interaction categories, provide partial validation measures. In a sense, they represent the confidence one can place in the model's ability to predict mean values.

A third test was employed to determine the characteristics of $\sigma(S_p)$, the standard deviation of the predicted distribution relative to the absolute value of $S_M - \overline{S}_p$. A cumulative plot of the relationship is given in APPENDIX II, Figure II-2.

Evaluation of System Performance Scores (SPS)

COSAM's primary output is a numerical estimate of operational performance. That is, the SPS is the probability of exceeding a specific SINAD threshold value (10 dB, in this study), which is relatable to an Articulation Score (AS) or an Articulation Index (AI) value. In other words, the predicted probability distribution is merely a means to an end. If possible, one would prefer to have a straightforward mathematical measure of the quality of the SPS scores, as compared to the measured SINAD values.

As indicated, two approaches to this problem were adopted, namely, the Bin Method and the Interference Condition Method.

The *Bin Method*. All of the SPS values were placed in bins, or groupings. Several bin sizes were examined. Twenty (20) bins were adopted since this value provides an approximately equal number of scores in each bin, except for the first and last bins. A larger number of equal bin sizes provided essentially identical results. TABLE 3-1 indicates the number of cases in each bin, N, and average SPS value associated with each bin, $\overline{SPS}$, together with the percentage of total cases per bin.

Also provided is the number of cases for each bin for which the measured SINAD values exceed the threshold of 10 dB, N_T. Then, we noted the quotient of N_T/N, defined as SPS_m.

The first and last bin are considerably larger than the others. This was because a large number of predictions were either zero or 1.0, accounting for approximately 30% of the total.

The last column, $SPS_m - \overline{SPS}$ represents another possible measure. Over half of the differences are negative, indicating that the model predicted too little interference. The average value of the differences was approximately 0.1 suggesting that, on the average, predicted SPS values will be too high by this amount.

Figure 3-1 is a plot of $\overline{SPS}$ versus SPS_m. The diagonal line describes the results an ideal model would provide if it were given a large homogeneous population. That is, since the SPS represents the probability of exceeding 10 dB, then by definition SPS should equal N_T/N.

TABLE 3-1

RESULTS OF COMPARISON OF PREDICTED SPS VALUES AND MEASURED SINAD VALUES
("THE BIN METHOD")

SPS Limits	Number of Cases (N)	Percent of Total	$\overline{SPS}$	N_T*	SPS_m**	$SPS_m - \overline{SPS}$
.00	140	24.96	.00	14	.10	.10
.01	30	5.35	.01	1	.03	.02
.02-.04	21	3.74	.03	3	.14	.11
.05-.06	21	3.74	.05	1	.05	.00
.07-.12	22	3.92	.10	5	.23	.13
.13-.18	23	4.10	.16	9	.39	.23
.19-.24	20	3.57	.21	4	.20	-.01
.25-.33	23	4.10	.29	7	.30	.01
.34-.42	21	3.74	.38	4	.19	-.19
.43-.51	22	3.92	.47	5	.23	-.24
.52-.59	21	3.74	.56	10	.48	-.08
.60-.68	21	3.74	.64	10	.48	-.16
.69-.77	23	4.10	.73	9	.39	-.34
.78-.83	22	3.92	.81	14	.64	-.17
.84-.89	21	3.74	.86	16	.76	-.10
.90-.93	22	3.92	.92	15	.68	-.24
.94-.96	20	3.57	.95	15	.75	-.20
.97-.98	19	3.39	.98	18	.95	-.03
.99	19	3.39	.99	18	.95	.04
1.00	30	5.35	1.00	29	.97	-.03

*N_T is the number of measured samples equaling or exceeding a SINAD value of 10 dB.

**SPS_m is defined as N_T/N, the effective measured SPS value.

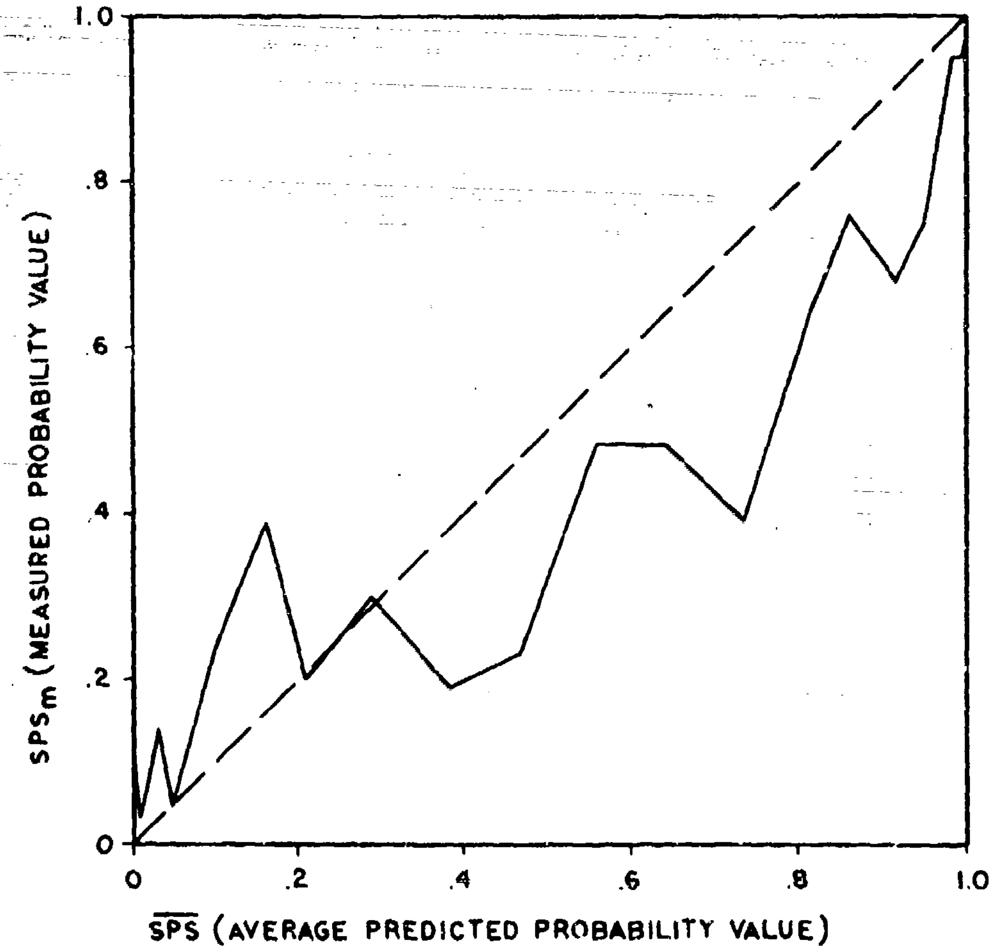

Figure 3-1. Comparison of Measured and Predicted SPS Binned Values

A measure of model error, in terms of SPS units, can be obtained by subtracting the values of SPS_m from the corresponding values of $\overline{SPS}$ on the idealized curve. At the lower values of $\overline{SPS}$, there was a tendency to predict too much interference, while at the mid and higher range values, the converse was true.

Figure 2-2, a cumulative probability distribution of errors (20 values), as defined, is constructed of data from the previous figure and TABLE 3-1. The ordinate probability values refer to the percentage of total cases (561) for which a specified error was noted. The smoothed curve provides an estimate of model error. As can be seen, for 90% of the cases, an error of less than 0.225 SPS units was noted. In practical terms, this indicates that the user can be confident that a prediction of SPS will be accurate within ±0.225 SPS units (for example 0.5 ± 0.225) with 90% confidence. If other confidence levels are required, they may be taken from Figure 2-2.

The smoothed curve in Figure 2-2 is the cumulative distribution function of a normal distribution with a mean of 0.116 and a σ of 0.085.

Interference Condition Method. The Bin method provides an overall error measure. It was also deemed desirable to provide a more detailed measure which could be applied to each type of interaction as well as to the overall population. The Bin method can be meaningfully applied only if a relatively large number of samples is available.

The Interference Condition Method is based on the hypothesis that a comparison of each measured value with each associated predicted SPS value is valid if viewed in operational terms. For example, if the SPS is 0.9 and the measured SINAD is 20 dB, one would note that this is a good prediction. Similarly, if the SINAD were 0 dB for the same SPS, one would say that this is a poor prediction. This type of decision is not entirely subjective, although some judgment is involved in specifying limits between good and poor predictions. However, past experience in rating interference conditions provides some precedent for employing this type of measure of prediction accuracy.

In simple terms, it should be apparent to the COSAM user that an SPS greater than 0.8, for example, represents good performance. Similarly, scores less than 0.2 should represent intolerably poor performance, while the range between 0.4 and 0.6 represents marginal performance. Whether 0.3 should be considered poor or marginal is a more tenuous decision.

The measured SINAD values present a similar problem in interpretation. This subject was discussed extensively in Reference 2. It was determined that SINAD output values greater than 15 are good and values less than 4 are poor with a range of 4-15 being marginal. Other choices are possible.*

Labeling ranges of SPS and SINAD in such a manner will permit one to compare COSAM SPS outputs with measured values. We wish to know, primarily, the likelihood of COSAM predictions resulting in gross errors. (A gross error is defined as a prediction of good performance when a measurement indicates intolerable degradation, or the converse situation.)

The 5-condition scale of TABLE 3-2 will be used to relate SPS and SINAD to operational degradation.

TABLE 3-2

SPS/SINAD FIVE-CONDITION SCALE

Condition	SPS Range	SINAD Range (dB)	AS Range
A	0.81-1.00	> 18	> 0.85
B	0.61-0.80	> 12; ≤ 18	0.75-0.85
C	0.41-0.60	> 7; ≤ 12	0.65-0.75
D	0.21-0.40	> 4; ≤ 7	0.5-0.65
E	0.00-0.20	≤ 4	< 0.5

Since our data includes 561 pairs of SPS/SINAD values, we may simply note the percentage which have no errors, 1-condition errors, 2-condition errors, 3-condition errors, and the maximum error of 4 conditions.

The 5-condition scale is quite suitable for this exercise since it will account for minor score or measurement differences. A 1-condition error would, presumably, be acceptable. A 2-condition error might be undesirable but still acceptable. (This assumption is discussed in more detail below.) A 3-condition error would be poor and a 4-condition error would be clearly unacceptable. We define 3- and 4-condition errors as gross errors.

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* For example, the CCIR (Vol. III, 1963) indicated that 6 dB was just acceptable for operator-to-operator, 15 dB was marginal for commercial use, and 33 dB was good for commercial use.

Before proceeding to an analysis of the data, we note the relationships between possible condition errors and SINAD dB differences. That is, if there is an X dB difference between a predicted and a measured SINAD value, what is the impact in terms of condition errors?

We assume a maximum SINAD of 30 dB. Higher values are possible, but none were recorded during the validation tests.

TABLE 3-3 indicates that a difference less than or equal to 7 dB will not result in three- or four-condition errors. Differences less than 10-12 dB will occasionally result in three-condition errors and a minimum difference of 14 dB is required to cause a four-condition error. In the extreme, even a 26 dB difference may result in only a three-condition error.

TABLE 3-3

SINAD dB DIFFERENCE VS CONDITION ERROR RANGE (FIVE CONDITION SCALE)

dB Difference [$\lvert S_m - \overline{S}_p \rvert$]	Condition Error Range	
	Minimum	Maximum
>26	4	4
22-26	3	4
18-22	2	4
14-18	1	4
12-14	1	3
7-12	0	3
4-7	0	2
0-4	0	1

For simplicity, we will define our interference condition confidence levels, p_{1c} and p_{2c}, as the probability of not experiencing an error of more than 1 or 2 conditions, respectively. APPENDIX II contains detailed data, including probabilities of not experiencing a condition error and experiencing one-, two-, three- and four-condition errors, as well as a discussion of the implications of dB differences.

A major requirement for a prediction model involving value judgments of performance is that the probability of committing a gross error, as defined above, should be small. If this capability exists, the analyst can be assured that a prediction of good performance can be assigned a relatively high confidence level. When good performance is predicted the chance of marginal performance occurring will be small, though not negligible, but the chance of poor performance occurring will be even smaller and, hopefully, negligible. The converse will also hold true.

If, as has been observed, one were to merely predict that all cases were marginal, there would be no errors greater than 2 conditions in a 5-condition scale, suggesting that the p_{2c} measure is not particularly meaningful. However, a value of p_{2c} greater than 0.9 is highly significant. If all cases were to be considered marginal, one would have to treat all of them as potential problems. Given a value of p_{2c} greater than 0.9, one can be assured that the chance of intolerable interference (i.e., SINAD $\leq$ 4 dB) occurring when the SPS is greater than 0.6 is quite small. Consequently, these higher SPS scores can be considered safe with only a small probability of gross error.

SUMMARY OF RESULTS

This section outlines the results of the analysis. Predicted values of selected validation measures for all interactions, as well as the results obtained for some of the individual interactions, are noted. APPENDIX II provides an expanded discussion of the findings, particularly intermodulation (IM) effects.

TABLE 3-4 provides the computed values of B, $\sigma(\Delta)$ and p_{2c} defined above. Note the distinction between adjacent signal and noise interactions. If no other interaction is noted, the effects are said to be due to noise. Numerous potential spurious responses, spurious emissions and IM interactions were found to be primarily due to noise and, in most cases, were predicted accordingly. For example, for desired signals of -95 and -105 dBm, both measurement and prediction would indicate a spurious response, due to a specified transmitter. At -85 dBm, there would be no specified transmitter noted in the measured data, indicating that the effects were due to noise. Consequently, the noise interactions, in effect, indicate the adequacy of the model's ability to properly predict no interference for all of the interactions involved. Several 7th order IM cases were included in the assignments but none proved to be significant.

TABLE 3-4

SUMMARY OF MAJOR VHF VALIDATION RESULTS

INTERACTION TYPES	B(dB)	$\sigma(\Delta)$ (dB)	P_{2c}	NUMBER OF CASES	% CASES
All Interactions	-1.72	5.58	0.92	561	100.0
Adjacent Signal	-1.64	5.03	0.94	224	39.9
Noise	-2.86	4.69	0.92	76	13.5
Spurious Responses	-0.93	6.77	0.90	61	10.9
Predicted & Noted	-1.21	6.47	0.92	60	10.7
Predicted But Not Noted	15.73	-	0.00	1	0.2
Spurious Emissions	-2.32	4.75	0.93	44	7.8
Receiver Intermodulation	-1.27	6.32	0.89	151	26.9
2-Signal 2nd, 3rd, 5th orders	1.11	3.47	1.00	62	11.1
3-Signal, 3rd, 5th Orders	-0.39	6.32	0.92	60	10.7
2-Signal noted but not predicted	-9.11	6.65	0.65	20	3.6
3-Signal noted but not predicted	-6.12	4.20	0.67	9	1.6
Transmitter Intermodulation	-6.05	2.93	0.80	5	0.9

Three types of spurious responses are significant, namely:

a. predicted and noted
b. predicted but not noted
c. noted but not predicted

There was only one case in the second category and none in the third. Effectively, this implies that the model predicted only one response incorrectly. This response is discussed in detail in APPENDIX II.

Spurious emissions are also discussed in detail in APPENDIX II. Three values, representing two predictions at different desired signal levels, were overly optimistic. The remaining cases showed close agreement between measurements and predictions. Most VHF transmitters of this type, for which measurements exist, exhibit well-defined in-band emissions. They are a function of a single conversion heterodyning process which translates a signal at 11.5 MHz to the operating frequency.

Although transmitter IM was predicted for all 2-signal IM cases, the effects were considerably less than those of receiver IM for all but five cases. Consequently, the transmitter IM model was not, in effect, validated in a quantitative sense. It is clear, however, that contributions from the interaction were generally negligible compared to receiver IM effects, thus providing partial validation.

A review of the numerical values in TABLE 3-4 indicates the following:

1. The bias value (B) for all 561 interactions was -1.72 dB.
2. For individual interactions (excluding transmitter IM, the one case of spurious response discussed above and undeclared 2- and 3-signal IM interactions) bias value magnitudes were all less than 2.4 dB.
3. Approximately 86% of the interactions resulted in $\sigma(\Delta)$ values of less than 6.3 dB. 3-signal IM values of $\sigma(\Delta)$ were, in general, somewhat larger than 2-signal IM values.
4. 2- and 3-signal RIM measures were $B = 0.37$, $\sigma(\Delta) = 5.13$, and $p_{2c} = 0.96$, suggesting that agreement between measurements and predictions of this highly significant and complex interaction was very close.
5. The p_{2c} values, representing the probability of predicting an SPS score incorrectly by two or fewer interference conditions in a 5-condition scale, were greater than or equal to 0.89

for 94% of the cases. For all interactions p_{2c} was 0.92, which represents a coarse confidence level for the model. Incidentally, p_{1c}, involving zero- or one-condition errors, for all interactions was 0.76.

6. It is of interest to compare the confidence levels obtained with the Bin and Interference Condition methods. The 90% confidence level of 0.225, obtained with the Bin method, involves a condition error slightly larger than one. The 76% level is approximately 0.18, a condition error slightly less than one. This suggests that 1- and 2-condition error confidence levels are supported by the bin approach.

DISCUSSION

APPENDIX II provides a summary of additional data and associated evaluations. This section presents a few brief highlights of the study.

If a dB measure of confidence is [illegible]d, APPENDIX II indicates that 90% of the cases resulted [illegible]erences between the measurements and the predicted mean values of less than 10 dB.

The user can be confident (using either the interference condition or bin measure) that SPS scores greater than 0.6 represent acceptable or better performance. Scores less than 0.2 are indicative of probable intolerable degradation.

Scores between 0.2 and 0.6 are indicative of marginal performance. If these values appear, they should be treated as requiring attention. Scores greater than 0.9 require no further attention. Ideally, all scores should be greater than this value.

The user is warned that, occasionally, spurious responses and emissions will not be properly evaluated by COSAM. Some could be predicted and not noted; some will be noted but not predicted. Measurement-supported analytical studies are being conducted in an attempt to reduce the uncertainties involved in these phenomena.

In regard to intermodulation, evaluation of the measured data revealed no cases where IM was predicted but did not appear. A significant number (20) of apparent 2-signal interactions occurred which were not predicted. These represent cases which are not presently included in COSAM, but which are being added. Only nine cases (involving two specific interactions) were noted where 3-signal

(5th order) IM occurred but was not declared. Changes being made to the model will correct this situation. In an operational situation, most of the cases will be either obviously acceptable or obviously unacceptable. Considerable effort was required to generate assignments whose SINAD outputs fell between 5 and 12 dB, corresponding to SPS values between 0.2 and 0.6. As indicated in APPENDIX II, 23% of the total cases were in this range. In an operational situation, a much smaller percentage of marginal values can be expected.

In other words, most of the scores will probably be greater than 0.6 or less than 0.2. On the basis of the noted confidence levels, the chance of a gross error for cases outside these limits is less than 8%, or, in betting parlance, about 11.5-to-one odds.

In general, the VHF-FM COSAM system predicts operational degradation accurately in spite of the large number and the magnitude of the uncertainties involved.

CONCLUDING COMMENTS

The measurement program appears to have achieved its primary objective, namely, validation of the VHF-FM COSAM system in a quantitative manner. Results of this analysis and Reference 2 suggest that the VHF/UHF/FM/AM portions of COSAM are valid. No major changes to the modeling concepts appear to be necessary.

Similar efforts will be pursued to develop and validate the HF/SSB/FM/AM portions of the model, and the COSAM system model.

This report and the earlier report (Reference 2), particularly APPENDIX I of each, represent a test-bed for those who either have or are developing a cosite analysis capability. The data can be used to validate any model of this type. The results of such a validation can be used to rate the model and compare it to COSAM's performance, if desired.

APPENDIX I

DESCRIPTION OF FIELD MEASUREMENTS

INTRODUCTION

This appendix is a copy of much of the material provided in Reference 4 (Volume III). It is provided for the following reasons:

1. The referenced document may not be readily obtainable.
2. Its availability provides authentication of the validation process described in this document.
3. It furnishes the basis for any agency to perform its own model validation of all or part of the total test.

DISCUSSION OF CONTENTS

Figures I-1 and I-2 represent the antenna and system configuration used. The large vans shown in Figure I-2 contained instrumentation only. The height of a man carrying a back-pack transceiver (e.g. AN/PRC-25 or 77) was simulated at both positions 1 and 2 by wooden structures. Equipment at positions 5 and 6 consisted of an AN/GRC-163. This system contains two jeep-mounted AN/VRC-12 (RT-524) transceivers to which frequency division multiplex (MUX) capabilities have been added. Positions 3 and 4 consisted of a second jeep (AN/VRC-49) with two simplex RT-524 transceivers. Figure I-3 shows these systems with their antennas and auxiliary power generator trailers.

TABLES I-1 through I-15 represent coupling data taken between all antenna pairs at four tuned frequencies, involving 460 samples. Measurements were actually taken over the entire band (30-76 MHz) by means of a sweeping technique but this information will not be provided here.

The technique involved recording the amplitudes of the received power levels (throughout the frequency range) on a spectrum analyzer. Given appropriate calibration and the known input power, coupling loss could be read directly from photographs of the analyzer display.

As indicated in TABLES I-1 to I-15, only four out of the available ten positions of the MX-2799 coupler were considered during the coupling test. The values noted in the fifth column (Spectrum

Analyzer, P_r) were read from the spectrum analyzer display, using the appropriate calibration factor.

Coupling loss (the last column) is, simply P_t (the 3rd column) minus P_r.

TABLE I-16 represents the 25 frequency assignments used in the test. Subtest 2.9 is described in the TEST DESCRIPTION section. An audio tape has been prepared which contains typical interference conditions of different levels due to the various phenomena encountered.

TABLES I-17 and I-18 indicate the (S+N)/N and (S+I+N)/(I+N) values for initial tests for desired signal levels of -105 dBm and -95 dBm, respectively. The remaining columns contain the actual transmitter power levels used. After these initial tests were run, the ECAC requested that these two cases be rerun and that additional tests be performed. The reruns differed in that interferers were tuned off in a pattern which identified the major interferers. These data are presented in TABLES I-19 and I-20. Some differences in results noted between the two tests emphasize equipment variabilities.

TABLES I-21 and I-22 contain data for additional tests with desired signals of -85 dBm and with levels greater than -85 dBm required to obtain a 10 dB (S+I+N)/(I+N) value, respectively.

TEST DESCRIPTION

The frequency combinations* given in TABLE I-16 were used for subtest 2.9. The transceiver connected to antenna 1 was designated as the desired equipment or test link receiver (TLR), and a desired signal of -105, -95, -85, or greater than -85 dBm, 30 percent modulated with the reference audio-frequency tone, was inserted. The transmitter portion was not activated. The transmitters of the remaining five transceivers were 100 percent noise modulated. Their corresponding receivers were in standby mode. Power output levels used were the maximum values attainable at the specified frequencies. The output levels were monitored and recorded. The following three measurements were taken:

1. Measurements of (S+N)/N were made with the noise modulation to the interference turned off.

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* The Roman numeral portion of each test number identifies the frequency combination for that test group of six runs. The Arabic numeral portion of the test number identifies the antenna to which the transceiver which is being used as the test link receiver (TLR) is connected.

2. The noise input was then introduced to the interferers and measurements of (S+I+N)/(I+N) were made.

3. The audio-frequency tone was then removed from the desired signal to the TLR, and the desired signal was modulated 100 percent with a standard voice message. The noise modulation was removed from the interfering signal which was then 100 percent modulated nonsynchronously with a second standard voice message. On some tests, a 30 second tape recording was taken and appropriately annotated; for example, "Test No. I-1" (followed by message).

The test was repeated with the same frequency combination but with the transceiver connected to antenna 2 operated as the desired receiver. One completed test involved measurements of six receivers (combinations I-1 through I-6).

A second frequency assignment combination (II) was then tested in the same manner. A total of 25 combinations representing 450 individual measurements of (S+I+N)/(I+N) was planned; however, not all frequencies could be used because of outside interference. Refer to TABLE I-16. Intermittent interference, from unknown sources, made several additional frequencies unusable during certain tests.

TEST RESULTS

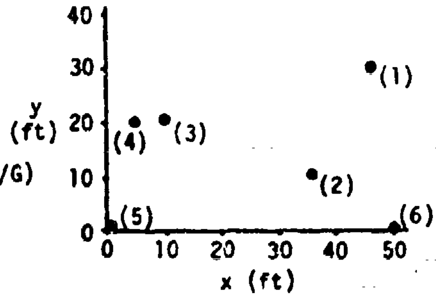
Values of (S+N)/N, (S+I+N)/(I+N), and interferer power levels are given in the tables listed below. These tables cover the test series of subset 2.9 in the following manner:

Table	S Level (dBm)	Test Type	Taped Record (No. of Cases)
I-17	-105	All Interferers on	None
I-18	-95	All Interferers on	None
I-19	-105	Interferer Isolation	6
I-20	-95	Interferer Isolation	6
I-21	-85	Interferer Isolation	9
I-22	> -85	(S+I+N)/(I+N) = 10 dB	None

An apparent anomaly was noted in a few cases where interference was less with all interferers on than with only one interferer on (the worst-case values are recorded in TABLE II-1 and used for this analysis). This phenomenon was confirmed by multiple checks, and therefore is believed to represent the true situation, although the explanation is not known.

In some cases, intermittent readings were obtained, thought to be due to alternate capture and release of the receiver's automatic frequency control. This might have been caused by external interference, an intermodulation product, the closeness in frequency of system 2 to system 1, or a similar phenomenon. These cases are referred to in the tables as "Alternate capture and release."

Position	Equipment	Antenna
1	PRC-25	AT-912
2	PRC-77	AT-912
3	VRC-12	AT-912
4	VRC-12	AT-912
5	VRC-12 (MUX)	Log-Periodic (AS-2169/G)
6	VRC-12 (MUX)	Log-Periodic (AS-2169/G)

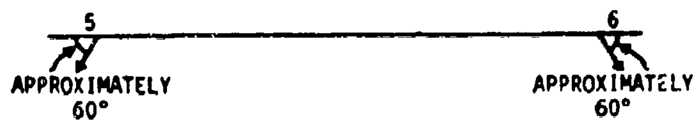


ANTENNA COORDINATES (ft)

POSITION	X	Y	Z (approx)
1	45	30	1
2	35	10	1
3	10	20	3
4	5.5	20	3
5	0	0	36
6	50	0	36

NOTES: (a) Antennas for terminals 1, 2, 3, 4 are vertical whips.

(b) Antennas for terminals 5 and 6 are horizontally polarized log-periodic types. The orientation of these antennas is away from the rest of the deployment, as follows:



(c) Antenna heights for whips (terminals 1, 2, 3, 4) refer to height of base above ground. Heights for log-periodic antennas (terminals 5, 6) refer to heights of feed points.

Figure I-1. Antenna layout, subtest 2.9.3

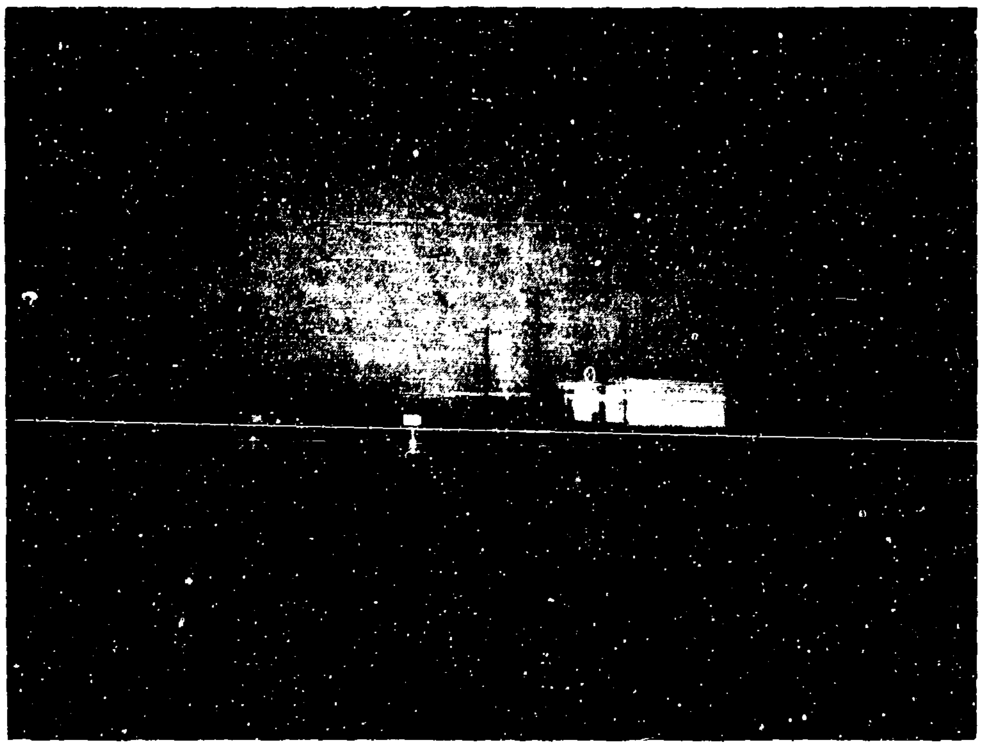


Figure I-2. 45X2 Test Site

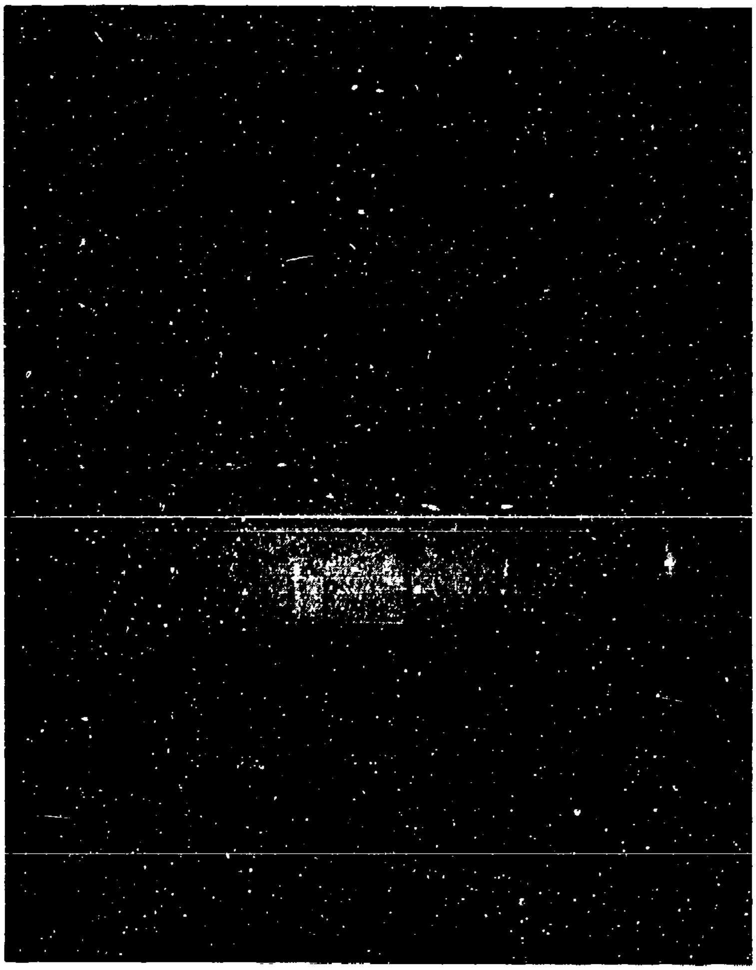


Figure I-3. AN/GRC-163 (Rear), and AN/VRC-49 Communications Systems

TABLE I-1

COSITE COUPLING LOSS, ANTENNA POSITIONS 1 AND 2

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 2

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)*	Coupling Loss (dB)
32.0	30.0 - 32.7	10	30.0 - 32.7	-16,2.10-5	26
	47.9 - 52.95			-45,2.10-6	55
	56.3 - 59.7			**,2.10-7	-
	70.9 - 75.95			-39,2.10-8	49
32.0	30.0 - 32.7	10	47.9 - 52.95	-48,2.10-9	58
	47.9 - 52.95			-60,2.10-10	70
	56.3 - 59.7			**,2.10-11	-
	70.9 - 75.95			-52,2.10-12	62
32.0	30.0 - 32.7	10	56.3 - 59.7	**,2.10-13	-
	47.9 - 52.95			**,2.10-14	-
	56.3 - 59.7			**,2.10-15	-
	70.9 - 75.95			**,2.10-16	-
32.0	30.0 - 32.7	10	70.9 - 75.95	-40,2.10-17	50
	47.9 - 52.95			-57,2.10-18	67
	56.3 - 59.7			**,2.10-19	-
	70.9 - 75.95			-55,2.10-20	65

*Numbers following commas are figure numbers of corresponding photos.

**Below sensitivity.

TABLE 1-1 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 2

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions ______

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)*	Coupling Loss (dB)
43.0	30.0 - 32.7	10	30.0 - 32.7	-42,2.10-5	52
	47.9 - 52.95			-44,2.10-6	54
	56.3 - 59.7			-40,2.10-7	50
	70.9 - 75.95			-58,2.10-8	68
43.0	30.0 - 32.7	10	47.9 - 52.95	-46,2.10-9	56
	47.9 - 52.95			-40,2.10-10	50
	56.3 - 59.7			-38,2.10-11	48
	70.9 - 75.95			-62,2.10-12	72
43.0	30.0 - 32.7	10	56.3 - 59.7	-45,2.10-13	55
	47.9 - 52.95			-38,2.10-14	48
	56.3 - 59.7			-36,2.10-15	46
	70.9 - 75.95			-39,2.10-16	49
43.0	30.0 - 32.7	10	70.9 - 75.95	**,2.10-17	-
	47.9 - 52.95			-49,2.10-18	59
	56.3 - 59.7			-48,2.10-19	58
	70.9 - 75.95			-56,2.10-20	66

*Numbers following commas are figure numbers of corresponding photos.

**Below sensitivity.

TABLE I-1 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 2

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions ______

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)*	Coupling Loss (dB)
54.0	30.0 - 32.7	10	30.0 - 32.7	**,2.10-5	-
	47.9 - 52.95			-45,2.10-6	55
	56.3 - 59.7			-50,2.10-7	60
	70.9 - 75.95			-53,2.10-8	63
54.0	30.0 - 32.7	10	47.9 - 52.95	-40,2.10-9	50
	47.9 - 52.95			-16,2.10-10	26
	56.3 - 59.7			-20,2.10-11	30
	70.9 - 75.95			-21,2.10-12	31
54.0	30.0 - 32.7	10	56.3 - 59.7	-42,2.10-13	52
	47.9 - 52.95			-20,2.10-14	30
	56.3 - 59.7			-22,2.10-15	32
	70.9 - 75.95			-27,2.10-16	37
54.0	30.0 - 32.7	10	70.9 - 75.95	-46,2.10-17	56
	47.9 - 52.95			-22,2.10-18	32
	56.3 - 59.7			-26,2.10-19	36
	70.9 - 75.95			-27,2.10-20	37

*Numbers following commas are figure numbers of corresponding photos.

**Below sensitivity.

TABLE I-1 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 2

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions ______

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)*	Coupling Loss (dB)
65.0	30.0 - 32.7	10	30.0 - 32.7	-52,2.10-5	62
	47.9 - 52.95			-52,2.10-6	62
	56.3 - 59.7			-42,2.10-7	52
	70.9 - 75.95			-40,2.10-8	50
65.0	30.0 - 32.7	10	47.9 - 52.95	-44,2.10-9	54
	47.9 - 52.95			-42,2.10-10	52
	56.3 - 59.7			-32,2.10-11	42
	70.9 - 75.95			-32,2.10-12	42
65.0	30.0 - 32.7	10	56.3 - 59.7	-40,2.10-13	50
	47.9 - 52.95			-37,2.10-14	47
	56.3 - 59.7			-30,2.10-15	40
	70.9 - 75.95			-26,2.10-16	36
65.0	30.0 - 32.7	10	70.9 - 75.95	-35,2.10-17	45
	47.9 - 52.95			-33,2.10-18	43
	56.3 - 59.7			-23,2.10-19	33
	70.9 - 75.95			-20,2.10-20	30

*Numbers following commas are figure numbers of corresponding photos.

TABLE I-2

COSITE COUPLING LOSS, ANTENNA POSITIONS 1 AND 3

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 3

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	30.0 - 32.7	-20	30
	47.9 - 52.95			-36	46
	56.3 - 59.7			-65	75
	70.9 - 75.95			-42	52
32.0	30.0 - 32.7	10	47.9 - 52.95	-28	38
	47.9 - 52.95			-43	53
	56.3 - 59.7			*	-
	70.9 - 75.95			-60	70
32.0	30.0 - 32.7	10	56.3 - 59.7	-58	68
	47.9 - 52.95			*	-
	56.3 - 59.7			*	-
	70.9 - 75.95			*	-
32.0	30.0 - 32.7	10	70.9 - 75.95	-43	53
	47.9 - 52.95			*	-
	56.3 - 59.7			*	-
	70.9 - 75.95			-66	76

*Below Sensitivity.

TABLE I-2 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 **Position** 1

Receiver Antenna AT-912 **Position** 3

Sweep Oscillator HP-8601A **S/N** 912-00810

Spectrum Analyzer HP-85533/8552A **S/N** 3339

Significant Control Positions ____________

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
43.0	30.0 - 32.7	10	30.0 - 32.7	-52	62
	47.9 - 52.95			-40	50
	56.3 - 59.7			-41	51
	70.9 - 75.95			-53	63
43.0	30.0 - 32.7	10	47.9 - 52.95	-49	59
	47.9 - 52.95			-37	47
	56.3 - 59.7			-36	46
	70.9 - 75.95			-49	59
43.0	30.0 - 32.7	10	56.3 - 59.7	-54	64
	47.9 - 52.95			-41	51
	56.3 - 59.7			-40	50
	70.9 - 75.95			-52	62
43.0	30.0 - 32.7	10	70.9 - 75.95	-62	72
	47.9 - 59.7			-49	59
	56.3 - 59.97			-48	58
	70.9 - 75.95			-64	74

TABLE I-2 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 3

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
54.0	30.0 - 32.7	10	30.0 - 32.7	*	-
	47.9 - 52.95			-51	61
	56.3 - 59.7			-55	65
	70.9 - 75.95			-60	70
54.0	30.0 - 32.7	10	47.9 - 52.95	-46	56
	47.9 - 52.95			-24	34
	56.3 - 59.7			-27	37
	70.9 - 75.95			-30	40
54.0	30.0 - 32.7	10	56.3 - 59.7	-48	58
	47.9 - 52.95			-26	36
	56.3 - 59.7			-29	39
	70.9 - 75.95			-32	42
54.0	30.0 - 32.7	10	70.9 - 75.95	-57	67
	47.9 - 52.95			-35	45
	56.3 - 59.7			-39	49
	70.9 - 75.95			-38	48

*Below sensitivity.

TABLE I-2 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 3

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
65.0	30.0 - 32.7	10	30.0 - 32.7	-58	68
	47.9 - 52.95			-55	65
	56.3 - 59.7			-46	56
	70.9 - 75.95			-44	54
65.0	30.0 - 32.7	10	47.9 - 52.95	-50	60
	47.9 - 52.95			-46	56
	56.3 - 59.7			-37	47
	70.9 - 75.95			-34	44
65.0	30.0 - 32.7	10	56.3 - 59.7	-45	55
	47.9 - 52.95			-38	48
	56.3 - 59.7			-31	41
	70.9 - 75.95			-28	38
65.0	30.0 - 32.7	10	70.9 - 75.95	-43	53
	47.9 - 52.95			-36	46
	56.3 - 59.7			-28	38
	70.9 - 75.95			-24	34

TABLE I-3

COSITE COUPLING LOSS, ANTENNA POSITIONS 1 and 4

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_r (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	30.0 - 32.7	-10	20
	47.9 - 52.95			-30	40
	56.3 - 59.7			-54	64
	70.9 - 75.95			-60	70
32.0	30.0 - 32.7	10	47.9 - 52.95	-25	35
	47.9 - 52.95			-37	47
	56.3 - 59.7			*	-
	70.9 - 75.95			-56	66
32.0	30.0 - 32.7	10	56.3 - 59.7	-53	63
	47.9 - 52.95			*	-
	56.3 - 59.7			*	-
	70.9 - 75.95			*	-
32.0	30.0 - 32.7	10	70.9 - 75.95	-31	41
	47.9 - 52.95			-46	56
	56.3 - 59.7			*	-
	70.9 - 75.95			-53	63

*Below sensitivity.

TABLE I-3 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
43.0	30.0 - 32.7	10	30.0 - 32.7	-43	53
	47.9 - 52.95			-30	40
	56.3 - 59.7			-30	40
	70.9 - 75.95			-45	55
43.0	30.0 - 32.7	10	47.9 - 52.95	-38	48
	47.9 - 52.95			-25	35
	56.3 - 59.7			-26	36
	70.9 - 75.95			-40	50
43.0	30.0 - 32.7	10	56.3 - 59.7	-41	51
	47.9 - 52.95			-29	39
	56.3 - 59.7			-28	38
	70.9 - 75.95			-44	54
43.0	30.0 - 32.7	10	70.9 - 75.95	-52	62
	47.9 - 52.95			-40	50
	56.3 - 59.7			-40	50
	70.9 - 75.95			-54	64

TABLE I-5 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
54.0	30.0 - 32.7	10	30.0 - 32.7	*	-
	47.9 - 52.95			-53	63
	56.3 - 59.7			-54	64
	70.9 - 75.95			-60	70
54.0	30.0 - 32.7	10	47.9 - 52.95	-37	47
	47.9 - 52.95			-16	26
	56.3 - 59.7			-19	29
	70.9 - 75.95			-26	36
54.0	30.0 - 32.7	10	56.3 - 59.7	-40	50
	47.9 - 52.95			-17	27
	56.3 - 59.7			-20	30
	70.9 - 75.95			-27	37
54.0	30.0 - 32.7	10	70.9 - 75.95	-43	53
	47.9 - 52.95			-21	31
	56.3 - 59.7			-25	35
	70.9 - 75.95			-30	40

*Below sensitivity.

TABLE I-3 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions ______

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
65.0	30.0 - 32.7	10	30.0 - 32.7	-47	57
	47.9 - 52.95			-42	52
	56.3 - 59.7			-33	43
	70.9 - 75.95			-30	40
65.0	30.0 - 32.7	10	47.9 - 52.95	-47	57
	47.9 - 52.95			-41	51
	56.3 - 59.7			-33	43
	70.9 - 75.95			-29	39
65.0	30.0 - 32.7	10	56.3 - 59.7	-40	50
	47.9 - 52.95			-35	45
	56.3 - 59.7			-27	37
	70.9 - 75.95			-24	34
65.0	30.0 - 32.7	10	70.9 - 75.95	-35	45
	47.9 - 52.95			-28	38
	56.3 - 59.7			-21	31
	70.9 - 75.95			-17	27

TABLE I-4

COSITE COUPLING LOSS, ANTENNA POSITIONS 1 AND 5

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AS-2169/G Position 5

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions ______

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	N/A	-32	42
	47.9 - 52.95			-43	53
	56.3 - 59.7			*	-
	70.9 - 75.95			-42	52
43.0	30.0 - 32.7	10	N/A	-54	64
	47.9 - 52.95			-50	60
	56.3 - 59.7			-44	54
	70.9 - 75.95			-54	64
54.0	30.0 - 32.7	10	N/A	-62	72
	47.9 - 52.95			-49	59
	56.3 - 59.7			-54	64
	70.9 - 75.95			-41	51
65.0	30.0 - 32.7	10	N/A	-53	63
	47.9 - 52.95			-50	60
	56.3 - 59.7			-39	49
	70.9 - 75.95			-36	46

*Below sensitivity.

TABLE I-5

COSITE COUPLING LOSS, ANTENNA POSITIONS 1 AND 6

Subtest 2.10.3

Transmitter Antenna AT-912 Position 1

Receiver Antenna AS-2169/G Position 6

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	N/A	-28	38
	47.9 - 52.95			-30	40
	56.3 - 59.7			-60	70
	70.9 - 75.95			-42	52
43.0	30.0 - 32.7	10	N/A	-50	60
	47.9 - 52.95			-35	45
	56.3 - 59.7			-32	42
	70.9 - 75.95			-37	47
54.0	30.0 - 32.7	10	N/A	-57	67
	47.9 - 52.95			-32	42
	56.3 - 59.7			-35	45
	70.9 - 75.95			-32	42
65.0	30.0 - 32.7	10	N/A	-37	47
	47.9 - 52.95			-37	47
	56.3 - 59.7			-28	38
	70.9 - 75.95			-28	38

TABLE I-6

COSITE COUPLING LOSS, ANTENNA POSITIONS 2 AND 3

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AT-912 Position 3

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	30.0 - 32.7	-18	28
	47.9 - 52.95			-43	53
	56.3 - 59.7			-65	75
	70.9 - 75.95			-36	46
32.0	30.0 - 32.7	10	47.9 - 52.95	-30	40
	47.9 - 52.95			-60	70
	56.3 - 59.7			*	-
	70.9 - 75.95			-55	65
32.0	30.0 - 32.7	10	56.3 - 59.7	-60	70
	47.9 - 52.95			*	-
	56.3 - 59.7			*	-
	70.9 - 75.95			*	-
32.0	30.0 - 32.7	10	70.9 - 75.95	-41	51
	47.9 - 52.95			-55	65
	56.3 - 59.7			*	-
	70.9 - 75.95			-56	66

*Below sensitivity.

TABLE I-6 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AT-912 Position 3

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
43.0	30.0 - 32.7	10	30.0 - 32.7	-43	53
	47.9 - 52.95			-36	46
	56.3 - 59.7			-32	42
	70.9 - 75.95			-50	60
43.0	30.0 - 32.7	10	47.9 - 52.95	-39	49
	47.9 - 52.95			-35	45
	56.3 - 59.7			-30	40
	70.9 - 75.95			-47	57
43.0	30.0 - 32.7	10	56.3 - 59.7	-41	51
	47.9 - 52.95			-36	46
	56.3 - 59.7			-32	42
	70.9 - 75.95			-47	57
43.0	30.0 - 32.7	10	70.9 - 75.95	-52	62
	47.9 - 52.95			-46	56
	56.3 - 59.7			-45	55
	70.9 - 75.95			-58	68

TABLE I-6 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AT-912 Position 3

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
54.0	30.0 - 32.7	10	30.0 - 32.7	-67	77
	47.9 - 52.95			-45	55
	56.3 - 59.7			-50	60
	70.9 - 75.95			-55	65
54.0	30.0 - 32.7	10	47.9 - 52.95	-44	54
	47.9 - 52.95			-17	27
	56.3 - 59.7			-22	32
	70.9 - 75.95			-23	33
54.0	30.0 - 32.7	10	56.3 - 59.7	-47	57
	47.9 - 52.95			-18	28
	56.3 - 59.7			-23	33
	70.9 - 75.95			-25	35
54.0	30.0 - 32.7	10	70.9 - 75.95	-55	65
	47.9 - 52.95			-26	36
	56.3 - 59.7			-30	40
	70.9 - 75.95			-30	40

TABLE I-6 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AT-912 Position 3

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
65.0	30.0 - 32.7	10	30.0 - 32.7	-33	43
	47.9 - 52.95			-50	60
	56.3 - 59.7			-45	55
	70.9 - 75.95			-41	51
65.0	30.0 - 32.7	10	47.9 - 52.95	-48	58
	47.9 - 52.95			-42	52
	56.3 - 59.7			-34	44
	70.9 - 75.95			-31	41
65.0	30.0 - 32.7	10	56.3 - 59.7	-43	53
	47.9 - 52.95			-35	45
	56.3 - 59.7			-27	37
	70.9 - 75.95			-24	34
65.0	30.0 - 32.7	10	70.9 - 75.95	-38	48
	47.9 - 52.95			-32	42
	56.3 - 59.7			-25	35
	70.9 - 75.95			-22	32

TABLE I-7

COSITE COUPLING LOSS, ANTENNA POSITIONS 2 AND 4

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	30.0 - 32.7	-16	26
	47.9 - 52.95			-40	50
	56.3 - 59.7			-62	72
	70.9 - 75.95			-37	47
32.0	30.0 - 32.7	10	47.9 - 52.95	-36	46
	47.9 - 52.95			-56	66
	56.3 - 59.7			*	-
	70.9 - 75.95			-58	68
32.0	30.0 - 32.7	10	56.3 - 59.7	-60	70
	47.9 - 52.95			*	-
	56.3 - 59.7			*	-
	70.9 - 75.95			*	-
32.0	30.0 - 32.7	10	70.9 - 75.95	-35	45
	47.9 - 52.95			-56	66
	56.3 - 59.7			*	-
	70.9 - 75.95			-52	62

*Below sensitivity.

TABLE I-7 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
43.0	30.0 - 32.7	10	30.0 - 32.7	-53	63
	47.9 - 52.95			-45	55
	56.3 - 59.7			-43	53
	70.9 - 75.95			-63	73
43.0	30.0 - 32.7	10	47.9 - 52.95	-47	57
	47.9 - 52.95			-40	50
	56.3 - 59.7			-36	46
	70.9 - 75.95			-55	65
43.0	30.0 - 32.7	10	56.3	-46	56
	47.9 - 52.95			-40	50
	56.3 - 59.7			-36	46
	70.9 - 75.95			-52	62
43.0	30.0 - 32.7	10	70.9 - 75.95	-58	68
	47.9 - 52.95			-53	63
	56.3 - 59.7			-48	58
	70.9 - 75.95			-64	74

TABLE I-7 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
54.0	30.0 - 32.7	10	30.0 - 32.7	*	-
	47.9 - 52.95			-53	63
	56.3 - 59.7			-57	67
	70.9 - 75.95			-58	68
54.0	30.0 - 32.7	10	47.9 - 52.95	-52	62
	47.9 - 52.95			-23	33
	56.3 - 59.7			-26	36
	70.9 - 75.95			-28	38
54.0	30.0 - 32.7	10	56.3 - 59.7	-55	65
	47.9 - 52.95			-25	35
	56.3 - 59.7			-30	40
	70.9 - 75.95			-32	42
54.0	30.0 - 32.7	10	70.9 - 75.95	-55	65
	47.9 - 52.95			-28	38
	56.3 - 59.7			-33	43
	70.9 - 75.95			-35	45

*Below sensitivity.

TABLE I-7 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
65.0	30.0 - 32.7	10	30.0 - 32.7	-55	65
	47.9 - 52.95			-47	57
	56.3 - 59.7			-39	49
	70.9 - 75.95			-36	46
65.0	30.0 - 32.7	10	47.9 - 52.95	-50	60
	47.9 - 52.95			-44	54
	56.3 - 59.7			-35	45
	70.9 - 75.95			-34	44
65.0	30.0 - 32.7	10	56.3 - 59.7	-48	58
	47.9 - 52.95			-46	56
	56.3 - 59.7			-27	37
	70.9 - 75.95			-25	35
65.0	30.0 - 32.7	10	70.9 - 75.95	-39	49
	47.9 - 52.95			-33	43
	56.3 - 59.7			-26	36
	70.9 - 75.95			-22	32

TABLE I-8

COSITE COUPLING LOSS, ANTENNA POSITIONS 2 AND 5

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AS-2169/G Position 5

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	N/A	-36	46
	47.9 - 52.95			-38	48
	56.3 - 59.7			-62	72
	70.9 - 75.95			-44	54
43.0	30.0 - 32.7	10	N/A	-42	52
	47.9 - 52.95			-36	46
	56.3 - 59.7			-30	40
	70.9 - 75.95			-45	55
54.0	30.0 - 32.7	10	N/A	-54	64
	47.9 - 52.95			-27	37
	56.3 - 59.7			-34	44
	70.9 - 75.95			-38	48
65.0	30.0 - 32.7	10	N/A	-53	63
	47.9 - 52.95			-40	50
	56.3 - 59.7			-31	41
	70.9 - 75.95			-31	41

TABLE I-9

COSITE COUPLING LOSS, ANTENNA POSITIONS 2 AND 6

Subtest 2.10.3

Transmitter Antenna AT-912 Position 2

Receiver Antenna AS-2169/G Position 6

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	N/A	-55	65
	47.9 - 52.95			-35	45
	56.3 - 59.7			-60	70
	70.9 - 75.95			-44	54
43.0	30.0 - 32.7	10	N/A	-45	55
	47.9 - 52.95			-50	60
	56.3 - 59.7			-45	55
	70.9 - 75.95			-46	56
54.0	30.0 - 32.7	10	N/A	*	-
	47.9 - 52.95			-35	45
	56.3 - 59.7			-38	48
	70.9 - 75.95			-39	49
65.0	30.0 - 32.7	10	N/A	-60	70
	47.9 - 52.95			-48	58
	56.3 - 59.7			-41	51
	70.9 - 75.95			-36	46

*Below sensitivity.

TABLE I-10

COSITE COUPLING LOSS, ANTENNA POSITIONS 3 AND 4

Subtest 2.10.3

Transmitter Antenna AT-912 Position 3

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	30.0 - 32.7	-3	13
	47.9 - 52.95			-38	48
	56.3 - 59.7			-40	50
	70.9 - 75.95			-22	32
32.0	30.0 - 32.7	10	47.9 - 52.95	-40	50
	47.9 - 52.95			-32	42
	56.3 - 59.7			*	-
	70.9 - 75.95			-50	60
32.0	30.0 - 32.7	10	56.3 - 59.7	-52	62
	47.9 - 52.95			-60	70
	56.3 - 59.7			*	-
	70.9 - 75.95			*	-
32.0	30.0 - 32.7	10	70.9 - 75.95	-20	30
	47.9 - 52.95			-46	56
	56.3 - 59.7			*	-
	70.9 - 75.95			-36	46

*Below sensitivity

TABLE I-10 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 3

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
43.0	30.0 - 32.7	10	30.0 - 32.7	-23	33
	47.9 - 52.95			-20	30
	56.3 - 59.7			-25	35
	70.9 - 75.95			-40	50
43.0	30.0 - 32.7	10	47.9 - 52.95	-20	30
	47.9 - 52.95			-18	28
	56.3 - 59.7			-22	32
	70.9 - 75.95			-35	45
43.0	30.0 - 32.7	10	56.3 - 59.7	-24	34
	47.9 - 52.95			-22	32
	56.3 - 59.7			-24	34
	70.9 - 75.95			-35	45
43.0	30.0 - 32.7	10	70.9 - 75.95	-40	50
	47.9 - 52.95			-35	45
	56.3 - 59.7			-37	47
	70.9 - 75.95			-46	56

TABLE I-10 (Continued)

Subtest 2.10.3

Transmitter Antenna AT-912 Position 3

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
54.0	30.0 - 32.7	10	30.0 - 32.7	-62	72
	47.9 - 52.95			-38	48
	56.3 - 59.7			-42	52
	70.9 - 75.95			-42	52
54.0	30.0 - 32.7	10	47.9 - 52.95	-42	52
	47.9 - 52.95			-4	14
	56.3 - 59.7			-6	16
	70.9 - 75.95			-9	19
54.0	30.0 - 32.7	10	56.3 - 59.7	-48	58
	47.9 - 52.95			-6	16
	56.3 - 59.7			-7	17
	70.9 - 75.95			-12	22
54.0	30.0 - 32.7	10	70.9 - 75.95	-43	53
	47.9 - 52.95			-9	19
	56.3 - 59.7			-11	21
	70.9 - 75.95			-14	24

TABLE I-10 (Continued)

Subrest 2.10.3

Transmitter Antenna AT-912 Position 3

Receiver Antenna AT-912 Position 4

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
65.0	30.0 - 32.7	10	30.0 - 32.7	-43	53
	47.9 - 52.95			-43	53
	56.3 - 59.7			-33	43
	70.9 - 75.95			-21	31
65.0	30.0 - 32.7	10	47.9 - 52.95	-47	57
	47.9 - 52.95			-32	42
	56.3 - 59.7			-25	35
	70.9 - 75.95			-22	32
65.0	30.0 - 32.7	10	56.3 - 59.7	-37	47
	47.9 - 52.95			-23	33
	56.3 - 59.7			-16	26
	70.9 - 75.95			-13	23
65.0	30.0 - 32.7	10	70.9 - 75.95	-29	39
	47.9 - 52.95			-20	30
	56.3 - 59.7			-14	24
	70.9 - 75.95			-6	16

TABLE I-11

COSITE COUPLING LOSS, ANTENNA POSITIONS 3 AND 5

Subtest 2.10.3

Transmitter Antenna AT-912 Position 3

Receiver Antenna AS-2169/G Position 5

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	N/A	-20	30
	47.9 - 52.95			-34	44
	56.3 - 59.7			-57	67
	70.9 - 75.95			-30	40
43.0	30.0 - 32.7	10	N/A	-34	44
	47.9 - 52.95			-50	60
	56.3 - 59.7			-43	53
	70.9 - 75.95			-40	50
54.0	30.0 - 32.7	10	N/A	-46	56
	47.9 - 52.95			-40	50
	56.3 - 59.7			-40	50
	70.9 - 75.95			-34	44
65.0	30.0 - 32.7	10	N/A	-53	63
	47.9 - 52.95			-64	74
	56.3 - 59.7			-52	62
	70.9 - 75.95			-33	

TABLE I-12

COSITE COUPLING LOSS, ANTENNA POSITIONS 3 AND 6

Subtest 2.10.3

Transmitter Antenna AT-912 Position 3

Receiver Antenna AS-2169/G Position 6

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	N/A	-43	53
	47.9 - 52.95			-54	64
	56.3 - 59.7			*	-
	70.9 - 75.95			-53	63
43.0	30.0 - 32.7	10	N/A	-56	66
	47.9 - 52.95			-48	58
	56.3 - 59.7			-55	65
	70.9 - 75.95			-60	70
54.0	30.0 - 32.7	10	N/A	*	-
	47.9 - 52.95			-36	46
	56.3 - 59.7			-39	49
	70.9 - 75.95			-45	55
65.0	30.0 - 32.7	10	N/A	*	-
	47.9 - 52.95			-51	61
	56.3 - 59.7			-44	54
	70.9 - 75.95			-38	48

*Below sensitivity.

TABLE I-13

COSITE COUPLING LOSS, ANTENNA POSITIONS 4 AND 5

Subtest 2.10.3

Transmitter Antenna AT-912 Position 4

Receiver Antenna AS-2169/G Position 5

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	N/A	-18	28
	47.9 - 52.95			-42	52
	56.3 - 59.7			*	-
	70.9 - 75.95			-32	42
43.0	30.0 - 32.7	10	N/A	-35	45
	47.9 - 52.95			-39	49
	56.3 - 59.7			-36	46
	70.9 - 75.95			-47	57
54.0	30.0 - 32.7	10	N/A	-50	60
	47.9 - 52.95			-29	39
	56.3 - 59.7			-34	44
	70.9 - 75.95			-30	40
65.0	30.0 - 32.7	10	N/A	-48	58
	47.9 - 52.95			-43	53
	56.3 - 59.7			-33	43
	70.9 - 75.95			-42	52

*Below sensitivity.

TABLE I-14

COSITE COUPLING LOSS, ANTENNA POSITIONS 4 AND 6

Subtest 2.10.3

Transmitter Antenna AT-912 Position 4

Receiver Antenna AS-2169/G Position 6

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	30.0 - 32.7	10	N/A	-32	42
	47.9 - 52.95			-54	64
	56.3 - 59.7			*	-
	70.9 - 75.95			-46	56
43.0	30.0 - 32.7	10	N/A	-45	55
	47.9 - 52.95			-44	54
	56.3 - 59.7			-48	58
	70.9 - 75.95			-64	74
54.0	30.0 - 32.7	10	N/A	*	-
	47.9 - 52.95			-39	49
	56.3 - 59.7			-45	55
	70.9 - 75.95			-43	53
65.0	30.0 - 32.7	10	N/A	-62	72
	47.9 - 52.95			-58	68
	56.3 - 59.7			-55	65
	70.9 - 75.95			-45	55

*Below sensitivity.

TABLE I-15

COSITE COUPLING LOSS, ANTENNA POSITIONS 5 AND 6

Subtest 2.10.3

Transmitter Antenna AS-2169/G Position 5

Receiver Antenna AS-2169/G Position 6

Sweep Oscillator HP-8601A S/N 912-00810

Spectrum Analyzer HP-8553B/8552A S/N 3339

Significant Control Positions

Test Freq (MHz)	Transmitter MX2799 Band (MHz)	Sweep Osc. P_t (dBm)	Receiver MX2799 Band (MHz)	Spectrum Analyzer P_r (dBm)	Coupling Loss (dB)
32.0	N/A	10	N/A	-26	36
43.0				-37	47
54.0				-42	52
65.0				-54	64

TABLE I-15

OPERATIONAL SUBTEST FREQUENCY COMBINATIONS

Subtest 2.9

Combination No.	Antenna No., Equipment, and Frequency (MHz)					
	1 PRC-25	2 PRC-77	3 VRC-12	4 VRC-12	5 VRC-12 MUX	6 VRC-12 MUX
I	50.40	36.10	32.40*	71.70	41.40	53.90
II	51.90	49.80	32.40	73.50	36.10	71.40
III	32.40	46.90	36.10	68.50	41.40	59.40
IV	69.10	49.70	38.50*	59.10	32.40*	54.10
V	32.40*	46.90	38.50	74.90	56.80	53.90
VI	50.40	74.30	36.90	49.70	32.40*	41.50
VII	50.10	73.10	34.10	75.50	41.40	68.20
VIII	71.60	41.20	30.40*	66.10	50.10	55.85
IX	34.60	69.20	32.40*	75.70	50.80	57.30
X	46.60	59.50	30.40*	75.70	34.30*	57.30
XI	53.60	57.70	32.40	71.60	41.40	69.20
XII	32.40	38.90	46.90	71.60	58.60	69.90
XIII	38.80	57.50	34.30	71.00	46.90	49.70
XIV	52.30	40.30	36.10	75.70	32.50	72.20
XV	53.70	53.10	30.40*	75.20	72.30	75.80
XVI	53.70	51.50	40.30	75.80	57.50	41.80
XVII	34.90	75.10	46.90	69.80	52.65	75.80
XVIII	75.80	57.10	57.90	36.20	68.60	72.40
XIX	32.90	34.10	40.20	73.70	54.10*	41.90
XX	50.50*	32.50	36.90	72.10	66.35	69.00
XXI	32.40	46.90	35.40	68.70	57.25*	75.80
XXII	54.10	75.70	34.60	71.50	57.75	41.20
XXIII	34.30	36.10	40.10	50.20	74.40	75.20
XXIV	49.70	38.25	51.15	72.75	69.20	70.40
XXV	69.10	57.55	30.40*	73.20	34.55	72.30

*Frequency unusable because of outside interference.

TABLE I-17

OPERATIONAL SUBTEST, (S+I+N)/(I+N), -105 dBm

Subtest 2.9.3

Desired Signal Level = -105 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)					
			1	2	3	4	5	6
I-1	14	2	R	2.2	62	74	64	32
I-2	16	2	1.7	R	62	74	64	32
*I-3					R			
I-4	16	2	1.7	2.2	62	R	64	32
I-5(1)	7	5	1.9	2.4	62	70	R	30
I-5(4)	8	5	1.9	2.4	62	70	R	30
I-6(1)	12	9	1.9	2.4	62	70	60	R
I-6(4)	16	13	2.0	2.3	64	68	62	R
II-1	14	2	R	2.1	65	43	57	32
II-2	21	2	2.0	R	65	43	57	32
II-3	10	1	2.0	2.1	R	43	51	33
II-4	18	2	2.0	2.1	65	R	57	32
II-5(1)	8	6	2.0	2.1	65	43	R	32
II-5(4)	8	7	2.0	2.1	65	43	R	32
II-6(1)	14	1	2.0	2.1	65	43	51	R
II-6(4)	13	1	2.0	2.1	65	43	51	R
III-1	16	2	R	2.2	65	55	62	59
III-2	20	10	1.7	R	57	55	60	48
III-3	16	2	1.7	2.2	R	55	60	48
III-4	16	2	1.7	2.2	57	R	60	48
III-5(1)	13	6	1.6	2.3	62	57	R	52
III-5(4)	12	7	1.6	2.3	62	57	R	52
III-6(1)	11	9	1.5	2.2	65	55	62	R
III-6(4)	12	10	1.5	2.2	65	55	62	R
IV-1	16	2	R	1.7	65	42	53	33
IV-2	22	2	1.5	R	65	42	53	33
*IV-3					R			
IV-4	19	6	1.5	1.7	65	R	53	33
*IV-5(1)							R	
*IV-5(4)							R	
IV-6(1)	10	8	1.5	1.7	65	42	53	R
IV-6(4)	10	8	1.5	1.7	65	42	53	R
V-1			R					
V-2	19	7	1.6	R	65	44	48	36

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-17 (Continued)

Subtest 2.9.3 Desired Signal Level = -105 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Rece[illegible] Location and Interfere[illegible] Level (Watts)					
			1	2		4	5	6
V-3	15	2	1.6	2.3	R	44	48	36
V-4	16	3	1.6	2.3	65	R	48	36
V-5(1)	16	14	1.6	2.3	65	44	R	36
V-5(4)	17	15	1.6	2.3	65	44	R	36
V-6(1)	9	4	1.6	2.3	65	44	48	R
V-6(4)	10	6	1.6	2.3	65	44	48	R
VI-1	14	2	R	1.3	50	72	50	43
VI-2	19	14	1.6	R	50	72	50	43
VI-3	16	5	1.6	1.3	R	72	50	43
VI-4	18	2	1.6	1.3	50	R	50	43
*VI-5(1)							R	
*VI-5(4)							R	
VI-6(1)	8	1	1.6	1.3	50	72	50	R
VI-6(4)	8	2	1.6	1.3	50	72	50	R
VII-1	7	2	R	1.4	60	32	58	27
VII-2	21	2	2.2	R	60	32	58	27
VII-3	19	0	1.7	1.7	R	47	64	34
VII-4	16	0	1.7	1.7	64	R	64	34
VII-5(1)	11	0	1.7	1.7	64	47	R	34
VII-5(4)	12	0	1.7	1.7	64	47	R	34
VII-6(1)	8	2	1.7	1.7	64	47	64	R
VII-6(4)	10	2	1.7	1.7	64	47	64	R
*VIII-1	17	2	R	2.1	46	68	59	38
VIII-2	21	2	1.3	R	46	68	59	38
*VIII-3					R			
VIII-4	16	5	1.3	2.1	46	R	59	38
VIII-5(1)	11	10	1.2	2.2	52	92	R	34
VIII-5(4)	11	10	1.2	2.2	52	92	R	34
VIII-6(1)	18	9	1.3	2.1	46	68	59	R
VIII-6(4)	19	12	1.3	2.1	46	68	59	R
IX-1	19	2	R	1.5	56	50	54	46
IX-2	20	2	1.5	R	56	50	54	46
*IX-3					R			
IX-4	16	1	1.5	1.5	56	R	54	46
IX-5(1)	10	1	1.4	1.4	57	53	R	47

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-17 (Continued)

Subtest 2.9.3 Desired Signal Level = -105 dbm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)					
			1	2	3	4	5	6
IX-5(4)	9	1	1.4	1.4	57	53	R	47
IX-6(1)	8	1	1.5	1.5	56	50	54	R
IX-6(4)	9	1	1.5	1.5	56	50	54	R
X-1	16	2	R	1.2	59	50	48	46
X-2	19	2	2.4	R	59	50	48	46
*X-3					R			
X-4	17	2	2.4	1.2	59	R	48	46
*X-5(1)							R	
*X-5(4)							R	
X-6(1)	10	1	2.4	1.2	59	50	48	R
X-6(4)	12	1	2.4	1.2	59	50	48	R
XI-1	13	2	R	2.0	57	64	60	48
XI-2	16	5	1.8	R	57	64	60	48
XI-3	18	6	1.8	2.0	R	64	60	48
XI-4	12	2	[illegible]	2.0	57	R	60	48
XI-5(1)	12	8	1.8	1.8	2.0	57	R	48
XI-5(4)	11	9	1.8	2.0	57	64	R	48
XI-6(1)	17	5	1.8	2.0	57	64	60	R
XI-6(4)	12	2	1.8	2.0	57	64	60	R
XII-1	18	7	R	2.6	69	46	58	30
XII-2	21	13	1.6	R	69	46	58	30
XII-3	11	0	1.6	2.6	R	46	58	30
XII-4	16	5	1.6	2.6	69	R	58	30
XII-5(1)	7	2	1.6	2.6	69	46	R	30
XII-5(4)	10	7	1.6	2.6	69	46	R	30
XII-6(1)	12	1	1.5	2.8	75	66	61	R
XII-6(4)	13	1	1.5	2.8	75	66	61	R
XIII-1	18	5	R	2.1	60	70	54	38
XIII-2	20	2	1.5	R	60	70	54	38
XIII-3	10	6	1.5	2.1	R	70	54	38
XIII-4	17	7	1.5	2.1	60	R	54	38
XIII-5(1)	11	7	1.5	2.1	60	70	R	38
XIII-5(4)	10	8	1.5	2.1	60	70	R	38
XIII-6(1)	8	4	1.5	2.1	58	71	58	R
XIII-6(4)	8	5	1.5	2.1	58	71	58	R

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-17 (Continued)

Subtest 2.9.3 **Desired Signal Level = -105 dBm**

Freq. Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)					
			1	2	3	4	5	6
XIV-1	16	2	R	2.0	62	51	47	42
XIV-2	22	16	4.3	R	62	51	47	42
XIV-3	12	2	4.3	2.0	R	51	47	42
XIV-4	16	4	4.3	2.0	62	R	47	42
XIV-5(1)	4	1	3.8	2.0	62	50	R	46
XIV-5(4)	5	2	3.8	2.0	62	50	R	46
XIV-6(1)	14	7	3.8	2.0	62	50	48	R
XIV-6(4)	13	6	3.8	2.0	62	50	48	R
XV-1	16	2	R	1.1	47	46	50	36
XV-2	22	2	1.8	R	47	46	50	36
*XV-3					R			
XV-4	16	2	1.8	1.1	47	R	50	36
XV-5(1)	13	10	1.8	1.1	52	46	R	36
XV-5(4)	14	10	1.8	1.1	52	46	R	36
XV-6(1)	8	1	1.8	1.1	52	46	46	R
XV-6(4)	8	1	1.8	1.1	52	46	46	R
XVI-1	11	2	R	2.2	64	52	47	21
XVI-2	19	2	1.6	R	64	52	47	21
XVI-3	17	1	1.6	2.2	R	52	47	21
XVI-4	15	10	1.6	2.2	64	R	47	21
XVI-5(1)	10	6	1.6	2.2	64	52	R	21
XVI-5(4)	10	6	1.6	2.2	64	52	R	21
XVI-6(1)	8	1	1.7	2.2	73	52	50	R
XVI-6(4)	8	1	1.7	2.2	73	52	50	R
XVII-1	18	2	R	2.1	69	89	43	30
XVII-2	20	2	1.4	R	69	89	43	30
XVII-3	18	1	1.4	2.1	R	89	43	30
XVII-4	17	2	1.4	2.1	69	R	43	30
XVII-5(1)	9	7	1.4	2.1	69	89	R	30
XVII-5(4)	9	7	1.4	2.1	69	89	R	30
XVII-6(1)	12	5	1.4	2.1	69	89	43	R
XVII-6(4)	12	10	1.4	2.1	69	89	43	R
XVIII-1	16	1	R	2.5	48	38	60	40
XVIII-2	19	2	1.8	R	48	38	60	40

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-17 (Continued)

Subtest 2.9.3 Desired Signal Level = -105 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) 1	2	3	4	5	6
XVIII-3	16	2	1.8	2.5	R	38	60	40
XVIII-4	15	2	1.8	2.5	48	R	60	40
XVIII-5(1)	11	1	1.8	2.5	48	38	R	40
XVIII-5(4)	12	1	1.8	2.5	48	38	R	40
XVIII-6(1)	10	1	1.8	2.5	48	38	60	R
XVIII-6(4)	10	1	1.8	2.5	48	38	60	R
XIX-1	15	1	R	3.5	70	43	54	13
XIX-2	19	2	1.7	R	70	43	54	13
XIX-3	17	2	1.7	3.5	R	43	54	13
XIX-4	16	12	1.7	3.5	70	R	54	13
*XIX-5(1)							R	
*XIX-5(4)							R	
XIX-6(1)	8	1	1.7	3.5	70	43	54	R
XIX-6(4)	8	1	1.7	3.5	70	43	54	R
XX-1			R					
XX-2	19	9	1.7	R	52	57	60	46
XX-3	17	6	1.7	2.0	R	57	60	46
XX-4	18	1	1.7	2.0	52	R	60	46
XX-5(1)	11	6	1.7	2.0	52	57	R	46
XX-5(4)	10	7	1.7	2.0	52	57	R	46
XX-6(1)	10	2	1.7	2.0	52	57	60	R
XX-6(4)	10	2	1.7	2.0	52	57	60	R
XXI-1	17	1	R	2.2	59	58	42	25
XXI-2	18	2	1.7	R	59	58	42	25
XXI-3	16	1	1.7	2.2	R	58	42	25
XXI-4	19	3	1.7	2.2	59	R	42	25
*XXI-5(1)							R	
*XXI-5(4)							R	
XXI-6(1)	9	9	1.7	2.2	59	58	42	R
XXI-6(4)	9	9	1.7	2.2	59	58	42	R
XXII-1	14	11	R	1.2	54	65	51	27
XXII-2	21	12	2.0	R	54	65	51	27
XXII-3	17	11	2.0	1.2	R	65	51	27
XXII-4	18	12	2.0	1.2	54	R	51	27
XXII-5(1)	10	1	2.0	1.2	54	65	R	27

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-17 (Continued)

Subtest 2.9.3 Desired Signal Level = -105 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) 1	2	3	4	5	6
XXII-5(4)	10	1	2.0	1.2	54	65	R	27
XXII-6(1)	9	6	2.0	1.2	54	65	51	R
XXII-6(4)	10	6	2.0	1.2	54	65	51	R
XXIII-1	19	1	R	2.3	67	87	40	32
XXIII-2	20	2	1.7	R	67	87	40	32
XXIII-3	10	1	1.7	2.3	R	87	40	32
XXIII-4	19	5	1.7	2.3	67	R	40	32
XXIII-5(1)	11	1	1.7	2.3	67	87	R	32
XXIII-5(4)	11	1	1.7	2.3	67	87	R	32
XXIII-6(1)	10	1	1.7	2.3	67	87	40	R
XXIII-6(4)	11	1	1.7	2.3	67	87	40	R
XXIV-1	15	2	R	3.2	51	43	38	17
XXIV-2	21	0	1.1	R	51	43	38	17
XXIV-3	16	1	1.1	3.2	R	43	38	17
XXIV-4	18	1	1.1	3.2	51	R	38	17
XXIV-5(1)	15	1	1.1	3.2	51	43	R	17
XXIV-5(4)	16	1	1.1	3.2	51	43	R	17
XXIV-6(1)	10	1	1.1	3.2	51	43	38	R
XXIV-6(4)	10	1	1.1	3.2	51	43	38	R
XXV-1	16	1	R	2.1	46	44	54	38
XXV-2	21	0	2.3	R	46	44	54	38
*XXV-3					R			
XXV-4	18	0	2.3	2.1	46	R	54	38
XXV-5(1)	10	1	2.3	2.1	46	44	R	38
XXV-5(4)	10	1	2.3	2.1	46	44	R	38
XXV-6(1)	9	1	2.3	2.1	46	44	54	R
XXV-6(4)	10	1	2.3	2.1	46	44	54	R

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-18

OPERATIONAL SUBTEST, (S+I+N)/(I+N), -95 dBm

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)					
			1	2	3	4	5	6
I-1	20	2	R	2.2	62	74	64	32
I-2	20	2	1.7	R	62	74	64	32
*I-3					R			
I-4	19	2	1.7	2.2	62	R	64	32
I-5(1)	21	18	1.9	2.4	62	70	R	30
I-5(4)	20	17	1.9	2.4	62	70	R	30
I-6(1)	20	20	2.0	2.3	64	68	62	R
I-6(4)	21	21	2.0	2.3	64	68	62	R
II-1	18	2	R	2.1	65	43	57	32
II-2	22	2	2.0	R	65	43	57	32
II-3	20	4	2.0	2.1	R	43	51	33
II-4	21	2	2.0	2.1	65	R	57	32
II-5(1)	20	16	2.0	2.1	65	43	R	32
II-5(4)	19	16	2.0	2.1	65	43	R	32
II-6(1)	21	1	2.0	2.1	65	43	51	R
II-6(4)	22	2	2.0	2.1	65	43	51	R
III-1	19	2	R	2.2	65	55	62	59
III-2	21	21	1.7	R	57	55	60	48
III-3	19	2	1.7	2.2	R	55	60	48
III-4	20	2	1.7	2.2	57	R	60	48
III-5(1)	23	15	1.6	2.3	62	57	R	52
III-5(4)	22	17	1.6	2.3	62	57	R	52
III-6(1)	21	20	1.5	2.2	65	55	62	R
III-6(4)	21	20	1.5	2.2	65	55	62	R
IV-1	21	2	R	1.7	65	42	53	33
IV-2	23	2	1.5	R	65	42	53	33
*IV-3					R			
IV-4	21	13	1.5	1.7	65	R	53	33
*IV-5(1)							R	
*IV-5(4)							R	
IV-6(1)	21	16	1.5	1.7	65	42	53	R
IV-6(4)	20	17	1.5	1.7	65	42	53	R
*V-1			R					
V-2	21	17	1.6	R	65	44	48	36

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-18 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)					
			1	2	3	4	5	6
V-3	20	13	1.6	2.3	R	44	48	36
V-4	19	16	1.6	2.3	65	R	48	36
V-5(1)	20	19	1.6	2.3	65	44	R	36
V-5(4)	22	21	1.6	2.3	65	44	R	36
V-6(1)	20	16	1.6	2.3	65	44	48	R
V-6(4)	20	13	1.6	2.3	65	44	48	R
VI-1	22	2	R	1.3	50	72	50	43
VI-2	23	22	1.6	R	50	72	50	43
VI-3	21	10	1.6	1.3	R	72	50	43
VI-4	18	3	1.6	1.3	50	R	50	43
*VI-5(1)							R	
*VI-5(4)							R	
VI-6(1)	21	4	1.6	1.3	50	72	50	R
VI-6(4)	20	4	1.6	1.3	50	72	50	R
VII-1	20	2	R	1.4	60	32	58	27
VII-2	23	2	2.2	R	60	32	58	27
VII-3	22	0	1.7	1.7	R	47	64	34
VII-4	20	0	1.7	1.7	64	R	64	34
VII-5(1)	22	0	1.7	1.7	64	47	R	34
VII-5(4)	22	0	1.7	1.7	64	47	R	34
VII-6(1)	20	2	1.7	1.7	64	47	64	R
VII-6(4)	20	2	1.7	1.7	64	47	64	R
VIII-1	21	2	R	2.1	46	68	59	38
VIII-2	22	2	1.3	R	46	68	59	38
*VIII-3					R			
VIII-4	20	15	1.3	2.1	46	R	59	38
VIII-5(1)	22	21	1.2	2.2	52	92	R	34
VIII-5(4)	20	19	1.2	2.2	52	92	R	34
VIII-6(1)	22	18	1.3	2.1	46	68	59	R
VIII-6(4)	22	18	1.3	2.1	46	68	59	R
IX-1	22	2	R	1.5	56	50	54	46
IX-2	22	2	1.5	R	56	50	54	46
*IX-3					R			

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-18 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	$\frac{S+N}{N}$ (dB)	$\frac{S+I+N}{I+N}$ (dB)	Test Receiver Location and Interferer Power Level (Watts)					
			1	2	3	4	5	6
IX-4	20	1	1.5	1.5	56	R	54	46
IX-5(1)	23	1	1.4	1.4	57	53	R	47
IX-5(4)	20	1	1.4	1.4	57	53	R	47
IX-6(1)	19	1	1.5	1.5	56	50	54	R
IX-6(4)	19	1	1.5	1.5	56	50	54	R
X-1	21	2	R	1.2	59	50	48	46
X-2	22	2	2.4	R	59	50	43	46
*X-3					R			
X-4	19	2	2.4	1.2	59	R	48	46
*X-5(1)							R	
*X-5(4)							R	
X-6(1)	21	1	2.4	1.2	59	50	48	R
X-6(4)	20	1	2.4	1.2	59	50	43	R
XI-1	21	2	R	2.0	57	64	60	48
XI-2	21	6	1.8	R	57	64	60	48
XI-3	21	12	1.8	2.0	R	64	60	46
XI-4	17	2	1.8	2.0	57	R	60	48
XI-5(1)	22	18	1.8	2.0	57	64	R	48
XI-5(4)	21	20	1.8	2.0	57	64	R	48
XI-6(1)	21	11	1.8	2.0	57	64	60	R
XI-6(4)	19	10	1.8	2.0	57	64	60	R
XII-1	21	7	R	2.6	69	46	58	30
XII-2	23	19	1.6	R	69	46	58	30
XII-3	19	0	1.6	2.6	R	46	58	30
XII-4	20	10	1.6	2.6	69	R	58	30
XII-5(1)	24	16	1.6	2.6	69	46	R	30
XII-5(4)	22	18	1.6	2.6	69	46	R	30
XII-6(1)	22	1	1.5	2.8	75	66	61	R
XII-6(4)	20	1	1.5	2.8	75	66	61	R
XIII-1	21	17	R	2.1	60	70	54	38
XIII-2	23	7	1.5	R	60	70	54	38
XIII-3	20	8	1.5	2.1	R	70	54	38
XIII-4	19	15	1.5	2.1	60	R	54	38

*No test because of interference from outside source
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-18 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) 1	2	3	4	5	6
XIII-5(1)	22	16	1.5	2.1	60	70	R	38
XIII-5(4)	21	17	1.5	2.1	60	70	R	38
XIII-6(1)	21	18	1.5	2.1	58	71	58	R
XIII-6(4)	19	12	1.5	2.1	58	71	58	R
XIV-1	20	2	R	2.0	62	51	47	42
XIV-2	22	21	4.3	R	62	51	47	42
XIV-3	20	2	4.3	2.0	R	51	47	42
XIV-4	18	7	4.3	2.0	62	R	47	42
XIV-5(1)	19	13	3.8	2.0	62	50	R	46
XIV-5(4)	16	13	3.8	2.0	62	50	R	46
XIV-6(1)	22	20	3.8	2.0	62	50	48	R
XIV-6(4)	21	18	3.8	2.0	62	50	48	R
XV-1	21	2	R	1.1	47	46	50	36
XV-2	22	2	1.8	R	47	46	50	36
*XV-3					R			
XV-4	17	2	1.8	1.1	47	R	50	36
XV-5(1)	23	21	1.8	1.1	52	46	R	36
XV-5(4)	20	19	1.8	1.1	52	46	R	36
XV-6(1)	21	1	1.8	1.1	52	46	46	R
XV-6(4)	19	1	1.8	1.1	52	46	46	R
XVI-1	19	2	R	2.2	64	52	47	21
XVI-2	21	9	1.6	R	64	52	47	21
XVI-3	21	1	1.6	2.2	R	52	47	21
XVI-4	17	16	1.6	2.2	64	R	47	21
XVI-5(1)	20	18	1.6	2.2	64	52	R	21
XVI-5(4)	20	17	1.6	2.2	64	52	R	21
XVI-6(1)	20	1	1.7	2.2	73	52	50	R
XVI-6(4)	19	2	1.7	2.2	73	52	50	R
XVII-1	20	4	R	2.1	69	89	43	30
XVII-2	21	2	1.4	R	69	89	43	30
XVII-3	21	6	1.4	2.1	R	89	43	30
XVII-4	18	2	1.4	2.1	69	R	43	30
XVII-5(1)	19	17	1.4	2.1	69	89	R	30

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-18 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) 1	2	3	4	5	6
XVII-5(4)	17	15	1.4	2.1	69	89	R	30
XVII-6(1)	23	22	1.4	2.1	69	89	43	R
XVII-6(4)	22	19	1.4	2.1	69	89	43	R
XVIII-1	21	1	R	2.5	48	38	60	40
XVIII-2	20	2	1.8	R	48	38	60	40
XVIII-3	21	2	1.8	2.5	R	38	60	40
XVIII-4	20	11	1.8	2.5	48	R	60	40
XVIII-5(1)	21	8	1.8	2.5	48	38	R	40
XVIII-5(4)	22	9	1.8	2.5	48	38	R	40
XVIII-6(1)	21	1	1.8	2.5	48	38	60	R
XVIII-6(4)	20	1	1.8	2.5	48	38	60	R
XIX-1	20	2	R	3.5	70	43	54	13
XIX-2	19	2	1.7	R	70	43	54	13
XIX-3	22	1	1.7	3.5	R	43	54	13
XIX-4	18	17	1.7	3.5	70	R	54	13
*XIX-5(1)							R	
*XIX-5(4)							R	
XIX-6(1)	19	1	1.7	3.5	70	43	54	R
XIX-6(4)	18	1	1.7	3.5	70	43	54	R
*XX-1			R					
XX-2	20	19	1.7	R	52	57	60	46
XX-3	22	10	1.7	2.0	R	57	60	46
XX-4	20	3	1.7	2.0	52	R	60	46
XX-5(1)	22	15	1.7	2.0	52	57	R	46
XX-5(4)	20	16	1.7	2.0	52	57	R	46
XX-6(1)	21	15	1.7	2.0	52	57	60	R
XX-6(4)	20	16	1.7	2.0	52	57	60	R
XXI-1	19	8	R	2.2	59	58	60	46
XXI-2	21	5	1.7	R	59	58	60	46
XXI-3	22	1	1.7	2.2	R	58	60	46
XXI-4	20	4	1.7	2.2	59	R	60	46
*XXI-5(1)							R	
*XXI-5(4)							R	

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-18 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N/N (dB)	S+I+N/I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)					
			1	2	3	4	5	6
XXI-6(1)	20	20	1.7	2.2	59	58	60	R
XXI-6(4)	20	20	1.7	2.2	59	58	60	R
XXII-1	19	18	R	1.2	54	65	51	27
XXII-2	22	19	2.0	R	54	65	51	27
XXII-3	22	16	2.0	1.2	R	65	51	27
XXII-4	19	7	2.0	1.2	54	R	51	27
XXII-5(1)	19	1	2.0	1.2	54	65	R	27
XXII-5(4)	20	1	2.0	1.2	54	65	R	27
XXII-6(1)	20	18	2.0	1.2	54	65	51	R
XXII-6(4)	19	8	2.0	1.2	54	65	51	R
XXIII-1	21	1	R	2.3	67	87	40	32
XXIII-2	21	3	1.7	R	67	87	40	32
XXIII-3	21	1	1.7	2.3	R	87	40	32
XXIII-4	23	18	1.7	2.3	67	R	40	32
XXIII-5(1)	20	1	1.7	2.3	67	87	R	32
XXIII-5(4)	21	1	1.7	2.3	67	87	R	32
XXIII-6(1)	20	3	1.7	2.3	67	87	40	R
XXIII-6(4)	20	3	1.7	2.3	67	87	40	R
XXIV-1	20	2	R	3.2	51	43	38	17
XXIV-2	22	0	1.1	R	51	43	38	17
XXIV-3	20	4	1.1	3.2	R	43	38	17
XXIV-4	20	1	1.1	3.2	51	R	38	17
XXIV-5(1)	21	9	1.1	3.2	51	43	R	17
XXIV-5(4)	21	9	1.1	3.2	51	43	R	17
XXIV-6(1)	20	1	1.1	3.2	51	43	38	R
XXIV-6(4)	19	1	1.1	3.2	51	43	38	R
XXV-1	21	1	R	2.1	46	44	54	38
XXV-2	21	0	2.3	R	46	44	54	38
*XXV-3					R			
XXV-4	21	0	2.3	2.1	46	R	54	38
XXV-5(1)	18	8	2.3	2.1	46	44	R	38
XXV-5(4)	18	10	2.3	2.1	46	44	R	38
XXV-6(1)	20	1	2.3	2.1	46	44	54	R
XXV-6(4)	20	1	2.3	2.1	46	44	54	R

*No test because of interference from outside source.
R - receiver connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-19

OPERATIONAL SUBTEST, INTERFERER ISOLATION, -105 dBm

Subtest 2.9.3 Desired Signal Level = -105 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
V-2	22	9	1.7	R	66	44	50	32
		3		R	66	44		
V-3	14	7	1.7	2.0	R	44	50	32
		8			R	44	50	
V-4	15	3	1.7	2.0	66	R	50	32
		3			66	R		
		4				R	50	32
VI-1	11	1	R	1.2	44	82	48	22
		1	R			82		
		2	R		44		48	22
VI-3	17	1[illegible]	1.6	1.2	R	82	48	22
VI-4	15	[illegible]	1.5	1.2	44	R	48	22
		1	1.6			R		
VI-6(1)	13	2	1.6	1.2	44	82	48	R
		7	1.6					R
		3			44			R
		5				82		R
		3					48	R
		2	1.6	1.2				R
VI-6(4)	10	3	1.6	1.2	44	82	48	R
		4			44			R
		[illegible]		1.2		82	48	R
VII-1	15	2	R	1.6	62	48	63	36
		2	R	1.6				
VII-2	22	0	1.4	R	62	48	63	36
		0	1.4	R				
		2		R	62	48		36
		2				48	63	36
VII-3	16	3	1.4	1.6	R	48	63	36
		2			R	48	63	
VII-4	14	0	1.4	1.4	56	R	63	36
		0			56	R	63	
VII-5(1)	10	0	1.4	1.4	56	48	R	36
		2			56	48	R	
VII-5(4)	9	1	1.4	1.4	56	[illegible]	R	36
		3			56		R	
VII-6(1)	11	3	1.4	1.4	56		[illegible]	R
		2			56			R
		3				4[illegible]	63	[illegible]

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE 1-19 (Continued)

Subtest 2.9.3 Desired Signal Level = -105 dBm

Freq. Comb. No.	S+N/N (dB)	S+I+N/I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
VII-6(4)	1[illegible]	3	1.4	1.4	56	48	63	R
		4			56			R
		2		1.4		48	63	R
VIII-1	16	2	R	1.2	26	95	64	27
		2	R			95		
		2	R	1.2	26			
VIII-2	22	0	2.6	R	26	95	64	27
		0	2.6	R	26			
VIII-4	15	3	2.6	1.2	26	R	64	27
		4	2.6	1.2	26	R		
		3		1.2	26	R	64	
		4		1.2	26	R		27
		4	2.6	1.2		R	64	27
		4	2.6		26	R	64	27
VIII-6(1)	7	6	2.6	1.2	26	95	64	R
VIII-6(4)	8	8	2.6	1.2	26	95	64	R
IX-1	18	2	R	1.4	50	53	34	22
		2	R		50			
IX-2	21	0	1.5	R	50	53	34	22
		0	1.5	R				
IX-4	1[illegible]	3	1.5	1.4	50	R	34	22
		2		1.4		R	34	22
		3			50	R	34	22
IX-5([illegible])	9	0	1.5	1.4	50	53	R	22
		0		1.4		53	R	22
		0			50	53	R	22
IX-5(4)	9	0	1.5	1.4	50	53	R	22
		0		1.4		53	R	22
		0			50	53	R	22
IX-6(1)	9	1	1.5	1.4	50	53	34	R
		2		1.4		53	34	R
		2			50	53	34	R
IX-6(4)	4	0	1.5	1.4	50	53	34	R
		0		1.4		53	34	R
		0			50	53	34	R

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-19 (Continued)

Subtest 2.9.3 Desired Signal Level = -105 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
X-1	18	2	R	1.2	30	54	34	22
		2	R	1.2	30	54		
X-2	20	2	1.8	R	30	54	34	22
		2	1.8	R	30	54		
X-4	15	2	1.8	1.2	30	R	34	22
		2	1.8	1.2	20	R		
X-6(1)	18	0	1.8	1.2	30	5'	34	R
		0					34	R
X-6(4)	14	0	1.8	1.2	30	54	34	R
		1					34	R
XI-1	12	2	R	1.8	65	64	38	26
		5	R	1.8				
		2	R	1.8				26
		2	R		65	64	38	
XI-2	14	14	1.6	R	65	64	38	26
XI-3	17	3	1.6	1.8	R	64	38	26
		4		1.8	R	64		26
		4	1.6		R	64	38	26
XI-4	17	1	1.6	1.8	65	R	38	26
		1		1.8		R		26
		4				R	38	26
		1	1.6		65	R	38	
		2	1.6		65	R		26
XI-6(1)	14	1	1.6	1.8	65	64	38	R
		3	3	1.8				R
		3	3			64		R
XI-6(4)	13	1	1.6	1.8	65	64	38	R
		3		1.8				R
		4				64		R
XII-3	6	0	1.7	2.6	R	62	58	30
		0			R			30
XII-4		2	1.7	2.6	64	R	58	30
		4				R		30
		3	1.7	2.6		R	58	
XII-5(1)	15	3	1.7	2.6	64	62	R	30
		4				62	R	30
		[illegible]		2.6	64	62	R	

*Blank spaces in[illegible]te transmitter, off.
R - receivers [illegible]ted to antenna indicated by column number
Note: Numbers [illegible]rentheses are channel numbers.

TABLE I-19 (Continued)

Subtest 2.9.3 Desired Signal Level = -105 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) *					
			1	2	3	4	5	6
XII-5(4)	11	3	1.7	2.6	64	62	R	30
		4				62	R	30
		3		2.6	64	62	R	
XII-6(1)	13	1	1.7	2.6	64	62	58	R
		1			64			R
		1				62		R
XII-6(4)	12	1	1.7	2.6	64	62	58	R
		1			64			R
		1				62		R
XIII-1	16	13	R	2.0	56	66	56	20
		6	R		56			
XIII-2	21	9	1.6	R	56	66	56	20
		10		R	56	66	56	20
XIII-4	13	11	1.6	2.0	56	R	56	20
XIV-1	18	2	R	1.9	64	57	53	38
		2	R	1.9				
**XIV-3	8	1	4.3	1.9	R	57	53	38
		2	4.3		R		53	
		2		1.9	R	57	53	
		2		1.9	R	57		38
		1			R	57	53	38
XIV-4	16	7	4.3	1.9	64	R	53	38
XIV-6(1)	13	1	4.3	1.9	64	57	53	R
		1			64			R
XIV-6(4)	21	1	4.3	1.9	64	57	53	R
		1			64			R
XV-1	12	1	R	1.1	50	46	50	22
		1	R	1.1				
		1	R			46	50	22
XV-2	23	1	2.3	R	50	46	50	22
		1	2.3	R				
XV-4	16	1	2.3	1.1	50	R	50	22
		1				R		22
XV-6(1)	12	1	2.3	1.1	50	46	50	R
		1				46		R
		1		1.1	50			R

Blank spaces indicate transmitters off.
** Constant level of external interference.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-19 (Continued)

Subtest 2.9.3 Desired Signal Level = -105 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
XV-6(4)	11	1	2.3	1.1	50	46	50	R
		1				46		R
		1		1.1	50			R
XVI-2	21	2	2.4	R	68	54	46	16
		2	2.4	R	68	54		16
XVI-3	10	2	2.4	2.2	R	54	46	16
		2			R			16
XVI-6(1)	10	1	2.4	2.2	68	54	46	R
		1			68			R
XVI-6(4)	11	2	2.4	2.2	68	54	46	R
		2			68			R
XVII-1	19	1	R	1.5	70	92	46	26
		2	R		70	92		26
XVII-2	22	2	1.5	R	70	92	46	26
		2	2	R				26
		1	1	R	70	90	46	
XX-2	17	5	1.6	R	48	57	60	44
		5		R	48			
XX-3	10	7	1.6	2.8	R	57	60	44
XX-4	18	1	1.6	2.8	48	R	60	44
		1				R	60	
XX-6(1)	15	1	1.6	2.8	48	57	60	R
		1				57	60	R
XX-6(4)	10	1	1.6	2.8	48	57	60	R
		4		2.8			60	R
		1				57	60	
XXI-1	19	2	R	2.0	60	59	44	25
		2	R		60			
END								

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-20

OPERATIONAL SUBTEST, INTERFERER ISOLATION, -95 dBm

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
VI-1	17	2	R	1.2	44	82	48	22
		2	R			82		
		1	R		44		48	
VI-3	20	17	1.6	1.2	R	82	48	22
VI-4	18	1	1.6	1.2	44	R	48	22
		1	1.6			R		
VI-6(1)	20	2	1.6	1.2	44	82	48	R
		3			44			R
		5	1.6	1.2		82	48	R
VI-6(4)	20	2	1.6	1.2	44	82	48	R
		4			44			R
		5	1.6	1.2		82	48	R
VII-1	22	2	R	1.6	62	48	63	36
		2	R	1.6				
VII-2	23	0	1.4	R	62	48	63	36
		0	1.4	R				
		2		R	62	48	63	36
VII-3	20	1	1.4	1.6	R	48	63	36
		1			R	48	63	
VII-4	19	0	1.4	1.4	56	R	63	36
		1			56	R	63	
VII-5(1)	21	3	1.4	1.4	56	48	R	36
		0			56	48	R	
VII-5(4)	22	2	1.4	1.4	56	48	R	36
		0			56	48		
VII-6(1)	22	3	1.4	1.4	56	48	63	R
		2			56			R
VII-6(4)	22	2	1.4	1.4	56	48	63	R
		2			56			R
VIII-1	21	2	R	1.2	26	95	64	27
		2	R	1.2	26			
VIII-2	23	0	2.6	R	26	95	64	23
		0	2.6	R	26			
IX-1	21	11	R	1.4	50	53	34	22

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-20 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
IX-2	22	0	1.5	R	50	53	34	22
		0	1.5	R				
IX-4	18	3	1.5	1.4	50	R	34	22
		2		1.4		R	34	22
		3			50	R	34	22
IX-5(1)	18	0	1.5	1.4	50	53	R	22
		0		1.4		53	R	22
		0			50	53	R	22
IX-5(4)	15	0	1.5	1.4	50	53	R	22
		0		1.4		53	R	22
		0			50	53	R	22
IX-6(1)	20	2	1.5	1.4	50	53	34	R
		2		1.4		53	34	R
		2			50	53	34	R
IX-6(4)	16	0	1.5	1.4	50	53	34	R
		0		1.4		53	34	R
		0			50	53	34	R
X-1	21	2	R	1.2	30	54	34	22
		2	R	1.2				
X-2	22	2	1.8	R	30	54	34	22
		2	1.8	R	30	54		
X-4	17	2	1.8	1.2	30	R	34	22
		2	1.8	1.2	30	R		
X-6(1)	23	0	1.8	1.2	30	54	34	R
		0					34	R
X-6(4)	20	1	1.8	1.2	30	54	34	R
		1					34	R
XI-1	19	2	R	1.8	65	64	38	26
		2	R	1.8				26
XI-2	22	22	1.6	R	65	64	38	26
XI-4	19	1	1.6	1.8	65	R	38	26
		2		1.8		R		26
		1	1.6		65	R	38	
XII-3	19	0	1.7	2.6	R	62	58	30
		0			R			30

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parenthesis are channel numbers.

TABLE I-20 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
XII-6(1)	22	1	1.7	2.6	64	62	58	R
		2			64			R
		3				62		R
XII-6(4)	20	2	1.7	2.6	64	62	58	R
		1			64			R
		2				62		R
XIII-2	22	21	1.6	R	56	66	56	20
XIII-3	20	18	1.6	2.0	R	66	56	20
XIII-6(1)	20	20	1.6	2.0	56	66	56	R
XIII-6(4)	17	17	1.6	2.0	56	66	56	R
XIV-1	21	4	R	1.9	64	57	53	38
		4	R	1.9	64		53	
XIV-3	14	1	4.3	1.9	R	57	53	38
		1	4.3	1.9	R		53	
		3	4.3		R	57	53	32
		1		1.9	R	57	53	32
XIV-4	19	17	4.3	1.9	64	R	53	32
XV-1	20	1	R	1.1	50	46	50	22
		2	R	1.1				
		3	R			46	50	22
XV-2	24	2	2.3	R	50	46	50	22
		1	2.3	R				
XV-4	20	1	2.3	1.1	50	R	50	22
		2				R		22
XV-6(1)	22	1	2.3	1.1	50	46	50	R
		1				46		R
		3		1.1	50			R
XVI-6(1)	21	2	2.4	2.2	68	54	46	R
		4			68			R
XVI-6(4)	19	3	2.6	2.2	68	54	46	R
		3			68			R
XVII-1	21	10	R	1.2	66	88	45	21
		5	R		66	88	45	21

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-20 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
XVII-2	23	2	1.5	R	70	92	46	26
		2		R		92		26
		2		R	70	92	46	
		2		R	70		46	26
XVII-3	20	15	1.5	1.5	R	92	46	26
XVII-4	20	0	1.5	1.5	70	R	46	26
		0	1.5			R		
XVIII-6(1)	19	2	1.7	2.7	40	52	60	R
		2				52		R
XVIII-6(4)	21	4	1.7	2.7	40	52	60	R
		4				52		R
XIX-2	23	16	1.6	R	61	44	46	16
		7	1.6	R	61	44	46	
XIX-3	19	1	1.6	3.4	R	44	46	16
		2		3.4	R	44	46	16
XIX-6(1)	19	2	1.6	3.4	61	44	46	R
		3			61			R
XIX-6(4)	19	3	1.6	3.4	61	44	46	R
		3			61			R
XXII-4	18	15	2.1	1.2	50	R	49	23
XXII-5(1)	18	1	2.1	1.2	50	65	R	23
		1	2.1				R	
XXII-5(4)	17	1	2.1	1.2	50	65	R	23
		1	2.1				R	
XXIII-1	19	0	R	2.4	64	77	46	36
		0	R		64		46	
XXIII-2	20	5	1.8	R	64	77	46	36
		3	1.8	R				
XXIII-5(1)	21	2	1.8	2.4	64	77	R	36
		1					R	36
		1	1.8		64		R	

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-20 (Continued)

Subtest 2.9.3 Desired Signal Level = -95 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
XXIV-3	21	3	1.3	3.1	R	50	44	35
		2	1.3		R			
XXIV-4	20	1	1.3	3.1	60	R	44	35
		1				R	44	35
XXIV-5(1)	23	8	1.3	2.1	60	50	R	35
		12					R	35
XXIV-5(4)	21	6	1.3	2.1	60	50	R	35
		9					R	35
XXIV-6(1)	20	2	1.3	2.1	60	50	44	R
		2					44	R
XXIV-6(4)	20	4	1.3	2.1	60	50	44	R
		3					44	R

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-21

OPERATIONAL SUBTESTS, INTERFERER ISOLATION, -85 dBm

Subtest 2.9.3 Desired Signal Level = -85 dBm

Freq Comb. No.	(S+N)/N (dB)	(S+I+N)/(I+N) (dB)	Test Receiver Location and Interferer Power Level (Watts) *					
			1	2	3	4	5	6
I-1	23	1	R	2.3	52	66	61	23
		1	R		52		61	
		4	R	2.3	52	66		23
I-2	23	17	1.8	R	52	66	61	23
I-3	20	1	1.8	2.3	R	66	61	23
		1	1.8		R		61	
I-4	20	20	1.8	2.3	52	R	61	23
I-5(1)	28	28	1.8	2.3	52	66	R	23
I-5(4)	27	27	1.8	2.3	52	66	R	23
I-6(1)	26	26	1.8	2.3	52	66	61	R
I-6(4)	24	24	1.8	2.3	52	66	61	R
II-1	21	2	R	1.9	48	42	51	37
		2	R		48	42		
		2	R	1.9		42		37
II-2	23	2	4.0	R	48	42	51	37
		2		R	48	42		
		2	4.0	R		42		37
II-3	20	16	4.0	1.9	R	42	51	37
II-4	19	15	4.0	1.9	48	R	51	37
II-5(1)	27	20	4.0	1.9	48	42	R	37
II-5(4)	27	21	4.1	1.9	48	42	R	37
II-6(1)	26	6	4.1	1.9	48	42	51	R
		6	4.1	1.9		42		R
II-6(4)	24	10	4.0	1.9	48	42	51	R
		10	4.0	1.9		42		R
III-1	21	2	R	2.1	56	52	60	38
		2	R		56	52		
III-2	24	24	1.8	R	56	52	60	38
III-3			Outside interference					
III-4	21	6	1.8	2.1	56	R	60	38
		6	1.8		56	R		
III-5(1)	25	24	1.8	2.1	56	52	R	38
III-5(4)	26	25	1.8	2.1	56	52	R	39
III-6(1)	26	25	1.5	2.2	54	54	59	R
III-6(4)	24	24	1.5	2.2	54	52	59	R

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-21 (Continued)

Subtest 2.9.3 Desired Signal Level = -85 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
IV-1	21	2	R	2.0	56	44	43	28
		2	R			44		28
		4	R	2.0	56	44		
IV-2	24	21	1.9	R	56	44	43	28
IV-3	22	21	1.9	2.0	R	44	43	28
IV-4	22	22	1.9	2.0	56	R	43	28
IV-5(1)	29	24	1.9	2.0	56	44	R	28
IV-5(4)	26	24	1.9	2.0	56	44	R	28
IV-6(1)	26	26	1.9	2.0	56	44	43	R
IV-6(4)	25	23	1.9	2.0	56	49	43	R
V-1	21	16	R	2.0	57	43	56	38
V-2	23	18	1.7	R	57	43	56	38
V-3		Outside interference						
V-4	21	15	1.7	2.0	57	R	56	38
V-5(1)	25	25	1.7	2.0	57	43	R	38
V-5(4)	26	26	1.7	2.0	57	43	R	38
V-6(1)	25	25	1.7	2.0	57	43	56	R
V-6(4)	24	24	1.7	2.0	57	43	56	R
VI-1	21	0	R	1.0	45	67	52	23
		0	R			67		
VI-2	23	22	1.8	R	45	67	52	23
VI-3	20	17	1.8	1.0	R	67	52	23
VI-4	20	11	1.8	1.0	45	R	52	23
VI-5(1)	25	19	1.8	1.0	45	67	R	23
VI-5(4)	27	21	1.8	1.0	45	67	R	23
VI-6(1)	26	20	1.8	1.0	45	67	52	R
VI-6(4)	23	19	1.8	1.0	45	67	52	R
VII-1	22	7	R	1.5	56	48	60	37
		**4	R	1.5	56			
		7	R	1.5	56	48		
VII-2	23	0	1.3	R	56	48	60	37
		0	1.3	R				
VII-3		Outside interference						
VII-4	20	1	1.3	1.5	56	R	60	37
		1			56	R	60	

*Blank spaces indicate transmitters off.
**Note anomalous effect on number 4 transmitter (see text).
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-21 (Continued)

Subtest 2.9.3 Desired Signal Level = -85 dBm

Freq Comb. No.	S+N/N (dB)	S+I+N/I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) *					
			1	2	3	4	5	6
VII-5(1)	24	1	1.3	1.5	60	49	R	36
		1			60	49	R	
VII-5(4)	25	1	1.3	1.5	60	49	R	36
					60	49	R	
VII-6(1)	21	1	1.3	1.5	60	49	64	R
		1			60	49	64	R
VII-6(4)	20	1	1.3	1.5	60	49	64	R
		1			60	49	64	R
VIII-1	22	2	R	1.4	43	87	65	36
		2	R			87		
		2	R	1.4	43			
VIII-2	23	1	2.0	R	43	87	65	36
		1	2.0	R	43			
VIII-3		Outside interference						
VIII-4	21	20	2.0	1.4	43	R	65	36
VIII-5(1)	24	24	2.0	1.4	43	87	R	36
VIII-5(4)	25	25	2.0	1.4	43	87	R	36
VIII-6(1)	23	23	2.0	1.4	43	87	65	R
VIII-6(4)	22	22	2.0	1.4	43	87	65	R
IX-1	22	10	R	1.3	50	50	51	38
IX-2	22	0	1.4	R	50	50	51	38
		0	1.4	R				
IX-3		Outside interference						
IX-4	20	0	1.4	1.3	50	R	51	38
		2		1.3		R	51	38
		0			50	R	51	3[illegible]
IX-5(1)	25	1	1.3	1.6	56	54	R	42
		4		1.6		54	R	42
		3			56	54	R	42
		1		1.6	56	54	R	42
IX-5(4)	26	1	1.3	1.6	56	54	R	42
		7		1.6		54	R	42
		2			56	54	R	42
		1		1.6	56	54	R	42
IX-6(1)	24	1	1.3	1.6	56	54	51	R
		1		1.6		54	51	R
		1			56	54	51	R

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-21 (Continued)

Subtest 2.9.3 Desired Signal Level = -85 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
IX-6(4)	23	1	1.3	1.6	56	54	51	R
		1		1.6		54	51	R
		1			56	54	51	R
X-1	20	2	R	1.2	47	54	45	42
		2	R	1.2	47	54		
X-2	23	2	2.2	R	47	54	45	42
		2	2.2	R	47	54		
X-3		Outside interference						
X-4	21	10	2.2	1.2	47	R	45	42
		11	2.2	1.2	47	R		
X-5(1)	28	18	2.2	1.2	47	54	R	42
X-5(4)	26	16	2.2	1.2	47	54	R	42
X-6(1)	23	2	2.2	1.2	47	54	45	R
		2					45	R
X-6(4)	23	3	2.2	1.2	47	54	45	R
		3					45	R
XI-1	23	2	R	1.8	49	65	56	48
		2	R	1.8				48
XI-2	25	24	2.2	R	49	65	56	48
XI-3		Outside interference						
XI-4	21	13	2.2	1.8	49	R	56	48
XI-5(1)	28	26	2.2	1.8	49	65	R	48
XI-5(4)	27	25	2.2	1.8	49	65	R	48
XI-6(1)	25	21	2.2	1.8	49	65	56	R
XI-6(4)	24	20	2.2	1.8	49	65	56	R
XII-1	23	23	R	2.5	67	65	47	31
XII-2	[illegible]	23	1.6	R	67	65	47	31
XII-3	[illegible]	1	1.6	2.5	R	65	47	31
		3			R			31
		1			R	65		31
XII-4	20	16	1.6	2.5	67	R	47	31
XII-5(1)	27	25	1.6	2.5	67	65	R	31
XII-5(4)	27	24	1.6	2.5	67	65	R	31
XII-6(1)	25	2	1.6	2.5	67	65	47	R
		2			67			R

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-21 (Continued)

Subtest 2.9.3 Desired Signal Level = -85 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) *					
			1	2	3	4	5	6
XII-6(4)	24	2	1.6	2.5	67	65	47	R
		2			67			R
XIII-1	22	21	R	2.1	54	70	51	23
XIII-2	23	22	1.5	R	54	70	51	23
XIII-3	Outside interference							
XIII-4	20	20	1.5	2.1	54	R	51	23
XIII-5(1)	26	24	1.5	2.1	54	70	R	23
XIII-5(4)	26	23	1.5	2.1	54	70	R	23
XIII-6(1)	24	24	1.5	2.1	54	70	51	R
XIII-6(4)	24	24	1.5	2.1	54	70	51	R
XIV-1	22	12	R	1.8	56	51	46	43
XIV-2	20	15	4.0	R	56	51	46	43
XIV-3	Outside interference							
XIV-4	21	21	4.0	1.8	56	R	46	43
XIV-5(1)	Outside interference							
XIV-5(4)	Outside interference							
XIV-6(1)	25	15	4.0	1.8	56	51	46	R
XIV-6(4)	24	14	4.0	1.8	56	51	46	R
XV-1	Not obtained**							
XV-2	24	2	2.0	R	55	46	45	36
		2	2.1	R				
XV-3	Outside interference							
XV-4	22	2	2.0	1.3	55	R	45	36
		3	2.0	1.3		R		36
XV-5(1)	25	24	2.0	1.3	55	46	R	36
XV-5(4)	25	24	2.0	1.3	55	46	R	36
XV-6(1)	25	8	2.1	1.0	48	45	49	R
		8				45		R
XV-6(4)	24	9	2.1	1.0	48	45	49	R
		9				45		R
XVI-1	22	2	R	2.2	60	53	45	21
		2	R	2.2		53		
	See text	0	R		60	53	45	

*Blank spaces indicate transmitters off.
**Alternate capture and release. See text.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-21 (Continued)

Subtest 2.9.3 Desired Signal Level = -85 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts)*					
			1	2	3	4	5	6
XVI-2	23	18	1.9	R	60	53	45	21
XVI-3	22	20	1.9	2.2	R	53	45	21
XVI-4	20	20	1.9	2.2	60	R	45	21
XVI-5(1)	29	26	2.0	2.1	65	55	R	20
XVI-5(4)	27	25	2.0	2.1	65	55	R	20
XVI-6(1)	25	17	2.0	2.1	65	55	38	R
XVI-6(4)	23	17	2.0	2.1	65	55	38	R
XVII-1	22	17	R	1.0	61	88	37	36
XVII-2	23	2	1.4	R	61	88	37	36
		6		R		88		36
		2		R	61		37	36
XVII-3	22	18	1.4	1.0	R	88	37	36
XVII-4	20	0	1.4	1.0	61	R	37	36
		0	1.4			R		
XVII-5(1)	25	25	1.4	1.0	61	88	R	36
XVII-5(4)	26	23	1.4	1.0	61	88	R	36
XVII-6(1)	24	24	1.4	1.0	61	88	37	R
XVII-6(4)	24	24	1.4	1.0	61	88	37	R
XVIII-1	21	0	R	2.6	45	36	57	46
		0	R	2.6			57	
		2	R				57	46
		1	R	2.6	45			46
XVIII-2	23	10	1.7	R	45	36	57	46
		11		R	45			
XVIII-3	21	0	1.7	2.6	R	36	57	46
		0		2.6	R		57	
XVIII-4	21	20	1.7	2.6	45	R	57	46
XVIII-5(1)	30	22	1.7	2.6	45	36	R	46
XVIII-5(4)	28	23	1.7	2.6	45	36	R	46
XVIII-6(1)	25	2	1.7	2.6	45	36	57	R
		2				36		R
XVIII-6(4)	24	2	1.7	2.6	45	36	57	R
		2				36		R
XIX-1	22	2	R	3.3	55	44	66	17
		2	R	3.3	55	44		

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-21 (Continued)

Subtest 2.9.3 Desired Signal Level = -85 dBm

Freq Comb. No.	S+N/N (dB)	S+I+N/I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) *					
			1	2	3	4	5	6
XIX-2	23	2	1.4	R	55	44	66	17
See text.		2	1.4	R	55	44		
XIX-3	23	18	1.4	3.3	R	44	66	17
XIX-4	20	19	1.4	3.3	55	R	66	17
XIX-5(1)	26	20	1.5	3.2	58	44	R	17
XIX-5(4)	26	20	1.5	3.2	58	44	R	17
XIX-6(1)	24	18	1.5	3.2	58	44	63	R
XIX-6(4)	22	16	1.5	3.2	58	44	63	R
XX-1	20	20	R	2.7	48	57	57	44
XX-2	22	21	1.9	R	48	57	57	44
XX-3		Outside interference						
XX-4	20	14	1.9	2.7	48	R	57	44
XX-5(1)	30	28	1.9	2.7	48	57	R	44
XX-5(4)	28	26	1.9	2.7	48	57	R	44
XX-6(1)	25	15	1.9	2.7	48	57	57	R
XX-6(4)	25	15	1.9	2.7	48	57	57	R
XXI-1	22	16	R	2.3	62	58	49	32
XXI-2	23	16	1.5	R	62	58	49	32
XXI-3	23	2	1.5	2.3	R	58	49	32
	**	2		2.3	R	58	49	
XXI-4	22	18	1.5	2.3	62	R	49	32
XXI-5(1)	28	24	1.5	2.3	62	58	R	32
XXI-5(4)	27	23	1.5	2.3	62	58	R	32
XXI-6(1)	26	26	1.5	2.3	62	58	49	R
XXI-6(4)	25	25	1.5	2.3	62	58	49	R
XXII-1	21	20	R	1.0	57	66	53	31
XXII-2	21	21	2.0	R	57	66	53	31
XXII-3	23	18	2.0	1.0	R	66	53	31
XXII-4	20	20	2.0	1.0	57	R	53	31
XXII-5(1)	27	24	2.0	1.0	57	66	R	31
XXII-5(4)	27	24	2.0	1.0	57	66	R	31
XXII-6(1)	25	15	2.0	1.0	57	66	53	R
XXII-6(4)	24	16	2.0	1.0	57	66	53	R
XXIII-1	20	0	R	2.2	69	72	38	32
		0	R		69		38	

*Blank spaces indicate transmitters off.
**Alternate capture and release. See text.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE 1-21 (Continued)

Subtest 2.9.3 Desired Signal Level = -85 dBm

Freq Comb. No.	S+N / N (dB)	S+I+N / I+N (dB)	Test Receiver Location and Interferer Power Level (Watts) *					
			1	2	3	4	5	6
XXIII-2	20	12	1.5	R	69	72	38	32
XXIII-3		Outside Interference						
XXIII-4	19	16	1.5	2.2	69	R	38	32
XXIII-5(1)	29	1	1.5	2.2	69	72	R	32
		2	1.5		69		R	
XXIII-5(4)	29	1	1.5	2.2	69	72	R	32
		2	1.5		69		R	
XXIII-6(1)	25	19	1.5	2.2	69	72	38	R
XXIII-6(4)	25	19	1.5	2.2	69	72	38	R
XXIV-1	22	10	R	3.3	56	48	48	30
		14	R	3.3				
		13	R		56			
XXIV-2	24	0	1.5	R	56	48	48	30
		0	1.5	R				
XXIV-3	23	19	1.5	3.3	R	48	48	30
XXIV-4	21	1	1.5	3.3	56	R	48	30
		1				R	48	30
XXIV-5(1)	27	17	1.5	3.3	56	48	R	30
XXIV-5(4)	25	16	1.5	3.3	56	48	R	30
XXIV-6(1)	22	15	1.5	3.3	56	48	48	R
XXIV-6(4)	23	15	1.5	3.3	56	48	48	R
XXV-1	22	2	R	1.7	44	44	56	43
		2	R			44		43
		7	R	1.7	44	44	56	
XXV-2	24	0	2.0	R	44	44	56	43
		0	2.0	R				
XXV-3	20	1	2.0	1.7	R	44	56	43
		2			R	44	56	
XXV-4	20	6	2.0	1.7	44	R	56	43
		9			44	R		43
XXV-5(1)	28	24	2.0	1.7	44	44	R	43
XXV-5(4)	27	23	2.0	1.7	44	44	R	43
XXV-6(1)	26	12	2.0	1.7	44	44	56	R
		12				44		R
XXV-6(4)	24	11	2.0	1.7	44	44	56	R
		11				44		R

*Blank spaces indicate transmitters off.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-22

OPERATIONAL SUBTEST, CONSTANT (S+I+N)/(I+N)

Subtest 2.9.3

Freq Comb. No.	S (dBm)	(S+N)/N (dB)	(S+I+N)/(I+N) (dB)	Test Receiver Location and Interferer Power Level (Watts) 1	2	3	4	5	6
I-1	-74	23	10	R	2.3	52	66	61	23
I-3	-74	22	10	1.8	2.3	R	66	61	23
II-1	-80	21	10	R	1.9	48	42	51	37
II-2	-64	23	10	4.0	R	48	42	51	37
II-6(1)	-83	27	10	4.0	1.9	48	42	51	R
III-1	-34	Insufficient power to obtain 10 dB (S+I+N)/(I+N).							
III-4	-79	21	10	1.8	2.1	56	R	60	38
IV-1	-58	21	10	R	2.0	56	44	43	28
VI-1	-50	21	10	R	1.0	45	67	52	23
VII-1	-84	22	10	R	1.5	56	48	60	37
	-82	22	10	R	1.5	56		**	
VII-5(1)	-47	25	10	1.3	1.5	60	49	R	36
VII-3(4)	-47	25	10	1.3	1.5	60	49	R	36
VII-6(1)	-74	22	10	1.3	1.5	60	49	64	R
VII-6(4)	-72	22	10	1.3	1.5	60	49	64	R
VIII-1	-47	22	10	R	1.4	43	87	65	36
VIII-2	-82	23	10	2.0	R	43	87	65	36
IX-2	-41	23	10	1.4	R	50	50	51	38
IX-4	-68	20	10	1.4	1.3	50	R	51	38
IX-5(1)	-71	26	10	1.3	1.6	56	54	R	42
IX-5(4)	-73	27	10	1.3	1.6	56	54	R	42
IX-6(1)	-68	24	10	1.4	1.3	50	50	51	R
IX-6(4)	-70	25	10	1.4	1.3	50	50	51	R
X-1	-74	22	10	R	1.2	47	54	45	42
X-2	-77	23	10	2.2	R	47	54	45	42
X-6(1)	-79	23	10	2.2	1.2	47	54	45	R
X-6(4)	-80	23	10	2.2	1.2	47	54	45	R
XI-1	-63	23	10	R	1.8	49	65	56	48
XII-3	-77	21	10	1.6	2.5	R	65	47	31
XII-6(1)	-74	26	10	1.6	2.5	67	65	47	R
XII-6(4)	-75	25	10	1.6	2.5	67	65	47	R
XV-2	-72	24	10	2.0	R	55	46	45	36
XV-4	-81	22	10	2.0	1.3	55	R	45	36
XV-6(1)	-83	25	10	2.1	1.0	48	45	49	R
*	-80	25	10	2.1	1.0		45		R
XV-6(4)	-84	24	10	2.1	1.0	48	45	49	R
*	-81	26	10	2.1	1.0		45		R
XVI-1	-62	22	10	R	2.2	60	53	45	21

*See text for discussion.
**Alternate capture and release. See text.
R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

TABLE I-21 (Continued)

Subtest 2.9.3

Freq Comb. No.	S (dBm)	$\frac{S+N}{N}$ (dB)	$\frac{S+I+N}{I+N}$ (dB)	Test Receiver Location and Interferer Power Level (Watts)					
				1	2	3	4	5	6
XVII-2	-74	24	10	1.4	R	61	88	37	36
XVII-4	-41	20	10	1.4	1.0	61	R	37	36
XVIII-1	Insufficient power to obtain 10 dB (S+I+N)/(I+N).								
XVIII-3	-62	21	10	1.7	2.6	R	36	57	46
XVIII-6(1)	-80	26	10	1.7	2.6	45	36	57	R
XVIII-6(4)	-79	25	10	1.7	2.6	45	36	57	R
XIX-1	-82	22	10	R	3.3	55	44	66	17
XIX-2	-78	24	10	1.4	R	55	44	66	17
XXI-3	-81	23	10	1.5	2.3	R	58	49	32
XXIII-1	-72	20	10	R	2.2	69	72	38	32
XXIII-5(1)	-77	30	10	1.5	2.2	69	72	32	R
XXIII-5(4)	-78	30	10	1.5	2.2	69	72	32	R
XXIV-2	-78	24	10	1.5	R	56	48	48	30
XXIV-4	-50	22	10	1.5	3.3	56	R	48	30
XXV-1	-64	22	10	R	1.7	44	44	56	43
XXV-2	-65	25	10	2.0	R	44	44	56	43
XXV-3	-51	23	10	2.0	1.7	R	44	56	43
XXV-4	-83	20	10	2.0	1.7	44	R	56	43

R - receivers connected to antenna indicated by column number.
Note: Numbers in parentheses are channel numbers.

APPENDIX II

QUANTITATIVE COMPARISON OF PREDICTED AND MEASURED DATA

This appendix provides a summary comparison of the measured and predicted data and a discussion of various computations performed to evaluate COSAM predictions. The following Table of Contents for this appendix is supplied for the convenience of the reader.

TABLE OF CONTENTS

MEASURED AND PREDICTED DATA

TABLE II-1 is a summary of the data obtained by field measurements, as extracted from tables supplied in APPENDIX I and associated predicted information. In the Measured Value columns, PD is the input desired signal in dBm; (S+N)/N and SINAD are the receiver output ratios, in dB, measured without and with simultaneous emissions from five transmitters, respectively. (See TABLES I-17 through I-22 in APPENDIX I.) The major interaction column refers to the major predicted interaction. The abbreviations employed are defined as follows:

AS: adjacent signal

SR: spurious response

SR (NF): (not found): refers to a predicted spurious response which was not noted as being a major interaction

SE: spurious emission

RIM: receiver intermodulation (3 refers to 3rd order, etc.)

TIM: transmitter intermodulation (3 refers to 3rd order, etc.)

RIM APP,
IM AP: (apparent): indicates an apparent intermodulation not predicted by COSAM

NOISE: indicates no significant interference from any specific transmitter

The numbers in brackets refer to the predicted significant interfering transmitter. Where two numbers appear for an intermodulation interaction, a 2-signal mix was predicted; three numbers signify a 3-signal mix.

Both transmitter and receiver intermodulation were predicted for every 2-signal, third, fifth or seventh order mix. TIM or RIM was listed depending on which interaction was predicted to be the more significant. RIM accounted for 13 of the 18 cases.

In the predicted values columns, SPS is the predicted system performance score (the probability of exceeding an output of 10 dB). SINAD is the mean (S+I+N)/(I+N) output value (S_p) of the predicted distribution in dB.

TABLE II-1

SUMMARY OF MEASURED AND PREDICTED DATA

TEST NO.	FREQ. MHZ	MEASURED VALUES: PD= -85 DBM S+N/N	SINAD	PD= -95 DBM S+N/N	SINAD	PD= -105 DBM S+N/N	SINAD	SINAD=10 DB S+N/N	PD=	MAJOR INTERACTION	PREDICTED VALUES: PD= -85 DBM SPS	SINAD	PD= -95 DBM SPS	SINAD	PD= -105 DBM SPS	SINAD	THRESH. PD SPS	SINAD
I -1	50.40	22.00	1.00	20.00	2.00	19.00	2.00	23.00	-79.	RIM3 (3,6)	.01	1.17	.00	.21	.00	.02	.15	4.79
I -2	36.10	23.00	17.00	20.00	2.00	16.00	2.00			AS (3)	.90	20.00	.41	9.60	.03	3.08		
I -3	32.40	20.00	1.00					22.00	-70.	TIM3 (1,6)	.42	10.20	.06	3.24	.00	.65	.75	16.60
I -4	71.70	20.00	20.50	19.00	2.00	16.00	2.00			AS (3)	.93	21.06	.49	10.69	.05	3.75		
I -5	91.40	20.00	27.00	20.00	17.00	6.00	[illegible]			AS (3)	.99	23.56	.82	15.39	.30	7.97		
I -6	83.90	29.00	29.00	20.00	20.00	12.00	9.00			NOISE	1.00	24.20	.97	19.01	.76	13.62		
II -1	81.90	21.00	2.00	18.00	2.00	19.00	2.00	21.00	-80.	RIM3(2,4,6)	.01	.61	.00	.12	.00	.02	.02	1.19
II -2	49.80	23.00	2.00	22.00	2.00	21.00	2.00	23.00	-69.	RIM3(1,4,6)	.91	19.79	.66	13.90	.18	6.20	1.00	24.95
II -3	32.90	20.00	14.00	20.00	4.00	10.00	1.00			TIM3 (1,6)	.87	18.52	.67	13.59	.04	4.30		
II -4	73.60	19.00	15.00	21.00	2.00	18.00	12.00			RIM3(1,2,6)	.01	1.13	.00	.35	.00	.05		
II -5	36.10	27.00	20.00	17.00	16.00	8.00	6.00			AS (3)	.46	16.67	.41	10.00	.11	4.47		
II -6	71.90	26.00	4.00	21.00	1.00	13.00	3.00	27.00	-83.	RIM3(1,2,4)	.19	6.69	.05	2.63	.00	.55	.19	5.74
III -1	32.90	21.00	3.06	19.00	2.00	16.00	2.00			RIM2 (3,4)	.00	.01	.00	.00	.00	.00		
III -2	46.90	29.00	29.00	21.00	21.00	20.00	10.00			NOISE	1.00	23.66	.99	20.90	.84	16.87		
III -3	36.10			19.00	2.00	16.00	2.00			RIM2 (1,4)	.00	.00	.00	.00	.00	.00		
III -4	60.50	21.00	6.00	20.00	2.00	14.00	2.00	21.00	-79.	RIM2 (1,3)	.09	2.70	.00	.41	.00	.12	.13	4.87
III -5	91.40	25.00	29.00	23.00	15.00	13.00	6.00			AS (3)	.95	21.91	.60	14.25	.23	6.91		
III -6	59.40	29.00	29.00	21.00	20.00	11.00	9.00			NOISE	.99	23.16	.96	20.47	.88	16.97		
IV -1	69.10	21.00	2.00	21.00	2.00	16.00	2.00	21.00	-58.	RIM5 (4,6)	.01	.14	.00	.06	.00	.31	.06	3.56
IV -2	49.70	29.00	21.00	23.00	2.00	22.00	2.00			RIM APP	1.00	24.67	.99	17.27	.87	16.99		
IV -3	30.50	22.00	21.00							AS (4)	.98	22.49	.54	11.27	.11	5.00		
IV -4	59.10	22.00	22.00	21.00	13.00	18.00	6.00			AS (3)	.98	22.23	.46	10.40	.07	4.96		
IV -5	32.90	26.00	24.00							NOISE	.98	23.48	.71	13.72	.35	8.99		
IV -6	57.10	25.00	23.00	21.00	16.00	10.00	8.00			NOISE	1.00	24.58	.92	14.85	.03	16.32		
V -1	32.90	21.00	16.00							SR (3)(NF)	.00	.27	.00	.02	.00	.00		
V -2	46.90	23.00	18.00	21.00	17.00	19.00	7.00			RIM(3,4)APP	1.00	23.54	.96	17.55	.88	15.60		
V -2	46.90					22.00	3.00			RIM(3,4)APP					.92	18.57		
V -3	38.50			20.00	13.00	18.00	2.00			AS (4)	1.00	23.48	.90	15.07	.49	10.93		
V -3	38.60					19.00	7.00			AS (4)					.69	11.84		
V -4	74.90	21.00	15.00	19.00	14.00	16.00	3.00			AS (3)	1.00	23.51	.93	16.59	.60	11.84		
V -4	74.90					15.00	3.00			AS (3)					.73	13.68		
V -5	66.60	26.00	25.00	40.00	19.00	16.00	19.00			AS (6)	.98	22.63	.80	19.98	.52	11.08		
V -6	83.90	29.00	29.00	20.00	13.00	9.00	4.00			AS (5)	.97	22.42	.81	15.01	.48	10.41		
VI -1	50.40	21.00	.00	22.00	2.00	19.00	2.00	21.00	-50.	SR (4)	.00	.00	.00	.00	.00	.00	.00	.00
VI -1	50.40			17.00	1.00	11.00	1.00			SR (4)	.00	.00	.00	.00	.00	.00		
VI -2	79.30	23.00	22.00	23.00	22.00	19.00	19.00			NOISE	1.00	23.60	.99	21.26	.93	17.33		
VI -3	36.90	28.00	17.00	21.00	10.00	16.00	5.00			AS (4)	.82	16.96	.20	6.76	.00	1.95		
VI -3	36.90			20.00	17.00	17.00	17.00			AS (4)	.00	.00	.19	6.23	.00	1.96		
VI -4	49.70	20.00	11.00	18.00	3.00	18.00	2.00			AS (11,13)	.59	13.18	.05	4.06	.00	.73		
VI -4	49.70			18.00	1.00	15.00	1.00			AS (11,13)	.00	.00	.05	4.11	.00	.79		
VI -5	37.40	25.00	19.00							AS (3)	.99	20.81	.64	13.20	.15	5.59		
VI -6	91.50	22.00	19.00	20.00	9.00	8.00	1.00			AS (3)	.99	23.29	.75	15.07	.21	6.63		
VI -6	91.50			20.00	2.00	13.03	2.00			AS (3)	.00	.00	.76	14.51	.20	6.45		
VII -1	50.10	22.00	7.00	20.00	2.00	7.00	2.00	22.00	-82.	SE (2)	.27	7.84	.01	1.67	.00	.20	.26	7.61
VII -1	50.10			23.00	2.00	15.00	2.00			SE (2)	.00	.00	.00	1.62	.80	.32		

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TABLE II-1 (Continued)

TEST NO.	FREQ. MHZ	MEASURED VALUES PD= -85 DBM S+N/N	SINAD	PD= -95 DBM S+N/N	SINAD	PD=-105 DBM S+N/N	SINAD	SINAD=10 DB S+N/N	PD=	MAJOR INTERACTION	PREDICTED VALUES PD=-85 DBM SPS	SINAD	PD=-95 DBM SPS	SINAD	PD=-105 DBM SPS	SINAD	THRESH. PD SPS	SINAD
VII -2	73.10	23.00	.00	23.00	2.00	21.00	2.00			SR (1)	.75	15.99	.19	6.61	.01	1.66		
VII -2	73.10			23.00	.00	22.00	.00			SR (1)	.00	.00	.38	6.38	.01	1.59		
VII -3	39.10			22.00	.00	19.00	.00	25.00	-97.	RIM2 (4,5)			.00	.00	.00	.00	.18	5.14
VII -3	39.10			20.00	1.00	16.00	2.00			RIM2 (4,5)	.00	.00	.00	.00	.00	.00		
VII -4	75.50	20.00	1.00	20.00	.00	16.00	.00			RIM2 (3,5)	.00	.00	.00	.01	.00	.00		
VII -4	75.50			19.00	.00	15.00	.00			RIM2 (3,5)	.00	.00	.00	.01	.00	.00		
VII -5	91.90	25.00	1.00	22.00	.00	12.00	.00	26.00	-97.	RIM2 (3,4)	.00	.01	.00	.00	.00	.00	.16	4.90
VII -5	91.90			21.00	.00	10.00	.00			RIM2 (3,4)	.00	.00	.00	.00	.00	.00		
VII -6	68.20	20.00	1.00	20.00	2.00	10.00	2.00	22.00	-72.	SR (3)	.29	6.63	.02	1.80	.00	.38	.71	16.26
VII -6	68.20			22.00	2.00	14.00	1.00			SR (3)	.00	.00	.02	1.78	.00	.35		
VIII -1	71.60	22.00	2.00	21.00	2.00	17.00	2.00	22.00	-97.	RIM2 (2,3)	.00	.19	.00	.02	.00	.00	.59	12.28
VIII -1	71.60			21.00	2.00	16.00	2.00			RIM2 (2,3)	.00	.00	.00	.06	.00	.01		
VIII -2	91.20	23.00	1.00	22.00	2.00	21.00	2.00	23.00	-82.	RIM2 (1,3)	.66	15.02	.29	7.93	.06	3.27	.00	.00
VIII -2	91.20			23.00	.00	22.00	.00			RIM2 (1,3)	.00	.00	.28	7.76	.03	2.91		
VIII -3	30.90	NO MEASUREMENTS DUE TO EXTERNAL INTERFERENCE								RIM2 (1,2)	.06	2.89	.00	.65	.00	.11		
VIII -4	66.10	21.00	20.00	20.00	18.00	16.00	5.00			AS(1,3,5,6)	1.00	23.38	.97	17.92	.66	12.89		
VIII -4	66.10					15.00	3.00			AS(1,3,5,6)					.39	9.99		
VIII -5	50.10	24.00	24.00	20.00	19.00	11.00	10.00			NOISE	1.00	23.23	.93	17.52	.56	11.70		
VIII -6	55.85	22.00	22.00	22.00	18.00	10.00	9.00			AS (ALL 5)	.98	22.89	.85	16.39	.51	11.26		
VIII -6	55.85					9.00	6.00			AS (ALL 5)					.38	8.06		
IX -1	39.60	22.00	10.00	22.00	2.00	19.00	2.00			AS (3)	.53	12.35	.05	3.47	.01	1.48		
IX -1	39.60			21.00	11.00	18.00	2.00			AS (3)	.00	.00	.11	5.00	.01	1.66		
IX -2	69.20	22.00	.00	22.00	2.00	20.00	2.00	23.00	-91.	SE (1)	.00	.03	.00	.00	.00	.00	.70	14.51
IX -2	69.20			22.00	.00	21.00	.00			SE (1)	.00	.00	.00	.00	.00	.00		
IX -3	37.90	NO MEASUREMENTS DUE TO EXTERNAL INTERFERENCE								AS (1)	.86	17.57	.62	9.92	.00	1.78		
IX -4	75.70	20.00	.00	20.00	1.00	16.00	1.00	20.00	-88.	RIM3(2,5,6)	.00	.29	.01	.70	.00	.01	.00	.00
IX -4	75.70			18.00	2.00	16.00	2.00			RIM3(2,5,6)	.00	.00	.00	.15	.00	.02		
IX -5	50.80	25.00	1.00	20.00	1.00	10.00	1.00	26.00	-71.	RIM3(3,4,6)	.06	2.21	.30	7.38	.00	.11	.00	.00
IX -5	50.80			15.00	.00	9.00	.00			RIM3(3,4,6)	.00	.00	.01	.79	.00	.19		
IX -6	57.30	23.00	1.00	19.00	1.00	9.00	1.00	24.00	-68.	RIM3(3,4,5)	.05	2.49	.12	3.68	.00	.07	.00	.00
IX -6	57.30			16.00	.00	9.00	.00			RIM3(3,4,5)	.00	.00	.01	.66	.00	.12		
X -1	46.60	20.00	2.00	21.00	2.00	16.00	2.00	22.00	-74.	RIM3(2,3,4)	.02	1.31	.00	.23	.00	.03	.13	4.35
X -1	46.60			21.00	2.00	16.00	2.00			RIM3(2,3,4)	.00	.00	.00	.37	.00	.06		
X -2	59.50	23.00	2.00	22.00	3.00	19.00	2.00	23.00	-77.	RIM3(1,3,4)	.72	21.32	.58	12.26	.19	5.49	.89	15.76
X -2	59.50			22.00	2.00	20.00	2.00			RIM3(1,3,4)	.00	.00	.72	14.36	.20	4.78		
X -3	30.90	NO MEASUREMENTS DUE TO EXTERNAL INTERFERENCE								SR (6)	.00	.06	.00	.02	.00	.00		
X -4	75.70	21.00	10.00	19.00	2.00	17.00	2.00			RIM3(1,2,3)	.08	3.27	.00	.42	.00	.08		
X -4	75.70			17.00	2.00	16.00	2.00			RIM3(1,2,3)	.00	.00	.01	1.18	.00	.20		
X -5	39.30	26.00	16.00							SR (6)	.32	8.71	.03	2.29	.00	.93		
X -6	57.30	23.00	3.00	20.00	1.00	12.00	1.00	23.00	-79.	SR (5)	.41	10.33	.07	3.56	.00	.96	.32	8.91
X -6	57.30			23.00	.00	14.00	.00			SR (5)	.00	.00	.10	9.20	.00	1.12		
XI -1	53.60	23.00	2.00	21.00	2.00	13.00	2.00	23.00	-63.	RIM5(3,4,5)	.15	9.01	.02	1.05	.00	.17	.99	11.00
XI -1	53.60			19.00	2.00	12.00	2.00			RIM5(3,4,5)	.00	.00	.03	1.39	.00	.29		
XI -2	57.70	28.00	24.00	21.00	6.00	16.00	5.00			NOISE	1.00	24.16	.95	18.96	.67	13.09		
XI -2	57.70			27.00	22.00	14.00	19.00			NOISE	.00	.00	.96	18.27	.53	10.80		

TABLE II-1 (Continued)

		MEASURED VALUES									PREDICTED VALUES							
TEST NO.	FREQ. MHZ	PD= -85 DBM		PD= -95 DBM		PD= -105 DBM		SINAD=10 DB		MAJOR INTERACTION	PD= -85 DBM		PD= -95 DBM		PD= -105 DBM		THRESH. PD	
		S+N/N	SINAD	S+N/N	SINAD	S+N/N	SINAD	S+N/N	PD=		SPS	SINAD	SPS	SINAD	SPS	SINAD	SPS	SINAD
XI -3	32.90			21.00	12.00	18.00	6.00			AS (ALL S)	1.00	23.67	.86	15.97	.33	8.25		
XI -3	32.90					17.00	3.00			AS (ALL S)					.23	7.53		
XI -4	71.00	21.00	13.00	17.00	2.00	12.00	2.00			AS (ALL S)	.96	21.37	.97	10.32	.02	3.96		
XI -4	71.60			19.00	1.00	17.00	1.00			AS (ALL S)	.00	.00	.88	11.32	.02	3.42		
XI -5	51.90	27.00	25.00	22.00	18.00	12.00	6.00			NOISE	.99	23.79	.86	16.49	.43	10.03		
XI -6	69.20	29.00	20.00	19.00	15.00	12.00	2.00			SE (2)	.75	17.30	.38	8.56	.07	3.19		
XI -6	69.20					13.00	1.00			SE (2)					.05	3.19		
XII -1	32.90	23.00	23.00	21.00	7.00	18.00	7.00			SR (4)	.91	16.26	.04	4.19	.00	1.11		
XII -2	38.90	29.00	23.00	23.00	19.00	21.00	13.00			NOISE	1.00	23.60	.98	19.00	.89	17.17		
XII -3	46.90	21.00	1.00	19.00	.00	11.00	.00	21.00	-77.	SR (6)	.79	18.73	.19	6.92	.00	1.79	.94	18.97
XII -3	46.90			19.00	.00	16.00	.00			SR (6)	.00	.00	.16	4.02	.00	1.32		
XII -4	71.60	20.00	14.00	20.00	10.00	16.00	5.00			AS (ALL S)	.83	16.66	.16	6.77	.00	2.07		
XII -4	71.60					17.00	2.00			AS (ALL S)					.00	1.79		
XII -5	58.60	27.00	29.00	29.00	10.00	7.00	2.00			AS (ALL S)	1.00	23.66	.98	18.93	.90	17.76		
XII -5	58.60					11.00	3.00			AS (ALL S)					.69	12.17		
XII -6	69.90	29.00	2.00	20.00	1.00	13.00	1.00	26.00	-79.	SR (3)	.39	9.39	.05	3.12	.00	.88	.82	18.21
XII -6	69.90			20.00	1.00	12.00	1.00			SR (3)	.00	.00	.06	3.35	.00	.79		
XIII -1	38.00	22.00	21.00	21.00	17.00	18.00	5.00			AS (3)	.87	18.32	.31	8.17	.01	2.68		
XIII -1	38.00					16.00	6.00			AS (3)					.02	2.69		
XIII -2	57.50	23.00	22.00	23.00	21.00	20.00	9.00			AS (ALL S)	1.00	23.58	.97	17.82	.98	19.09		
XIII -2	57.50			22.00	21.00	21.00	9.00			AS (ALL S)	.00	.00	.99	19.40	.89	15.69		
XIII -3	39.30			20.00	8.00	10.00	4.00			NOISE	1.00	23.39	.93	15.89	.51	10.78		
XIII -3	39.30			20.00	16.00					NOISE			.94	17.31				
XIII -4	71.00	20.00	20.00	19.00	15.00	17.00	7.00			NOISE	1.00	23.00	.85	15.19	.36	9.29		
XIII -4	71.00					13.00	11.00			NOISE					.27	8.25		
XIII -5	46.90	26.00	23.00	22.00	16.00	11.00	7.00			AS (4)	.93	20.53	.63	12.42	.23	4.66		
XIII -6	49.70	29.00	29.00	19.00	12.00	8.00	9.00			AS (5)	.94	21.05	.60	12.17	.22	4.68		
XIII -6	49.70			17.00	17.00					AS (5)			.63	12.90				
XIV -1	52.30	22.00	12.00	20.00	2.00	16.00	2.00			IM(2,3,5)AP	.99	22.07	.65	12.71	.12	5.47		
XIV -1	52.30			21.00	9.00	18.00	2.00			IM(2,3,5)AP	.00	.00	.62	11.96	.03	3.58		
XIV -2	40.30	20.00	15.00	22.00	21.00	22.00	16.00			AS (3)	.96	25.25	.62	12.89	.21	4.86		
XIV -3	30.10			20.00	2.00	12.00	2.00			RIMB(1,4,5)	.88	18.23	.32	6.53	.09	2.92		
XIV -3	30.10			19.00	1.00	8.00	1.00			RIMB(1,4,5)	.00	.00	.27	7.52	.01	2.09		
XIV -4	75.70	21.00	21.00	18.00	7.00	16.00	9.00			AS (ALL S)	.99	22.75	.84	15.51	.35	8.99		
XIV -4	75.70			19.00	17.00	16.00	7.00			AS (ALL S)	.00	.00	.80	14.38	.10	5.88		
XIV -5	32.50			16.00	13.00	9.00	1.00			SR (3)	.00	.09	.00	.01	.00	.00		
XIV -6	72.20	29.00	19.00	21.00	18.00	13.00	6.00			SR (3)	.85	16.96	.36	9.10	.06	3.36		
XIV -6	72.20					11.00	1.00			SR (3)					.02	2.49		
XV -1	63.70			21.00	2.00	16.00	2.00			AS (2)	.09	1.70	.01	.95	.00	.09		
XV -1	63.70			20.00	1.00	12.00	1.00			AS (2)	.00	.00	.01	.77	.00	.19		
XV -2	53.10	29.00	2.00	22.00	2.00	22.00	2.00	29.00	-72.	AS (1)	.19	5.96	.01	1.59	.00	.31	.65	14.01
XV -2	53.10			29.00	1.00	23.00	1.00			AS (1)	.00	.00	.00	1.29	.00	.21		
XV -3	30.90	NO MEASUREMENTS DUE TO EXTERNAL INTERFERENCE								AS (9)	1.00	22.79	.82	18.47	.33	9.07		
XV -4	75.20	22.00	2.00	17.00	2.00	14.00	2.00	22.00	-81.	AS (4)	.00	.65	.00	.13	.00	.02	.00	.03
XV -4	75.20			20.00	1.00	16.00	1.00			AS (6)	.00	.00	.00	.14	.00	.03		

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TABLE II-1 (Continued)

TEST NO.	FREQ. MHZ	MEASURED VALUES: PD= -55 DBM S+N/N	SINAD	PD= -95 DBM S+N/N	SINAD	PD=-105 DBM S+N/N	SINAD	SINAD=10 DB S+N/N	PD=	MAJOR INTERACTION	PREDICTED VALUES: PD=-85 DBM SPS	SINAD	PD=-75 DBM SPS	SINAD	PD=-125 DBM SPS	SINAD	THRESH. PD SPS	SINAD
XV -5	72.30	25.00	24.00	20.00	19.00	14.00	10.00			AS (4)	.98	23.52	.82	15.69	.48	11.10		
XV -6	75.80	25.00	8.00	19.00	1.00	8.00	1.00	25.00	-83.	AS (4)	.15	9.70	.01	1.23	.00	.23	.00	1.47
XV -6	75.80			22.00	1.00	11.00	1.00			AS (4)	.00	.00	.01	1.11	.00	.19		
XVI -1	53.70	22.00	2.00	19.00	2.00	11.00	2.00	22.00	-62.	RIM(2,4)APP	.80	16.49	.12	5.39	.00	1.20	1.00	21.25
XVI -2	51.50	23.06	18.00	21.00	9.00	19.00	2.00			AS (1)	.99	23.60	.81	19.60	.35	8.70		
XVI -2	51.50					21.00	2.00			AS (1)					.25	7.26		
XVI -3	40.30	22.00	20.00	21.00	1.00	17.00	1.00			AS (6)	.97	21.92	.53	11.03	.07	5.79		
XVI -3	40.30					10.00	2.00			AS (6)					.06	4.61		
XVI -4	75.80	20.00	20.00	17.00	16.00	15.00	15.00			NOISE	1.00	24.53	.91	16.35	.53	13.19		
XVI -5	67.50	27.00	25.00	20.00	17.00	10.00	4.00			NOISE	1.00	24.97	.88	16.02	.59	11.72		
XVI -6	41.80	23.00	17.00	20.00	1.00	8.00	1.00			SR (3)	.15	5.42	.01	1.19	.00	.15		
XVI -6	41.80			21.00	2.00	10.00	1.00			SR (3)	.00	.00	.00	1.01	.00	.13		
XVII -1	34.90	22.00	17.00	20.00	4.00	18.00	2.00			AS (3,4,5)	.96	21.83	.69	14.09	.21	6.92		
XVII -1	34.90			21.00	5.00	19.00	1.00			AS (3,4,5)	.00	.00	.65	13.20	.20	6.53		
XVII -2	76.10	23.00	2.00	21.00	2.00	20.00	2.00	24.00	-79.	AS (4,6)	.95	10.84	.12	4.62	.01	.93	.87	18.35
XVII -2	76.10			23.00	2.00	22.00	2.00			AS (4,6)	.00	.00	.10	4.98	.01	1.16		
XVII -3	46.90	22.00	18.00	21.00	6.00	18.00	1.00			AS(ALL 5)	.89	17.22	.27	7.79	.00	2.01		
XVII -3	46.90			20.00	15.00					AS (ALL 5)			.25	7.46				
XVII -4	69.80	20.00	.00	18.00	2.00	17.00	2.00	20.00	-91.	SE (1)	.00	.12	.00	.01	.00	.00	.82	18.17
XVII -4	69.80			20.00	.00					SE (1)			.00	.01				
XVII -5	57.65	26.00	23.00	17.00	15.00	9.00	7.09			NOISE	.98	22.59	.82	16.68	.41	9.77		
XVII -6	75.80	24.00	24.00	22.00	19.00	12.00	5.00			AS (2)	.98	22.51	.77	15.99	.34	8.80		
XVIII-1	75.80	21.00	.00	21.00	1.00	16.00	1.00			RIM(2,5)APP	.94	21.68	.49	10.79	.01	2.68		
XVIII-2	57.10	23.00	10.00	20.00	2.00	19.00	2.00			AS (3)	.09	2.66	.00	.69	.00	.09		
XVIII-3	57.90	21.00	.00	21.00	2.00	16.00	2.00	21.00	-62.	RIM(2,5)APP	.51	11.69	.05	4.91	.00	1.21	.99	19.13
XVIII-4	36.20	21.00	20.00	20.00	11.00	15.00	2.00			NOISE	1.00	24.67	.99	20.49	.83	15.01		
XVIII-5	68.60	30.00	22.00	21.00	8.00	12.00	1.00			NOISE	.99	23.35	.77	15.40	.25	7.25		
XVIII-6	72.90	24.00	2.00	20.00	1.00	10.00	1.00	25.08	-79.	SR (4)	.95	22.17	.49	11.13	.13	5.26	.00	.27
XVIII-6	72.90			19.00	2.00					SR (4)			.47	10.51				
XIX -1	32.70	21.00	2.00	20.00	2.00	15.00	1.00	22.00	-82.	IM(2,3,4)AP	.70	14.80	.11	5.19	.00	1.19	.74	16.09
XIX -2	39.10	23.00	3.00	19.00	2.00	19.00	2.00	24.00	-78.	AS (ALL 5)	.71	15.95	.16	6.06	.01	1.72	.73	2.,44
XIX -2	39.10			23.00	7.00					AS (ALL 5)			.21	6.72				
XIX -3	40.20	23.00	18.00	22.00	1.00	17.00	2.00			AS (ALL 5)	.98	21.92	.56	11.93	.05	4.60		
XIX -3	40.20			29.00	1.00					AS (ALL 5)			.66	12.97				
XIX -4	73.70	20.00	19.00	18.00	17.00	16.00	12.00			NOISE	1.00	23.48	.93	16.40	.58	11.63		
XIX -5	59.10	24.00	20.00							SR (4)	.54	12.53	.09	4.90	.01	1.36		
XIX -6	41.90	22.00	14.00	18.00	1.00	8.00	1.00			AS (3)	.19	4.01	.03	1.38	.00	.25		
XIX -6	41.90			19.00	2.00					AS (3)			.03	1.39				
XX -1	50.50	20.00	20.00							NOISE	.99	23.75	.79	19.19	.13	5.69		
XX -2	32.50	22.00	21.00	20.00	19.00	19.00	9.00			AS (3)	1.00	24.59	.96	18.62	.71	13.52		
XX -2	32.50					17.00	5.00			AS (3)					.58	11.37		
XX -3	36.90			22.00	10.00	17.00	6.00			AS (2)	.78	22.96	.70	13.55	.23	7.59		
XX -3	36.90					10.00	7.00			AS (2)					.10	11.37		
XX -4	72.10	20.00	19.08	20.00	3.00	18.00	1.00			SR (5)	.93	20.61	.39	8.93	.01	2.95		
XX -4	72.10					18.00	1.00			SR (5)					.00	2.27		

TABLE II-1 (Continued)

TEST NO.	FREQ. MHZ	MEASURED VALUES PD= -85 DBM S+N/N	SINAD	PD= -95 DBM S+N/N	SINAD	PD= -105 DBM S+N/N	SINAD	SINAD=10 DB S+N/N	PD	MAJOR INTERACTION	PREDICTED VALUES PD= -85 DBM SPS	SINAD	PD= -95 DBM SPS	SINAD	PD= -105 DBM SPS	SINAD	THRESH. PD SPS	SINAD
XX -5	64.35	20.00	26.00	29.00	16.00	11.00	6.00			NOISE	.99	23.66	.01	15.00	.95	9.96		
XX -6	69.02	25.00	15.00	21.00	15.00	10.00	2.00			AS (4,5)	.98	23.19	.79	19.30	.33	8.16		
XX -6	69.00					10.00	1.00			AS (4,5)					.18	6.93		
XXI -1	32.90	22.00	16.00	19.00	8.00	17.00	3.00			AS (3)	.91	20.78	.59	11.78	.06	4.22		
XXI -1	32.90					19.00	2.00			AS (3)					.04	4.90		
XXI -2	66.90	23.00	16.00	21.00	6.00	10.00	2.60			NOISE	1.00	24.38	1.00	21.49	.95	17.92		
XXI -3	39.90	23.00	2.00	22.00	6.00	24.00	1.00	23.00	-81.	SE (2)	.31	6.67	.09	2.99	.00	.31	.99	10.99
XXI -4	66.70	22.00	10.00	20.00	4.00	19.00	3.00			NOISE	1.00	24.60	.99	19.25	.96	10.02		
XXI -5	87.25	27.00	23.00							NOISE	1.00	26.32	.99	20.74	.89	16.33		
XXI -6	76.00	25.00	25.00	25.00	20.00	9.00	9.00			NOISE	1.00	24.38	.99	20.05	.91	16.57		
XXII -1	59.10	21.00	20.00	17.00	10.00	14.00	11.00			NOISE	.98	21.65	.59	11.70	.09	9.98		
XXII -2	75.70	21.00	21.00	22.00	17.00	21.00	12.00			AS (4)	.96	21.61	.61	12.91	.25	7.35		
XXII -3	39.60	23.00	15.00	22.00	16.00	17.00	11.00			NOISE	1.00	23.56	.96	17.29	.83	15.05		
XXII -4	71.50	20.00	20.00	19.00	7.00	18.50	12.00			AS(3),AS(2)	1.00	22.76	.77	13.73	.29	7.66		
XXII -4	71.50			16.00	10.00					AS (2,3)			.81	14.17				
XXII -5	57.75	27.00	29.00	19.00	1.00	10.00	1.00			SE (1)	.99	22.76	.79	19.50	.43	10.19		
XXII -5	57.75			17.00	1.00					SE (1)			.00	19.79				
XXII -6	91.20	25.00	15.00	19.00	8.00	10.00	6.90			SE (2)	.99	22.60	.73	13.79	.30	8.39		
XXIII-1	39.30	20.00	.00	21.00	1.00	19.00	2.00	20.00	-72.	RIM2(3,5)	.00	.00	.00	.00	.00	.00	.00	.00
XXIII-1	39.30			19.00	.00					RIM2 (3,5)			.00	.00				
XXIII-2	36.10	20.00	12.00	21.00	3.00	20.00	2.00			AS (1)	.91	20.25	.38	9.09	.02	2.59		
XXIII-2	36.10			20.00	3.00					AS (1)			.39	8.99				
XXIII-3	40.10			21.00	1.00	10.00	1.00			3IM2 (1,5)	.00	.68	.00	.00	.00	.01		
XXIII-4	50.20	19.00	16.00	23.00	10.00	19.00	5.00			AS (3)	.69	14.11	.11	5.83	.01	1.09		
XXIII-5	79.90	29.00	1.00	20.00	1.00	11.00	1.00	30.00	-77.	RIM2 (1,3)	.05	2.36	.30	.43	.00	.07	.04	3.53
XXIII-5	79.90			21.00	1.00					RIM2 (1,3)			.00	.38				
XXIII-6	75.20	25.00	19.90	20.00	3.50	11.00	1.00			AS (5)	.60	18.47	.41	10.06	.16	5.20		
XXIV -1	49.70	22.00	10.00	20.00	2.00	15.00	2.20			AS (3)	.52	12.21	.08	4.96	.00	1.29		
XXIV -2	30.26	29.00	.00	22.00	.50	21.00	.00	24.00	-78.	SE (1)	.39	8.06	.05	3.19	.00	.09	.63	13.95
XXIV -3	51.15	23.00	19.00	20.00	9.00	16.00	1.00			AS(1),AS(4)	.99	18.69	.39	9.33	.01	2.70		
XXIV -3	51.15			21.00	2.00					AS (1)			.33	6.79				
XXIV -4	72.75	21.00	1.00	20.00	1.00	16.00	1.00	22.00	-80.	RIM6 (5,6)	.01	.66	.00	.12	.00	.09	.93	10.63
XXIV -4	72.75			20.00	1.00					RIM6 (5,6)			.09	.11				
XXIV -5	69.20	26.00	14.00	21.00	9.00	10.00	1.00			AS (6)	.90	19.96	.56	12.08	.25	7.29		
XXIV -5	69.20			21.00	6.00					AS (6)			.59	12.43				
XXIV -6	78.40	22.00	15.00	19.00	1.00	10.00	1.00			AS (5)	.65	19.07	.50	11.37	.18	5.08		
XXIV -6	79.40			20.00	2.00					AS (5)			.47	10.93				
XXV -1	69.10	22.00	2.00	21.00	1.00	16.00	1.00	23.00	-63.	SE (5)	.62	16.81	.16	5.06	.00	1.32	1.00	26.17
XXV -2	57.55	24.00	.00	21.00	.50	21.00	.00	25.00	-65.	SE (1)	.00	.33	.00	.09	.00	.00	.13	5.20
XXV -3	38.90	20.00	1.00					23.00	-51.	RIM(4,6)APP	.91	19.63	.96	18.30	.09	3.79	1.00	25.00
XXV -4	73.20	20.00	4.00	21.00	.05	18.00	.00	20.00	-83.	AS(3),AS(6)	.81	15.02	.10	5.51	.00	3.99	.00	.17
XXV -5	39.55	27.00	21.00	19.00	8.00	10.00	1.00			AS(3),SE(2)	.75	16.19	.10	6.01	.01	1.70		
XXV -6	72.30	29.00	11.00	20.00	1.00	10.00	1.00			AS (4)	.87	19.21	.65	11.63	.29	6.67		

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General Comments

TABLE II-2 summarizes the computed average values (B) and standard deviations [$\sigma(\Delta)$] of the quantity $S_m - \bar{S}_p$, where S_m is the measured SINAD output and $\bar{S}_p$ is the predicted SINAD mean value. The condition errors indicate the number (and percent) of the cases which resulted in zero conditions error, one-condition error, etc., as defined in TABLE 3-2.

The data in this table provide three different, though related, measures of comparison between measured and predicted values. Examining all interactions, we note a mean difference value of -1.72 dB. This indicates that for all 561 interactions, on the average, COSAM predicted the output mean SINAD values to be greater than the associated measured values, representing less interference by this amount. Considering the fact that all measured values were reported to the nearest dB, the likelihood of some measurement error, the fact that the average (rather than the precise) value of transmitter power was used, and the other numerous uncertainties involved, it is concluded that -1.72 dB is a negligibly small bias. This value compares favorably with the 1.55 dB mean deviation resulting from UHF validation (see TABLE II-3).

The second measure, $\sigma(\Delta)$, indicates the spread of the deviations between the measured values and the predicted means.

Figure II-1, is a cumulative plot of the distribution. The value of $\sigma(\Delta)$, for all interactions, is 5.6 dB, representing about 71.5% of the cases. A value of 10 dB represents approximately 90% of the cases. This compares favorably with the 92% value for the UHF validation reported in Reference 2 and also shown in Figure II-1. The values of $\sigma(\Delta)$ provide approximate measures of deviations from the measured values which can be compared with each other.

The third measure, involving condition errors, indicates that 76% of all the cases resulted in no more than 1-condition error, whereas 92% of the cases resulted in no more than a 2-condition error. These results are identical to those in the UHF validation.

Examination of the individual interactions indicates that B value magnitudes are less than 2.9 dB for 94% of the cases. $\sigma(\Delta)$ values were no greater than 6.2 dB for 96% of the cases. Major discrepancies due to adjacent signal, noise, spurious emissions,

TABLE II-2

SUMMARY OF dB VARIATIONS AND CONDITION ERRORS

INTERACTIONS	$S_m - \bar{S}_p$, dB Mean (±)	$S_m - \bar{S}_p$, dB ± (Δ)	NUMBER AND PERCENT OF MEASURED CASES IN ERROR BY THE FOLLOWING NUMBER OF CONDITIONS: 0 NO.	0 %	1 NO.	1 %	2 NO.	2 %	3 NO.	3 %	4 NO.	4 %	TOTAL CASES
ALL	-1.72	5.58	308	54.9	120	21.4	88	15.7	32	5.7	13	2.3	561
Adjacent Signal	-1.67	5.04	110	48.9	64	28.4	38	16.9	12	5.3	1	0.4	225
Noise	-2.77	4.66	35	46.7	25	33.3	9	12.0	3	4.0	3	4.0	75
SR (all cases)	-0.93	6.77	34	55.7	10	16.4	11	18.0	5	8.2	1	1.6	61
SR pred. and noted	-1.21	6.47	34	56.7	10	16.7	11	18.3	4	6.7	1	1.7	60
SR pred. but not noted	15.73	-	0	0	0	0	0	0	1	100.0	0	0	1
SE	-2.32	4.75	28	63.6	9	20.5	4	9.1	2	4.5	1	2.3	44
IM (RIM & TIM)	-1.42	6.30	101	64.7	12	7.7	26	16.7	10	6.4	7	4.5	156
RIM (all)	-1.27	6.32	100	66.2	10	6.6	25	16.6	9	6.0	7	4.6	151
2nd order, 2-signal	0.89	3.68	39	79.6	3	6.1	6	12.3	1	2.0	0	0	49
3rd order, 2-signal	2.20	1.93	3	75.0	0	0	1	25.0	0	0	0	0	4
5th order, 2-signal	1.85	2.46	8	88.9	0	0	1	11.1	0	0	0	0	9
3rd order, 3-signal	-0.21	6.79	32	64.0	2	4.0	11	22.0	3	6.0	2	4.0	50
5th order, 3-signal	-1.29	2.88	8	80.0	2	20.0	0	0	0	0	0	0	10
2-signal RIM (apparent)	-9.11	6.65	6	30.0	2	10.0	5	25.0	2	10.0	5	25.0	20
3-signal RIM (apparent)	-6.12	4.20	4	44.4	1	11.1	1	11.1	3	33.3	0	0	9
TIM	-6.05	2.93	1	20.0	2	40.0	1	20.0	1	20.0	0	0	5
10 dB threshold cases	0.31	7.95	4	9.3	8	18.6	31	72.1	0	0	0	0	43

TABLE II-3

SUMMARY OF MAJOR UHF VALIDATION RESULTS

Interaction Types	B (dB)	$\sigma(\Delta)$ (dB)	P_{2c}	Number of Cases	% Cases
All Interactions	1.55	5.34	0.92	436	100
Adjacent Signal	2.01	3.93	0.98	111	25.5
Noise	0.30	1.72	1.00	136	31.2
Spurious Responses	1.51	7.10	0.87	63	14.4
(a) predicted and noted	2.25	6.21	0.89	54	12.4
(b) noted but not predicted	−9.44	3.96	0.83	6	1.4
(c) predicted but not noted	10.12	3.05	0.33	3	0.7
Spurious Emissions	6.39	8.11	0.78	9	2.1
Receiver Intermodulation (IM)	2.22	7.18	0.83	117	26.8
(a) 2-signal IM; 3rd, 5th, 7th orders	3.48	5.83	0.89	65	14.9
(b) 3-signal IM; 3rd, 5th orders	1.86	7.34	0.79	48	11.0
(c) 3-signal IM noted but not predicted	−13.98	4.36	0.25	4	0.9

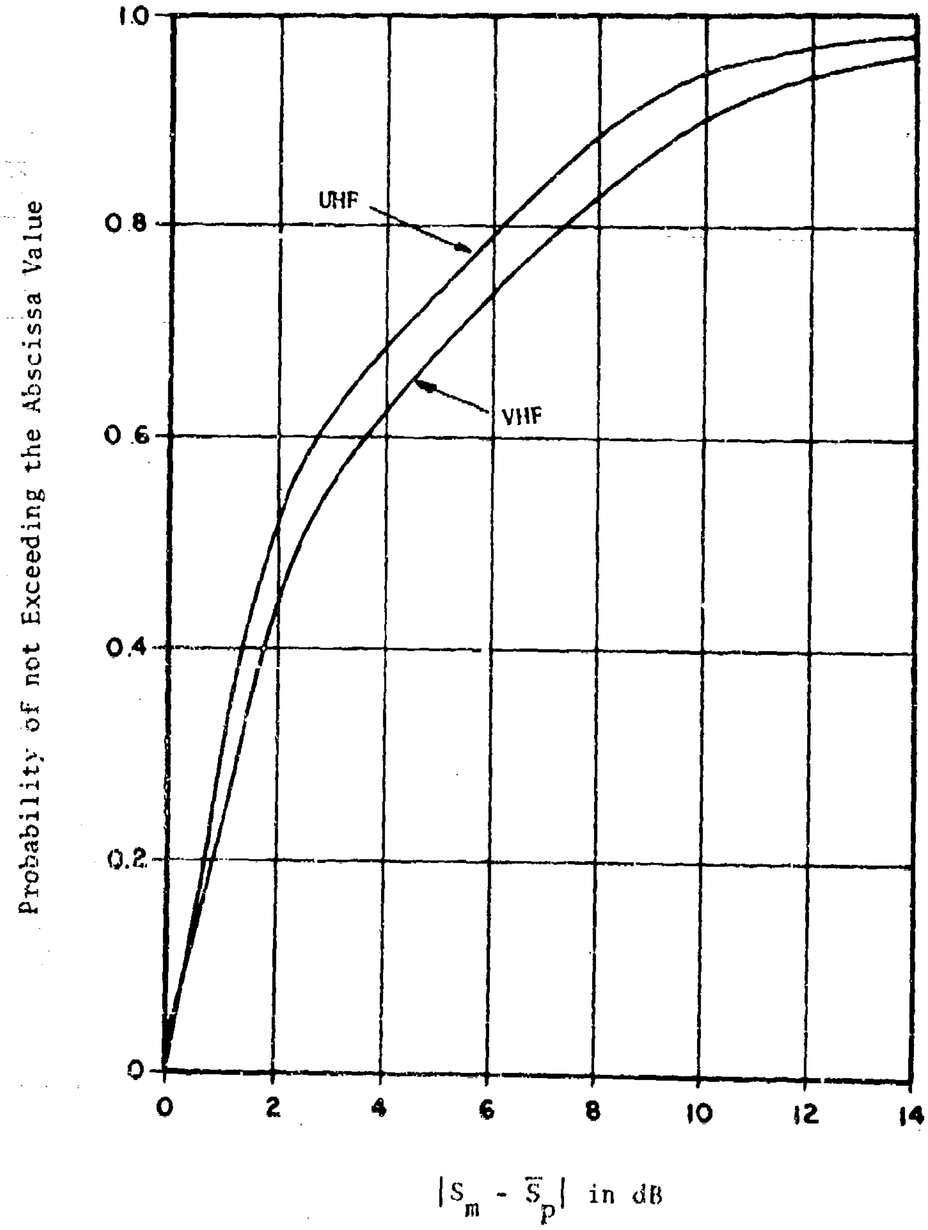

Figure II-1. Cumulative Probability Distribution of $|S_m - \bar{S}_p|$

spurious responses, and intermodulation interactions are discussed below.

The measures of condition error provide somewhat cruder, though meaningful, results than those provided by the B and $\sigma(\Delta)$ values. As seen in TABLE II-2, there were 32 cases involving 3-condition errors and 13 cases involving 4-condition errors (a total of 8% of what may be termed gross errors). These and other apparently large discrepancies are discussed in a following section.

EVALUATION OF $\sigma(S_p)$

Figure II-2 represents a measure of the relationships between S_m, $\overline{S}_p$, and $\sigma(S_p)$ (the standard deviation of the predicted SINAD output distribution around $\overline{S}_p$). The probability value for 1 σ was about 0.54 which is somewhat less than what would be achieved by a normal distribution. The values for 2σ, 3σ, etc., are also slightly less than what would be exhibited by a normal distribution.

The individual interactions were not analyzed in detail, but it appears that, in 10 to 15% of the cases, the σ (S_p) values are relatively small compared to the associated values of $|S_m - \overline{S}_p|$.

One possible explanation for the occurrence of small σ (S_p) values is worth noting. COSAM initially predicts output values of $[S/(I+N)]$ with an associated σ. If severe interference is predicted, large negative values are computed. When these are converted to SINAD values, most are found to be equal to or slightly greater than zero. Hence, even if the σ of the $[S/(I+N)]_o$ distribution is large, the σ of the SINAD distribution can be quite small. A similar situation arises if little or no interference is predicted.

The results of the analysis do not suggest that a change in this aspect of the model would provide significantly closer agreements between predictions and measurements.

DISCUSSION OF INDIVIDUAL INTERACTIONS

This section discusses the results obtained by comparing the measured and predicted data compiled for each type of interaction.

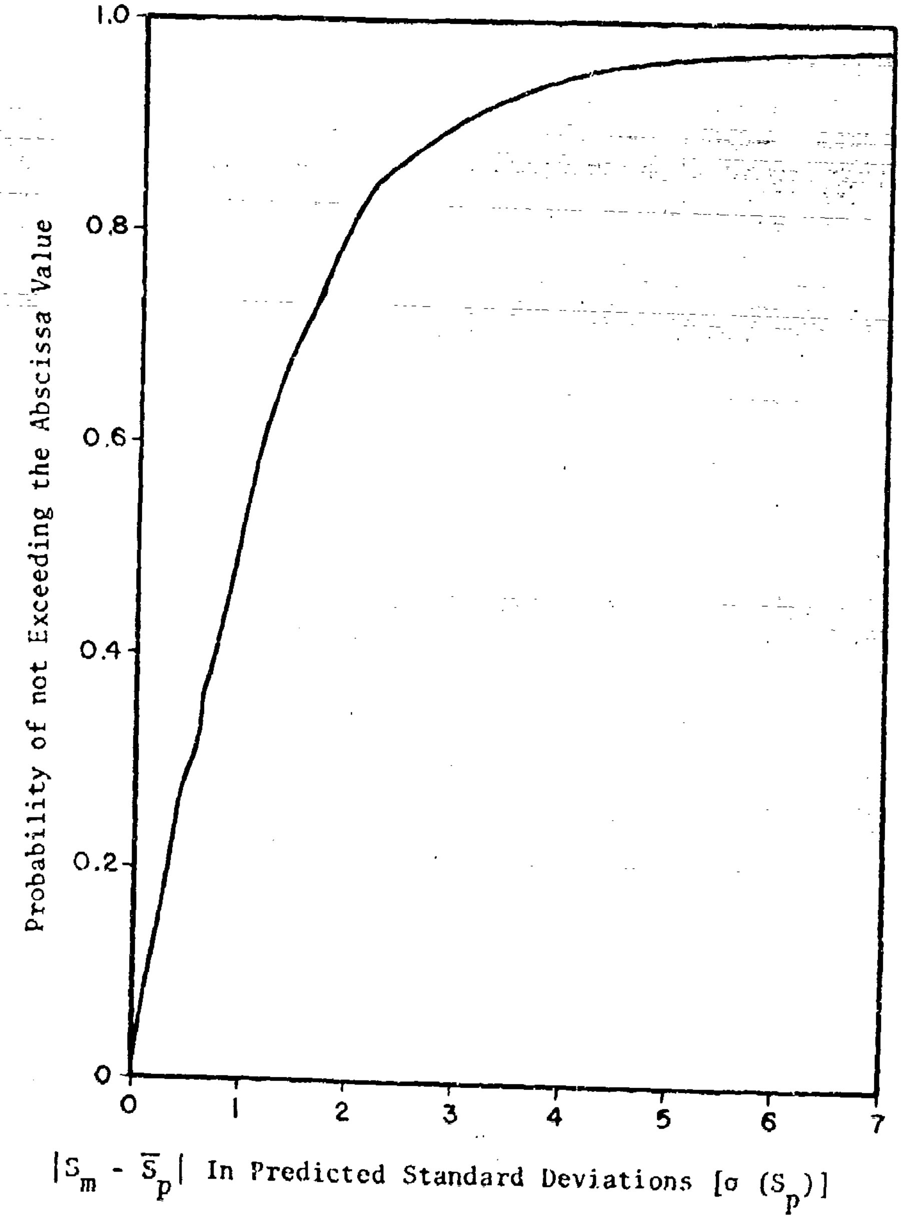

Figure II-2. Cumulative Distribution of Relationship Between $|S_m - \overline{S}_p|$ and $\sigma(S_p)$

Adjacent Signal

As noted in TABLE II-2, and TABLE 3-4, the values of B, $\sigma(\Delta)$, p_{1c}, and p_{2c} for adjacent signal interactions were -1.67, 5.04, 0.78 and 0.94, respectively. The values of B and $\sigma(\Delta)$ for 225 cases, suggest that the adjacent signal model is computing a mean value which is quite close to the measured values, with a small optimistic bias. The $\sigma(\Delta)$ value suggests that approximately 90% of the mean predictions are within ±6.5 dB of the measured values. The p_{2c} value indicates that relatively few gross errors can be anticipated in this category, which involves the combined effects of cross-modulation, desensitization, saturation and transmitter noise. A discussion of applicable gross error cases will appear in a following section.

Additional emphasis on cumulative effects of transmitter noise appears to be desirable.

Noise

This interaction refers to those cases where no apparent interference, due to a specific transmitter, was present. The values of B, $\sigma(\Delta)$, p_{1c} and p_{2c} were: -2.77, 4.66, 0.80 and 0.92, respectively, for 75 cases. Many of these interactions predicted by COSAM as being due to noise were either not identified by the measurement agency as being due to a specific transmitter or were identified as being due to four or, more frequently, all five transmitters. Where no apparent intermodulation mixes could be identified, these interactions were presumed to be caused by the combined effect of transmitter noise.

In a few cases (where only one or two interfering sources were noted) involving P_d values of -105 dBm, COSAM SINAD predictions, said to be due to noise, were too high, indicating underestimation of transmitter noise effects.

Spurious Emissions

As noted in TABLE II-2 and TABLE 3-4, the values of B, $\sigma(\Delta)$, p_{1c}, and p_{2c} for spurious emission interactions were -2.32, 4.75, 0.84, and 0.93, respectively, for 44 samples. Of the 44 cases, only three resulted in 3- and 4-condition errors. Two of the three cases represented the same emission (interaction number 22-5) measured at P_d = -95 dBm for both the normal and interferer isolation data sets. This emission, from the AN/PRC-25 transmitter at position one, is the fifth harmonic of the 11.55 MHz oscillator frequency (5 x 11.55 = 57.75 MHz). The AN/PRC-25 was tuned close to this frequency (54.10 MHz), resulting in a spurious emission level which was less than the average amount assumed by COSAM. This resulted in less interference being predicted than was actually measured.

The other large error case (interaction number 25-1, P_d=-85 dB) involved a second harmonic from the AN/GRC-163 transmitter at position five. As was the case above, COSAM predicted less interference than was measured. This suggests the need for a reduction in the AN/GRC-163 second harmonic mean rejection value (by approximately 10 dB). Unfortunately, no other spurious emissions of this type from the AN/GRC-163 were included in the field test. Therefore, no change in the model is warranted.

Spurious Responses

TABLES II-2 and 3-4 list the values of B, σ(Δ), p_{1c} and p_{2c} for spurious response interactions as -0.93, 6.77, 0.72, and 0.90, respectively, for 61 samples. These values show an improvement over the corresponding results found at UHF [(B, σ(Δ), p_{1c}, and p_{2c} of 1.51, 7.10, 0.64 and 0.87, respectively, for 63 samples)]. Of the 61 VHF cases, only six resulted in 3- and 4-condition errors.

The only case (interaction number 5-1, AN/PRC-25 TLR, P_d=-85 dBm) where a spurious response was predicted but not measured in the field may be of interest. The predicted response was identified as a p = 5, q = 6 (+) mix, as defined by the following equation:

$$F_{sr} = \frac{pF_{lo} \pm F_{if}}{q} \tag{II-1}$$

where:

F_{sr} = Frequency of the spurious response, in MHz

F_{lo} = Local oscillator frequency, in MHz

F_{if} = Intermediate frequency, in MHz

= 11.5 MHz for this case

p, q = Harmonic identifying integers

This particular spurious response was measured at only one of the three tuned frequencies tested for the AN/PRC-25 spectrum signature. It was included in COSAM but labelled with a special "low probability" flag provided in the model for questionable interactions. A check of spurious responses measured during bench tests of the TLR AN/PRC-25 units (Reference 4) revealed no 5, 6 (+) responses found. Therefore, this response will be removed from the COSAM equipment file.

Intermodulation

Review of Data. Intermodulation effects represent a rather complex problem of interpretation, since a number of independent parameters are involved. TABLE II-4 is an expansion of the data presented in TABLE II-2. One would have preferred to have a larger sample size for certain interaction types on which to base generalizations, but this would have required a much more extensive test.

Receiver Intermodulation. The small bias (B) magnitude and high p_{2c} values for all receiver intermodulation interactions suggest that the RIM model and equipment parameter values are adequate.

A number of additional 2-signal 3rd order interactions were included in the frequency plan but difficulties due to external interference reduced the number considerably. Several 7th order cases were also included but none were noted as being significant.

Several interesting cases should be mentioned in which intermodulation apparently occurred during field measurements but was not predicted.

In order to determine the effect of second-order intermodulation products centered at receiver intermediate frequencies, assignment number 18 was deliberately designed to include such a product. Specifically, terminal numbers 2 and 5 had frequencies assigned which differed by 11.5 MHz, the common intermediate frequency for all TLR's. All TLR's except 2 and 5 should, therefore, experience this IM interaction, if the product does indeed exist. TABLE I-21

TABLE II-4

INTERMODULATION VALIDATION MEASURES

	B	σ(Δ)	P_{2c}	No. of Cases	Total % Cases
ALL IM	-1.42	6.30	.89	156	27.8
RIM	-1.27	6.32	.89	151	26.9
2-Signal RIM	1.11	3.47	.98	62	11.1
2nd Order	0.89	3.68	.98	49	8.7
3rd Order	2.20	1.93	1.00	4	0.7
5th Order	1.85	2.46	1.00	9	1.6
3-Signal RIM	-0.39	6.06	.92	60	10.7
3rd Order	-0.21	6.79	.90	50	8.9
5th Order	-1.29	2.88	1.00	10	1.8
2-Signal RIM (Apparent)	-9.11	6.65	.65	20	3.6
3-Signal RIM (Apparent)	-6.12	4.20	.67	9	1.6
TIM	-6.05	2.93	.80	5	0.9

indicates that the intermodulation product was present at TLR numbers 1 and 3. A spurious response was dominant at TLR number 6 and the IM was not noted. The IM was probably present at TLR number 4 but was not noted in interferer isolation subtests (TABLES I-19, I-20, and I-21). A noise interaction was predicted but the low measured (S+I+N)/(I+N) values suggest the presence of some other interaction, probably the IM.

The COSAM receiver intermodulation interaction model (Equation III-17) will be expanded to include products of the form:

$$F_{IF} = |mF_a \pm nF_b| \qquad \text{(II-2)}$$

where:

F_{IF} = first intermediate frequency of the subject receiver, MHz

F_a, F_b = interfering frequencies, MHz

m, n = integers

m + n = order of the intermodulation product

Additional studies will be necessary to define the appropriate parameter values. The preliminary model given below will be used until such time as the model is finalized. It gives reasonable accuracy (±6 dB) for the test cases of assignment 18 in this study.

$$P_{im} = m(P_a - \beta_a) + n(P_b - \beta_b) - \beta_{IF} - K'_{m,n} \qquad \text{(II-3)}$$

where:

P_{im} = power, in dBm, of the intermodulation product produced in the receiver

m, n = integers (Same as Equation II-2)

P_a, P_b = power level, in dBm, of undesired signals

β_a, β_b = off-frequency rejection in dB, a function of the undesired frequencies (F_a, F_b), receiver tuned frequency (F_R), and circuitry between the antenna input and RF amplifier.

B_{IF} = off-frequency rejection in dB, a function of the intermediate frequency (F_{IF}), tuned frequency (F_R), and circuitry between the RF amplifier and first mixer.

$K'_{m,n}$ = receiver RF amplifier conversion loss (same as Equation III-17)

Test link receiver 25-3 experienced an intermodulation interference of a type not normally predicted by COSAM. Its tuned frequency, 30.4 MHz, was one channel removed from the fourth order product generated from transmitters 5 and 4 at 34.55 MHz and 73.2 MHz, respectively (3 x 34.55 - 73.2 = 30.45 MHz). Even ordered intermodulation products higher than the second are not predicted because they are rarely measured in a spectrum signature. A prediction could have been made using Equation III-17 had fourth order parameter values for these equipments been known. Some study is underway to derive the theoretical relationships between the different ordered nonlinear parameters. It is not necessary to modify the model to include these even ordered IM interactions until such time as the studies are completed and the resulting methods are validated.

The nine cases of apparent three signal receiver intermodulation resulted from only two TLR's, number 14-1 measured for five desired signal level combinations and number 19-1 measured for four combinations. Both were fifth order. The TLR 14-1 product was of the form:

$$F_1 = 3F_2 - F_3 - F_5$$

$$52.3 = 3 \times 40.3 - 36.1 - 32.5 \text{ MHz} \qquad \text{(II-4)}$$

This differs from those 3-signal RIM interactions presently calculated by COSAM, and restricted to:

$$F_r = n(F_{i1} - F_{i2}) + F_{i3} \qquad \text{(II-5)}$$

where:

F_r = receiver tuned frequency, MHz

F_{i1}, F_{i2}, F_{i3} = frequencies of the three interferers, MHz n = integer; 1, 2, or 3 where IM order = 2n + 1

The fifth order product at TLR 19-1 also differed from Equation II-5. It took the form:

$$F_1 = 2(F_4 - F_3) - F_2$$

$$32.9 = 2(73.7 - 40.2) - 34.1 \qquad \text{(II-6)}$$

All nine of the resulting cases would have been predicted with an accuracy of ±6 db had they been calculated. Therefore, the COSAM 3-signal RIM model will be expanded to include possible IM products in addition to those defined in Equation II-5.

Transmitter Intermodulation. Five cases where transmitter intermodulation (TIM) was predicted to be dominant over RIM resulted in values of B, $\sigma(\Delta)$, p_{1c} and p_{2c} of -6.05, 2.93, 0.60, and 0.80 respectively. None of the cases resulted in a large discrepancy. The B and $\sigma(\Delta)$ values suggest a consistent underestimation of TIM interference levels. Unfortunately, the small sample size for TIM does not support a recommendation for model change. It is somewhat surprising that the resulting B magnitude value is high because the COSAM TIM model fits the measured data better than any of the other individual interaction models. Uncertainties in the coupling predictions (σ for coupling was 8.1 dB) are believed to be the cause of these errors.

EVALUATION OF LARGE DISCREPANCIES

TABLE II-5 lists the 56 cases (of the total of 561) where the absolute value of the difference between the measured SINAD and the predicted mean was greater than 10 dB. Thirteen of the cases had differences less than 11 dB. Nine of these cases resulted in only a 2-condition error.

The positive values of dB and condition error differences indicate that the measured SINAD ratio was greater than the mean prediction, resulting in a pessimistic bias. Negative values express the converse situation.

TABLE II-6 summarizes the results noting the various interactions and whether they indicated too much interference (+) or too little interference (-).

TABLE II-5

EVALUATION OF LARGE DISCREPANCIES [$|S_m - \overline{S}_p| \geq 10$ dB]

Interaction Identity	TD (dBm)	Type Interaction	Notes	S_m - $\overline{S}_p$ Diff. Between Meas. & Pred. Means (dB)	Condition Error
2-2	-85	3 Sig-3rd		-17.8	-4
2-2	-95	3 Sig-3rd		-11.9	-3
2-2	-64	3 Sig-3rd		-15.0	-2
2-4	-85	3 Sig-3rd		13.9	3
2-4	-105	3 Sig-3rd		12.0	2
4-2	-95	2 Sig RIM-APP		-15.3	-4
4-2	-105	2 Sig RIM-APP		-15.0	-4
5-1	-85	SR-NF		15.7	3
5-2	-105	2 Sig RIM-APP		-15.6	-4
5-4	-105	AS	1	-10.7	-3
6-3	-95	AS	2	10.8	3
6-3	-105	AS	2	15.5	3
6-6	-95	AS		-11.0	-3
6-6	-95	AS		-12.5	-3
7-2	-85	SR		-15.9	-3
8-2	-85	2 Sig-2nd		-14.0	-3
10-2	-85	3 Sig-3rd		-19.3	-4
10-2	-95	3 Sig-3rd		-10.3	-2
10-2	-95	Sig-3rd		-12.4	-3
11-2	-95	NOISE	2	-12.5	-3
11-4	-95	AS	1	-10.3	-2
12-1	-85	SR		-12.8	2
12-3	-85	SR		-14.7	-3
12-5	-105	AS	1	-15.8	-4
13-2	-105	AS	1	-10.0	-2
14-1	-85	3 Sig RIM-APP	3	-10.0	-2
14-1	-95	3 Sig RIM-APP	3	-10.7	-3
14-5	-95	SR		13.0	3
16-1	-85	2 Sig RIM-APP		-15.0	-3
16-1	-62	2 Sig RIM-APP		-11.3	-2
16-3	-95	AS		-10.0	-2
16-6	-85	SR		11.6	3
17-1	-95	AS	1	-10.0	-3
18-1	-85	2 Sig RIM-APP	3	-21.7	-4
18-3	-85	2 Sig RIM-APP	3	-11.6	-2
18-4	-105	NOISE/RIM-APP	3	-13.0	-4
18-6	-85	SR		-20.2	-4
18-6	-95	SR		-10.1	-2
19-1	-85	3 Sig RIM-APP	3	-12.9	-3
19-2	-85	AS		-13.5	-3
19-2	-78	AS		-11.5	-2
19-3	-95	AS	1	-10.4	-2
19-3	-95	AS	1	-11.5	-3
19-6	-85	AS		12.0	3
21-2	-95	NOISE	1	-16.5	-3
21-2	-105	NOISE	1	-15.4	-4
21-4	-95	NOISE	1	-15.3	-4
22-5	-95	SE	4	-13.6	-3
23-4	-95	AS	5	12.2	3
24-6	-95	AS		-15.4	-2
25-1	-85	SE	4	-14.8	-4
25-1	-64	SE	1	-11.2	-2
25-3	-85	2 Sig RIM-APP	3	-18.5	-4
25-3	-51	Sig RIM-APP	3	-15.0	-2
25-6	-95	AS		-10.6	-2

TABLE II-5 (Continued)

NOTES:

1. Insufficient transmitter noise levels, due to multiple transmitter emissions, predicted.

2. Large anomaly between normal (TABLES I-17 and I-18) and Interferer Isolation (TABLES I-19 and I-20) subtest measured data for identical configurations.

3. Discussion and recommendation in RIM individual interaction subsection.

4. Discussion in spurious emission individual interaction subsection.

5. MEASURED SINAD for PD = -95 dBm greater than coresonding SINAD for PD = -85 dBm.

TABLE II-6

SUMMARY OF LARGE DISCREPANCIES (> 10 dB)

Interaction	Total (+)	Total (-)	Interactions
Spurious Responses	4	4	8
SR Predicted/Noted	3	4	7
SR NF	1	0	1
Spurious Emissions	0	4	4
IM (Total)	2	19	21
2-Signal, 2nd Order	0	1	1
3-Signal, 3rd Order	2	6	8
2-Signal, App	0	9	9
3-Signal, App	0	3	3
Adjacent Signal	4	14	18
Noise	0	5	5
	10	46	56

Most of these large error cases were due to the coupling prediction model. As stated earlier, the coupling model bias was 1.4 dB with the rather large standard deviation of 8.1 dB. Such large uncertainties in coupling prediction will undoubtedly result in some cases with large errors. However, there were only 10% such cases in spite of the large coupling uncertainties.

Note on Population Composition

The significance of any statistical analysis is necessarily dependent on the sample size and the nature of the sample. Ideally, the selected sample will be representative of the real world with the result that conclusions drawn from the analysis will be applicable to the real world.

TABLE II-7 reflects the distribution of measured SINAD values and predicted SPS values. The distributions are not uniform and are, in fact, denser at the extremes than at the center. As can be seen, only 23% of the SINAD cases lie between 5 and 12 dB.

TABLE II-7

POPULATION DISTRIBUTION

Condition No.	Measured SINAD Values			Predicted SPS Values		
	SINAD (dB)	No.	%	SPS	No.	%
A	> 18	70	12	.81-1.00	147	26
B	> 12; ≤ 18	67	12	.61-.80	48	9
C	> 7; ≤ 12	87	16	.41-.60	52	9
D	> 4; ≤ 7	42	7	.21-.40	49	9
E	≤ 4	295	53	.00-.20	265	47

Considerable effort was devoted to generation of frequency assignments that would result in a uniform distribution of output SINAD values and would, in addition, provide approximately equal numbers of all of the types of interactions noted in TABLE II-2.

In operational situations, existing cosite assignments will probably provide SINAD ratios greater than 12-15 dB for a larg percentage of possible interactions. For those cases where interference is expected (usually avoided by not activating certain transmitters simultaneously) most SINAD ratios will probably be below 4 dB. Similarly, most real-life assignments will not contain as many effects due to spurious responses and emissions and intermodulation as were deliberately inserted into the test assignments. Most cosite frequency assignments are made essentially at random with major emphasis on adjacent signal separation. The Navy selects UHF frequencies from lists which are free of two-signal 3rd, 5th and 7th order mixes.

In other words, typical situations represent reasonably clear-cut cases of degradation and/or no degradation. The chance of a marginal situation is rather remote.

Consequently, the distributions indicated in TABLE II-7 are probably more homogeneous in the middle range than would be expected in actual operating conditions. This feature was desirable to test the model over all possible ranges.

If, however, a more realistic population range had been employed, there would probably have been even more "bunching" at the extremes. And, since fewer spurious responses and emissions and intermodulation cases (the most difficult to predict) would be present, the number of gross errors (those involving more than two interference-condition errors or more than 10 dB between the measured value and the predicted mean) would probably be smaller than the number recorded in TABLE II-2.

However, whether p_{2c} is precisely 0.92 or 0.95 or greater is not of particular concern. In general, it has been shown that the chance of committing a gross error is small. In operational situations, the likelihood of such an error is believed to be even smaller.

COMMENTS ON MEASURED DATA ADEQUACY

The preceding analysis presupposes that all of the measured data were correct and accurate to within ±1 dB or better. Apparent prediction errors or large variations are assumed to be due to the analysis program rather than the measurements.

However, a review of the measured data, independent of the analysis, indicated numerous items that could either be explained by measurement inaccuracies or large variations in performance of specific equipments. The second hypothesis is assumed to be the probable explanation.

The requirement for interferer isolation determination, which was added after testing was started, resulted in 110 cases being remeasured. Investigation of these data will reveal the degree of repeatability achieved with the test configuration. Measured SINAD differences of 2 dB or less would be expected for a repeatable test. TABLE II-8 lists the distribution of measured SINAD value differences for all these repeated cases. The percentage that were repeatable, based on the 2 dB or less criterion, is 80.9%. 8.2% of the cases experienced differences of 7 dB or greater, revealing the variability inherent in equipments such as these.

In general, COSAM component models are based on laboratory type measurements. The variations among equipments suggest that a minimum error of at least 5 dB will be inherent in any prediction model. This uncertainty is somewhat compensated for in COSAM by statistically varying desired signal, interfering signal, and ambient noise levels.

Several other cases could be cited involving possible measurement error. For example, several cases of "apparent" 2-signal IM which were not predicted by COSAM could not be attributed to any identifiable mix. If an error had been made in measuring any of the frequencies involved, this would have accounted for the fact that COSAM did not properly identify the interactions.

If all of the anomalous situations referred to above had been eliminated from the validation analysis, COSAM predictions would have been even closer to measured values.

It is concluded that some measurement errors may have occurred and that, at best, the measured equipment performance was inconsistent during the test (see TEST RESULTS, APPENDIX I). These factors affected the results of the validation analysis to some extent but, in another sense, also indicated the range of uncertainty the analyst may expect in evaluating the performance of specific nomenclatures. Large variations can evidently be anticipated, requiring a statistical description of the input parameters as well as a statistical description of output performance.

INTERPRETATION OF PREDICTED SPS VALUES

The preceding material provides the major results of the analysis. Many more detailed evaluations could have been made and, the measured data (and the analyses) will be re-evaluated in other contexts.

TABLE II-8

DISTRIBUTION OF REPEATED MEASUREMENTS

$\|SINAD_A - SINAD_I\|$, dB	No.	%
0	38	34.5
1	38	34.5
2	13	11.8
3	5	4.5
4	3	2.7
5	4	3.6
7	1	0.9
8	1	0.9
9	3	2.7
10	2	1.8
12	1	0.9
16	1	0.9

$SINAD_A$ is value measured during tests with all interferers on. (TABLES I-17 and I-18)

$SINAD_I$ is corresponding value measured during interferer isolation tests. (TABLES I-19 and I-20)

The final subject to be considered is the practical problem facing the COSAM user. When he secures an SPS value, how much confidence can he place in it? And what action is indicated?

In coarse terms, it is believed that the analysis has shown that if the SPS value is greater than 0.6, the analyst can be reasonably certain (with confidence level greater than 0.92) that intolerable interference (i.e., a SINAD value less than 4 dB) will *not* occur. Similarly, if the SPS is less than 0.2, he can be reasonably certain that good or acceptable performance (i.e., SINAD values greater than 15 or 12, respectively) will *not* occur.

If the scores lie between 0.2 and 0.6, he should indicate that marginal performance is likely. The term "marginal" means that although there is a possibility of either adequate or intolerable performance, the situation is not a desirable one and should be improved, if possible.

If at all possible, "fixes" of one kind or another should be suggested which will bring the scores above 0.9. Then, despite uncertainties, one will be reasonably certain that, at worst, an output SINAD of at least 10 dB will be achieved.

APPENDIX III

THE COSITE ANALYSIS MODEL (COSAM)

INTRODUCTION

COSAM is an automated system model used to evaluate the electromagnetic compatibility of a single site where a large number of transmitting and receiving communication equipments are employed. Such a "co-site" EMC analysis must take into account the close distances between antennas, and the high level of undesired signals present at receiver inputs and transmitter outputs.

THE $[S/(I+N)]_{ino}$ CONCEPT

The parameter $[S/(I+N)]_{ino}$ is calculated by the COSAM program for each receiver specified in the analysis. This parameter is defined as the effective input on-frequency signal to interference plus noise ratio resulting from any of, or the combined effects of, the five types of interactions predicted by COSAM. These interaction types, listed below, are calculated by COSAM for each receiver versus the transmitters specified in the analysis:

1. Adjacent Signal.
2. Receiver Intermodulation.
3. Transmitter Intermodulation.
4. Receiver Spurious Response.
5. Transmitter Spurious Emission.

Three variables are involved. S is the desired signal power (P_d); N is the ambient noise power level (P_n); and I is the sum of effective input on-frequency interference power levels (ΣP_{ino}). P_{ino} is the effective input on-frequency interference power level due to a single interaction. The summation involves a conversion from dBm to watts; when the addition is made, the result is reconverted to dBm. We have:

$$[S/(I+N)]_{ino} = 10 \log [P_d/(P_n + \Sigma P_{ino})] \qquad \text{(III-1)}$$

When P_d, P_n, and P_{ino} are expressed in watts the ratio is in dB.

In co-site situations, frequencies of interfering signals will not be equal to the desired signal (receiver) frequency. However, equations are supplied for each of the five interactions which convert input values of P_d (at f_o) and P_i (at f_i) to P_{ino} permitting conversion to $[S/(I+N)]_{ino}$. This can then be easily converted to $[S+I+N)/(I+N)]$, commonly called SINAD, for the model output.

DEGRADATION CONSIDERATIONS

Operational degradation is a somewhat loosely defined term which implies relating such parameters as receiver output S/(I+N) or (S+I+N)/(I+N) ratios to measures that will be meaningful to users, designers, and analysts. One of the most commonly used measures is the articulation score which is the percentage of a standard word list that can be recognized as a function of output (S/N) ratio.

The COSAM model computes the statistical distribution of the desired signal, the noise, and each P_{ino}. Since the anticipated output SINAD is therefore also statistical, an articulation score measure is used to select a SINAD threshold. The COSAM model then computes the probability of exceeding this threshold. This gives a numerical "score" upon which the user may base his decision as to the seriousness of degradation to a system. A threshold value of 10 dB, which corresponds to an articulation score of approximately 70%, is commonly used.

COSAM provides three numerical scores, discussed in more detail below. See Figures III-1 and III-2. The upper performance score (UPS) is the probability of providing "adequate" or "good" performance if no interference is present. The system performance score (SPS) is the probability of adequate (or good) performance in the presence of interference. The relative performance score (RPS = SPS/UPS) provides the user with another measure which, in conjunction with the other scores, gives additional understanding of receiver performance. For example, if the SPS were 0.4, one would predict poor performance. However, if the UPS were also 0.4, RPS = 1.0, and it can be seen that the inadequate desired signal would be the major problem.

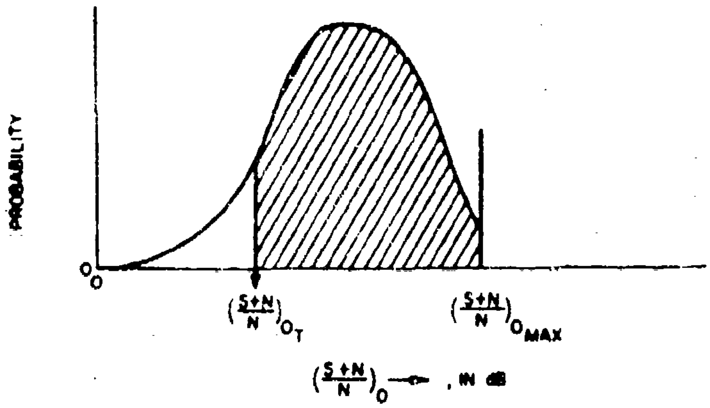

Figure III-1. Representative Distribution of $\left(\frac{S+N}{N}\right)_o$ for a Given Receiver (Upper Performance Score Calculation)

NOTES 1. $\left(\frac{S+N}{N}\right)_{O_T}$ and $\left(\frac{S+I+N}{I+N}\right)_{O_T}$ are threshold values of signal plus noise-to-noise, and signal plus interference plus noise-to-interference plus noise ratios, respectively.

2. The scores, from 0 to 1, are the cross-hatched area divided by the total area, for each curve.

3. To account for variable dynamic ranges, the maximum values of $\left(\frac{S+N}{N}\right)_o$ and $\left(\frac{S+I+N}{I+N}\right)_o$ are specified by the user. Calculated values above the maximum appear at the maximum.

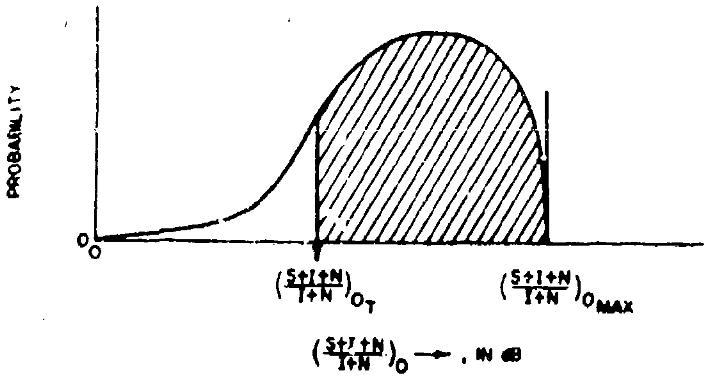

Figure III-2. Representative Distribution of $\left(\frac{S+I+N}{I+N}\right)_o$ for a Given Receiver (System Performance Score Calculation)

DEGRADATION COMPUTATIONS

Receiver detector transfer function equations are used to convert input [S/(I+N)] ratios to output [S/(I+N)] ratios. The following relationships have been tentatively established (the heading for each case lists the desired signal first and the undesired signal second):

AM - AM

$$\left(\frac{S}{I+N}\right)_o = \left(\frac{S}{I+N}\right)_{Ino} - 8 \qquad \text{(III-2)}$$

AM - NOISE

$$\left(\frac{S}{I+N}\right)_o = \left(\frac{S}{I+N}\right)_{Ino} + 10 \text{ Log } BW_{MHz} + 11 \qquad \text{(III-3)}$$

FM - FM

$$\left(\frac{S}{I+N}\right)_o = \left(\frac{S}{I+N}\right)_{Ino} + 5 \qquad \text{(III-4)}$$

FM - NOISE

$$\left(\frac{S}{I+N}\right)_o = \left(\frac{S}{I+N}\right)_{Ino} + 2 \qquad \text{(III-5)}$$

SSB - SSB AND SSB - NOISE

$$\left(\frac{S}{I+N}\right)_o = \left(\frac{S}{I+N}\right)_{Ino} \qquad \text{(III-6)}$$

CALCULATION OF MEAN POWER LEVELS

As mentioned above, equations are used to convert off-tune interfering powers to on-tune mean P_{Ino} values for the five types of interference interactions considered. In order to use these equations (presented below) the power present at a victim receiver due to each interfering transmitter must be calculated. COSAM calculates coupling loss by one of two methods depending upon the CO-SITE installation. If a ground or ship installation is being analyzed one method is used. If, on the other hand, the installation is an aircraft, a second method must be used so that coupling around the aircraft fuselage may be considered. Coupling loss, as defined below, includes the gains of the antennas as well as the space loss between antennas.

Ship and Land Coupling Loss

The statistical expression for ship and land coupling loss as used by COSAM is:

$$\overline{C(1,2)} = -G(1)-G(2)-37-60\sin^2\theta + 20(1+\sin^2\theta)\log_{10}(df) + 14P(1-\sin\theta)^2, \quad f \geq 30 \text{ MHz} \tag{III-7a}$$

$$= -G(1) - G(2) + 5 + 20\log_{10}(1 + .0226\,df) + 14P(1-\sin\theta)^2, \quad f < 30 \text{ MHz} \tag{III-7b}$$

where:

$\overline{C(1,2)}$ = Mean coupling loss between antennas 1 and 2, (dB). This is the value which, when subtracted from the interfering transmitter power (dBm), gives the received interfering power (dBm).

$G(1), G(2)$ = Gains in dB of antennas 1 and 2, respectively

d = the distance between antennas, in feet

f = the frequency of the transmitted signal, in MHz

θ = the vertical angle between antenna positions, in degrees (See Figure III-3)

P = polarization factor (1 for cross polarization, 0 otherwise)

Each antenna location is identified by its X, Y, Z cooordinates (in feet). An example is given in Figure III-3, illustrating the computation of θ:

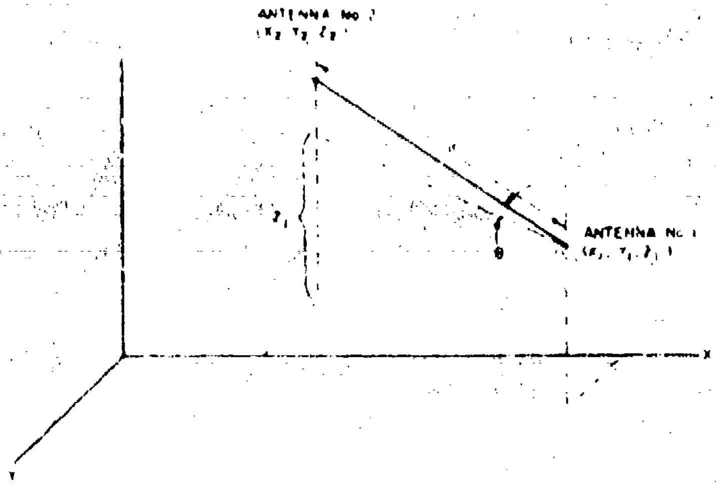

Figure III-3. Antenna Coordinate System for Shipboard and Land Configurations

$$\theta = \arc\sin \frac{Z_2 - Z_1}{d} \qquad \text{(III-8)}$$

$$d = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2 + (Z_2 - Z_1)^2}$$

If $\theta = 0$, Equation (III-7) reduces the free space equation minus 7 dB. The statistical distribution of (III-7) is assumed to be normal and a value of standard deviation is supplied.

Aircraft Coupling Loss

The expression for coupling loss on an aircraft assumes that antennas are on or above a perfectly conducting cylindrically or conically shaped airframe. The geometry of the airframe is depicted in Figure III-4. Some of the features are:

1. Raised antennas on stabilizer only
2. Cylindrically shaped body
3. Conically shaped tail section

The expression for mean coupling loss is:

$$\overline{C(1,2)} = -G(1)-G(2)-37.9 + 20 \operatorname{Log}_{10} (df) + CF \qquad \text{(III-9)}$$

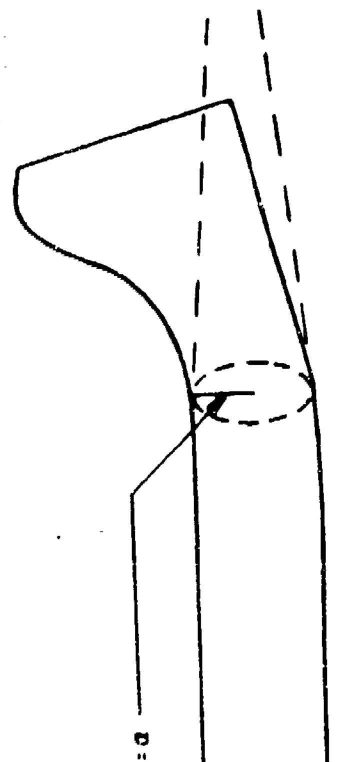

Figure III-4. Airframe Geometry, Assuming a Combined Cylindrically and Conically Shaped Fuselage

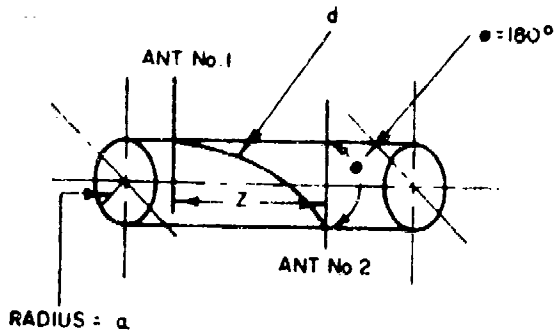

Figure III-5. Illustration of Cylindrical Terms

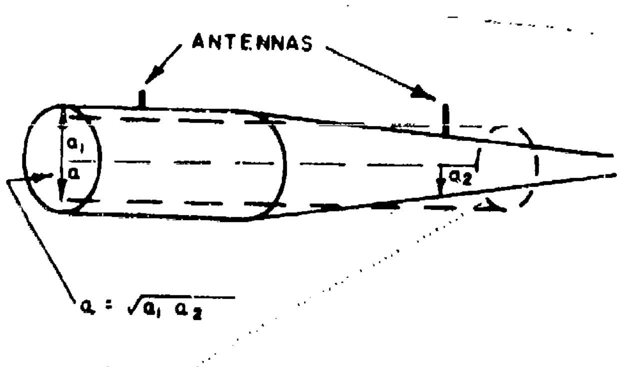

Figure III-6. Geometric Mean Cylinder

where:

G(1), G(2) = Antenna gains (dB)

d = shortest distance in feet along the surface of the cylinder between the antennas (Figure III-5)

$$= \left[Z^2 + \left(\frac{a\theta}{57.3}\right)^2\right]^{1/2}$$

f = frequency in MHz

a = radius of the cylindrical airframe in feet. If the airframe is conical, $a = \sqrt{a_1 \cdot a_2}$, the geometric mean radius. (See Figure III-6)

CF = curvature factor which is a function of the variable y

$$y = 7.64 \times 10^{-4} \left[\frac{(a/\lambda)\theta^2}{\sqrt{d/\lambda}}\right]$$

θ = the angle in degrees separating two planes that contain the longitudinal axis and the transmitting and receiving antennas, respectively

Z = the distance in feet separating the projections of the transmitting and receiving antennas on the longitudinal axis

λ = wavelength in feet of the transmitted frequency

A curve of y versus curvature factor (dB) is used in the computation of path loss due to curvature around the cylinder. A special case of coupling is also considered. This is illustrated by a raised antenna (e.g., on a stabilizer) which is not line-of-sight with an antenna on the airframe. The minimum separation distance between the antennas is the sum of the straight line portion from the raised antenna to a tangent point on the cylinder plus the curved helical distance from the tangent point to the antenna on the cylinder.

The statistical distribution for (III-9) is also assumed to be normal and a standard deviation value is supplied.

Antenna Couplers

The off-frequency rejection loss [β(C)] due to antenna couplers is assumed to be that of N cascaded single-pole Butterworth bandpass filters and is given as follows:

$$\beta(C) = 10\,N\,\mathrm{Log}_{10}\left[1 + Q^2\left(\frac{f_o + \Delta f}{f_o} - \frac{f_o}{f_o + \Delta f}\right)^2\right] \qquad \text{(III-10)}$$

where:

N = The number of tuned stages

Q = The quality factor or ratio of reactance to resistance of the circuit

f_o = Tuned frequency of the circuit (MHz)

Δf = Operating frequency minus f_o (MHz)

Power Loss Computation

To compute the mean received power at the input to the receiver (R_2) due to a single interfering transmitter (T_1) the following is used:

$$\bar{P}_r = \bar{P}_o(T_1) - \beta(C_1) - \bar{C}(1,2) - \beta(C_2) \qquad \text{(III-11)}$$

where:

$\bar{P}_o$ = mean transmitter power output, in dBm

$\bar{P}_r$ = mean received power, in dBm

The variance (σ^2) of the P_i distribution is:

$$\sigma^2 (P_i) = \sigma^2 (P_o) + \sigma^2 [C(1,2)] \quad \text{(III-12)}$$

Losses of all significant paths are checked. For example, if T_1, T_3 and R_2 form a third order IM triplet (discussed below), such that:

$$2f_1 - f_3 = f_2$$

we say that a transmitter IM (TIM) product as well as a receiver IM (RIM) product will be formed. Further, T_1 is the "victim" transmitter in the TIM triplet and T_3 is the interfering transmitter.

To compute the mean TIM power at R_2 we must first compute the power at T_1 due to T_3, using Equation (III-11). Briefly, a new product is said to be generated by T_1 at frequency f_2. Equation (III-11) is then used again; however, this time Δf will be $f_2 - f_1$ and $f_o = f_1$. $\bar{\beta}(C_2)$ will be assigned a nominal value of 1 dB to account for coupler insertion loss.

Computation of mean RIM power levels at f_1 and f_2 will involve consideration of the paths from each transmitter to the receiver.

If T_1 has a spurious emission, Equation (III-11) is employed in the same manner as in the case of a TIM product. Adjacent signal and spurious response computations also employ Equation (III-11) as indicated.

COMPUTATION OF P_{Ino} VALUES

Adjacent Signal Interference

The equation for the mean value of the effective input on-frequency interference power level from an adjacent signal is:

$$P_{Ino} = P_i - \beta_{eff} + (1 - M)(P_d - R_s - 5) \quad \text{(III-13)}$$

where:

P_i = input undesired power, in dBm

β_{eff} = effective off frequency rejection (due to Δf), in dB

P_d = input desired power, in dBm

M = a value of the slope $\Delta P_i / \Delta P_d$,

= 1.0, $P_i \leqslant P_{ib}$

< 1.0, $P_i > P_{ib}$

R_s = receiver sensitivity, in dBm

P_{ib} = a specified interfering power break point

Values for β_{eff}, M, and R_s are obtained from equipment spectrum signature measured data.

Spurious Responses

The expression for spurious response calculations is:

$$P_{ino} = (1 - q) R_s + q (P_i - \beta_{sr}) \qquad \text{(III-14)}$$

where:

P_{ino} = the effective on-tune interference power, dBm

P_i = input undesired power, dBm

R_s = receiver sensitivity, dBm

β_{sr} = effective spurious response rejection, dB

q = a positive integer which represents the harmonic of the spurious frequency

Note that if $q = 1$, $\bar{P}_{ino}$ is simply $\bar{P}_i - \bar{\beta}_{sr}$. However, if $q = 2$, an increase of 10 dB in P_i will result in an increase of 20 dB in P_{ino}. Limited measured data supports this hypothesis for the $p = 2$, $q = 2$ response. Digital equations are used in COSAM to determine the various receiver IF and local oscillator (LO) frequencies as a function of tuned frequency. The spurious response frequency is then calculated as a function of the IF and LO frequencies.

Spurious Emissions

The expression to compute the spurious emission power at the receiver takes the form:

$$P_{ino} = P_t - \beta_{se} - \beta(C_t) - C_{tr} - 1 \qquad \text{(III-15)}$$

where:

P_{ino} = the effective on-tune interference power, dBm

P_t = transmitter power, dBm

β_{se} = effective spurious emission rejection, dB

$\beta(C_t)$ = off-frequency rejection due to the transmitter coupler, dB

C_{tr} = coupling loss between transmitter and receiver due to antenna gains and path loss, in dB

The value of 1 dB represents the insertion loss of the receiver coupler.

Transmitter Intermodulation

The transmitter intermodulation power is given by the equation:

$$P_{Im} = mP_v + n(P_i - \beta_{vi}) - K_{m,n} - \beta_{vr} \qquad \text{(III-16)}$$

where:

P_{Im} = power level in dBm of the IM product at the transmitter at frequency f_{Im}

P_v = output power level in dBm of the victim transmitter signal at f_v

P_i = received power level in dBm of the interfering transmitter signal at f_i

β_{vi} = off frequency rejection in dB, a function of frequency difference between f_v and f_i and the victim transmitter output selectivity

$K_{m,n}$ = transmitter conversion loss term for the m+n order case

β_{vr} = off-frequency rejection in dB, a function of the difference between f_v and f_r where $f_r \approx f_{Im}$, and f_r is the tuned frequency of a victim receiver

m, n = integers

f_{Im} = $mf_v - nf_i$

Values for $K_{2,1}$, $K_{3,2}$ and $K_{4,3}$ have been computed from spectrum signatures.

Receiver Intermodulation

The receiver intermodulation power is:

$$P_{Im} = m(P_v - \beta_{vr}) + n(P_i - \beta_{ir}) - K_{m,n} \quad \text{(III-17)}$$

where:

P_{Im} = power, in dBm, of the intermodulation product produced in the receiver m, n = integers (same as Equation III-16)

P_v, P_i = power level, in dBm, of undesired signals

β_{vr}, β_{ir} = off-frequency rejection in dB, a function of the difference between undesired frequencies and receiver tuned frequency (f_r), where $f_r \approx f_{Im}$

f_r = $mf_v - nf_i$

$K_{m,n}$ = receiver RF amplifier or first mixer conversion loss

Values of $K_{1,1}$, $K_{2,1}$, $K_{3,2}$, and $K_{4,3}$ for the first mixer, and $K'_{1,1}$, $K'_{2,1}$, $K'_{3,2}$ and $K'_{4,3}$ for the RF amplifier, have been computed from spectrum signature data.

STATISTICAL METHODS

Application of Monte Carlo Techniques

Each of the five interactions results in intermediate predicted distributions of P_d, P_i and P_n at the input to the receiver. In order to account for certain non-linearities in the receiver, specific power break-points have been specified in the adjacent signal and receiver intermodulation equations. For each equation, if the interfering power level exceeds the break-point, one constant ($M < 1$ or $K'_{m,n}$, respectively) is used; if it does not, another constant ($M = 1$ or $K_{m,n}$, respectively) is used.

It is anticipated that the P_i distributions will frequently include values above and below the break-point(s). Consequently, a Monte Carlo procedure is used to select a single P_i value from the computed distribution by employing a random number generator and, depending on the value, the appropriate equation is selected. The process is then repeated many times to compute P_{Ino} and $[S/(I+N)]_{Ino}$.

In brief, one receiver is selected; an interaction table is examined to determine which transmitters are potentially significant. Then, for each interaction, the appropriate P_i, P_d and other parameter distributions are selected and a single value chosen from each by means of a random number generator.

A single value of P_{ino} is computed from these values; the next interaction is considered, using the same points, as applicable, and so on. This process is termed a "run". Then, for the same receiver, approximately 1,000 runs are performed, eventually resulting in a predicted $[(S+I+N)/(I+N)]_o$ output distribution. Each receiver is considered in the same manner.

Computation of $[S/(I+N)]_{Ino}$

Each run (of the many runs per receiver) contains a list of computed P_{ino} values. TABLE III-1 illustrates some typical results.

TABLE III-1

TYPICAL P_{Ino} OUTPUT VALUES

RECEIVER NO. 1						
Trans. No.	Type	Run No 1	Run No. 2	- -	Run No. 1000	$\bar{P}_{ino}$
No 2	ADJ SIG.	-120	-125		-123	-122
No. 3	ADJ. SIG.	-100	-104		-102	-103
No. 4	ADJ. SIG.	85	-90		-87	- 89
No. 5	SPUR. RESP.	-130	-124		-126	-127
No. 6	SPUR. EMISS.	-125	-130		-128	-128
No. 7	3 rd. ORDER	- 110	-112		-114	-112
No. 8	TIM					
No. 7	3 rd. ORDER	-100	-93		-98	- 96
No. 8	RIM					
	ΣP_{Ino}					
P_d		-74	-78		-76	-75 ($\bar{P}_d$)
P_n		-108	-112		-110	-110 ($\bar{P}_n$)

Each column in TABLE III-1 contains a list of P_{ino} values for each run. The last column contains the mean value of P_{Ino} due to each interaction. The program considers each run separately and computes the sum of P_{ino} . Also included are values of P_d and P_n.

These distributions are not computed by COSAM. They are assumed for each problem and may be changed for different situations. $[S/(I+N)]_{in}$ is then computed using Equation (III-1).

OUTPUT

A distribution of $[S/(I+N)]_o$ values is determined using the appropriate transfer function (Equations III-2 through III-6). This distribution is then transformed to a SINAD distribution as follows:

$$\text{SINAD} = [(S+I+N)/(I+N)]_o \text{ dB} = 10 \log_{10} [1 + 10^{0.1 [S/(I+N)]_o}] \text{ dB} \qquad \text{(III-18)}$$

After the computation of each receiver's degradation scores (Figures III-1 and III-2), a print is given summarizing the results of the interference analysis. The average $P_{I,o}$ values for each interference situation are given along with the three degradation scores. A plot of the SINAD distribution is also printed.

After all receivers have been examined, a final print lists all receivers and their associated scores.

APPENDIX IV

ANTENNA AT-912/VRC ANALYSIS

BACKGROUND

This appendix contains a description of antenna AT-912/VRC, along with an analysis of its off-frequency operating characteristics. Antennas of this nomenclature were used in conjunction with the equipment at positions 1 through 4 during operational field subtests. The various measures of comparison between measurements and predictions of antenna characteristics are also described. Finally, a summary of major results of the antenna analysis is provided.

AT-912/VRC DESCRIPTION

Antenna AT-912/VRC (References 8 & 9) is a ten foot, center-fed vehicular whip designed to operate as part of a VHF (30-76 MHz) communications set. The external appearance of the center-fed whip differs little from the common base fed whip. Referring to the simplified schematic diagram of Figure IV-1, its principal features can be summarized as follows:

1. The impedance matching problem is solved by dividing the frequency range into the ten fairly narrow bands shown in TABLE IV-1, by providing a separate fixed-tuned network for each of the bands at the base of the antenna, and by switching to the proper matching network by means of an automatic remote control activated by the frequency select control of the radio set.

TABLE IV-1

AT-912/VRC FREQUENCY BANDS

Band No.	Frequency Range (MHz)	Band No.	Frequency Range (MHz)
1	30 to 33	6	53 to 56
2	33 to 37	7	56 to 60
3	37 to 42	8	60 to 65
4	42 to 47.5	9	65 to 70.5
5	47.5 to 53	10	70.5 to 76

Thus, the feed cable from the antenna to the radio set can be of arbitrary length. No manual tuning is involved other than depot (5th echelon) maintenance level adjustment of the matching networks to achieve a standing wave ratio (SWR) smaller than 3:1 over the entire range.

2. The vertical antenna is fed near its center through a coaxial cable (RG-63 B/U, 125 ohms characteristic impedance) and terminated at its lower end into a bifilar choke. Its reactance can be varied by shorting taps of an inductor connected in parallel with the bifilar choke secondary, which itself is connected between the antenna base section and the vehicle body. A switch ganged with the stepping switch for the matching networks automatically selects the proper reactance value for each band. This permits controlling the current distribution along the lower section of the radiator below the feed point to place a current node at or near the lower end of the antenna in all bands. The resulting current distributions are shown in Figure IV-2. As a result, the distortion of the azimuth pattern and the loss caused by unintentional excitation of the vehicle body are minimized. Most important, the decoupling actually achieved between antenna and vehicle body is sufficient to make differences in impedance due to vehicle type, mounting location and ground conditions negligibly small. As a secondary effect, the power gain with respect to the field strength on the ground, as compared to a base-fed antenna, is improved noticeably at the upper end of the frequency range.

3. The proven mechanical advantages of the whip configuration are not compromised. There are no moving parts, telescoping sections, or lumped reactors in the whip itself.

ANTENNA MATCHING UNIT MX-2799/VRC

The antenna band selection switch, base loading reactance, and matching networks are all contained in a separate, removable housing with nomenclature MX-2799/VRC. The housing has threaded inserts to permit mounting on a variety of vehicle types. A handle provides ease of maintenance and also provides physical protection for the two sealed connectors mounted near it. The detailed MX-2799/VRC schematic diagram of Figure IV-3 shows that each of the 10 matching networks has either one or two variable (piston trimmer) capacitors for tuning. Approximate component values are given for the remaining capacitors and inductors. Fifth echelon maintenance instructions (Reference 12) call for adjustment of the variable capacitors of each network to obtain a SWR (50 ohm system) of 3:1 or less within the applicable frequency sub-band in TABLE IV-1.

COUPLER SELECTIVITY MODEL

As noted in Section 3, the coupler selectivity model used was based on a single set of field measurements (Reference 7). The configuration consisted of two AT-912/VRC antennas separated by approximately five feet. Combined matching unit, antenna, and path losses were measured versus frequency with both co-mounted antennas tuned to band 1. The tests were repeated for the other nine bands.

The coupler selectivity prediction model was derived by subtracting path loss from the measured loss value and then assuming that half the resulting value was due to each coupler. The coupler selectivity models for the ten frequency bands are plotted as a solid line (labelled USAEPG Data) in Figures IV-4 through IV-13. These selectivity models were used for the COSAM predictions described in APPENDIX II.

SELECTIVITY MODEL VALIDATION

AVCO Data - ECAP

In-band antenna impedance data for each of the ten frequency bands are presented in Reference 9 and reproduced here as Figure IV-14. The data reference point is shown as A-A in Figure IV-1. Impedance data at this point includes the effect of the bifilar choke along with its variable shunt inductance. This effect may be noted as discontinuous curves between frequency bands in the plot of Figure IV-14. Exceptions are bands 5, 6, and 7, and bands 8 to 9, which are continuous.

It was possible to arrive at a MX-2799/VRC coupler selectivity model by combining the measured antenna impedance data with the matching unit circuit diagrams of Figure IV-3. The out-of-band antenna impedances for each band position were assumed to be approximately equal to the in-band impedances measured for each of the remaining nine positions. The error resulting from this assumption was small compared with the other uncertainties involved.

Matching unit variable capacitor values (JFD Model VC32GW, 0.8 - 18 pf) were selected analytically such that the 3:1 in-band SWR requirements were met (where possible). Bands 1, 3, 4, 7, 8 and 9 each contained one or more in-band frequencies for which the SWR could not be reduced to below 3:1. Capacitor values for these bands were selected for minimum SWR. The analytic method utilized the Electronic Circuit Analysis Program (ECAP, Reference 10).

ECAP was then used to derive the coupler rejection curves labelled "AVCO-ECAP" in Figures IV-4 through IV-13.

Band 6 was chosen to study the selectivity model's sensitivity to changes in tuning capacitor settings. The ECAP analytic method was used to determine capacitor C613 and C614 values which would satisfy the 3:1 SWR criterion. Wide variation in the resulting coupler rejection curve (Figure IV-15) was found, depending on the capacitor values assumed. It is felt that rejection characteristics for the other nine bands are equally sensitive to tuning capacitor settings. This tends to explain differences in off-tuned coupling measured in Reference 5 and the large (8.1 dB) coupling model standard deviation.

TRACE

Selectivity data were measured between the input and reference point "A-A" for each of the ten bands of a MX-2799/VRC antenna matching unit loaned to ECAC by USMC for this purpose. Matching unit input and output impedances (50 ohm load) and antenna impedances were also measured. These data were processed by the Transmitter/Receiver, Antenna, Coupler Evaluation (TRACE) analytic model to arrive at a second, independent set of selectivity curves for validation purposes. TRACE is a computer program which can, among other functions, arrive at a statistical selectivity function for an antenna/coupler/transmission line system given 50 ohm insertion loss data and impedance data measured at selected points throughout the system (Reference 11). The statistics account for variations in the selectivity function due to varying transmission line lengths and tuning element values. The resultant mean selectivity values are plotted in Figures IV-4 through IV-13 and labelled "TRACE".

SPECTRUM SIGNATURE

Far-field power density measured data were included in the AN/VRC-12 spectrum signature for six of the ten ATC-912/VRC bands. Data was recorded in 10 MHz frequency increments in order to get the coupler rejection to be expected out-of-band. Two samples were tested. The results are plotted in Figures IV-4, 6, 8, 9, 11 and 13 and labelled "SPECT. SIG.".

RESULTING REJECTION MODEL

Coupler rejection variabilities shown in Figures IV-4 through IV-13 and Figure IV-15 suggest the need for a statistical AT-912/MX-2799 rejection model. The individual band mean value models, which will be incorporated into COSAM, are plotted in Figures IV-16 through IV-20. They were derived by averaging all the individual curves described above. The in-band standard deviation will be on the order of 1 dB; a standard deviation of 5 dB may be expected out-of-band.

CONCLUDING COMMENTS

Several replacement antennas for the AT-912/VRC have been developed and deployed recently. They may be used interchangeably. One such antenna has the nomenclature AS-1729/VRC. It has a matching unit which was redesigned from the MX-2799 so that the number of components could be reduced, thus improving reliability. This is mentioned here because the newer designs do not have the out-of-band selectivity incorporated in the AT-912 design. Therefore, it is sometimes advantageous to use the older model (AT-912) from an EMC standpoint. EMC analysts should be made aware of this fact.

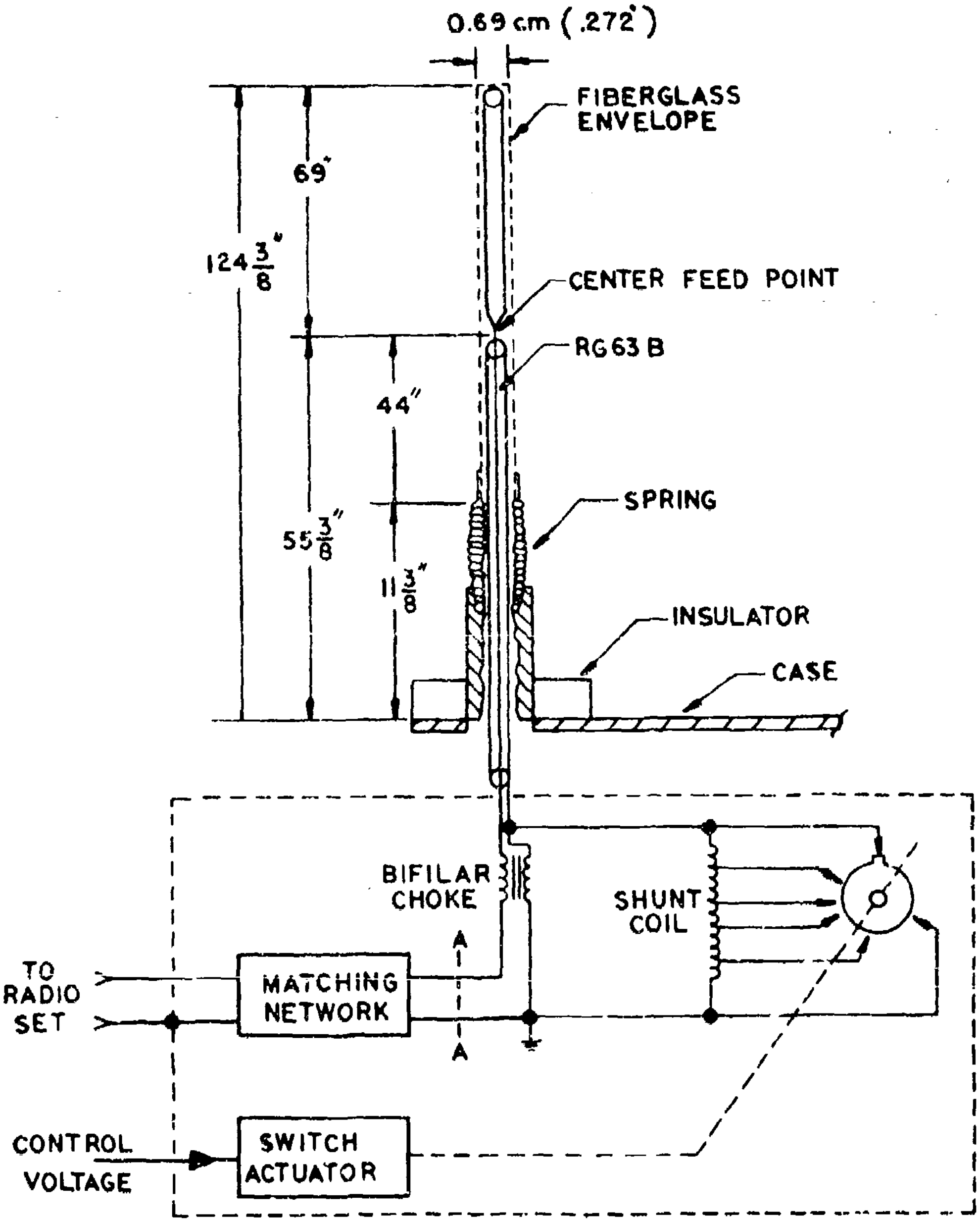

Figure IV-1. Center-Fed Antenna, Simplified Schematic Diagram

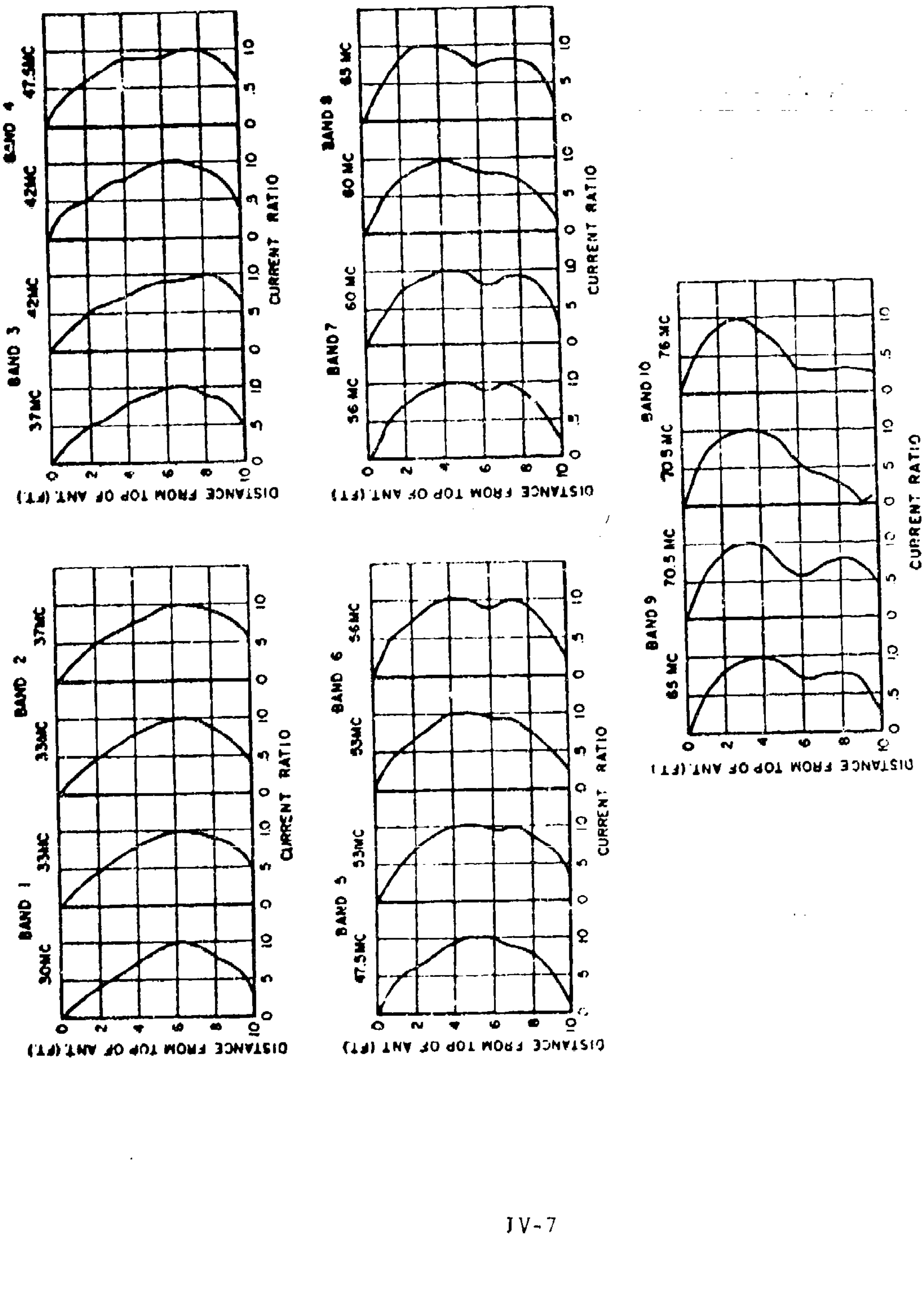

Figure IV-2. Current Distribution, Center-Fed Antenna

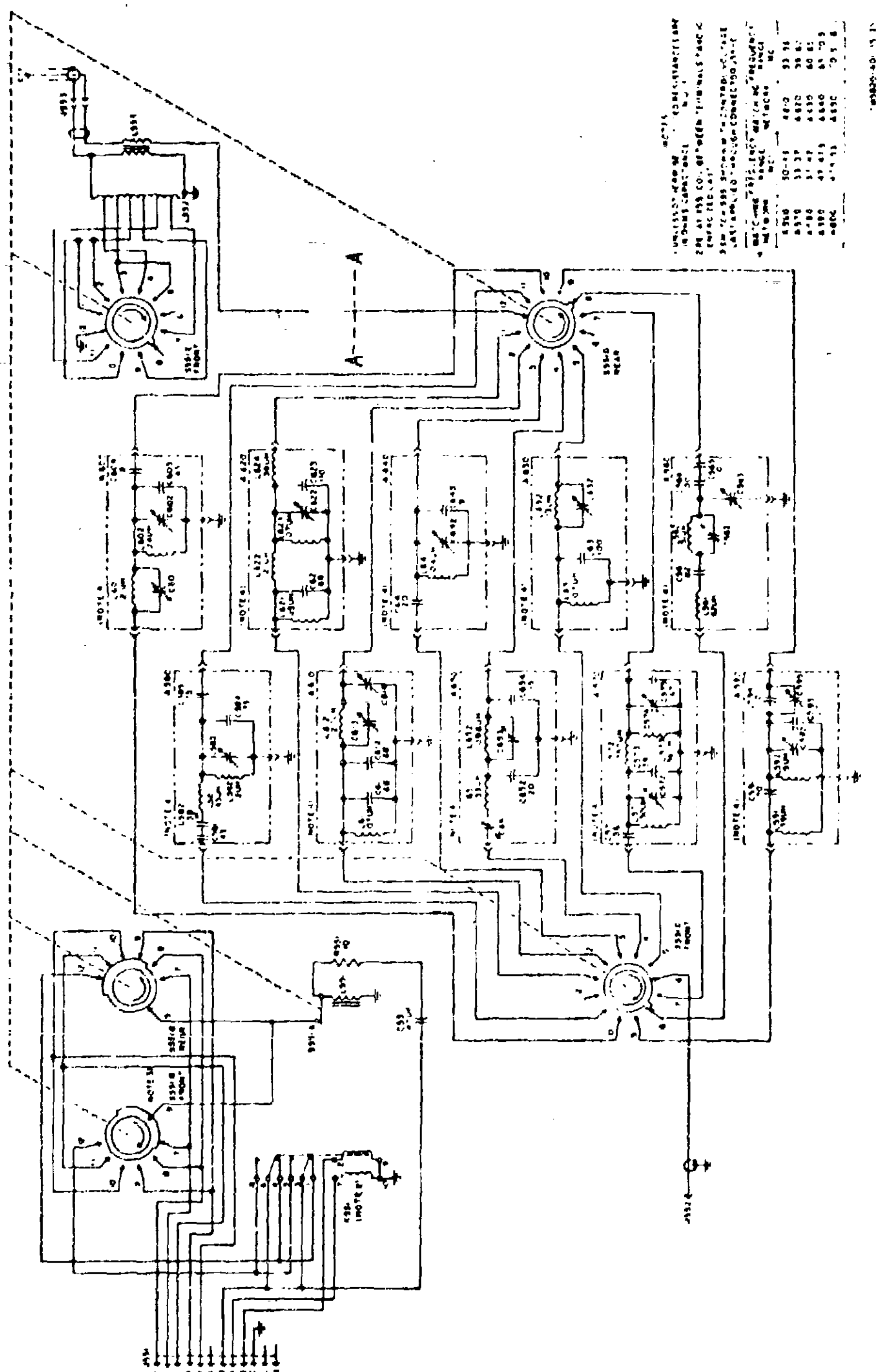

Figure IV-3. Antenna Matching Unit MX-2799/VRC, Schematic Diagram

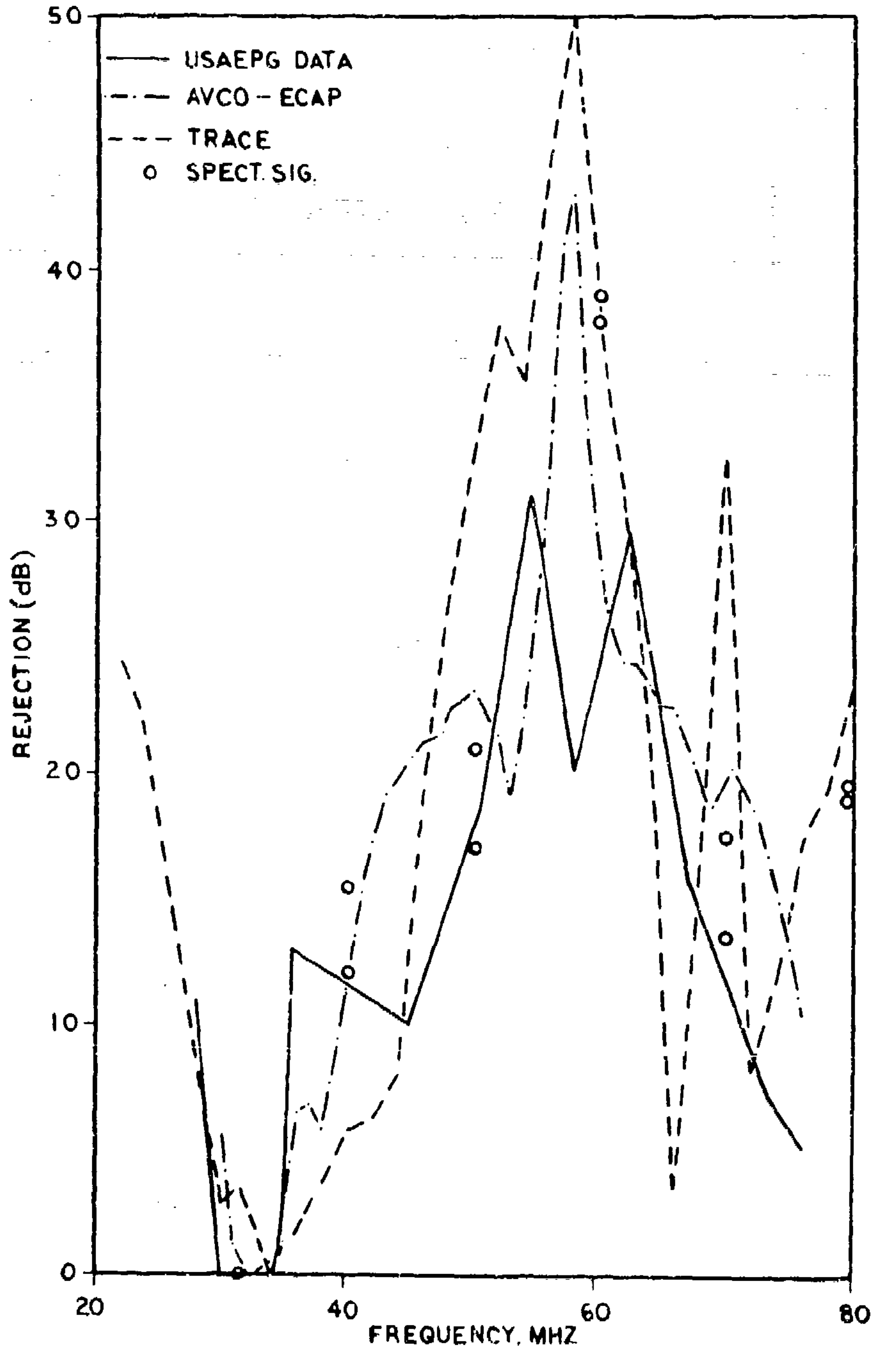

Figure IV-4. AT-912/VRC Band 1 Rejection

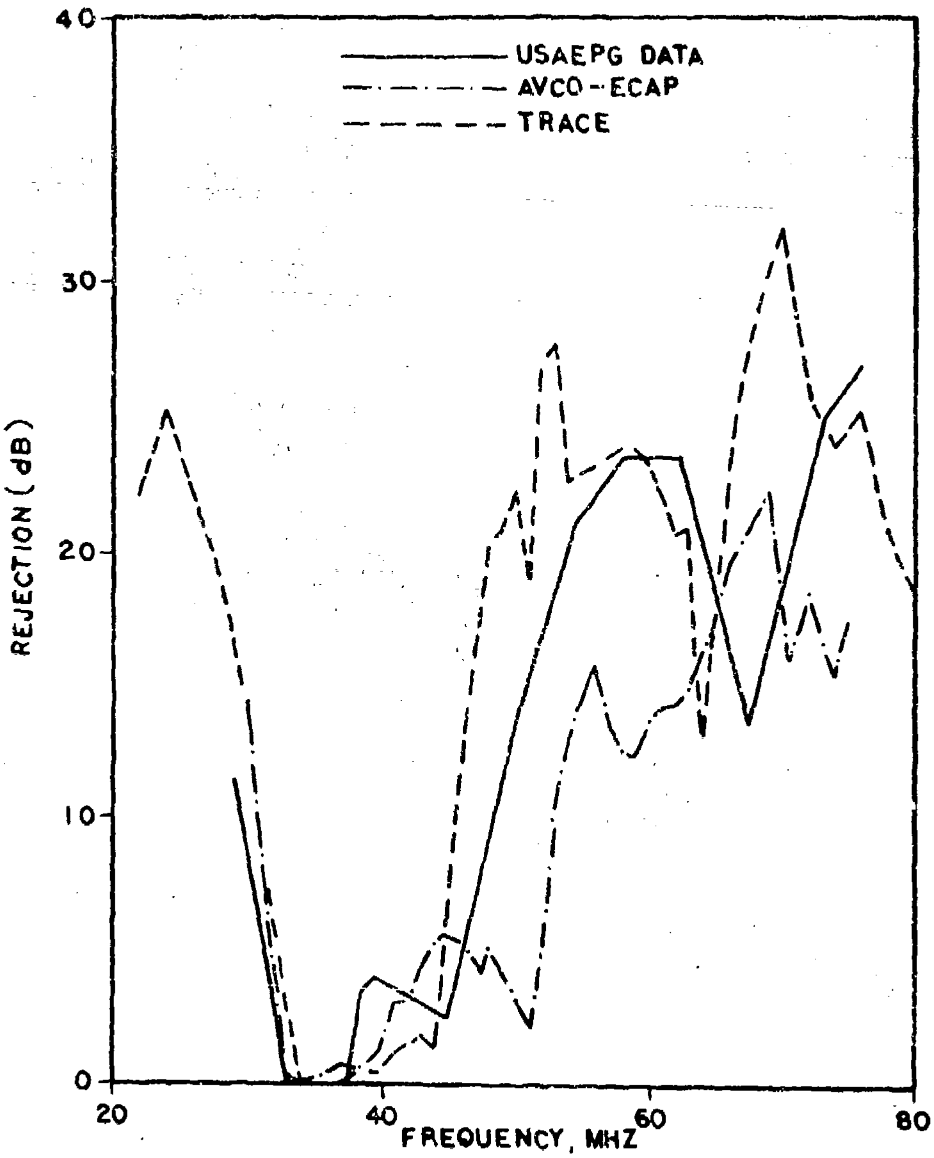

Figure IV-5. AT-912/VRC Band 2 Rejection

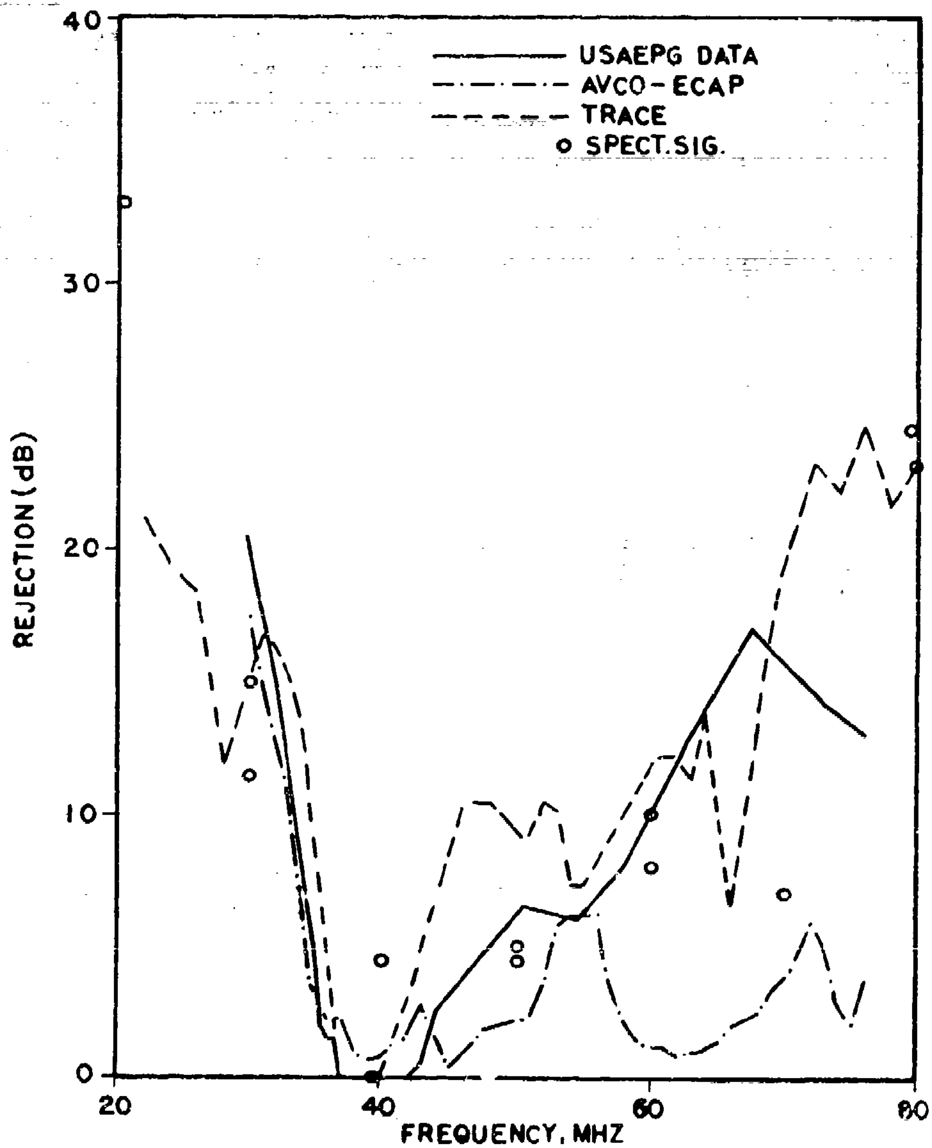

Figure IV-6. AT-912/VRC Band 3 Rejection

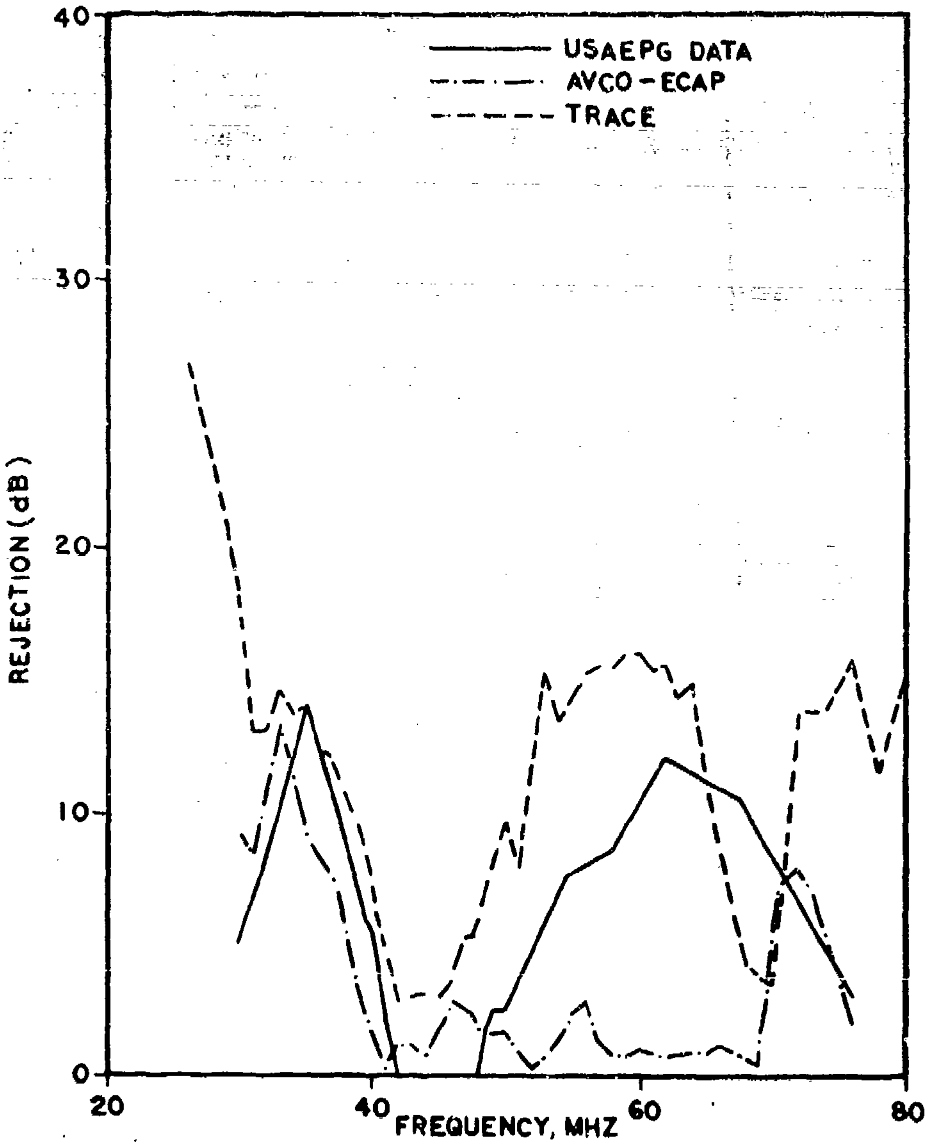

Figure IV-7. AT-912/VRC Band 4 Rejection

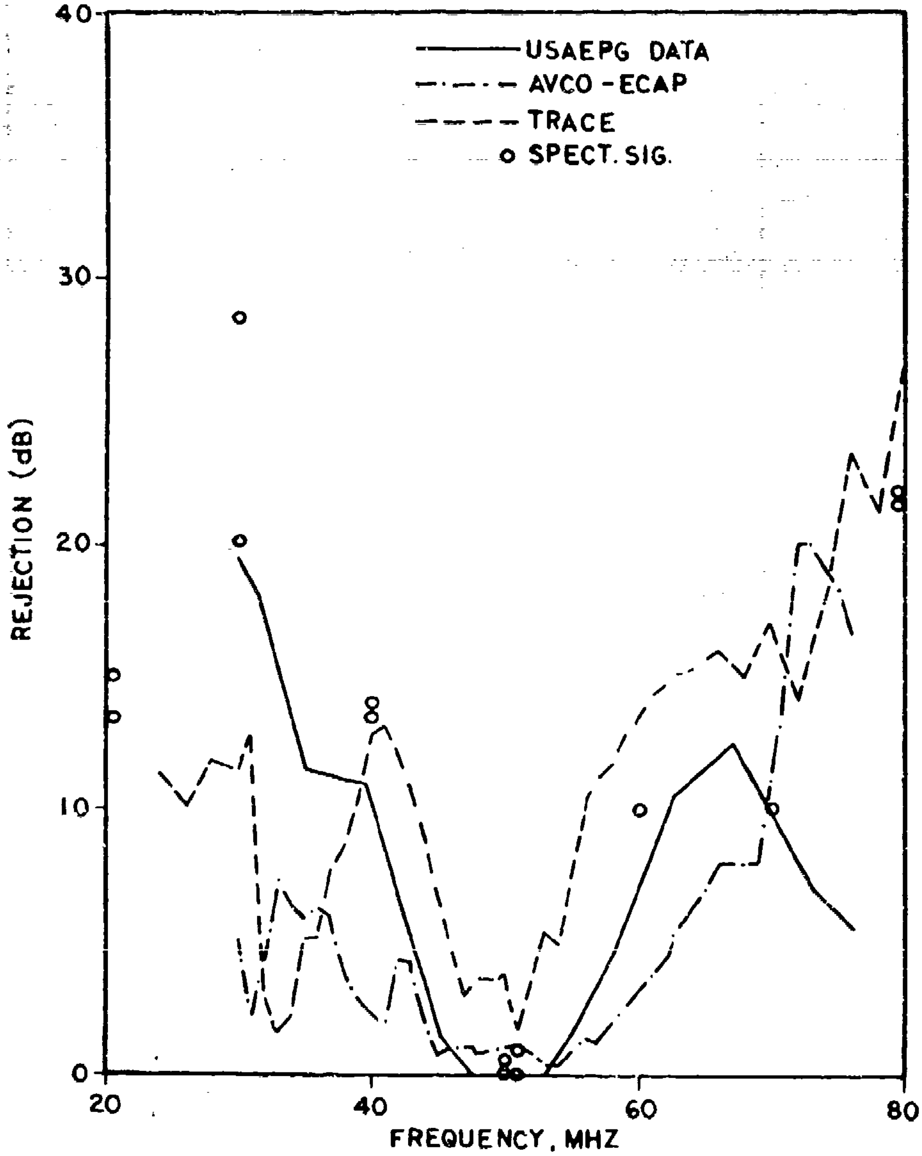

Figure IV-8. AT-912/VRC Band 5 Rejection

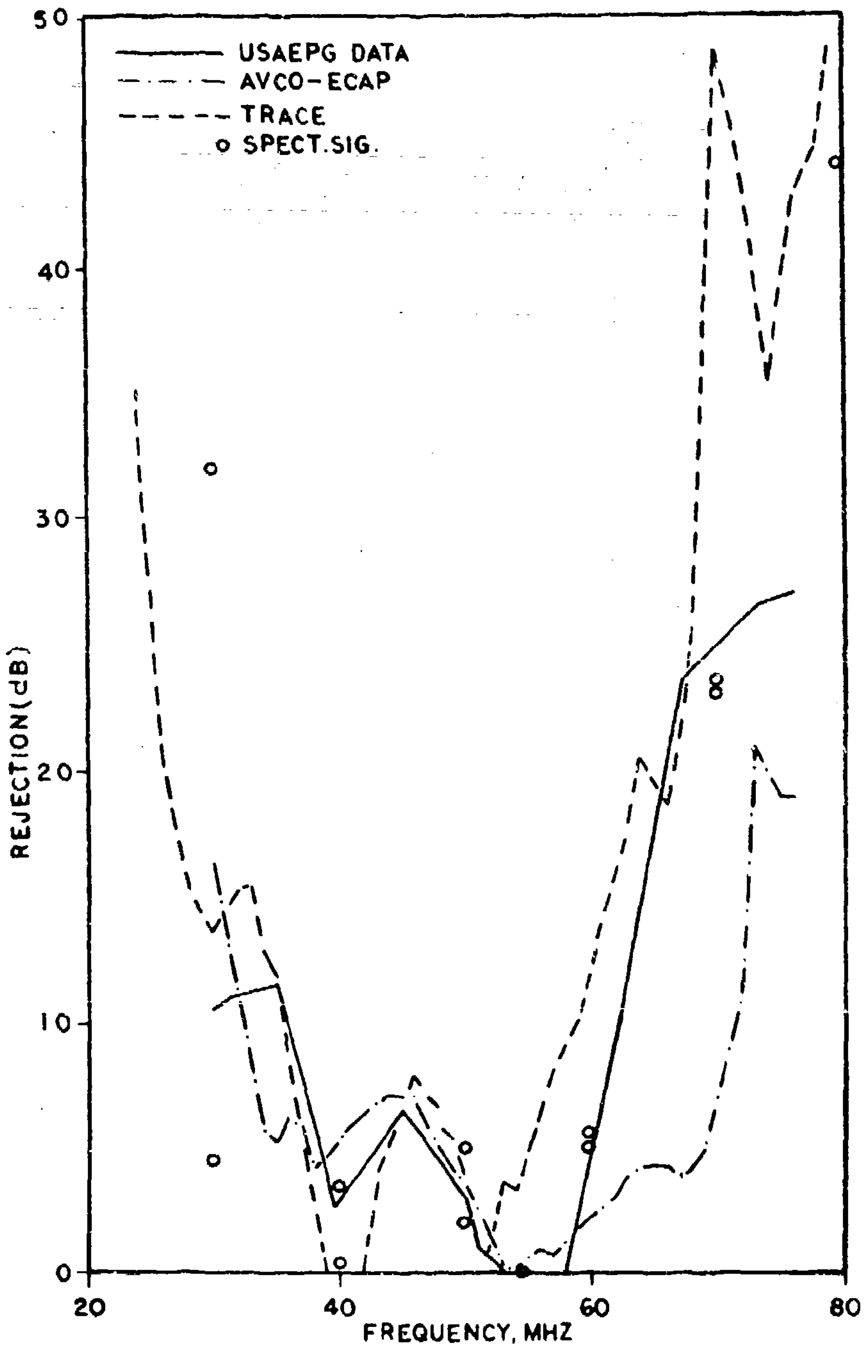

Figure IV-9. AT-912/VRC Band 6 Rejection

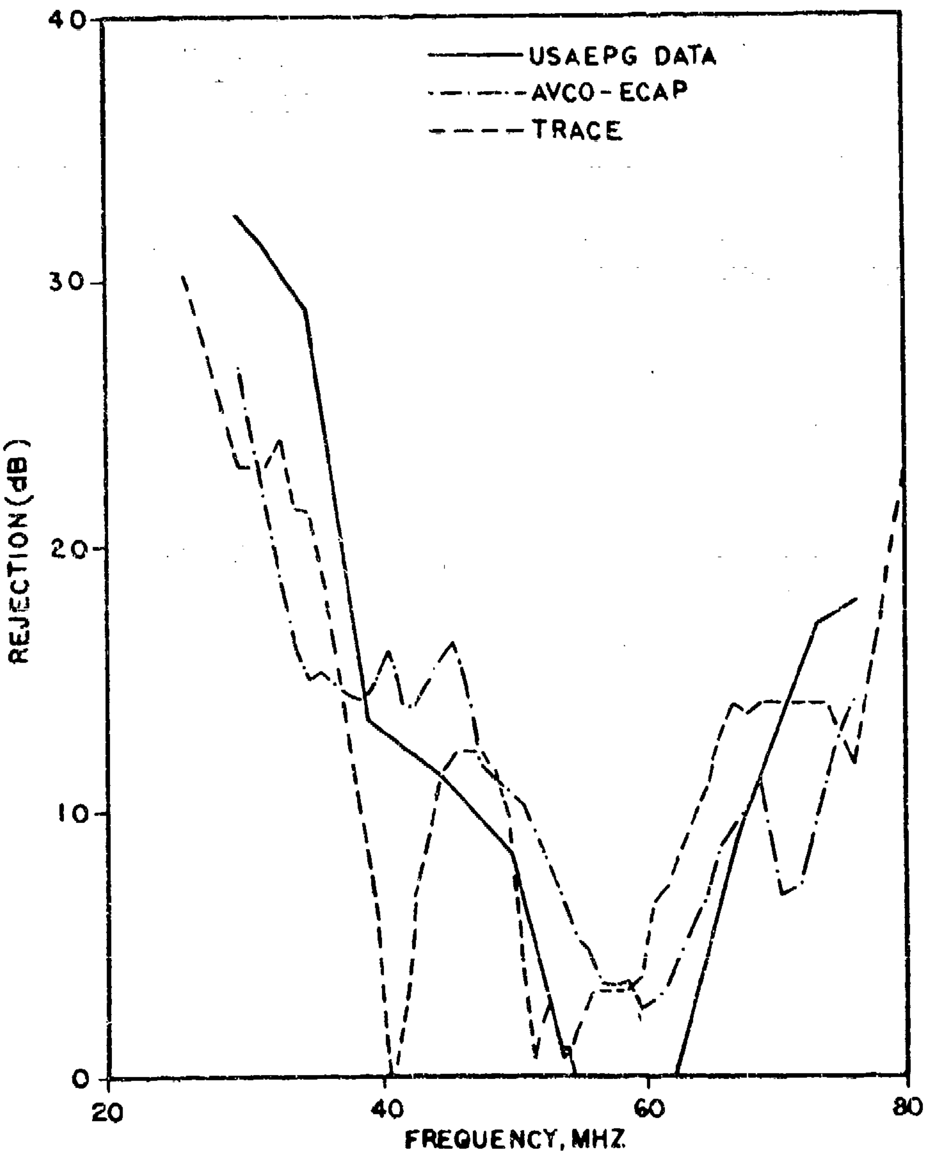

Figure IV-10. AT-912/VRC Band 7 Rejection

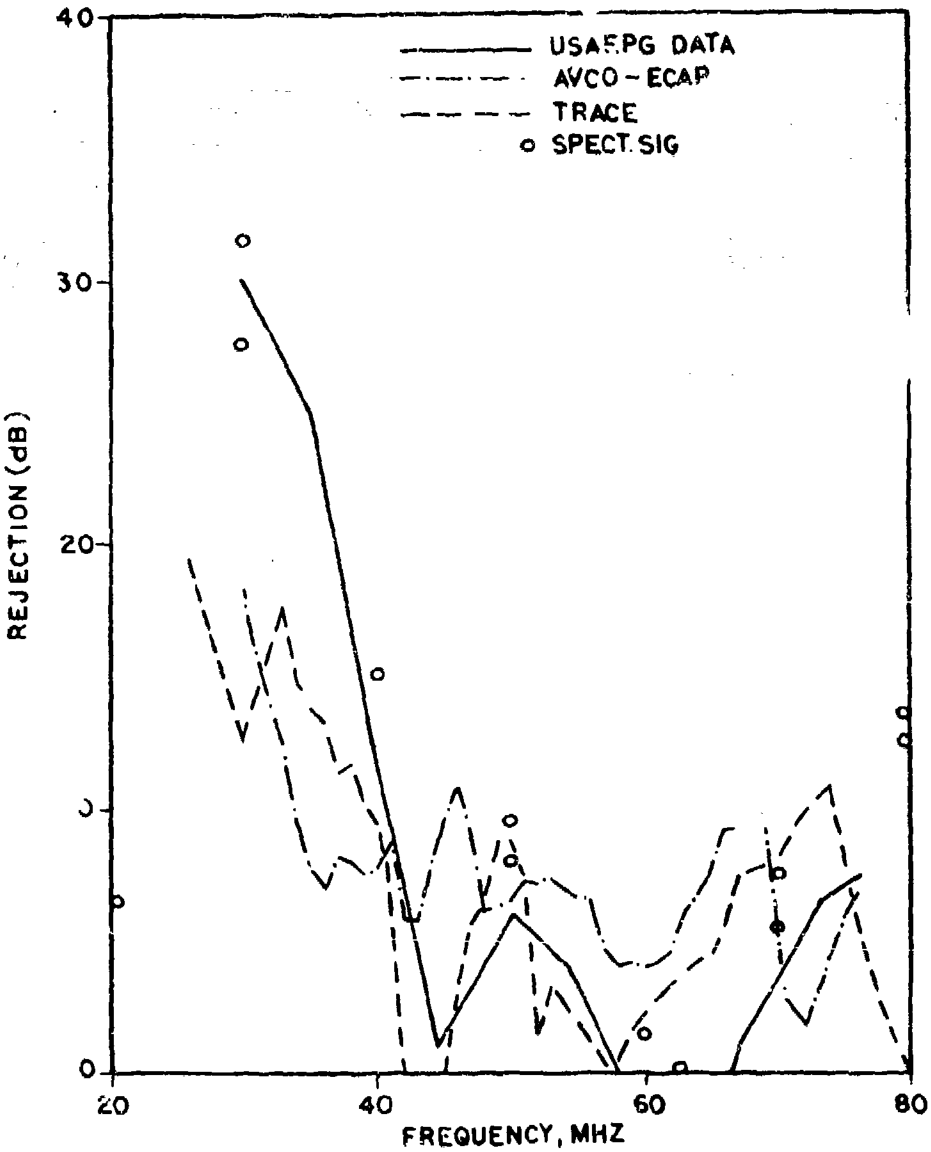

Figure IV-11. AT-912/VRC Band 8 Rejection

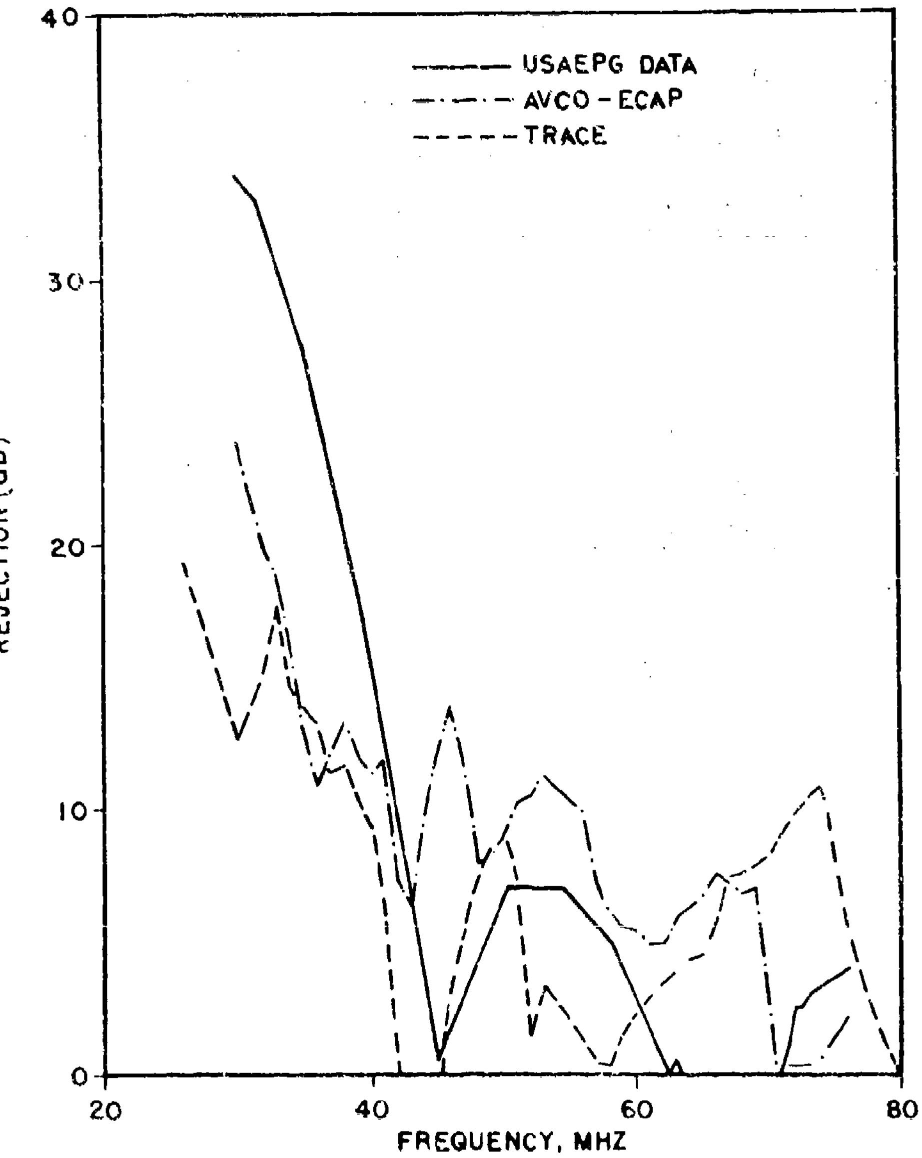

Figure IV-12. AT-912/VRC Band 9 Rejection

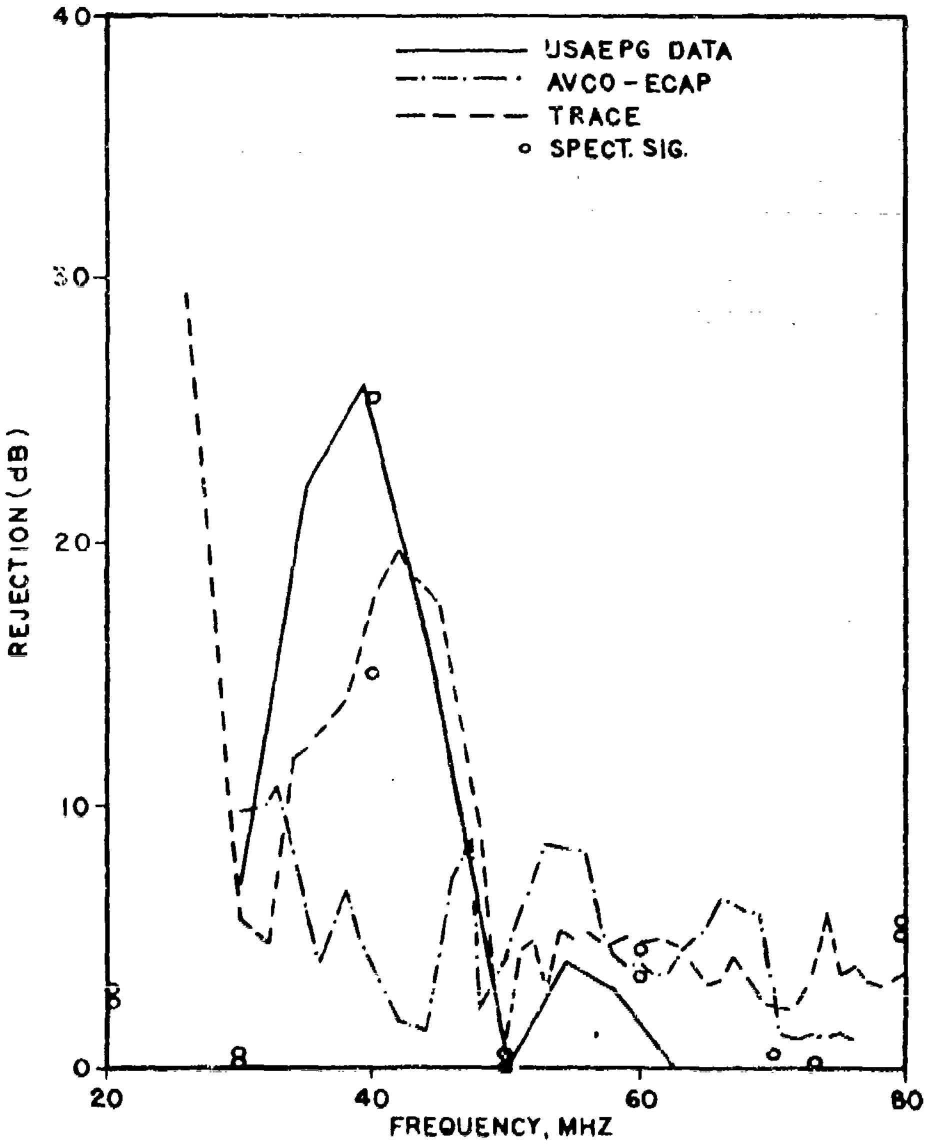

Figure IV-13. AT-912/VRC Band 10 Rejection

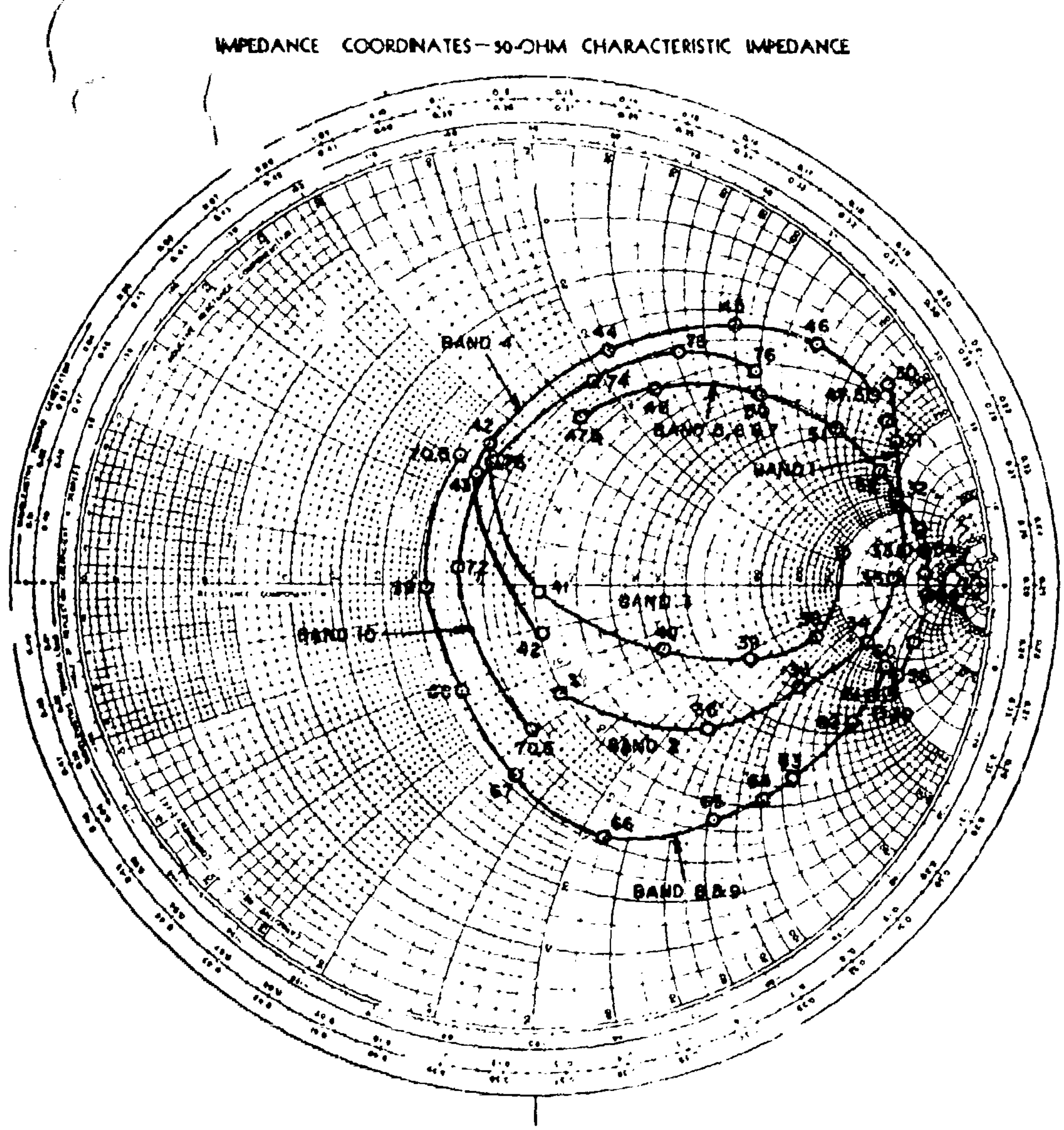

Figure IV-14. Measured Impedance of AT-912/VRC Center-Fed Antenna

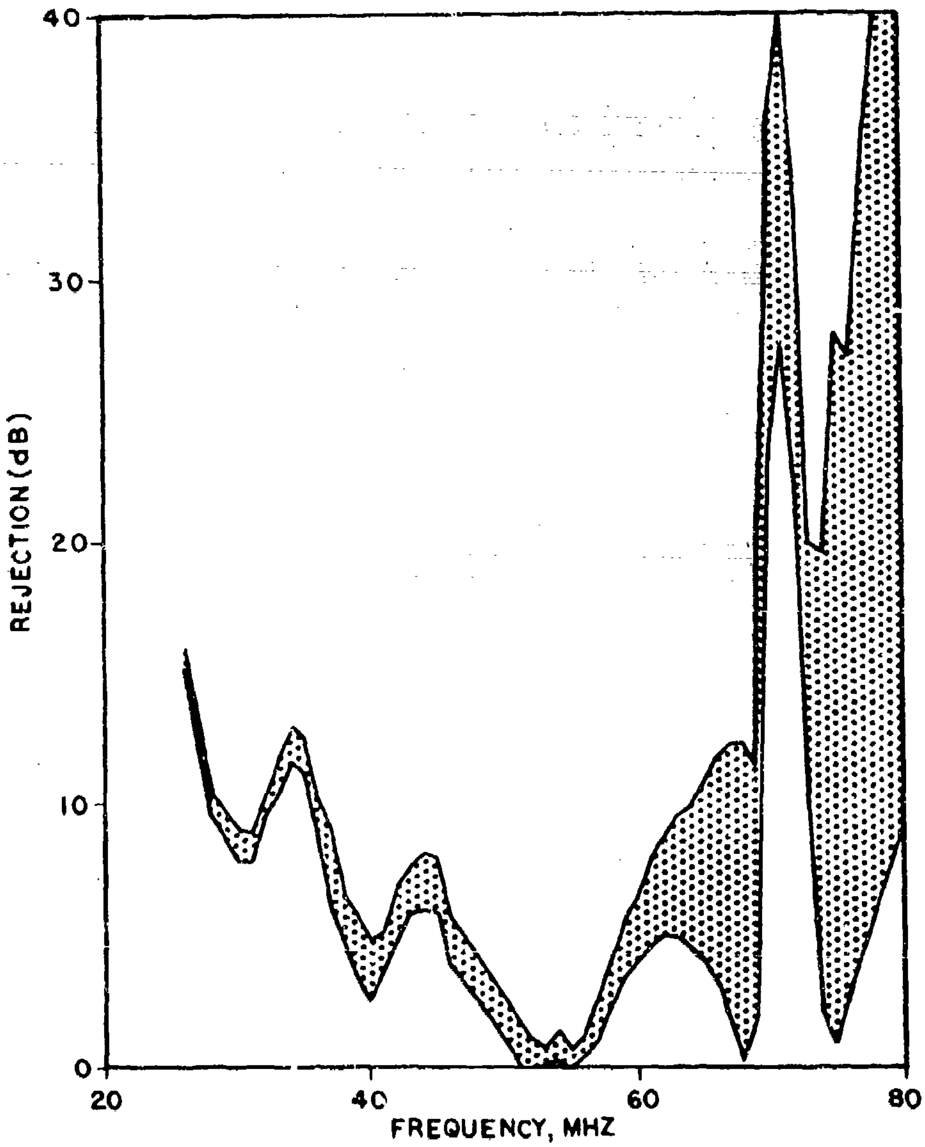

Figure IV-15. Band 6 Rejection - Sensitivity to C613 and C614 Settings

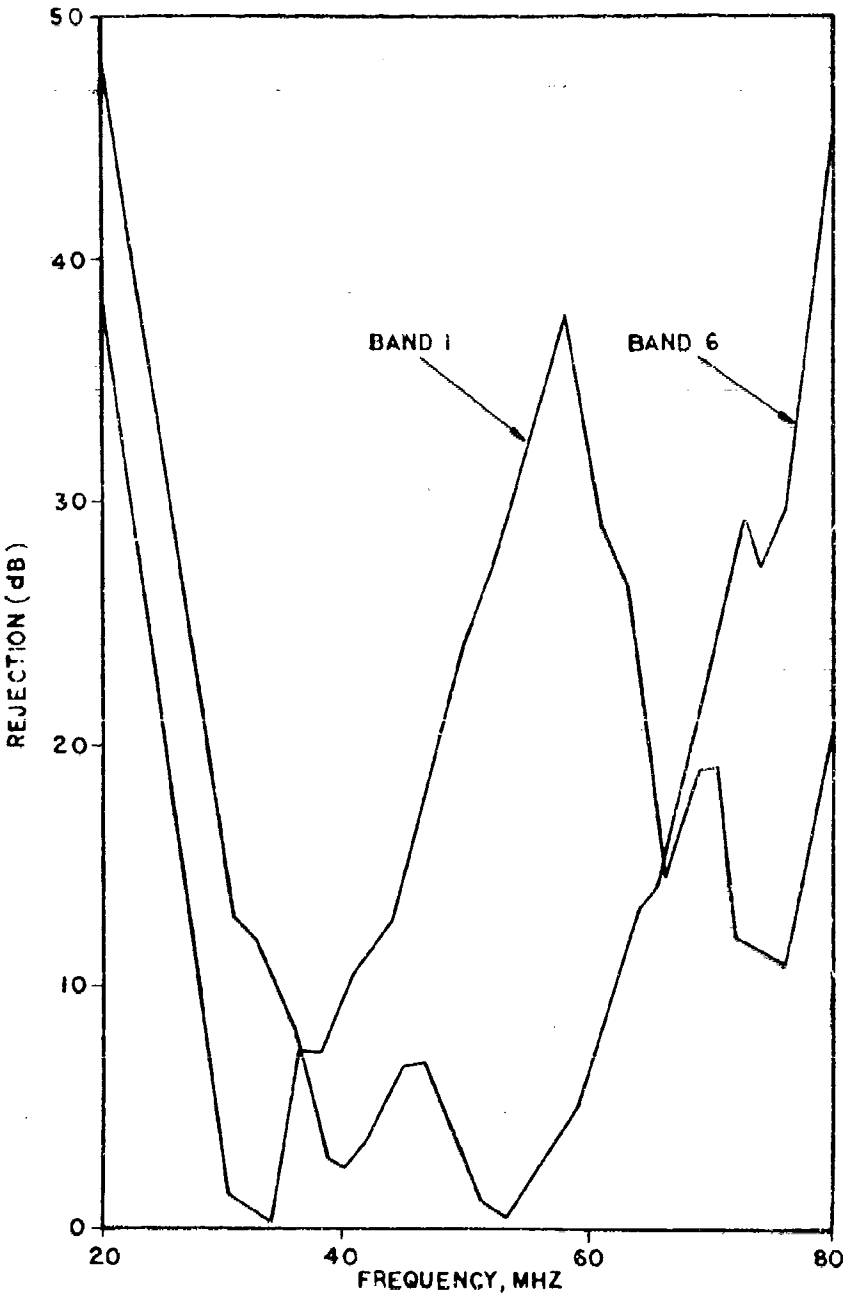

Figure IV-16. Recommended AT-912/VRC Band 1 & 6 Rejection Model

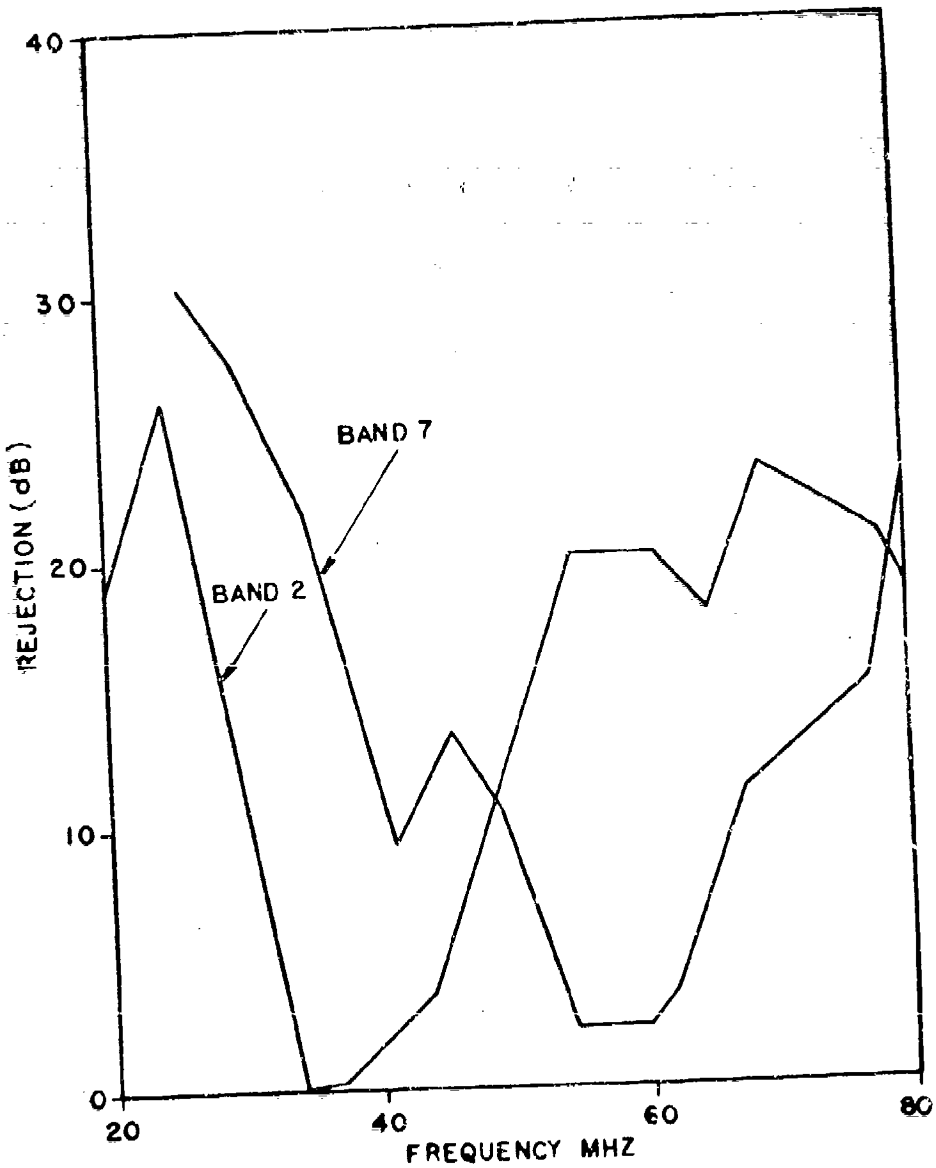

Figure IV-17. Recommended AT-912/VRC Band 2 & 7 Rejection Model

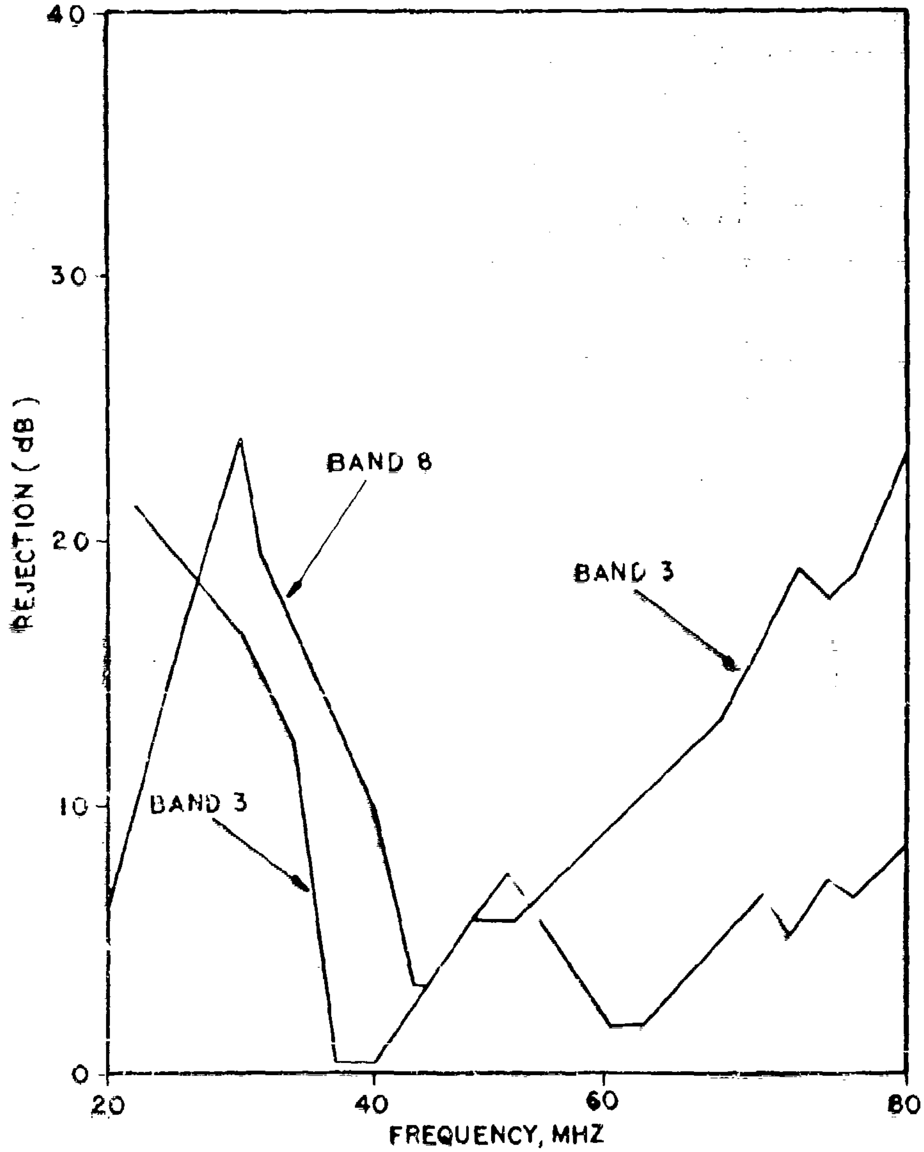

Figure IV-18. Recommended AT-912/VRC Band 3 & 8 Rejection Model

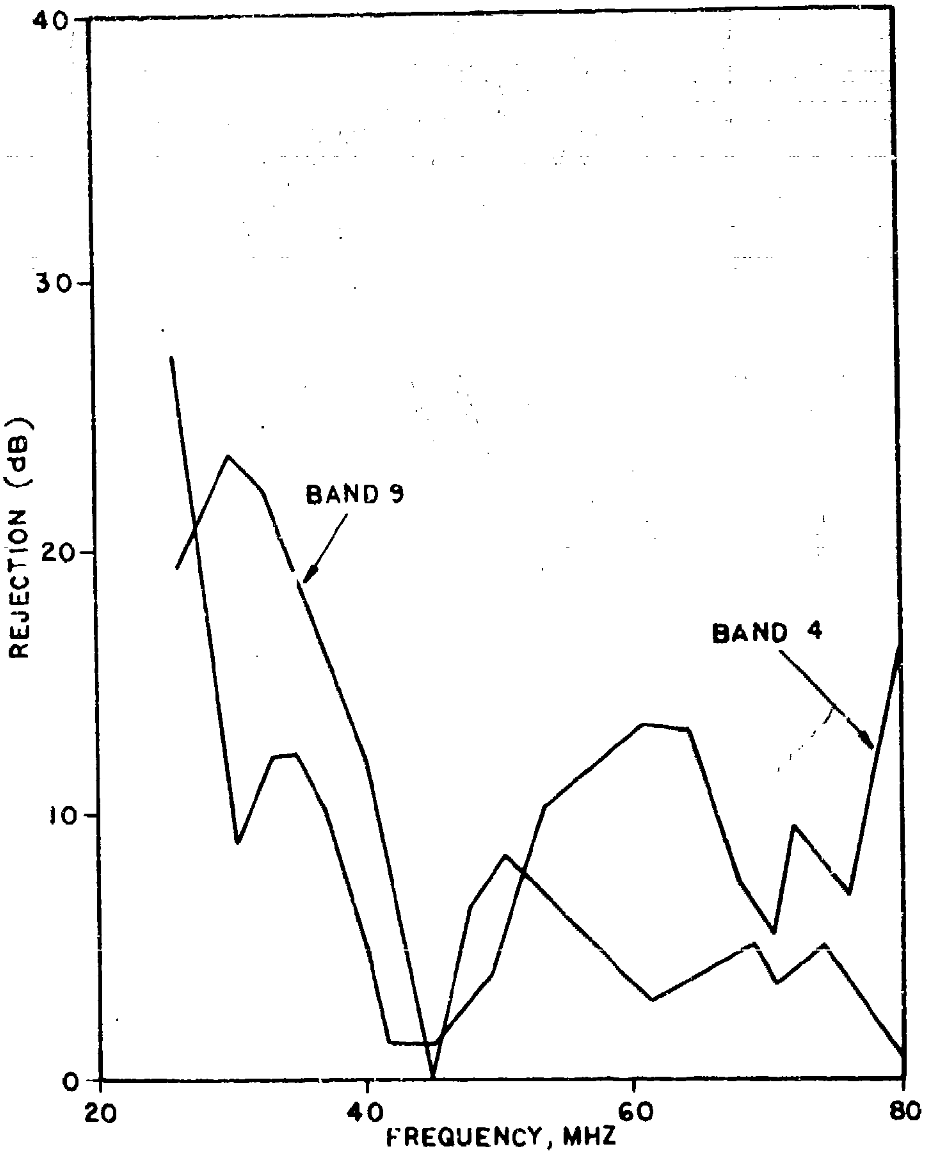

Figure IV-19. Recommended AT-912/VRC Band 4 & 9 Rejection Model

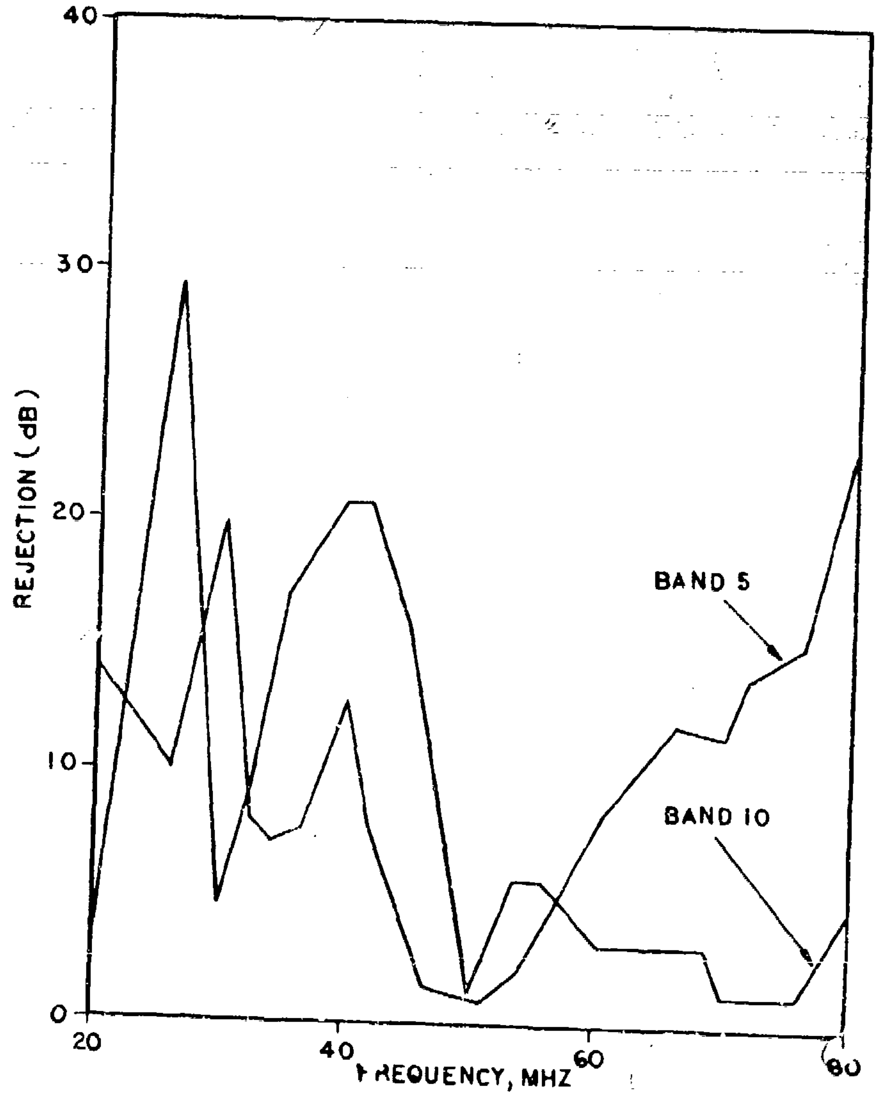

Figure IV-20. Recommended AT-912/VRC Band 5 & 10 Rejection Model

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13. ABSTRACT

Measurements were made of numerous interactions at a typical cosite installation; results were compared with predictions made by the Cosite Analysis Model (COSAM) developed by the DoD Electromagnetic Compatibility Analysis Center (ECAC). Tests involved six FM voice communications transceivers operating in the 30-76 MHz VHF range. Twenty-five frequency assignments were tested, with several desired signal levels. Types of interactions included adjacent signals, spurious responses, spurious emissions, receiver and transmitter intermodulation (2 and 3-signal mixes; 2nd, 3rd, 5th and 7th orders).

Results show that model accuracy is adequate for predicting the operational performance of collocated VHF-FM tactical communication equipment. Confidence levels are presented.

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ELECTROMAGNETIC COMPATIBILITY ANALYSIS CENTER
North Severn, Annapolis, Maryland 21402

4 October 1973

REPLY TO ATTN OF: ACG

SUBJECT: Changes to ESD-TR-73-016.

TO: Distribution List (Attachment 1)

1. Reference ESD-TR-73-016, Validation of the Cosite Analysis Model (COSAM) for Selected VHF FM Equipments, ECAC, Annapolis, MD, July 1973.

2. Holders of the referenced document are requested to replace pages 1-1, 1-2, 2-1, 2-2, 2-3/2-4, 3-3, 3-4, 3-5, 3-6, 3-9 and 3-10 with the attached corrected pages of the same numbers.

3. The major findings of the report are unaffected by these changes.

GUSTAV J. AKERLAND
Colonel, USAF
Director

2 Atch.
1. Distribution List
2. Replacement pages (6 sheets)

SECTION 1

INTRODUCTION

BACKGROUND

Reference 1 describes a cosite analysis model (COSAM) designed to statistically evaluate interactions between communications equipment. The first phase of model development dealt primarily with conventional UHF-AM transmitter/receiver systems which employ single channel voice modulation. Validation of this portion of the model is documented in References 2 and 3.

The second development phase dealt with single channel and multiplexed FM transmitter/receiver systems at VHF. Transmitter and receiver equipment models were derived from spectrum signature measured data. A coupling model was developed from measured VHF coupling data (Reference 6).

Although the model components were based, primarily, on equipment and coupling measured data, a full scale validation program, conducted in several phases was desirable to determine how well the overall COSAM system could predict cosite situations.

Consequently, a measurement program involving VHF equipments was conducted by the U.S. Army Electronic Proving Grounds (USAEPG), Fort Huachuca, Arizona (Reference 4). Supplemental tests were conducted at the Naval Electronic Systems Test and Evaluation Facility (Reference 5). This report compares the measurements obtained during this program with predictions made using COSAM.

The original intent of the effort was to validate the COSAM program for simulated operational configurations of equipments for which no spectrum signature data were available. If this were possible, the desired independence of model development from measured equipment data could have been determined. All tactical VHF equipments fall into one of three or four basic designs. Equipments of each design have been measured in the spectrum signature program. Attempts to obtain equipments of different design, such as commercial land mobile VHF-FM equipments, for this validation program were not successful. Consequently, the effort was necessarily limited to validation of the prediction program relative to equipments with the same nomenclatures as those for which measured data, of the spectrum signature type, were previously available. Three-signal intermodulation measured data were not available from the spectrum signature program, so that, for this type of interaction, results obtained represent a test of capability to estimate performance with no measurements.

Most available measured data are, at best, small samples of equipment performance. In general, spectrum signatures involve limited ranges of frequency separation and input power levels for adjacent signal, transmitter and receiver intermodulation, and spurious response and spurious emission tests. They also involve limited samples of equipments of the same nomenclature. The data do not necessarily represent the behavior of all the receivers and transmitters at all frequencies in the tuning range.

OBJECTIVE

The objective of this study was to compare measured data with predictions made by the ECAC COSAM VHF-FM prediction program for the purpose of validating the predictive technique, and to provide quantitative descriptions of confidence in the model and its various components. The objective was necessarily limited to a consideration of equipment for which measured spectrum signature data was available.

APPROACH

The major findings of the measurement program were described and compared with COSAM predictions. Several measures were used to indicate how well the analysis results compared with the measurements.

Measured coupling data were compared with results of the COSAM coupling model. The average difference between the measured and predicted mean values was noted; the standard deviation of the differences was calculated.

The overall model bias and the associated standard deviation were also provided. Model bias is defined as the average value of the differences between the measured SINAD output values and the associated predicted mean values. (The term SINAD represents the signal-plus-interference-plus-noise to interference-plus-noise ratio, or (S+I+N)/(I+N), where S refers to the desired signal power, I is the effective sum of all interference and distortion effects and N refers to noise.) The summation is made in watts, the ratio is in dB.

It was determined that every interaction could be identified [illegible], primarily, to a specific mechanism, that is, adjacent [illegible] effects, two- or three-signal intermodulation (2nd, [illegible]), receiver spurious responses or transmitter [illegible]. Bias and associated standard deviation values

SECTION 2

RESULTS

The VHF-FM COSAM system predicts operational degradation accurately in spite of the large number and the magnitude of the uncertainties involved. The major results, in terms of agreement between measurements and predictions, were as follows:

1. A comparison of 460 measured coupling values and associated predicted mean values resulted in an average difference of 1.4 dB, with a standard deviation of 8.1 dB.
2. The system model bias for 561 SINAD distribution predictions was -1.72 dB, implying a small tendency toward prediction of too little interference. The standard deviation was 5.6 dB.
3. An evaluation of the interactions identified as being due to each of the specified mechanisms indicated that, for 86% of the cases, the bias value magnitudes for each mechanism were less than 2.4 dB and that standard deviation values were less than 6.3 dB. The bias value magnitudes were less than 6.2 dB for 94% of the cases.
4. As shown in Figure 2-1, 90% of all of the cases resulted in differences between measured SINAD values (S_m) and associated predicted mean values ($\overline{S}_p$) of less than 10 dB.
5. Results of the bin method, depicted in Figure 2-2, indicate that, if SPS is a predicted value, there is 90% confidence that SPS_m will lie within the interval SPS ± 0.225, where SPS_m is the measured value of SPS.
6. Results of the Interference Condition method, using a 5-condition scale, indicated that COSAM results were within one condition for 76% of the cases and within two conditions for 92% of the cases.
7. Using the results of the coarser Interference Condition method, the probability of a COSAM prediction resulting in a gross error is less than 0.08. (A gross error is defined as a situation where a prediction will indicate acceptable or better performance when a measurement indicates intolerable degradation, or the converse situation.)

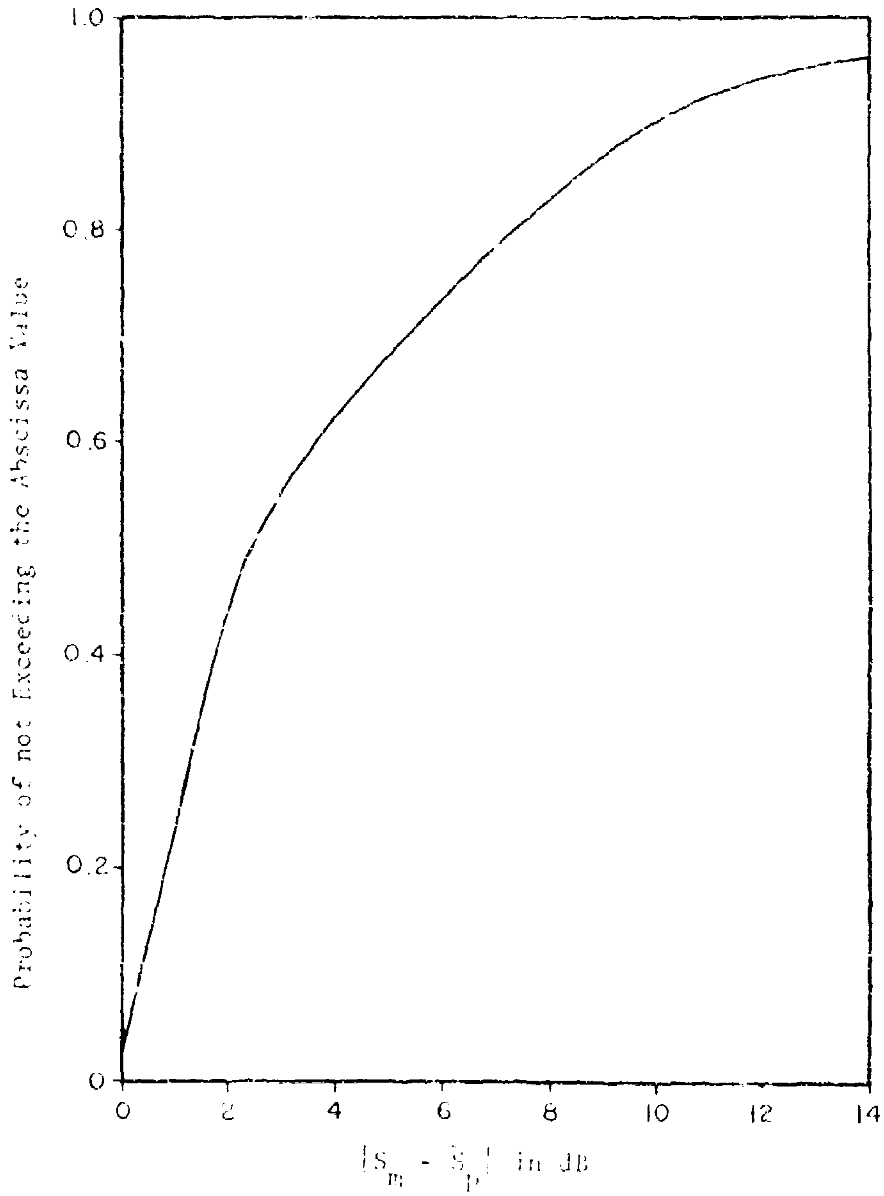

Figure 2-1. Cumulative Probability Distribution of $|S_m - \bar{S}_p|$

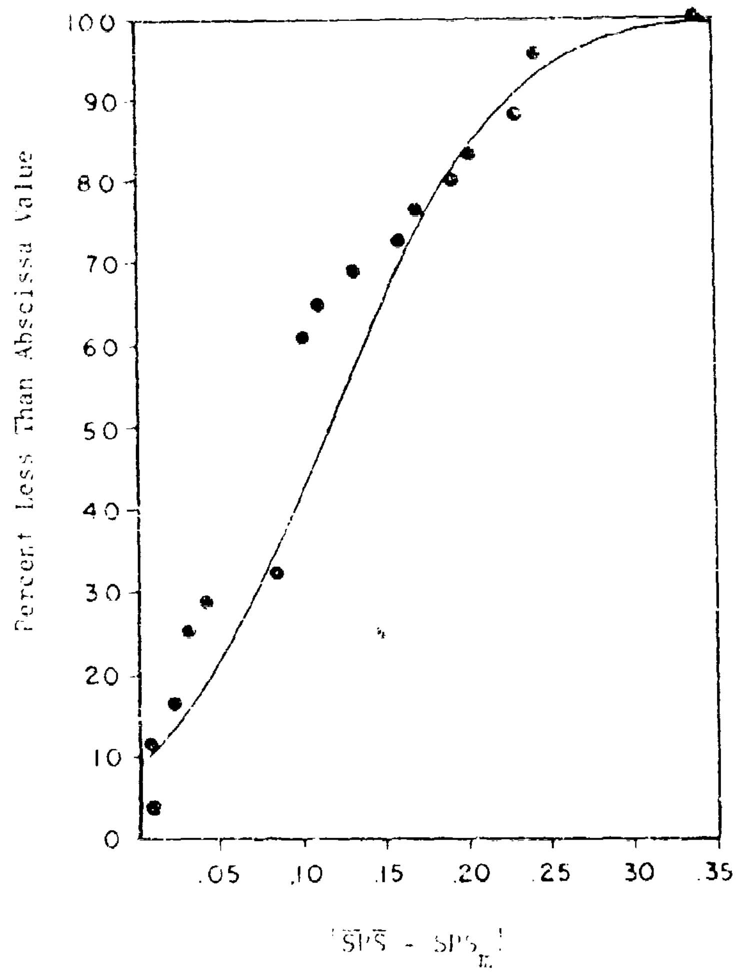

Figure 2-2. Cumulative Probability Distribution of $|\overline{SPS} - SPS_m|$

The interaction identifications provided in TABLE II-1 refer only to the major mechanisms predicted by COSAM. In many cases, SPS values are influenced by more than one mechanism and more than one transmitter. Consequently, even though, for example, an adjacent signal or a spurious response is identified, the score may reflect the effects of other transmitters and other mechanisms.

MODEL VALIDATION

Evaluation of Coupling Predictions

As noted in APPENDIX I, 460 coupling measurements were made among the 6 antennas. Four of the antennas were connected to MX-2799 antenna couplers, which provide 10 tuning positions. Four tuned frequencies were used in conjunction with four tuning positions of the couplers. The bias was approximately 1.4 dB; i.e., measured values, on the average, exceeded predicted values by this amount. The standard deviation was approximately 8.1 dB.*

Note that the coupling values for a large majority of the measurements included the attenuating effects of the couplers. The coupler selectivity model was based on a single set of measurements made at Fort Huachuca several years ago (Reference 7). The instruction manual for the coupler (Reference 12) indicates that the device is matched to the antenna and the transceiver by ensuring that an input VSWR of 3:1 is not exceeded. The matching procedure involves adjustment of one or two capacitors in each of the ten networks.

For a large majority of the coupling measurements, both couplers were in off-tune positions relative to the measurement frequency. APPENDIX IV indicates that the matching procedure can result in circuits which can have considerably different off-frequency rejection characteristics from one coupler to another. Transmission line length can also have a significant effect. Variations up to 12 dB are possible.

Evaluation of the coupling data suggests that prediction errors can be attributed to the combined effects of antenna-to-antenna coupling and antenna coupler selectivity. Eighty percent of the total sample involved errors less than 10 dB; approximately 94% of the sample involved errors less than 15 dB.

* The predicted mean values have not been tabulated with the measured values. If desired, one can perform this comparison, using [illegible] supplied in APPENDIX I, Equation III-7 in APPENDIX III, and [illegible] provided in APPENDIX IV, labelled USAEPG data. The mean [illegible] used in the equation were -1.6 dB for the whip and [illegible] for the [illegible].

Reference 6 indicates that a standard deviation (σ) of 6 or 7 dB can be expected for the antenna-to-antenna coupling model. The uncertainties involved in coupler tuning can be expected to increase this value to at least 8.1 dB, which was the computed standard deviation.

It is of interest that the path between antennas #1 and #4 consistently indicated errors involving too little loss as compared with predictions. The orientation of the antennas (including the effects of antenna #3 on the jeep; see Figure I-1) evidently resulted in increased gains over this path.

Conversely, combinations 1-2 and 3-4 (on the jeep) exhibited more loss than was predicted.

However, the uncertainties involved with coupler selectivity suggest that there is no justification for modifying the coupling model. A revised statistical coupler loss model which will provide slightly more accuracy, is presented (Figure IV-19 to IV-23), but it appears that no generalized model for the configuration in question could be devised which could reduce the overall σ to a value of less than 7 dB.

In general, the small bias value suggests that the models of path loss and coupler selectivity are predicting average values adequately. Some improvement in the coupler model (involving transmission line length and average values of the tuning capacitors) will be achieved by incorporating the revised statistical model. Construction of improved coupling models for specific configurations (i.e., different orientations relative to a jeep or some other obstacle) does not appear to be warranted.

Evaluation of dB Variations

As indicated, 561 SINAD output distributions were predicted and compared with the same number of measured SINAD output values. Each measurement is said to be a sample of each distribution.

We wish to determine how well the distributions represent the measured values. This is a rather unusual problem in statistical analysis. Instead of having one distribution to evaluate, we have a family of distributions. The methods applied in the following subsections were developed in Reference 2.

The model bias (B) is defined as follows:

$$B = \frac{1}{N} \sum_{i=1}^{N} \Delta i \qquad (3\text{-}1)$$

where:

Δi = the ith value of S_M minus the ith value of $\overline{S}_p$, in dB

S_M = the measured output SINAD value, in dB

$\overline{S}_p$ = the predicted output SINAD mean value, in dB

N = the number of samples

B, therefore, represents the mean deviation, or the average difference between the measured values and the associated predicted mean values, in dB. A positive value will indicate, on the average, that the model is predicting too much interference. A value close to zero would be desirable.

The second test performed was the computation of $\sigma(\Delta)$, defined as follows:

$$\sigma(\Delta) = \left[\sum_{i=1}^{N} (B - \Delta_i)^2 / N \right]^{1/2} \qquad (3\text{-}2)$$

$\sigma(\Delta)$ is defined as the standard deviation of the $S_M - \overline{S}_p$ distribution and provides a measure of the spread of the deviations from the mean. A plot of the cumulative distribution is given in Figure 2-1. Examination of the plot provides the percentage of the total which is less than any specified dB level.

The values of B and $\sigma(\Delta)$, for all of the measurements and the various interaction categories, provide partial validation measures. In a sense, they represent the confidence one can place in the model's ability to predict mean values.

A third test was employed to determine the characteristics of σ_p, the standard deviation of the predicted distribution relative to the absolute value of $S_M - \overline{S}_p$. A cumulative plot of the relationship is given in APPENDIX II, Figure II-2.

Evaluation of System Performance Scores (SPS)

COSAM's primary output is a numerical estimate of operational performance. That is, the SPS is the probability of exceeding a specific SINAD threshold value (10 dB, in this study), which is relatable to an Articulation Score (AS) or an Articulation Index (AI) value. In other words, the predicted probability distribution is merely a means to an end. If possible, one would prefer to have a straightforward mathematical measure of the quality of the SPS scores, as compared to the measured SINAD values.

As indicated, two approaches to this problem were adopted, namely, the Bin Method and the Interference Condition Method.

The *Bin Method*. All of the SPS values were placed in bins, or groupings. Several bin sizes were examined. Twenty (20) bins were adopted since this value provides an approximately equal number of scores in each bin, except for the first and last bins. A larger number of equal bin sizes provided essentially identical results. TABLE 3-1 indicates the number of cases in each bin, N, and average SPS value associated with each bin, $\overline{SPS}$, together with the percentage of total cases per bin.

Also provided is the number of cases for each bin for which the measured SINAD values exceed the threshold of 10 dB, N_T. Then, we noted the quotient of N_T/N, defined as SPS_m.

The first and last bin are considerably larger than the others. This was because a large number of predictions were either zero or 1.0, accounting for approximately 30% of the total.

The last column, $SPS_m - \overline{SPS}$ represents another possible measure. Over half of the differences are negative, indicating that the model predicted too little interference. The average value of the differences was approximately 0.1 suggesting that, on the average, predicted SPS values will be too high by this amount.

Figure 3-1 is a plot of $\overline{SPS}$ versus SPS_m. The diagonal line describes the results an ideal model would provide if it were given a large homogeneous population. That is, since the SPS represents the probability of exceeding 10 dB, then by definition [illegible] would equal N_T/N.

A measure of model error, in terms of SPS units, can be obtained by subtracting the values of SPS_m from the corresponding values of $\overline{SPS}$ on the idealized curve. At the lower values of $\overline{SPS}$, there was a tendency to predict too much interference, while at the mid and higher range values, the converse was true.

Figure 2-2, a cumulative probability distribution of errors (20 values), as defined, is constructed of data from the previous figure and TABLE 3-1. The ordinate probability values refer to the percentage of total cases (561) for which a specified error was noted. The smoothed curve provides an estimate of model error. As can be seen, for 90% of the cases, an error of less than 0.225 SPS units was noted. In practical terms, this indicates that the user can be confident that a prediction of SPS will be accurate within ±0.225 SPS units (for example 0.5 ± 0.225) with 90% confidence. If other confidence levels are required, they may be taken from Figure 2-2.

The smoothed curve in Figure 2-2 is the cumulative distribution function of a truncated normal distribution with a mean of 0.116 and a σ of 0.085.

Interference Condition Method. The Bin method provides an overall error measure. It was also deemed desirable to provide a more detailed measure which could be applied to each type of interaction as well as to the overall population. The Bin method can be meaningfully applied only if a relatively large number of samples is available.

The Interference Condition Method is based on the hypothesis that a comparison of each measured value with each associated predicted SPS value is valid if viewed in operational terms. For example, if the SPS is 0.9 and the measured SINAD is 20 dB, one would note that this is a good prediction. Similarly, if the SINAD were 0 dB for the same SPS, one would say that this is a poor prediction. This type of decision is not entirely subjective, although some judgment is involved in specifying limits between good and poor predictions. However, past experience in rating interference conditions provides some precedent for employing this type of measure of prediction accuracy.

In simple terms, it should be apparent to the COSAM user that an SPS greater than 0.8, for example, represents good performance. Similarly, scores less than 0.2 should represent intolerably poor performance, while the range between 0.4 and 0.6 represents marginal performance. Whether 0.5 should be considered poor or marginal [illegible] decision.

The measured SINAD values present a similar problem in interpretation. This subject was discussed extensively in Reference 2. It was determined that SINAD output values greater than 15 are good and values less than 4 are poor with a range of 4-15 being marginal. Other choices are possible.*

Labeling ranges of SPS and SINAD in such a manner will permit one to compare COSAM SPS outputs with measured values. We wish to know, primarily, the likelihood of COSAM predictions resulting in gross errors. (A gross error is defined as a prediction of good performance when a measurement indicates intolerable degradation, or the converse situation.)

The 5-condition scale of TABLE 3-2 will be used to relate SPS and SINAD to operational degradation.

TABLE 3-2

SPS/SINAD FIVE-CONDITION SCALE

Condition	SPS Range	SINAD Range (dB)	AS Range
A	0.81-1.00	> 18	> 0.85
B	0.61-0.80	> 12; ≤ 18	0.75-0.85
C	0.41-0.60	> 7; ≤ 12	0.65-0.75
D	0.21-0.40	> 4; ≤ 7	0.5-0.65
E	0.00-0.20	≤ 4	< 0.5

Since our data includes 561 pairs of SPS/SINAD values, we may simply note the percentage which have no errors, 1-condition errors, 2-condition errors, 3-condition errors, and the maximum error of 4 conditions.

The 5-condition scale is quite suitable for this exercise since it will account for minor score or measurement differences. A 1-condition error would, presumably, be acceptable. A 2-condition error might be undesirable but still acceptable. (This assumption is discussed in more detail below.) A 3-condition error would be poor and a 4-condition error would be clearly unacceptable. We define 3- and 4-condition errors as gross errors.

* For example, the CCIR (Vol. III, 1963) indicated that 6 dB was acceptable for operator-to-operator, 15 dB was marginal for voice use, and 33 dB was good for commercial use.