September 4, 1969

Dear Mr. Goldberg:

Thank you for your letter of August 27th regarding the interest of the CBS Television Network Affiliates Association in our review of domestic communications satellite policy.

I would be pleased to meet with Mr. Ebel on one of the dates you suggest. You or Mr. Ebel can call my secretary to set up a mutually convenient time.

Sincerely,

Clay T. Whitehead
Staff Assistant

Mr. Henry Goldberg
Covington & Burling
888 Sixteenth Street, N. W.
Washington, D. C. 20006

cc: Mr. Whitehead
Central Files

CTWhitehead:ed

tape

COVINGTON & BURLING
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Dr. Clay T. Whitehead
Staff Assistant
Room 110
Executive Office Building
Washington, D.C.

August 27, 1969

Dear Dr. Whitehead:

On August 5, 1969, I wrote to you of the interest that the CBS Television Network Affiliates Association had in the work of the White House group that is investigating future uses of domestic communications satellites.

As I stated in my letter, the CBS Television Affiliates Association would appreciate the opportunity of having one of their members meet with you to discuss certain of the issues involved in providing satellite interconnection service to television broadcast stations. I realize the time constraints that you and your group are working under, but I believe that a meeting in the near future would be fruitful. Mr. A. James Ebel, Chairman of the Satellite Communications Committee of the CBS Television Affiliates Association would be available to meet with you some time between September 17 and September 19. Please advise me as to whether a brief meeting with you could be arranged on one of these dates.

Sincerely yours,

Henry Goldberg

Henry Goldberg

Attorney for
CBS Television Network Affiliates Association

cc: Mr. A. James Ebel

maje

September 5, 1969

Dear Mr. Ross:

Thank you for your letter of September 4th informing me of your new firm and the qualifications of you and the other officers.

However, the nature of our review of communications satellite policy and the short time we have set make it infeasible to utilize outside assistance. I was pleased to learn about your firm and wish you the best success in your new endeavor.

Sincerely,

Clay T. Whitehead
Staff Assistant

Mr. Dan C. Ross
President
Ross Telecommunications Engineering Corporation
1750 Pennsylvania Avenue, N. W.
Washington, D. C. 20006

cc: Mr. Whitehead
Central Files

CTWhitehead:ed

tape

Ross Telecommunications Engineering Corporation

1750 PENNSYLVANIA AVENUE, N. W.
WASHINGTON, D. C. 20006

DAN C. ROSS
F. RICHARD ZITZMANN

TELEPHONE
202 298-7476
CABLE "ROSSTEC"

4 September 1969

Dr. Clay T. Whitehead
Executive Office of the President
17th and Pennsylvania Avenue, N.W.
Washington, D.C.

Dear Dr. Whitehead:

I have read about your current activities in the telecommunications policy area with considerable interest and wondered if I, or one of my colleagues, might possibly be of some assistance to you in the near future.

We opened this firm on 16 July 1969 and plan to work in the system design field, particularly in those applications involving both communications and computers. All of the principals of this firm have had extensive experience in the satellite communications field as you will see by reference to the enclosed resumes. Mr. Zitzmann joined our staff on 11 August, leaving his position of Director of Systems Analysis at COMSAT. Mr. Sampson is joining us on 8 September 1969; he and I were responsible for most of the work on the "Electromagnetic Interference Study of the BNS System" in connection with the Ford Foundation falling in FCC Docket 16495. While I was still with IBM, I headed a Corporate Task Force which investigated, inter alia, the use of satellite communications as the backbone of the internal communications network of the Corporation.

We feel that our background of experience puts us in a good position to be of service to you and your staff in your current study of domestic satellite communications and other key problems of telecommunications policy. I would be very pleased to meet with you or your staff at your earliest convenience to discuss any of these problem areas which may be of mutual interest, or to explore further any possible service that we might provide.

Sincerely yours,

Dan C. Ross

Dan C. Ross
President

Enclosures:

"Electromagnetic Interference Study of the BNS System"

Resumes of: Dan C. Ross
F. Richard Zitzmann
Charles E. Sampson

DCR:se

ELECTROMAGNETIC INTERFERENCE

STUDY OF THE BNS SYSTEM

This study of potential interference between a domestic satellite system and the terrestrial microwave services was performed in connection with FCC Docket 16495 by the Communications Systems Department of the IBM Center for Exploratory Studies. This work was supervised by Dr. Dan C. Ross who managed the department at that time. Mr. Charles E. Sampson was the principal investigator on this study. Both Dr. Ross and Mr. Sampson are now officers of RossTEC.

Ross Telecommunications
Engineering Corporation

WASHINGTON, D. C. 20006

IBM

Electromagnetic Interference Study of the BNS System

Center for Exploratory Studies
Federal Systems Division
International Business Machines Corporation
Rockville, Maryland

PART 5

Electromagnetic Interference
Study of the BNS System

Prepared for the Ford Foundation

29 November 1966

Center for Exploratory Studies
Federal Systems Division
International Business Machines Corporation
Rockville, Maryland

NOTE

The Ford Foundation arranged to have this study reviewed by John P. Hagen, Professor of Astronomy, Pennsylvania State University. Professor Hagen has advised the Foundation that he concurs in both the methodology and conclusions of the study.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

1. Summary of Results

The purpose of this study is to answer as fully as possible the questions on electromagnetic interference posed by the FCC in the Notice of Inquiry of 2 March 1966, supplemented on 21 October 1966. These questions are interpreted here in terms of potential interference between the proposed BNS system and terrestrial microwave relay services or the global commercial communication satellite system. A general discussion of the various interference paths and present recommendations on allowable levels of interference is given in Section 2. In Section 3, the relevant parameters of the BNS system and of terrestrial microwave relays are stated, and selected interference phenomena are described and quantified. The problem comes down to that of finding feasible areas for siting the BNS earth stations, i.e., areas in which potential interference levels may be kept within tolerable limits. The procedure used and results obtained in an engineering study of potential interference in a major metropolitan area is presented in Section 4. This preliminary study is based on actual microwave relay facilities within 275 miles of New York City.

The conclusions reached in this study include:

- The BNS system is technically feasible under presently recommended limits on satellite power.
- It is technically feasible and economically desirable to moderate the restrictions on spectral density to provide for increasing signal strengths for higher elevation angles of arrival, as recommended by the recent CCIR meeting in Oslo.

- Assuming the existence of limits on spectral density, such as the present limits or modified limits as suggested above, restrictions on total power density are unnecessary.

- Compatible operation between BNS and the global commercial communication satellite system can be achieved by separating the satellites in longitude to enable the required amount of interference suppression by the earth station antennas.

- The most significant interference effect in the proposed BNS system under present restrictions is that produced by common-carrier transmitters at earth station receivers via scatter paths existing during a small fraction of the time. For example, rainstorms of 30 mm/hr will produce perceptible, but not objectionable, degradation of the BNS downlink signal. Rainstorms of such severity occur less than 0.02% of the time in a representative area such as New York City.

- As shown in Figure 1.1, a number of sites in and around New York City are feasible for BNS earth stations as far as interference considerations are concerned, including several sites within a radius of one microwave link from the center of Manhattan.

- Preliminary studies indicate that other areas, e.g., Denver and Atlanta, will present much greater freedom of site selection than New York.

- Gain of some BNS earth station antennas located in a few of the largest metropolitan areas must be less than -24 db in the direction of nearby common-carrier facilities, including the effect of site shielding by excavation or other means.

- Measurements are needed of: (1) common-carrier field strengths near potential BNS sites, (2) scattering cross-sections of large aircraft for all angles of scatter, and (3) psychophysical effects of common-carrier interference with the proposed BNS downlink signal.

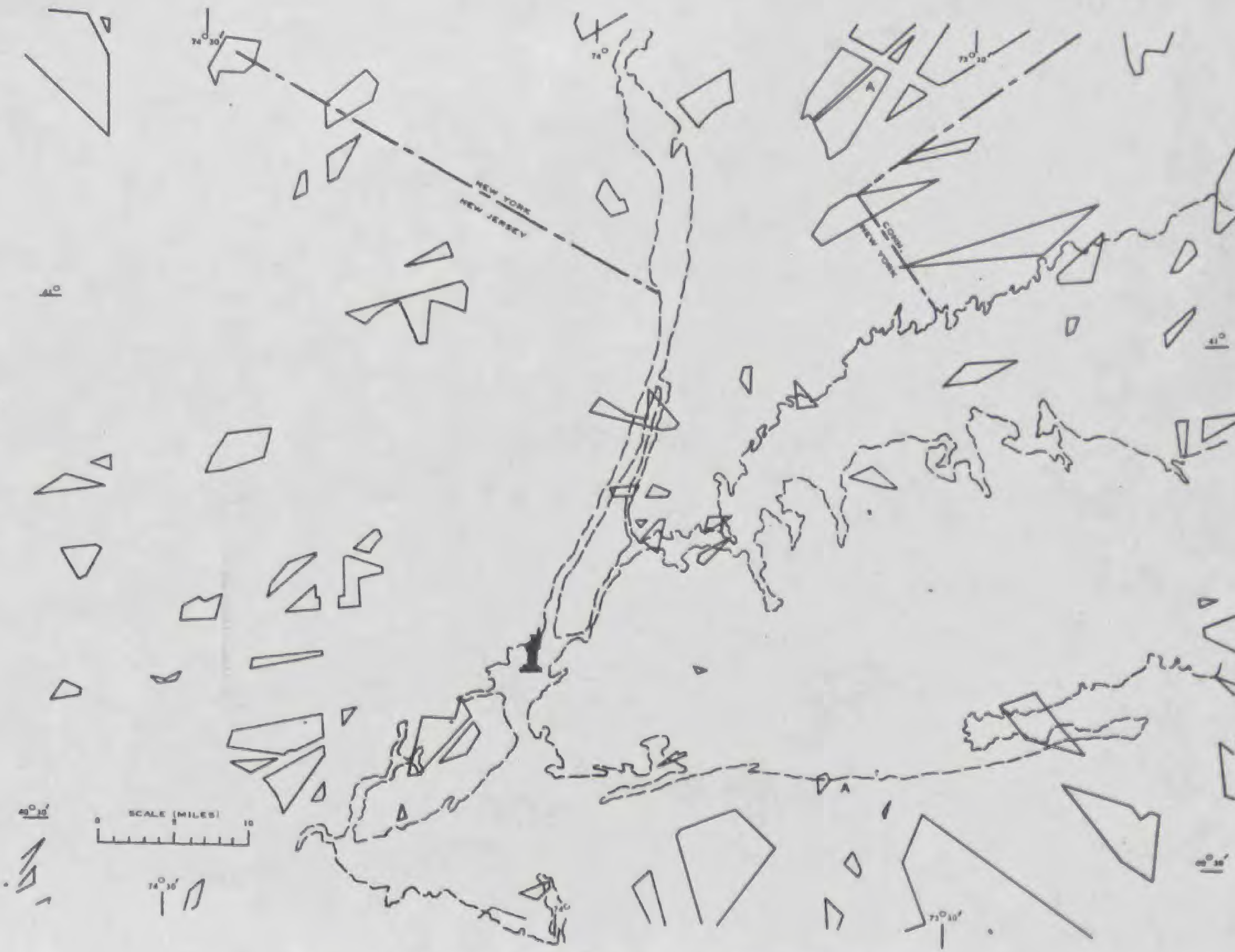


Figure 1.1 Areas for Consideration in Siting BNS Earth Stations

24

Dispersal 0 %

Shieldings – 24 %

2. General Discussion of the Interference Problem

The questions on electromagnetic interference posed by the FCC Notices of Inquiry are discussed in this section in general terms. The existence of a longitude "window" is shown in which BNS satellites may be placed with minimal effect on common-carrier microwave systems.

2.1. FCC Notices of Inquiry

The specific questions in the FCC Notice of Inquiry of 2 March 1966 which are here addressed are the following:

> "4(d) Is it technically feasible to accommodate the space service contemplated, in light of the requirement:
>
> (1) That the power flux density produced at the earth's surface in the band 3700-4200 Mc/s by emissions from a space station employing wide-deviation frequency (or phase) modulation, not exceed -149 dbW/m^2 in any 4 Kc/s band for all angles of arrival, nor a total of -130 dbW/m^2 for all angles of arrival;
>
> (2) That the power flux density produced at the earth's surface in the band 3700-4200 Mc/s by emissions from a space station employing other than wide-deviation frequency (or phase) modulation, not exceed -152 dbW/m^2 in any 4 Kc/s band for all angles of arrival;
>
> (3) That earth stations receiving signals from space stations in the band 3700-4200 Mc/s be so located with respect to the existing common-carrier microwave complex in that band that they are not subjected to harmful interference from such terrestrial microwave systems;

(4) That transmitting earth stations in the band 5925-6425 Mc/s:

(a) Not exceed a mean effective radiated power of 45 dbW in any 4 Kc/s band in the horizontal plane; and

(b) Not cause harmful interference to the existing common carrier microwave complex in the same band."

As seen in Figure 2.1, questions 4d(1) and 4d(2) relate to the interference from the down-link feeding into the terrestrial microwave networks; question 4d(3), interference from the microwave network into the broadcast stations; question 4d(4), interference from the up-link into the microwave network. Since the representative BNS systems discussed earlier are based on wide-deviation frequency modulation, question 4d(2) is not applicable.

The specific questions addressed here that were stated by the FCC in the Supplemental Notice of Inquiry dated 21 October 1966 are as follows.

> "4. For the most part, comments filed thus far have not been fully responsive to the technical questions raised in the first Notice of Inquiry as to the adequacy of existing allocations to the communication satellite service or as to the electromagnetic interference to and from both present and projected operations of the global commercial communication satellite system and the domestic fixed public services sharing the same frequency bands. The latter question is complicated further by the fact that the plenary assembly of the CCIR (Oslo, June 1966), has recommended changes in the technical criteria applicable to the power flux density delivered at the earth's surface from space stations. Therefore, pending resolution of the legal status of the Oslo criteria vis-a-vis those criteria now in the international Radio Regulations, interested parties, in responding to the questions raised in our prior notice and

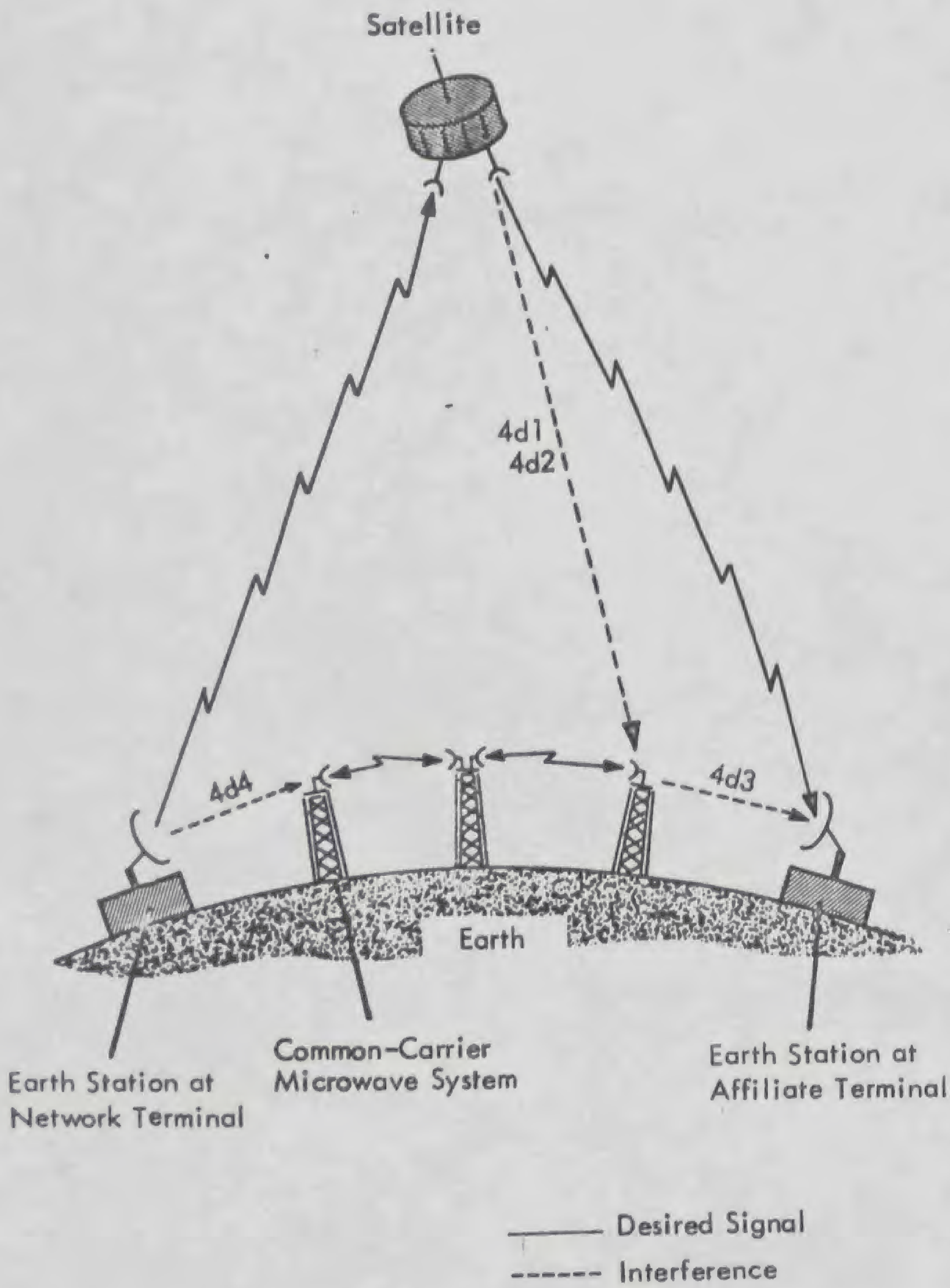


Figure 2.1 Types of Possible Radio Interference

herein (which include the technical questions explicitly set out in our prior notice), should direct their responses to both the present and Oslo criteria. Additionally, to permit an evaluation of the impact from proposed systems, parties should indicate as fully as they now can the planned positioning of space stations on the equator for the system under consideration if equatorial stationary satellites are involved."

2.2 Restrictions on Satellite ERP

Distribution of TV programs via satellite is classified under the communications-satellite service which shares most of its allocated spectrum with various terrestrial services (ITU 1963). The most important bands involved in such shared allocations at the present time relate to common-carrier microwave relays, as shown in Figure 2.2. Sharing of common bands requires that each service follow some form of restriction on effective radiated power (ERP).

The restrictions on total flux density and on spectral density given in the FCC Notice of Inquiry were recommended by the Comité Consultatif International Radio (CCIR). Figure 2.3 illustrates the limitation imposed by these flux density restrictions on the ERP from a synchronous satellite. The -130 dbw/m^2 total flux restriction limits satellite ERP to 31 dbw, while the spectral density restriction for FM of -149 dbw/m^2 per 4 Kc/s band limits satellite ERP to the range 39-48 dbw, depending upon the bandwidth of the RF signal. The curves for satellite ERP vs. flux in a 4 Kc/s channel are based on the following assumptions:

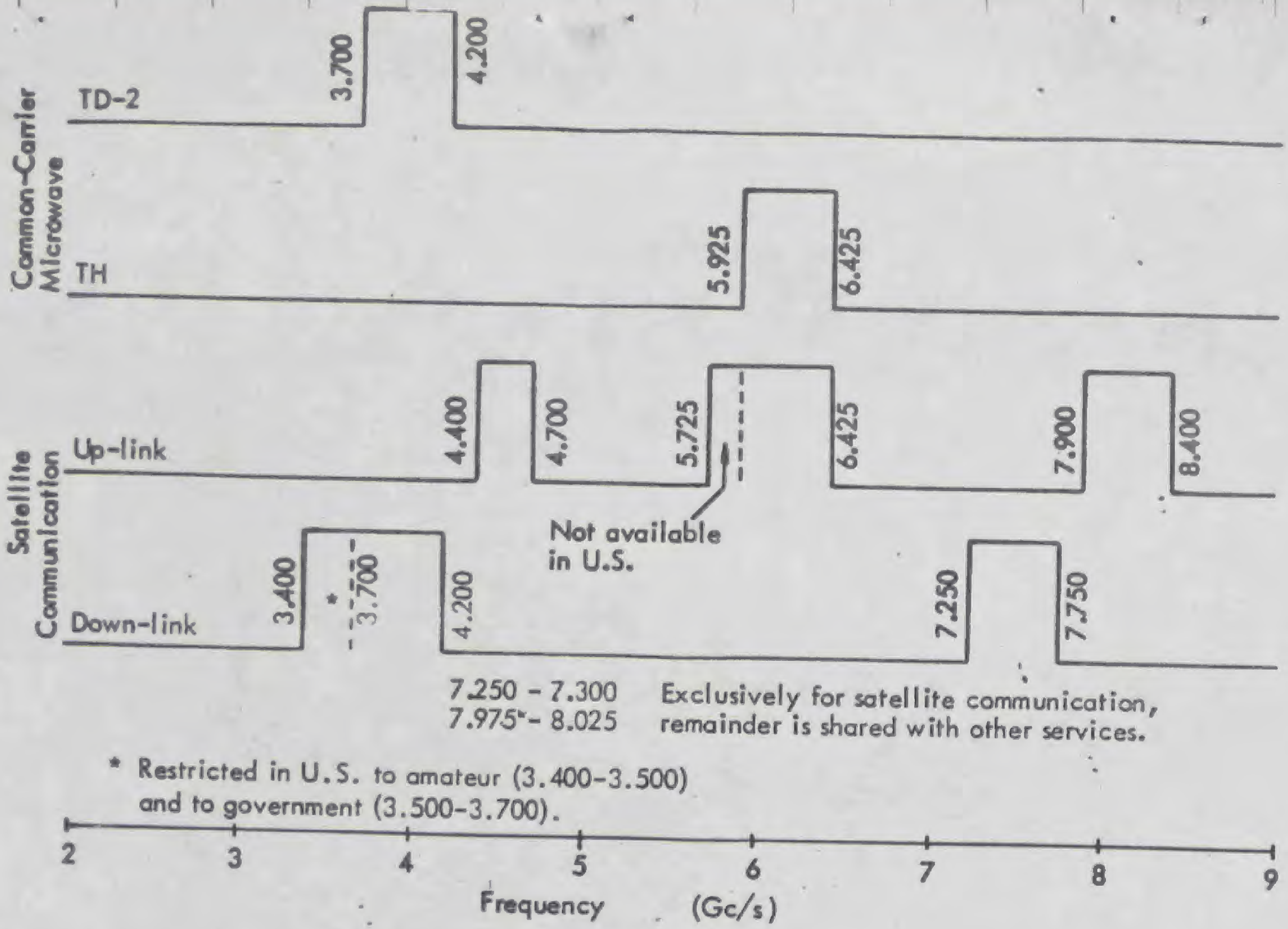


Figure 2.2 Frequency Allocations

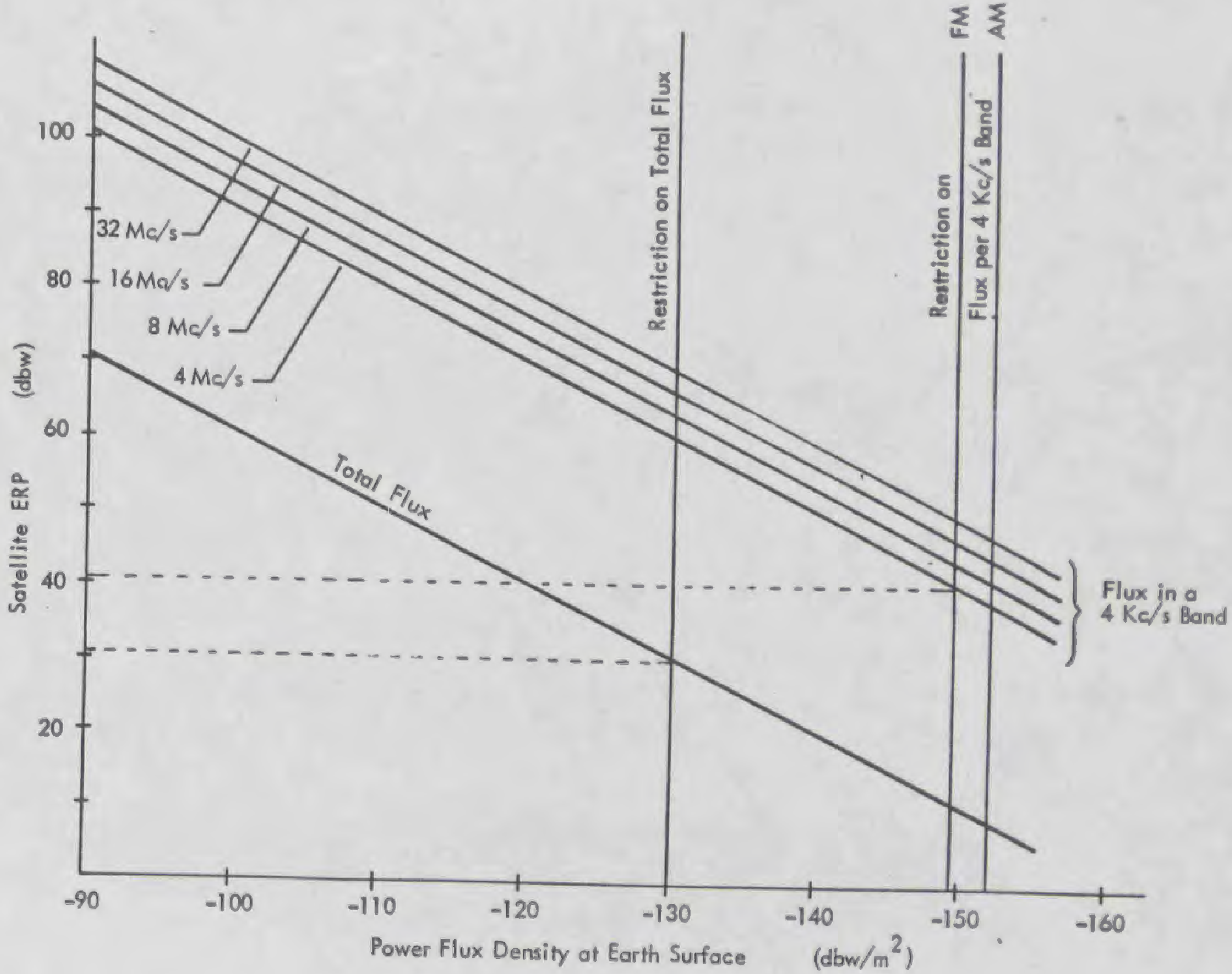


Figure 2.3 ERP vs. Power Density

- The video bandwidth is 4 Mc/s.

  The power density distribution of the satellite signal is uniform over the RF bandwidth (i. e., a flat transmitted spectrum).

There are several papers (CCIR, USPC IV/122 and IV/192-E) which claim that the restriction to -149 dbw/m^2 per 4 Kc/s band for FM, and the 3 db tighter restriction for AM are justified. These calculations were made for a synchronous satellite positioned on the main beam of a common-carrier relay antenna. The interference produced by this situation may approach, but not exceed, the acceptable limits of interference for telephone channels set forth by the CCIR. In data furnished to CCIR Study Group IV (CCIR, 21 August 1964), it has been shown that beam intersection will occur only if the satellite is positioned above the Atlantic or the Pacific Ocean. For a domestic satellite positioned near the central meridian of the United States, the beam-intersection computations ought to be modified by the gain of the common-carrier antenna in the direction of the satellite. This suppression of interference by the vertical pattern of the common-carrier antenna allows a higher tolerable level of power density. Typical patterns for microwave antennas used in common-carrier systems are given in Section 3. 1.

The elevation angle of the satellite signal at any point on earth can be obtained from Figure 2.4. For a given position of the satellite, the angle of elevation of the satellite as viewed from each point in the continental United States may be found, and the minimum of these angles of elevation selected.

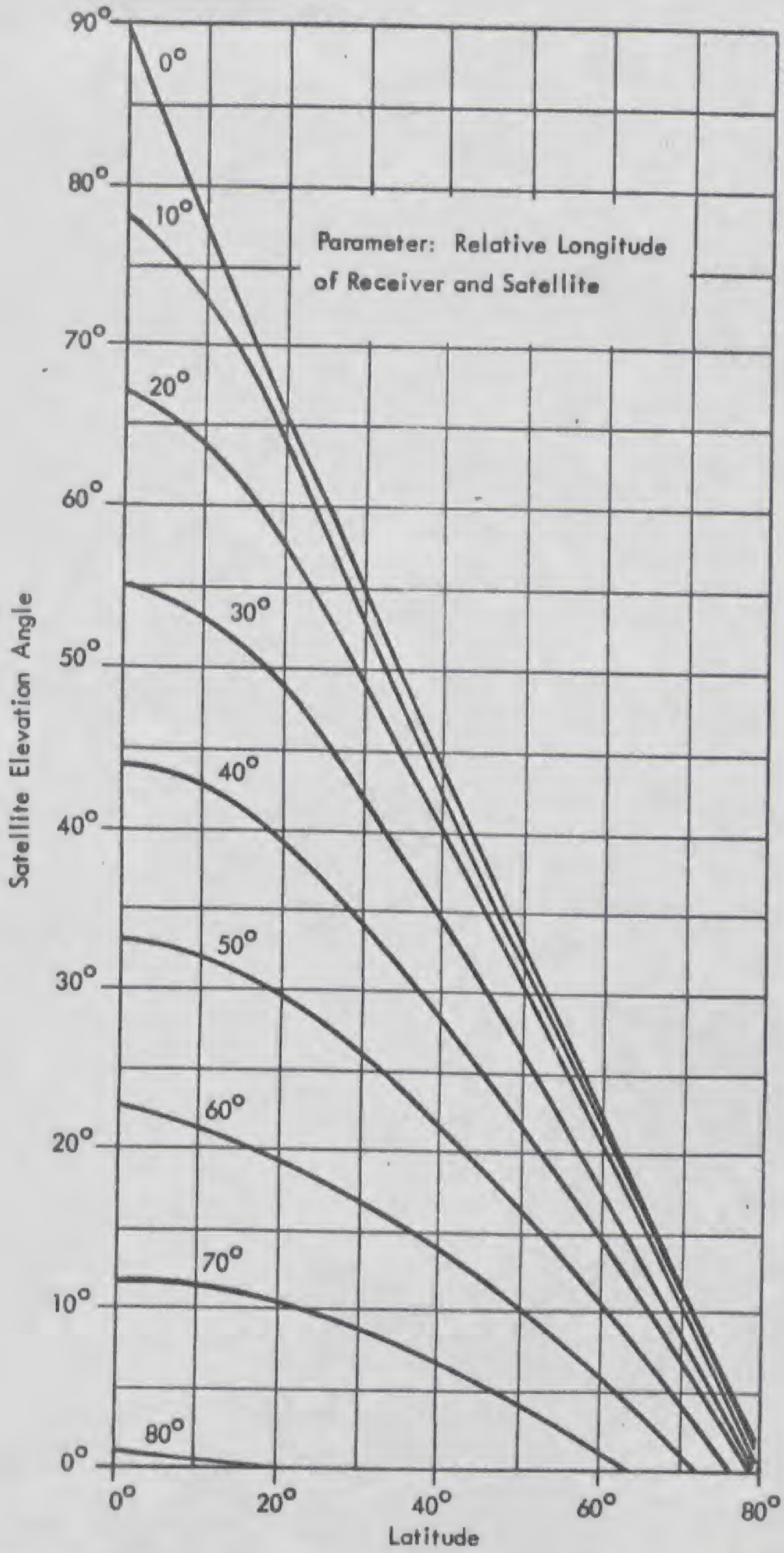


Figure 2.4 Satellite Elevation vs. Latitude and Relative Longitude

The resulting minimum angle of arrival for each position of the satellite is shown as the curve marked 0° in Figure 2.5. In the calculations, a maximum latitude of 47° was used for the continental United States. For each position of the satellite, the direction of arrival was determined at the microwave relay station in the United States most distant from the satellite. This corresponds to the point of minimum elevation of arrival of the signal from the satellite. The worst case assumed in this study corresponds to a common-carrier antenna elevation of 5 degrees, pointed in azimuth at the sub-satellite point, and located geographically at the worst point in the coverage area. The angle of arrival α of the satellite signal referenced to the main beam of the common-carrier antenna is then found and plotted in Figure 2.5 as a function of satellite longitude. Using the calculated values of α, the increased antenna interference suppression can be estimated from the antenna pattern shown in Figure 3.1. The suppression provided by the antenna directivity can be translated into an increase of the tolerable level of power density. Figure 2.6 shows the power density vs. satellite position which would create an equivalent interference with a microwave receiver as would a satellite on the axis of the microwave antenna beam operating at the present power limit.

A satellite may create interference through the antenna side lobes of each of a series of stations in a microwave network. In analyzing this problem, we assume the reference relay network of 50 stations suggested by CCIR, and an interference of the same low order of magnitude occurring in each station.

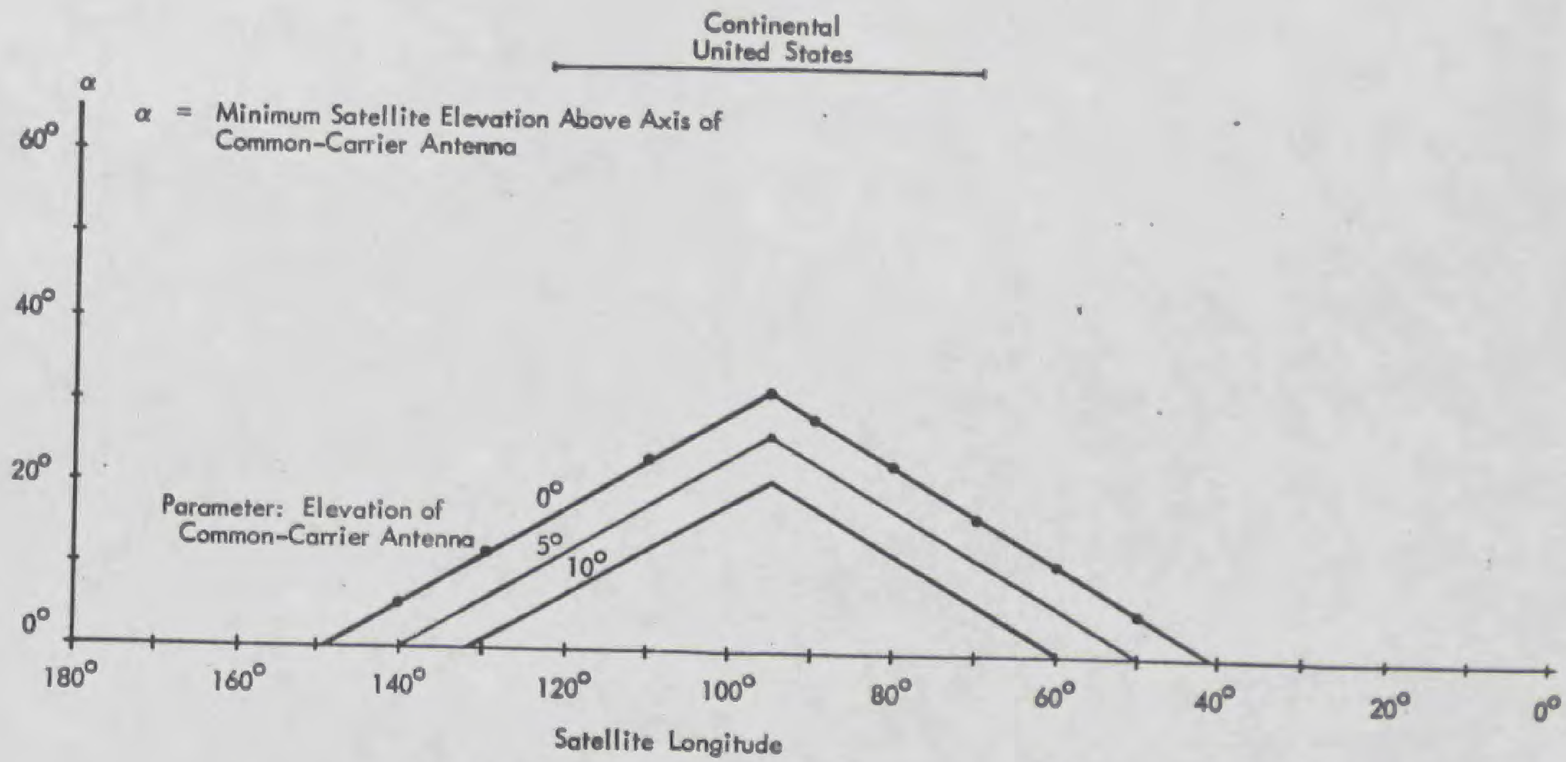


Figure 2.5 Satellite Elevation Above Axis of Common-Carrier Antenna vs. Satellite Longitude

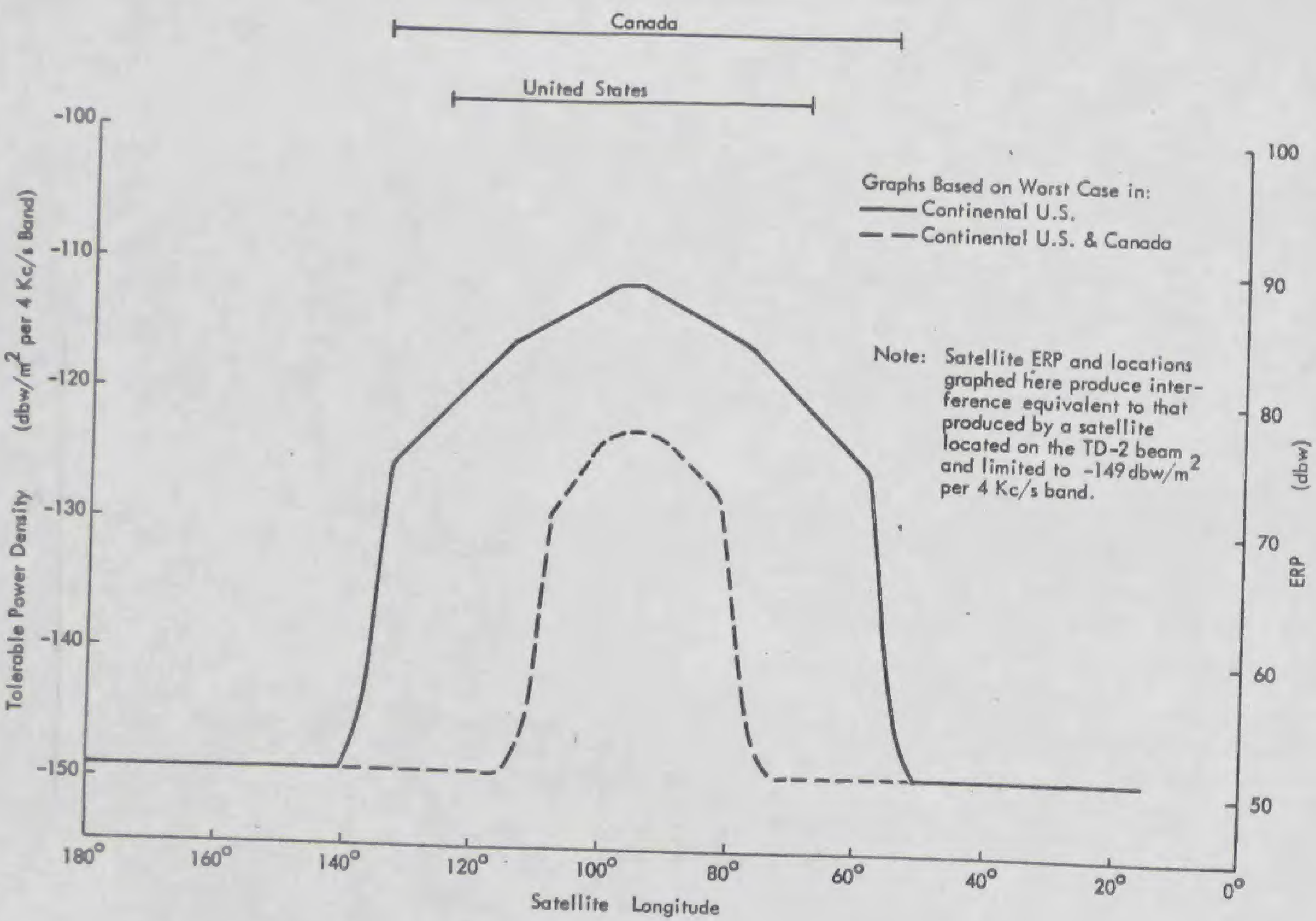


Figure 2.6 Tolerable Power Density Level and ERP vs. Satellite Longitude

Under these conditions, the tolerable flux level would be reduced by a factor of 50, i.e., 17 db. Even when the values plotted in Figure 2.6 are reduced by 17 db, there still remains ample margin for increase in satellite ERP without creating excessive interference with the common-carrier microwave systems. Thus, the limit of -149 dbw/m^2 per 4 Kc/s band may be increased when the TV distribution satellite is emplaced in the longitude window.

The directivity pattern used in computing the longitude window of Figure 2.6 corresponds to an antenna with less than the best available side-lobe suppression. The allowable increase in satellite ERP would be even greater if only antennas such as those described in Figure 3.1 are considered.

The recommendations made by CCIR Working Group IV at the meeting in Oslo in July 1966, allow small increases in satellite ERP for high angles of arrival. The Oslo meeting recommended that the restriction on spectral density be changed to $(-152 + \theta/15)$ dbw/m^2 per 4 Kc/s band, where θ is the angle of arrival of the interfering signal above the horizon. Assuming the use of common-carrier antennas of reasonable directivity, it would seem more appropriate to increase the coefficient of θ in the Oslo rule from 1/15 to possibly 1/4 or 1/3.

The Oslo meeting also recommended that the -130 dbw/m^2 restriction on total flux density be abandoned. Assuming the existence of limits on spectral density, such as the present limits or modified limits as suggested above, restrictions on total power density are unnecessary.

A possible constraint on ERP in the BNS down-link is imposed by the consideration of potential interference to the earth station receivers of the global commercial communication satellite (Comsat) systems.

Assuming a required ratio of carrier to interference of 40 db at the Comsat receiver terminals and the same ERP for both the Comsat satellite and the BNS satellite, the two satellites must be positioned so that the Comsat earth station antenna provides 40 db of interference suppression. This can be achieved if the satellites are separated by 3° in longitudinal positioning, assuming an 85-ft Comsat earth station antenna. If 50 db of antenna suppression is required, the satellites must be separated approximately 15° to control the interference to the Comsat earth station. Additional suppression can be obtained by using orthogonal polarizations from adjacent satellites.

In controlling the interference caused by Comsat satellites to the BNS earth station, the interference suppression is provided by the BNS earth station antenna. It will be shown in Section 3.3 that the desired carrier-to-interference ratio considering narrow-band FM interference to the BNS system is 37 db. Although Comsat satellites use wide-deviation FM, the 37-db value is used here for discussion as a pessimistic assumption. For equal ERP from both satellites, sufficient interference suppression will be provided by the BNS antenna if the satellites are spaced 10° apart. Closer spacing can be tolerated if polarization discrimination is utilized.

It is not necessary to restrict further the allowable ERP of the BNS satellite since compatible operations can be achieved through satisfactory positioning of the satellites. Generally speaking, the natural locations for Comsat satellites are at oceanic longitudes and those of BNS satellites are at continental longitudes; thus, there is no present and little future conflict in locating satellites for the domestic TV and international communication services.

A closely related question is why Comsat has experienced such difficulty in siting a very small number of terminals in the United States for use with its international satellites, yet BNS expects to site 223 earth terminals for use with its domestic satellites. The explanation rests on two essential differences between the present Comsat system and the proposed BNS system:

> First, the down-link beam from the international satellite is very much wider than for the BNS satellite (approximately 17 degrees compared with 3 degrees). The resulting weaker signal from the international satellite requires the use of a much larger antenna and more sensitive receiver in its associated terminal.
>
> Second, the antenna at an international terminal scans a sector of the equatorial belt. At times, the antenna may be depressed to receive signals with low angles of arrival. Under these circumstances, the terrestrial microwave facilities are likely to interfere with the highly sensitive international terminal.

In contrast, the stronger signals from domestic satellites arrive at a high angle at any BNS earth terminal. The suppression of unwanted signals through high antenna directivity coupled with appropriate site shielding would permit location of BNS terminals in close proximity even to major metropolitan areas.

2.3 Restrictions on Earth Stations

Preliminary studies show that a domestic satellite TV distribution system such as the proposed BNS system is feasible within present restrictions on interference. The only question is how restricted the siting problem becomes in metropolitan areas where the density of common-carrier facilities is maximum. In these areas, the various interference problems must be studied in detail to determine the extent to which the BNS system is restricted and to estimate the resulting increases in system cost.

There is no problem of controlling interference between BNS earth stations and Comsat earth stations, nor between BNS satellites and Comsat satellites. Consideration must be given to possible interference from the BNS earth station transmitter to the satellite receivers of other Comsat systems. It has been proposed that the ERP from common-carrier facilities in the direction of the synchronous equatorial belt be limited to 47 dbw. The ERP from a BNS earth station at a major network terminal will be less than 47 dbw for angular offsets greater than 10° from the axis of the antenna.

The required longitudinal separation between BNS satellites and other Comsat satellites to control interference from a Comsat earth station transmitter to a BNS satellite is dependent upon the transmitter power of the Comsat earth station. If the Comsat earth station radiated power is 10 db above the BNS up-link radiated power, the gain of the Comsat antenna in the direction of the BNS satellite must be less than 6 db to maintain a 37 db carrier-to-interference ratio. This is achieved if the longitudinal spacing between satellites is approximately 15°.

The main problem in preventing mutual interference between the BNS system and other existing and planned systems comes down to potential interference between BNS and common-carrier terrestrial microwave systems. In this study, these interference situations are divided into the following four cases for convenience:

Case 1	Common-carrier interference at the BNS satellite.
Case 2	Common-carrier interference at the BNS earth station
Case 3	BNS satellite interference at the common-carrier receivers.
Case 4	BNS earth station interference at the common-carrier receivers.

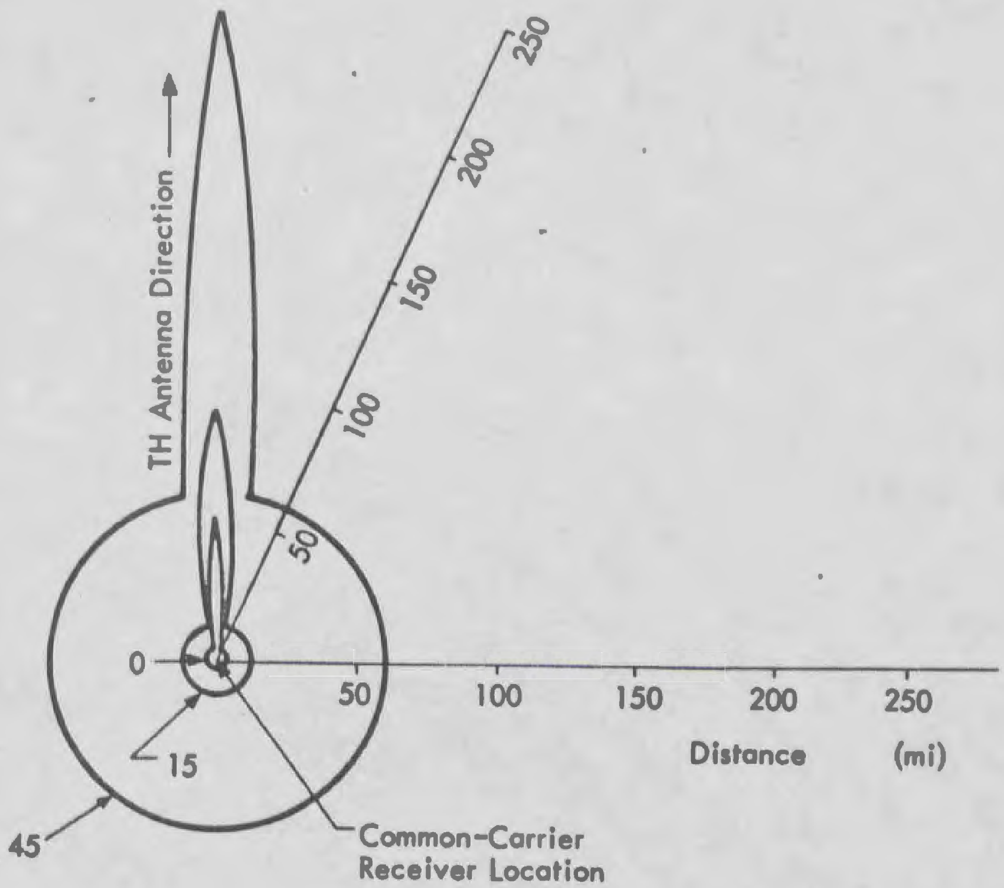
Cases 1 and 4 occur in the 6 Gc/s band (5.925-6.425 Gc/s), while 2 and 3 occur in the 4 Gc/s band (3.700-4,200 Gc/s).

These interference problems are important to the design and the economics of the BNS system through the restrictions they impose on the feasible range of various system parameters. For example, to control Case 3 interference, an upper limit must be placed on satellite ERP. The resulting lower limit on earth station sensitivity then poses a potential increase in system cost since the earth stations greatly outnumber the satellites in the proposed BNS system.

Another example is the possible restriction on location of earth stations in areas near many potentially interfering microwave beams. Or, as shown in Figure 2.7, the location of an earth station may be restricted to limit the interference it produces at some nearby common-carrier receiver. Problems of this sort become quite involved and must be considered in detail as in the sample problem in Section 4. Feasible solutions to these problems may require that some earth stations be located one or more microwave hops away from the locations desired. The cost of the supplemental terrestrial links required over and above the minimum number possible must be included in the total cost of the BNS system and regarded as elements of cost required to satisfy interference criteria.

In summary, interference criteria affect system design mainly through restrictions on the BNS earth stations. These restrictions increase system cost in three ways.

> Key parameters must be fixed at values other than those required for minimum cost.
>
> Side-lobe suppression techniques such as shielding, improved antennas, etc., must be incorporated in some of the earth stations and common-carrier facilities located in the metropolitan area.
>
> Supplemental terrestrial links are required to permit some earth stations in metropolitan areas to be located more than the minimum number of microwave links away from the locations desired.



Note:

Parameter is the power radiated (dbw) in the horizontal plane from an Earth station. Interference at the TH receiver is tolerable for all locations of the Earth station outside the contour.

Figure 2.7 Interference Contours around TH Receiver

3. Interference Characteristics

In this section, the characteristics of the BNS system and of the common carrier microwave relays that pertain to the interference problem are presented along with the tolerable levels of interference for these systems. Various interference phenomena are described briefly and the magnitudes of their effects are estimated.

3.1 Characteristics of Terrestrial Microwave Relays

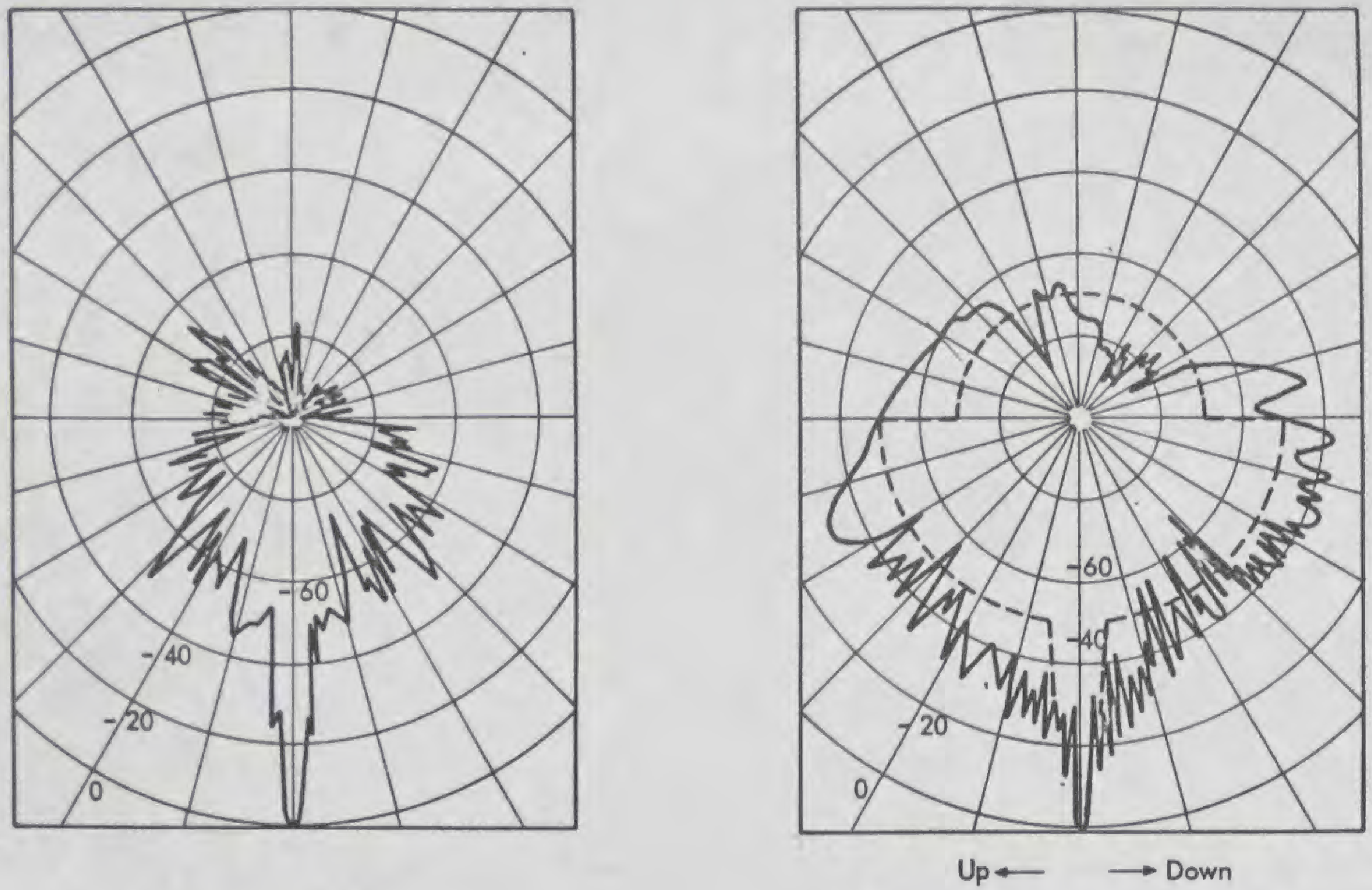
Most of the interference calculations in this study are based on the TD-2 microwave relay systems of the AT&T Company (Roetken 1951) and the newer TH system (Kinzer 1961). The TH system is designed to use the same towers and antenna as the TD-2. Selected characteristics of the TD-2 and TH systems are given in Table 3.1 and typical antenna patterns (gain in db relative to the main beam) are shown in Figure 3.1 for 4 Gc/s operation. The same antenna, shared by the TH system at 6 Gc/s, has a proportionately narrower main beam.

Consideration has also been given in this study to common-carrier microwave relays other than the TD-2 and TH systems but operating in the same bands. Many of these systems use antennas, such as those described by Figures 3.2 and 3.3, which have much less side-lobe suppression than the horn reflectors used by AT&T.

Table 3.1 Characteristics of Microwave Relay Systems

	TD-2	TH
Frequency Band	3700-4200 Mc/s	5925-6425 Mc/s
Multiplexing	Frequency Division	Frequency Division
Modulation	Low-index FM	Low-index FM
Signal Bandwidth	4 Mc/s	10 Mc/s
Transmitter Power (Per Channel)	-3 dbw	7 dbw
Antenna Gain	40 db	43 db
Beamwidth	1.65^{o}	1.15^{o}
Received Carrier Power	-68 dbw	-57 dbw
Working Channels (max.)	6	6
Channel Capacity	1860 TP or 1 TV	1860 TP or 1 TV
Channel Spacing	20 Mc/s	30 Mc/s
Relay Spacing (avg.)	25-30 mi.	25-30 mi.

Stanford Research Institute has published measurements of TD-2 field strengths in the vertical plane (Turner 1965). Results of flights over a TD-2 station equipped with two horn reflectors transmitting on 3.77, 3.85, and 4.01 Gc/s are shown in Figure 3.4 where the radial scale is gain in db above an isotropic radiator. These measurements show the pattern of actual



(a) Horizontal Pattern

(b) Vertical Pattern

Horn Reflector Antenna at 3.74 Gc/s:

——— Measured Pattern for Vertical Polarization

- - - - Estimated Envelope for Horizontal Polarization

Figure 3.1 Vertical and Horizontal Pattern of TD-2 Antenna

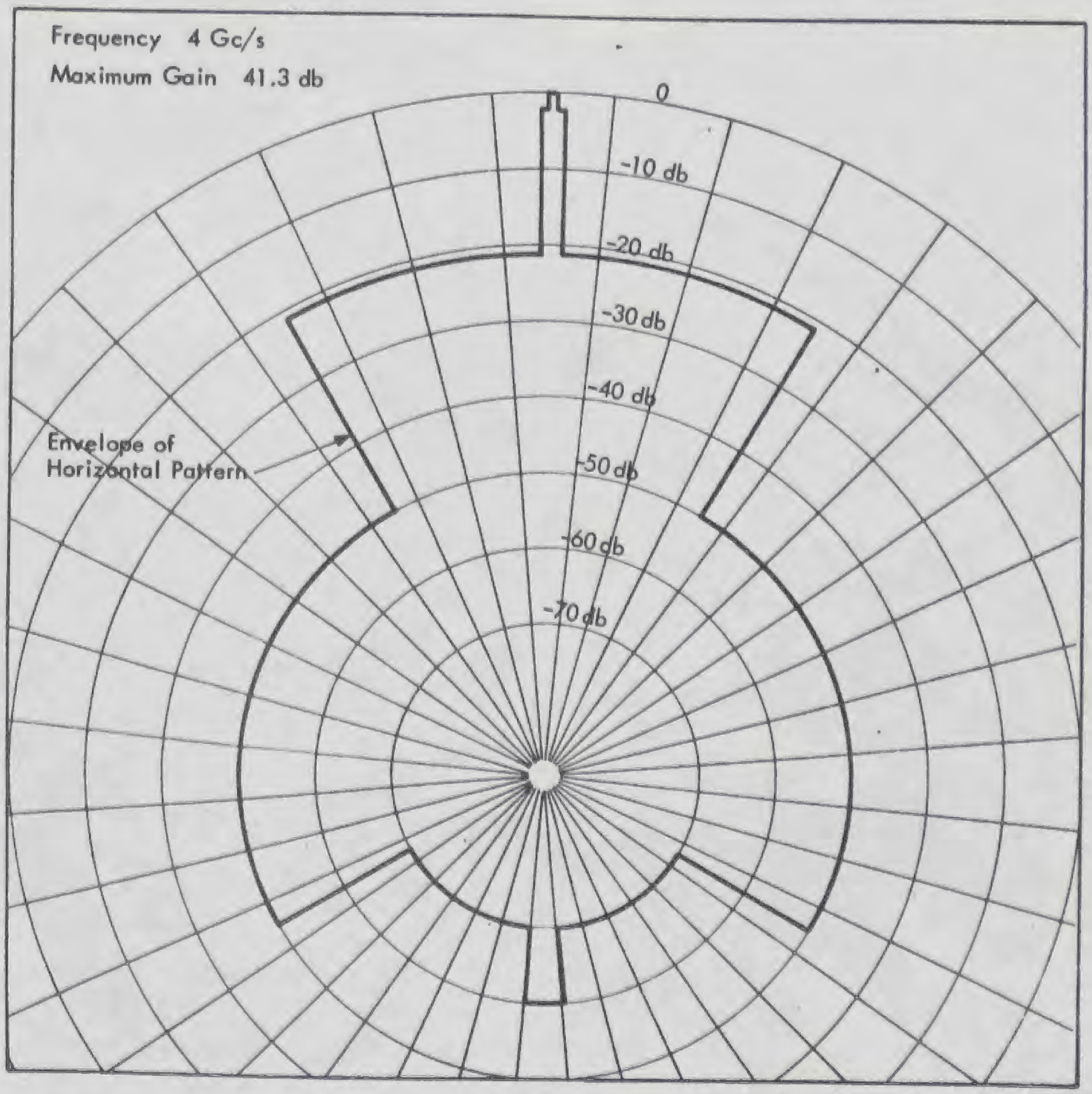


Figure 3.2 Pattern of Parabolic Antenna for Microwave Relay Service

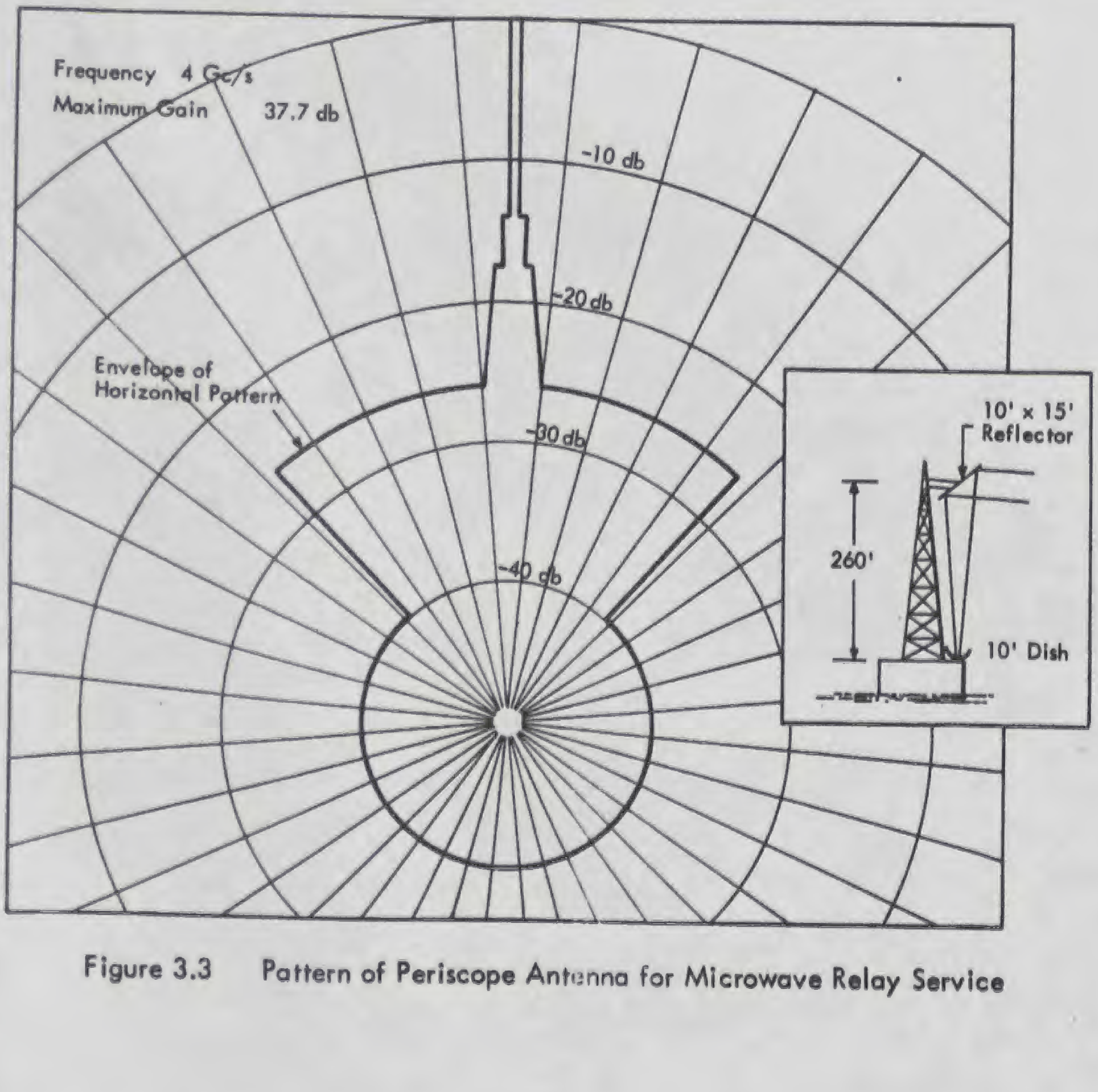
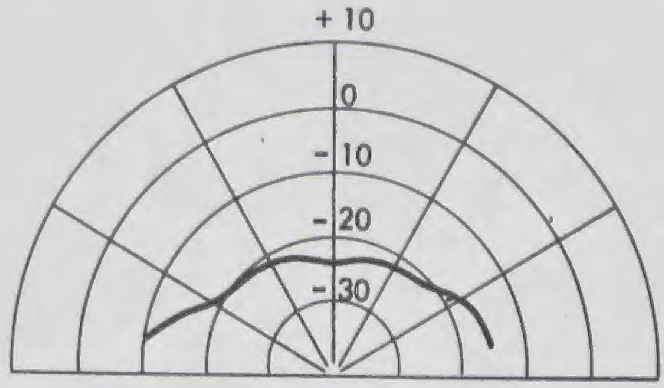
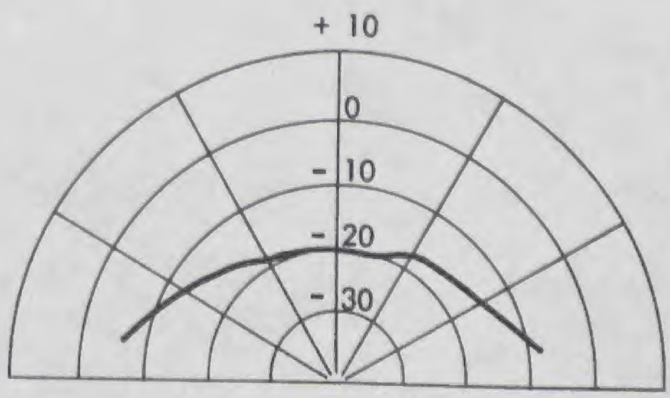


Figure 3.3 Pattern of Periscope Antenna for Microwave Relay Service



(a) Flight Azimuth 51°

(b) Flight Azimuth 115°



<u>Note:</u>

Gain vs. elevation angle was measured in B-25 flight at 12,000 ft over a pair of TD-2 horn reflectors at 38.1° N, 122.6° W., directed at azimuths 143° and 342°.

Figure 3.4 Aircraft Measurements of Microwave Antenna Pattern installations in the vertical and horizontal planes through the main beam. More field measurements of this sort would be helpful in further study of the problem.

3.2 Characteristics of BNS-3

Preliminary studies of system design economics and interference considerations have been used to determine a range of values for each key parameter of the system. The system design problem is then to satisfy the interference limits at minimum total system cost.

The solution of each interference case will narrow the range of values of a given number of system parameters. Interference Cases 1 and 3 negligibly constrain the selection of system parameters.

3.2.1 Cases 1 and 3

Case 1 interference is that produced by 6 Gc/s common-carrier transmitters at the satellite receiver. It is clearly desirable to provide signal levels in the up-link sufficient to suppress any interfering signal. Since it is relatively easy to provide the necessary levels of ERP in the earth station, other interference situations must be considered in determining limits on up-link ERP.

Case 3 interference is related to the allowable flux density produced at the surface of the earth by the satellite transmitter. It appears that economic considerations of the BNS system will lead to satellite ERP values less than that which would interfere with common-carrier receivers in the 4Gc/s band.

The major interference problems which must be taken into account in the selection and specification of system parameters arise from considerations of Cases 2 and 4, both of which pertain to terrestrial interference paths.

We will discuss the parameters of the BNS system which will determine the level of interference in these two cases. We will show in Section 4, through a specific example, how the selection of these parameters can influence the siting of earth stations in the BNS system.

3.2.2 Case 2

The tolerable level of common-carrier interference at the earth station is determined by the BNS carrier power at the receiver terminals, i.e., the ratio of the two power levels is significant. To reduce interference, the BNS carrier power must be increased or the interference from the common-carrier must be decreased. The BNS carrier power level is determined by the main-lobe gain of the BNS earth station and the satellite ERP. Since the gain of the satellite antenna is constrained by the desired time-zone coverage, the satellite ERP can only be changed by a costly increase of transmitter power in the satellite. The most economical way of increasing the BNS carrier power received is by increasing the size of the antenna in the BNS earth station. However, such a change will increase the amount of precipitation scatter from common-carrier transmitters, an effect which we will later show to be potentially significant.

Assuming that the the transmitted signal and interfering powers are fixed, direct Case 2 interference can be controlled only by changing location or reducing the effective horizontal gain of the antenna in the BNS earth station. The latter may be achieved by suitable site shielding or by improved antenna design. In the sample problem of Section 4, we will show that the effective horizontal gain for BNS earth stations in metropolitan areas should be about -24 db relative to an isotropic radiator. This value includes the effect of site shielding.

3.2.3 Case 4

For interference over the direct path, the interfering flux density in a common-carrier facility is determined by the earth station ERP. In Section 4, we will show that the Case 2 interference over the direct path predominates and considerations related to that type of interference will dictate the selection of the system parameters. Interference due to the scatter path is determined by the transmitter power and the main-lobe gain of the BNS earth terminal. The main-lobe gain of the BNS earth terminal generally should not be reduced to improve the situation for Case 4 interference since such a change would reduce the desired signal power received and could increase Case 2 interference.

3.3. Tolerable Levels of Interference

Table 3.2 summarizes the allowable levels of interference at the appropriate receiving installation for the various interference cases under consideration. In each case the level of interference is derived from a system specification or an appropriate CCIR recommendation.

3.3.1 Case 1

An interfering radio relay signal appearing within the passband of the satellite up-link will appear as a strong carrier spike with sidebands that are

Table 3.2 Tolerable Levels of Interference at Receiver Terminals

Case	Interference Conditions	Frequency (Gc/s)	Interference Path	Applicable Specification	Tolerable Interference at Receiver Terminals (dbw)	References
1	Common Carrier to BNS Satellite	6	Direct	$\frac{C}{I}$ = 37 db	-129	Section 3.3
2	Common Carrier to BNS Earth Station	4	Direct	$\frac{C}{I}$ = 37 db	-143	Section 3.3
			Scatter from Side-lobe	$\frac{C}{I}$ = 27 db	-133	
			Scatter from Main-lobe	$\frac{C}{I}$ = 27 db	-133	
3	BNS Satellite to Common-Carrier Relay	4	Direct	-148 dbw/m^2 per 4 Kc/s channel; 500 pwp	-119.5	Figure 2.6 and (CCIR 1963)
4	BNS Earth Station to Common-Carrier Relay	6	Direct	500 pwp	-119.5	Section 3.3
			Scatter from Side-lobe	40,000 pwp	-100.5	and
			Scatter from Main-lobe	40,000 pwp	-100.5	(CCIR 1963)

negligible as far as interference effects are concerned, since the terrestrial microwave system is basically a low-deviation system. The spectral density of the Bell System TD-2 sidebands, for example, is 74 db per c/s below the unmodulated carrier level (Curtis 1962). To illustrate the interference problem for a typical satellite communication application, a calculation will be made for the case of a TV transmission via the satellite link.

When the desired down-link signal is such that energy is concentrated in a fairly narrow band, such as might be produced when a picture of large grey area is transmitted, the common-carrier spike will produce a sinusoidal base-band tone which will superimpose an interference pattern on the received picture. Threshold observations have been made to determine acceptable signal-to-noise ratios for this type of interference as a function of frequency (BTL 1964). The requirement is stated in terms of the ratio of peak-to-peak signal voltage to the root-mean-square value of the interfering tone.

The ratio of signal to interfering tone is given by

$$\frac{S}{I} = \left(\frac{\text{P-P signal}}{\text{rms tone}}\right)^2 = \left[\frac{\Delta F}{f\left(\frac{I}{2C}\right)^{1/2}}\right]^2 = \left(\frac{\Delta F}{f}\right)^2\left(\frac{2C}{I}\right)$$

where

ΔF = peak-to-peak deviation of down-link signal

$= B_{RF} - 2 f_v = 40-2(4) = 32$ Mc/s

f = frequency difference between desired and undesired signal

$\frac{C}{I}$ = ratio of down-link carrier to interfering carrier

Choosing f = 4 Mc/s for the most severe case, and choosing S/I = 58 db (BTL 1964, p.389), we have C/I = 37 db.

The preceding analysis is based on an absolute worst case. In this regard, the following points should be noted.

- The 58 db of required signal-to-interference ratio previously cited is based on the envelope of the graph of worst interference vs. frequency in the various portions of the video spectrum. The graph itself would show a large number of maxima and minima as the interference frequency approaches and recedes from synchronization with multiples of the line frequency.

- Since the down-link will include a carrier-dispersion signal, the interfering carrier will appear as a band of energy rather than a spike. The interference reduction potential of this technique has not been measured.

- The preceding analysis is based on the physical interference effect considered, which increases with the frequency of the difference between the BNS carrier and the interfering carrier. However, the psychophysical effects may be completely different and the greatest subjective effect may occur at some point other than the upper edge of the video spectrum. In that event, the required carrier-to-interference ratio would be less than 37 db. Subjective interference tests using the proposed BNS signal, including the carrier dispersion component, must be conducted before complete answers can be given to these questions.

- An excavated pit might be used to shield the earth station antenna from common-carrier interference. At least 40 db of pit shielding is feasible and 70 db may be possible with carefully designed pit walls (Hagn 1965). In the sample siting problem analyzed in Section 4.0 below, pit shielding of less than 30 db suffices to isolate the BNS earth stations from common-carrier facilities. This is well within the range of shielding attainable according to measurements made by Hagn of the Stanford Research Institute.

In areas where such installations may not be feasible, additional techniques for interference attenuation are available. Directional selectivity of the Earth station antenna can be improved at the circumference of the parabola to reduce unwanted side-lobes. Also, the antenna feed can be offset from center to reduce unwanted energy in a given direction. A combination of the latter two techniques could achieve additional side-lobe suppression to result in a gain in a selected direction of approximately -10 db relative to an isotropic radiator. Another possibility is to use fences a few meters in width to shield the earth station antenna in selected directions (Ruze 1966). The effect of such fences can be considered independently of the antenna pattern itself if they are located a few hundred meters away from the antenna.

- Consideration ought to be given to assigning BNS carrier frequencies to minimize the interference produced in the down-link by TD-2 carriers ($f = 3690 + 20\,k$ for $k = 1, 2, \ldots, 20$). Tests of the effects of this interference are necessary to determine the optimum assignment which is expected to be near

  $$f = 3690 + 40\,k \qquad k = 1, 2, \ldots, 12.$$

  An assignment of this sort has the additional value of providing 20 Mc/s at the band edges for commercial and educational audio channels and for BNS control and administration.

3.3.2 Case 2

The frequency of occurrence of interference from the direct path of propagation will differ from that of the scatter path. Direct interference will be nearly constant. On the other hand, interference due to precipitation scatter will occur only during heavy rainstorms. The characteristics of the interference will be similar to Case 1 and, therefore, a carrier-to-interference ratio of 37 db or more is desired. Since the most significant interference from the scatter path arrives through the main lobe of the earth station antenna, while the interference from the direct path arrives from the side lobes, the tolerable flux densities in these two situations will be different. The allowable interfering power at the receiving terminals for each path will be -143 dbw for a BNS carrier power of -106 dbw. The carrier-to-interference ratio applied to the scatter case will be dependent upon the characteristics and frequency of occurrence of the interfering signal. In evaluating the interference, it is appropriate that the frequency of occurrence be matched to the amount of allowable down-time of the system. The current television distribution system of the United States is down about 0.02% of the time. In the proposed BNS system, a signal of reduced quality will be obtained for a similar fraction of the time. Rainfall rates of 30 mm/hr or greater occur about 0.02% of the time in the New York area, and we will use this rate of precipitation in establishing the level of interference at the receiver in the BNS earth station.

3.3.3 Case 3

The allowable power per 4 Kc/s channel from a satellite transmission is 500 pwp (picowatt, psophometrically weighted) at a point of zero reference level when there are two interfering sources (CCIR 1963, Recommendation 367).

Since the common-carrier link uses low-deviation FM, the noise introduced into a typical telephone channel can be computed by determining the power density of the interfering signal compared to the side-band power density of the common-carrier signal. A calculation will be made using the interference level permitted by the latest CCIR recommendation in order to determine the minimum isolation that must be provided between the two services.

The latest CCIR recommendation states that earth station transmissions shall not introduce more than 1000 pwp in any telephone channel. Assuming that interference to a particular radio relay route may be caused by two different earth stations, the allowance for each is 500 pwp. Since the thermal noise level in a telephone channel under non-fading conditions is about 25 pwp, the allowable interference power density is 13 db above thermal noise.

Assuming a receiver noise temperature of 750°K, the thermal noise power density is -164 dbw per 4 Kc/s channel. Allowing for 3 db of transmission-line loss between the common-carrier antenna and receiver, the allowable interference power density at the antenna terminals is $-164 + 13 + 3 = -148$ dbw per 4 Kc/s channel.

It will be assumed that the earth station is transmitting TV using frequency modulation with an RF bandwidth of 40 Mc/s. It will also be assumed that carrier energy dispersal is employed, using a triangular waveform added to the normal video signal. Using the amount of dispersion recommended in the most recent CCIR report, which results in a 10-percent increase in RF bandwidth, the ratio of the maximum power per 4 Kc/s channel bandwidth to the carrier power is given in db by

$$-(14 + 10 \log \Delta F)$$

where ΔF is the peak-to-peak deviation of the video signal in Mc/s. Using Carson's rule for the RF bandwidth of an FM signal, and applying the 10-percent dispersion factor, the value of ΔF can be found from the parameters given previously.

$$B_{RF} = 1.1 \ (\Delta F + 2f_v)$$

$$\Delta F = (B_{RF}/1.1) - 2f_v$$

If the video bandwidth f_v is taken as 4 Mc/s, then $\Delta F = 28$ Mc/s. It follows that the dispersed power per 4 Kc/s channel is 28.5 db below full BNS carrier power.

3.3.4 Case 4

CCIR Recommendation 356 states that, at a point of zero reference level, the allowable interfering power from an earth station is 500 pwp for 20% of the time and 40,000 pwp for 0.02% of the time. In interpreting this recommendation, we have applied the 500-pwp restriction to interference arriving via the direct propagation path and the 40,000 pwp to interference arriving from the scatter path. As in Case 2, direct path interference will be fairly constant. Again, a rain rate of 30 mm/hr will be used in determining the scattered flux as this corresponds to a frequency of about 0.02% of the time in the New York area. The allowable interference is accordingly higher for the scatter path than the direct path.

3.4 Propagation Effects

Several propagation effects will be discussed with emphasis on precipitation scatter.

3.4.1 Direct Path Propagation

The propagation characteristics for interference over the direct path between common-carrier facilities and BNS earth stations are given in Figure 3.5 (Curtis 1962). The characteristic is divided into two regions, the first of which is free-

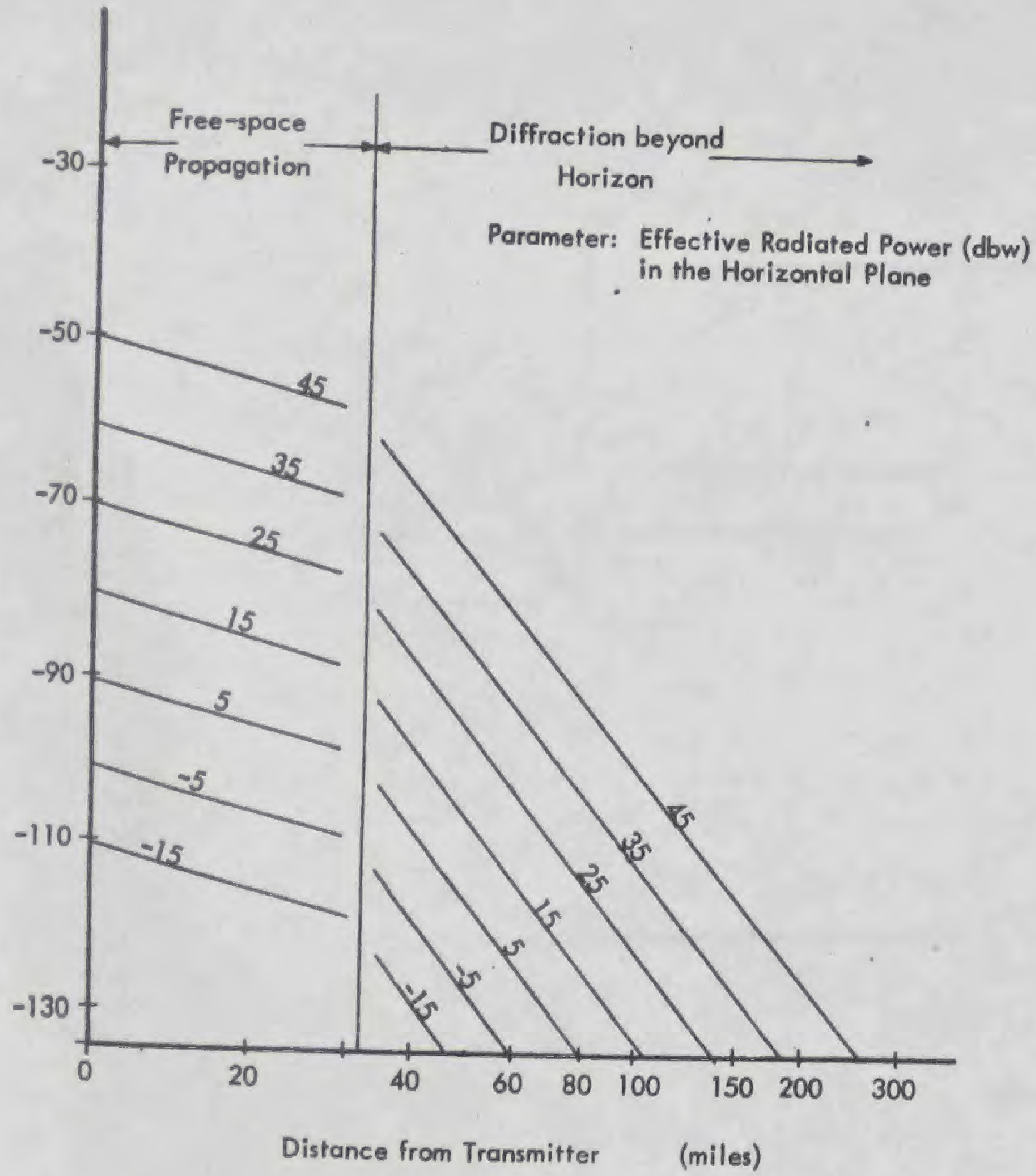


Figure 3.5 Free-space Propagation Characteristic with Diffraction Effect

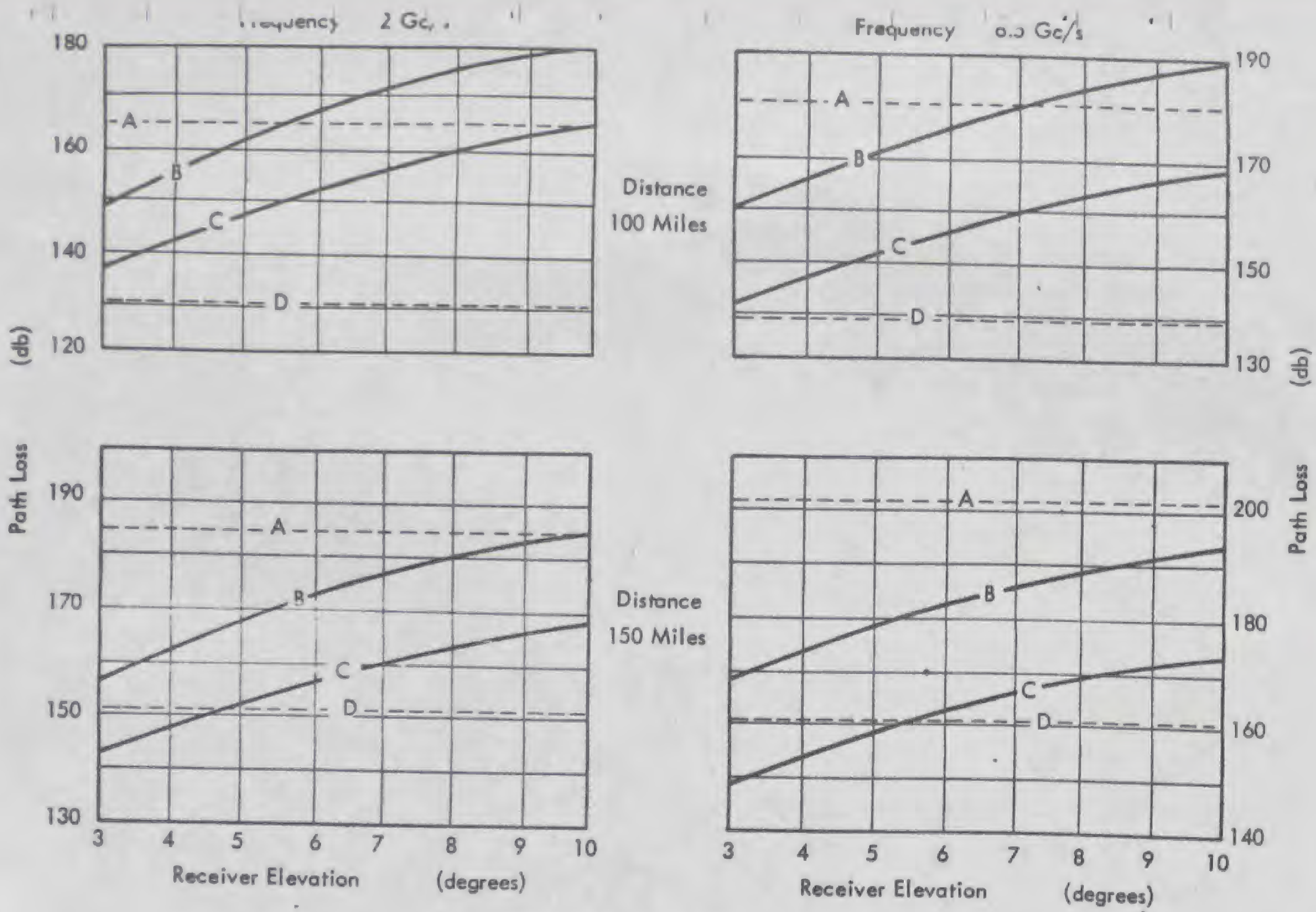
space or line-of-sight propagation and is predicted using the 4/3 earth-radius approximation. The diffraction region exists below the radio line of sight beyond the horizon. Figure 3.5 is given for an average terrain condition. The characteristics of diffraction are highly dependent upon the type of terrain and the terrain profile. The diffraction effect can be accurately determined only in individual cases. A way of evaluating the diffraction effect is to construct an earth profile between the transmitter and receiver and find the amount of diffraction by considerations of knife-edge effects.

Besides free-space propagation and diffraction, anomalous modes of propagation may also exist. These include super-refraction or ducting which will effectively extend the line of sight of the transmitted wave indefinitely. It should be pointed out that anomalous propagation characteristics exist predominantly near large water masses which result in inversion of the index of refraction in the atmosphere.

Worst-case considerations of interference effects can be made by assuming free-space propagation within the region of consideration.

3.4.2 Tropospheric Scatter

Tropospheric scatter effects are minimal for the case at hand because of the high elevation angle of the earth station antenna and the low power radiated in directions slightly above the horizontal plane. Tropospheric scatter considerations are usually restricted to cases of low elevation angles. Figure 3.6 shows typical loss curves of tropospheric scatter systems for elevation angles up to 10^{o}



A Isotropic to Isotropic
B 10-foot Dish to 60-foot Dish, Side Lobe Only
C 10-foot Dish to 60-foot Dish, Main Lobe Only
D 10-foot Dish to Isotropic

Figure 3.6 Path Loss of Trophospheric Propagation vs. Angle of Elevation

(Hartman 1965). The loss figures given by these curves apply 99.9% of the time. Although the curves are developed for 60-ft and 10-ft antennas, they are easily extrapolated to the BNS system. It is necessary to have a path loss greater than 180 db to avoid Case 2 type interference via troposcatter. Considering Figure 3.6 and the fact that the satellite elevation angle will be greater than 40°, tropospheric loss of greater than -180 db will be obtained at ranges much less than 100 miles. In Section 3.4.3, we will show that control of interference due to precipitation scatter will require that microwave relays be considered at longer ranges. Thus, control of precipitation scatter interference will insure control of tropospheric scatter interference.

3.4.3 Precipitation Scatter

The geometry of precipitation scatter shown in Figure 3.7 applies in principle to all of our interference cases, but only in Cases 2 and 4 are the effects significant. The precipitation scatter path consists of three parts: (1) a direct path from interfering transmitter to (2) the scattering volume, and (3) a direct path from there to the interfered receiver. Free-space propagation is assumed for the two direct paths. It is necessary to estimate the height of common-carrier beams above terrain at various distances from the common-carrier transmitter. For a smooth earth, and using the 4/3 earth-radius approximation, the height h in feet of the beam at a distance of R miles from a common-carrier transmitter aimed at the radio horizon is given by

$$h = 0.5\ (R - 24.5)^2$$

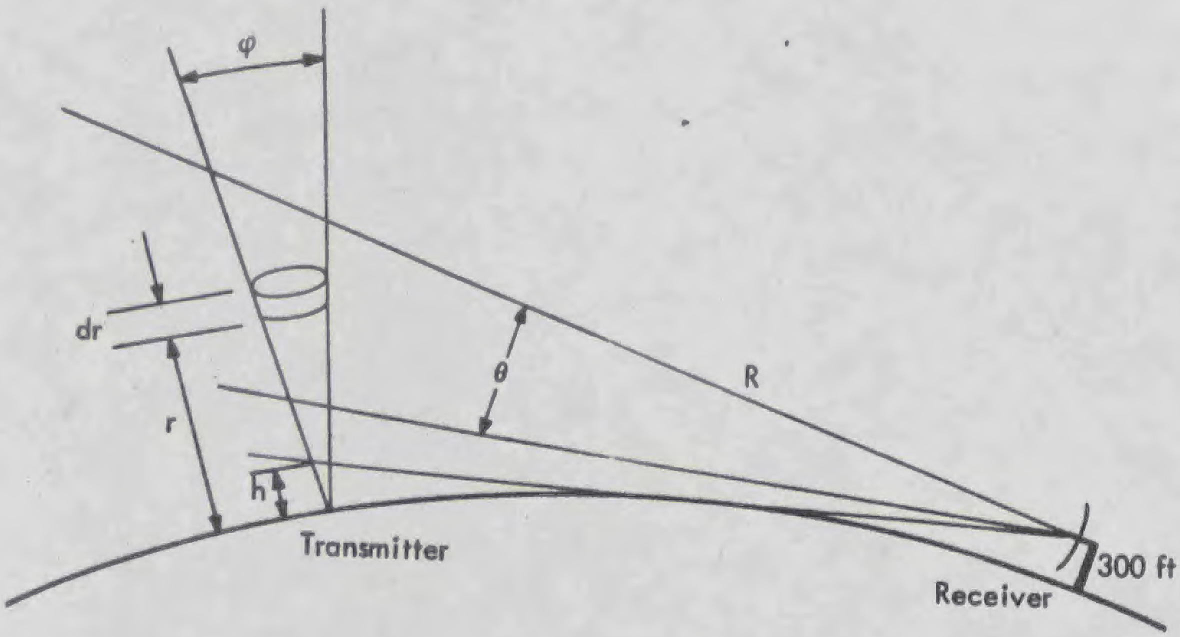


Figure 3.7 Geometry of Precipitation Scatter

Attention will be confined to scatter from rainstorms, since water droplets scatter microwave energy more strongly than snow. This is explained by the large ratio of dielectric constants of the two materials. The backscattering cross-section per unit volume increases with rainfall rate. For the wavelength $\lambda = 5.7$ cm., the backscattering cross-section is given by

$$s = 5.59 \times 10^{-5} \; Q^{1.6} \tag{3.1}$$

in cm^2/m^3, where Q is the rainfall rate in mm/hr (Gunn 1954). When the water droplet radius is much less than the wavelength, as is the case here, the scattering intensity is a maximum in the forward and backward directions and a minimum at right angles to the incident energy (Born 1959, p. 650). The minimum is roughly half the maximum, but we will use the backscattering cross-section here as a pessimistic estimate of interference due to precipitation scatter.

We begin our analysis by considering Case 4. Assume that the transmitter is pointed in the vertical direction with power P_t, gain G_t and beamwidth ϕ. Assume that the receiver has a beamwidth of θ, and is located at a height of 300 feet and at a distance R from the transmitter.

Consider an element of volume at a distance r above the transmitter.

$$dV = \pi\left(\frac{\phi}{2} r\right)^2 dr$$

The flux density illuminating this volume element is

$$F_s = \frac{P_t G_t}{4 \pi r^2}$$

The total power scattered from a volume V is then given by

$$P_s = \int_V F_s \, s dV$$

Assuming that all elements of the volume can be seen by the receiver antenna, one gets for the flux density at the receiver

$$F = \frac{P_s}{4\pi R^2} = \frac{P_t G_t}{16\pi R^2} \left(\frac{\phi}{2}\right)^2 \int_V \; s(r)dr$$

$$= K \frac{S}{R^2}$$

where

$$K = \frac{P_t G_t}{16 \; \pi} \left(\frac{\phi}{2}\right)^2$$

and

$$S = \int_V s(r)dr$$

Now with $P_t = 50$ w, $G_t = 50$ db, and an up-link beam width of 0.5^o, i.e., $\phi = 0.5 \; \pi/180$, we find that $K = 1.9$ w. It is convenient to express S in $cm^2 ft/m^3$ and R in miles, and then we have $K = 2.24 \times 10^{-11}$.

We consider two cases. In the first, the receiver beam intersects the transmitter beam, and in the second, it does not intersect.

In the first case, we are interested in calculating the flux F_B in the receiver beam. F_B is the received power density scattered from the volume of a rainstorm, common to the main beams of interfering and interfered antennas. We consider only the situation where the beams are positioned so as to maximize the scattered flux received. The height of the total volume of interest is given by $\Delta r = \theta R$ which becomes

$$\Delta r = 92.2R \tag{3.5}$$

for a common-carrier beamwidth of 1.23°, i.e., $\theta = 1.23\,\pi/180$, where R is given in miles and Δr in feet.

In the second case, the receiver beam does not intersect the transmitter beam. The flux F_L is the received power density scattered from the volume of a rainstorm in the main beam of the earth station, visible from a common-carrier facility.

In either case, part of the transmitter beam, below height h, will be obscured by the curvature of the earth. If d is the distance to the horizon and R_E is the radius of the earth then

$$d^2 = (R_E + h)^2 - R_E^2 = h(2R_E + h) \doteq 2hR_E$$

With the receiver antenna at 300 ft and $R_E = 4000$ mi, then

$$h = 0.5\ (R - 24.5)^2 \tag{3.6}$$

where h is given in feet and R in miles.

Figure 3.8 shows a model of a thunderstorm cloud in terms of rainfall rate versus altitude. The model was chosen to exceed all characteristics of a typical thundercloud (Valley 1965, pp 5-11). From 0 to 8000 ft., Q = 30 mm/hr and, by Equation 3.1, $s = 0.0067\ cm^2/m^3$. From 8000 ft to 24,000 ft, Q = 60

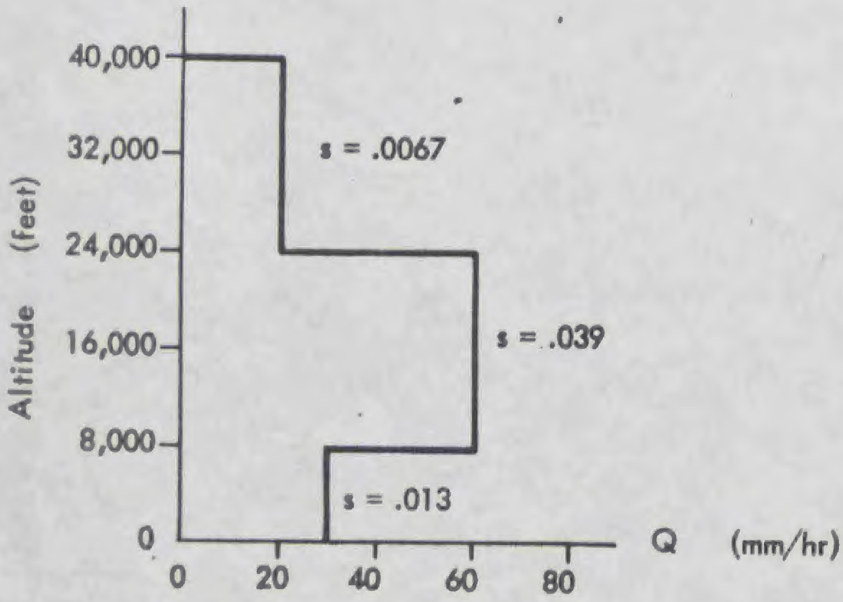


Figure 3.8 Model of an Extreme Thunderstorm

and s = 0.039. From 24,000 ft. to 40,000 ft., Q = 20 and s = 0.013. Based on this model, the quantities S_B and S_L corresponding to F_B and F_L may be calculated from Figure 3.8 and Equation 3.4, with integration limits determined by Equations 3.5 and 3.6. The results of calculation for several values of R are shown in Table 3.3.

The values calculated in this example were scaled to fit the interference cases of interest in the sample problem discussed in Section 4. The wavelength used here was selected to facilitate comparison with measured backscatter data (Gunn 1954). Equation 3.1 may be scaled to 4.200 and 6.425 Gc/s in proportion to the fourth power of frequency. It is also necessary to scale F_B and F_L to account for the changes in ERP and beamwidths from the values used in the example above to the interference cases considered in Section 4. The resulting flux densities obtained for Cases 2 and 4 are graphed in Figure 3.9.

Case 2 interference may be analyzed with the aid of Figure 3.7 but with the roles of the receiver and transmitter interchanged. Here we have

$$F_s = \frac{P_t G_t}{4\pi R^2}$$

The power scattered from dV is $sF_s dV$ and the corresponding power density produced at the receiver is

$$dF = \frac{sF_s}{4\pi r^2}\, dV = \frac{sF_s}{4\pi r^2}\, \pi\left(\frac{\phi r}{2}\right)^2 dr$$

$$= \frac{P_t G_t}{16\pi R^2}\left(\frac{\phi}{2}\right)^2 s\,dr$$

Table 3.3 Sample Calculations of Scattered Flux

R (mi)	h (ft)	r (ft)	S_B $\left(\frac{cm^2 ft}{m^3}\right)$	S_L $\left(\frac{cm^2 ft}{m^3}\right)$	F_B (w/m^2)	F_L (w/m^2)
5	0	575	22.4	838	2.01×10^{-11}	7.50×10^{-10}
10	0	1,150	44.8	838	1.01×10^{-11}	1.87×10^{-10}
25	0.12	2,870	112	838	3.97×10^{-12}	3.00×10^{-11}
50	325	5,750	224	836	2.01×10^{-12}	7.48×10^{-12}
100	2,850	11,500	448	798	1.01×10^{-12}	1.79×10^{-12}
150	7,870	17,200	633	730	6.30×10^{-13}	7.28×10^{-13}
200	15,400	23,000	441	450	2.47×10^{-13}	2.52×10^{-13}
250	25,400	28,700	97.8	97.8	3.50×10^{-14}	3.50×10^{-14}
300	38,000	34,500	13.0	13.0	2.37×10^{-15}	2.37×10^{-15}

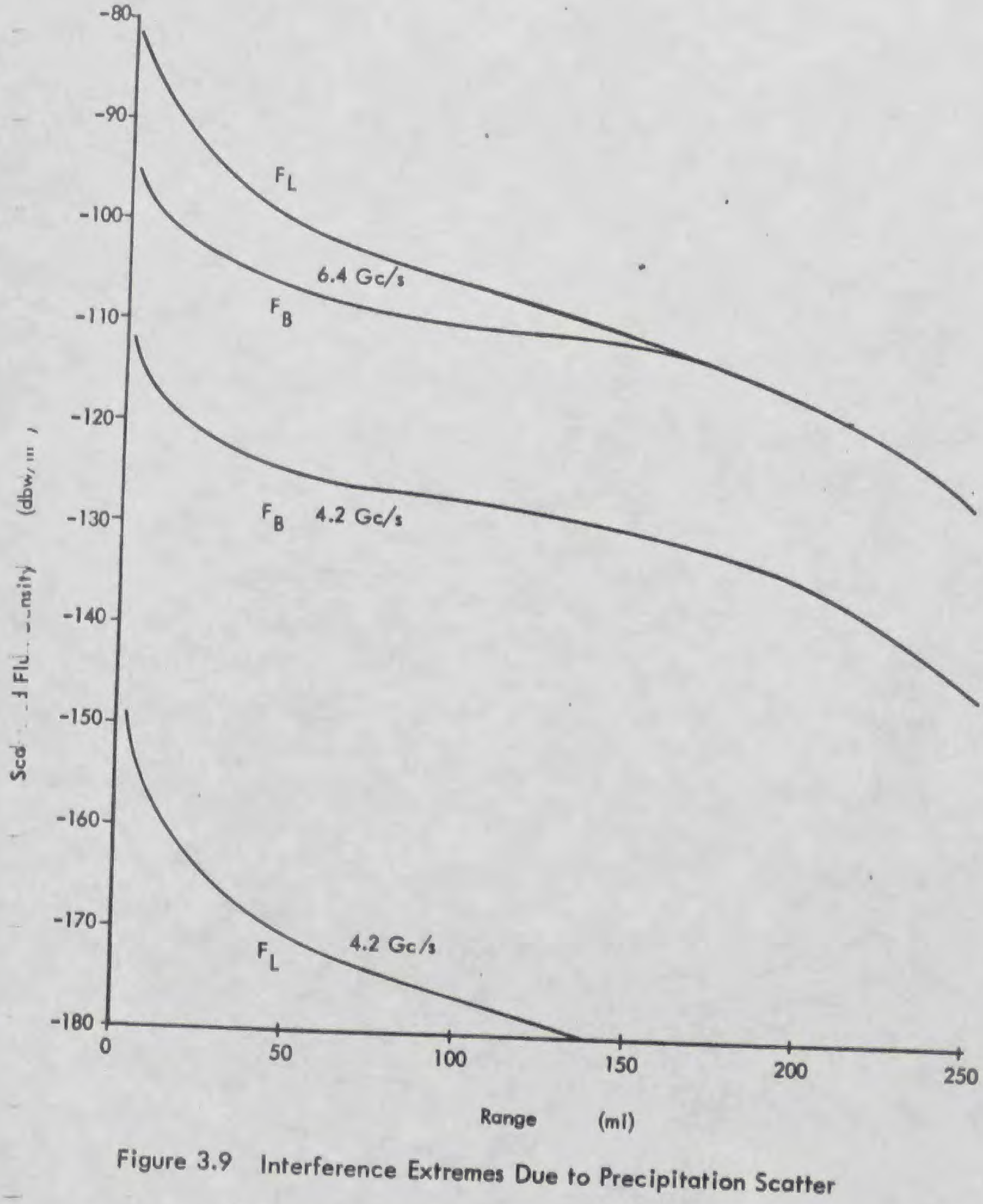


Figure 3.9 Interference Extremes Due to Precipitation Scatter

Thus, the flux density at the receiver due to scattering by the volume V is given by

$$F = \frac{P_t G_t}{16\pi R^2}\left(\frac{\phi}{2}\right)^2 \int_V \dot{s}\,dr$$

which has exactly the same form as that obtained in Case 4.

3.4.4 Aircraft Scatter

A potential source of mutual interference between common-carrier facilities and the proposed BNS earth stations is the scattering of signals by aircraft. We consider just those situations where the paths of both the incident and scattered rays are in the free-space region. The power density F in w/m^2 at a common-carrier receiver located R meters from an aircraft flying h meters from a BNS earth station is given by

$$F = \frac{P_t G_t}{4\ h^2}\,\sigma\,\frac{1}{4\pi R^2} \qquad (3.7)$$

where σ is the scattering cross-section of the aircraft in m^2 and $P_t G_t$ is the ERP of the transmitter in the direction of the aircraft.

Measurements of cross-section of various aircraft for backscatter are readily available but values of σ for other scattering angles are not. A reasonable assumption is that σ will not exceed the backscatter cross-section. A paper on this subject prepared for the FCC and the House of Representatives by the Microwave Committee of the Electronic Industries Association suggests a value of 75 m^2 for σ and we have followed this suggestion (U.S. Congress 1961). A more complete review of the literature on aircraft scatter is needed, and if the desired data is not available, measurements of σ for various aircraft and aspect angles should be conducted.

Clearly, F increases as h decreases until the point where either the incident or scattered ray enters the diffraction region. Further decrease of h will result in a decrease of scattered power density because of increased attenuation in the diffraction region. Thus, for the high elevation angles of BNS earth station antennas, h is roughly approximated by the aircraft altitude and the worst interference for a given R occurs near the value of h for which the transmission path is tangent to the terrain. As before, the 4/3 earth-radius approximation is used.

The preceding discussion was based on Case 4 interference. The worst-case result for Case 2 has the same form as Equation 3.7.

Except for the immediate area around major airports, aircraft of large cross-section almost always fly at altitudes of several thousand feet or more. For the purpose of preliminary estimates of aircraft scatter interference, attention is restricted to altitudes between 5,000 and 50,000 feet. For a given BNS earth station and common-carrier facility, the altitude h yielding maximum interference and lying between the altitude limits is easily found from Equation 3.6. In every case of interest, the result is one of the limiting altitudes.

For the case of the scattering aircraft in the main beam of the BNS earth station, the required coordination distances are given in Table 3.4 for various aspect angles of the common-carrier antenna and various aircraft altitudes. The altitude of greatest interference for each situation is denoted by h_m. These results are based on an ERP of 73 dbw for the BNS earth station and 53 dbw for the common-carrier transmitter.

Table 3.4 Coordination Distances for Aircraft Scatter

Interference Situation	Coordination Distance (mi)		
	h = 5,000 feet	h = 50,000 feet	$h = h_m$
Case 2			
Main Lobe	100	316	316
First Side Lobe	100	10	100
Other Lobes	10	1	10
Case 4			
Main Lobe	62.5	6.25	62.5
First Side Lobe	10.0	1.00	10.0
Other Lobes	<1.0	<0.10	<1.0

The design procedure used in the sample problem described in Section 4 to control direct interference and precipitation scatter yields BNS earth station locations which avoid intersections of main lobes of the interfering and interfered beams for all common-carrier facilities within 275 miles of the area considered for siting. Main-lobe to main-lobe scattering for R greater than 275 miles occurs when an aircraft above 37,800 feet flies through the BNS beam, a rare event of short duration.

Much of the potential for mutual interference between BNS beams and common-carrier side lobes is eliminated by the design procedure used to control precipitation scatter. The remaining aircraft scatter situations result in brief intervals of interference occurring rarely because of the small beam width of the BNS earth station. The frequency of occurrence and intensity of these events is considerably greater for Case 2 than for Case 4 interference. By locating the BNS earth station so that the beam does not pass through airways carrying heavy traffic at low altitudes, the frequency of occurrence of these interference events can be kept within tolerable limits.

Typical durations of the aircraft interference events are in the range of 0.1 to 1.0 second. The mode is near 0.4 second corresponding to 200-mi/hr aircraft near 10,000 feet and 600-mi/hr aircraft near 30,000 feet. About two such events per hour can be tolerated by each BNS terminal for a restriction to 0.02% of the time. Location of BNS terminals five miles or more from major airports should be sufficient to keep the probability of flights through the beam within tolerable limits.

A complete analysis of aircraft scatter interference requires a study of flight patterns and traffic densities in the vicinity of major airports. Also, before this problem can be completely determined, a specification is required that states tolerable interference as a well-defined function of occurrence frequency. Such specifications are currently being considered by CCIR.

4. Location of Earth Stations in the BNS System

In the preceding section, relevant interference phenomena have been described and quantified. The approach now is to proceed to a consideration of the actual interference situations in and near some particular metropolis, e.g., New York City and the surrounding area from Sussex and Cranbury, New Jersey to Bridgeport, Connecticut. This engineering approach is difficult and tedious. However, much of the procedure can be programmed so that computer assistance can be used to reduce engineering costs of repeating the procedure in siting studies required for each BNS earth station.

One of the major system design problems in the BNS system is the siting of the earth stations, since these must connect to TV transmitters that are often located in or near large metropolitan areas which also contain many common-carrier facilities. In the siting of the earth station, interference Cases 2 and 4 must be considered.

The procedure followed here is to consider each interference possibility separately and to determine regions within the overall area that must be excluded. Regions which are not excluded after study of all the various interference situations will be feasible for siting purposes. These acceptable areas can then be evaluated with regard to other criteria and the most desirable location within these acceptable regions selected.

4.1 Design Procedure

The interference conditions which must be considered are the case of the common-carrier transmitter interfering at the earth terminal receiver via both direct path and scatter path and the case of the earth station transmitter interfering with local common-carrier receivers via both direct and scatter paths. The general procedure in making a site analysis is to first determine the range from the prospective area within which common-carrier facilities must be considered in the various interference cases. Specific interference contours are then determined using the techniques illustrated in Section 3 for each case of interference surrounding the appropriate common-carrier facility. The interference contour surrounding a microwave facility for Case 2 direct path interference is given below.

$$R_2 = (\lambda/4\pi)\sqrt{\rho_2 G_{CH}}$$

where

$$\rho_2 = G_{EH}\, P_{TC}/P_{RE} \tag{4.1}$$

Similarly, the contour for Case 4 direct path interference is

$$R_4 = (\lambda/4\pi)\sqrt{\rho_4 G_{CH}}$$

where (4.2)

ρ_4 = $G_{EH} P_{TE}/P_{RC}$

P_{TC} = the power radiated by the common-carrier transmitter

P_{TE} = the power radiated by the earth station transmitter

P_{RC} = the tolerable interference level at the common carrier receiver terminals

P_{RE} = the tolerable interference level at the earth station receiving terminals

G_{EH} = the gain of the earth station antenna in horizontal plane

G_{CH} = the gain of the common-carrier antenna in horizontal plane

Using the maximum power permitted by CCIR Recommendation 406, P_{TC} = 13 dbw. From the proposed specifications of BNS-3, P_{TE} = 20. Rounding off the value -119.5 given in Table 3.2, we have P_{RC} = -120. Assuming that the dispersion signal proposed for use in the BNS system, in addition to reducing Case 4 interference, will also reduce the effect of Case 2 interference by as much as 5 db, then C/I = 37 - 5 = 32 db. For a carrier power level of -106 dbw at the BNS earth station receiver, we have P_{RE} = -106 -32 = -138 dbw. Any optimism in the assumed 5 db of improvement due to carrier dispersion is offset by the assumption of an ERP 8 db above the maximum level used in the TD-2 system.

With these assumptions, we have

$$\rho_2/\rho_4 = 12.5 \quad \text{and} \quad R_2/R_4 = 5.25 \qquad (4.3)$$

These results show that the interference contour for the direct path dominates for the case of common-carrier interference with the earth station receiver. It should be noted that Equations 4.1 and 4.2 are developed for free-space propagation. This is an extreme case.

In considering a specific example, interference contours can be plotted for different values of ρ and the effect in site selection obtained by varying G_{EH}

can be determined. This procedure will help define the required amount of site shielding to provide adequate freedom in siting. The technique for site shielding can then be selected to provide the required value of G_{EH}.

The range of consideration for scatter interference is given in Table 4.1 for the proposed BNS system. The allowable interference at the receiver terminals is translated into power density for the different cases of scatter interference (main lobe, first side lobe, and other side lobes) and then compared with the power density resulting from an extreme case of precipitation scattering shown in Figure 3.9 to obtain the required separations shown in Table 4.1. The interference contours of all beams pointed toward the siting area within the range given in Table 4.1 are then plotted to determine the areas blocked by precipitation scatter considerations. A practical example will illustrate that precipitation is the predominant mode of interference for the main lobe only. The range of possible interference from a common-carrier facility within the main beam will be determined by the precipitation scatter path of interference.

4.2 Sample Problem: New York City

Figure 4.1 shows the positions of microwave facilities within the immediate New York City area. This is the area within which a preliminary site-selection study has been made. The data shown in Figure 4.1 as well as all data which will be used in this example was obtained from the FCC. The area of consideration is approximately defined by a 40-mile radius around New York City.

Table 4.1 Range of Consideration for Rain Scatter

Case	Interference Conditions	Frequency (Gc/s)	Main Lobe or Side Lobe	Tolerable Interference Level (dbw)	Assumed Antenna (db re 1 m^2)	Tolerable Power Density (dbw/m^2)	Range of Consideration (mi)
2	Common-Carrier to BNS Earth Station	4	Main Lobe	-133*	16	-149	275
			1st Side Lobe	-133*	16	-149	7
			Other Lobes	-133*	16	-149	2
4	BNS Earth Station to Common-Carrier Relay	6	Main Lobe	-100.5	6.5	-94	5
			1st Side Lobe	-100.5	-23.5	-77	< 0.5
			Other Lobes	-100.5	-43.5	-57	< 0.2

* This level corresponds to C/I = 27 db at the receiver terminals in the earth station.

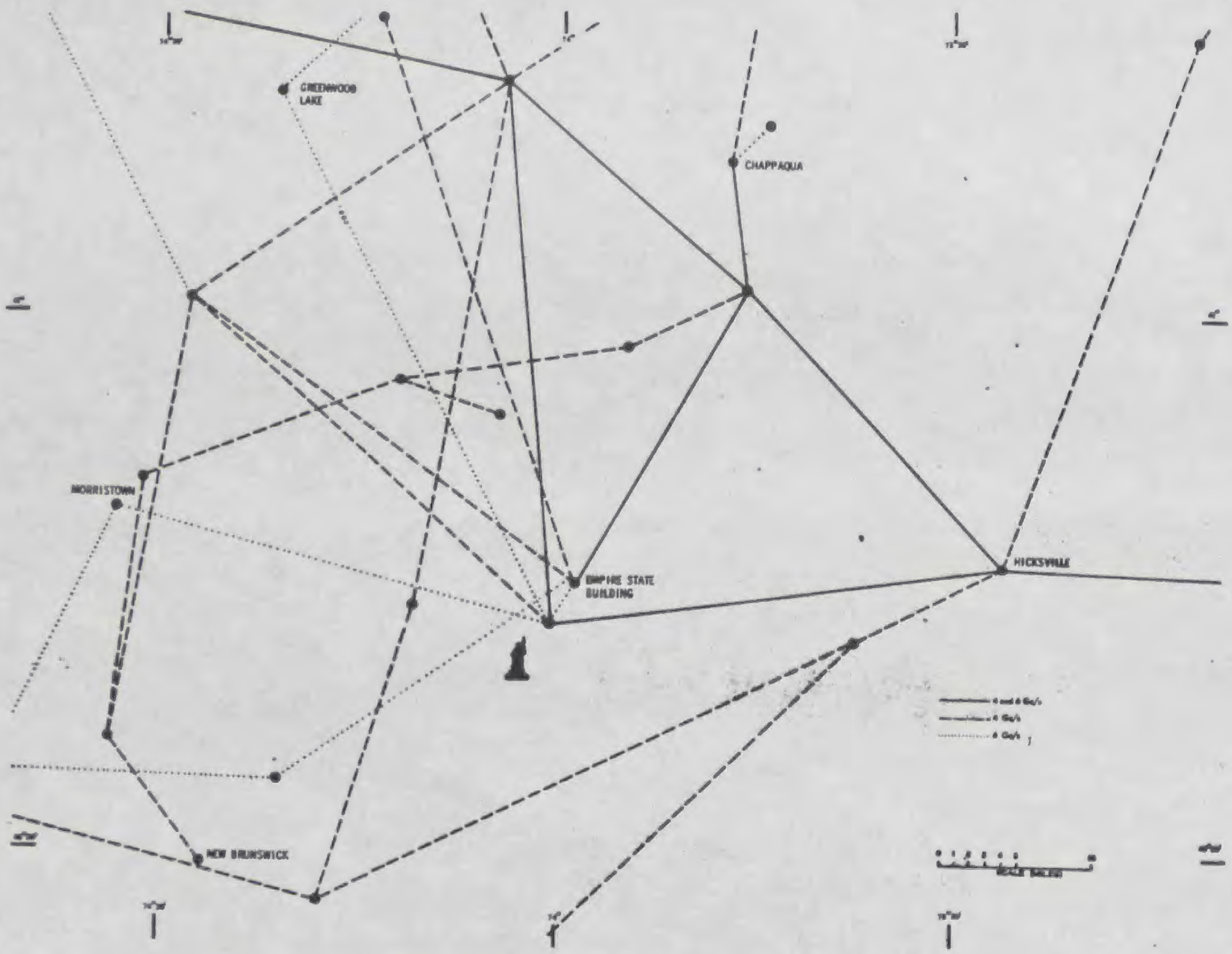


Figure 4.1 Locations of Microwave Relay Facilities near New York City

Besides the data shown in Figure 4.1, it is necessary to consider all microwave facilities out to 275 miles for the case of scatter interference from the common-carrier transmitter to the earth station receiver in the 4 Gc/s band. In determining the various interference contours the full horizontal pattern of the common-carrier antenna is utilized, while for the cases of precipitation scatter interference only the main beams will be considered. The parameters shown for Equation 4.3 are assumed with $G_{EH} = -24$ db, yielding $\rho_2 = 127$ and $\rho_4 = 116$ db. The gain of the transmitting antenna in the horizontal plane will be assumed to be omni-directional. The conclusions can then be modified to account for the actual measured horizontal pattern.

Figure 4.2 shows the areas which are excluded by Case 4 local interference. Within the region of consideration, potential interference to and from the microwave facilities is considered from all directions. The contours surrounding the stations are a rough approximation to the horizontal gain pattern of a horn reflector. Figure 4.3 shows the areas which are excluded by Case 2 interference over the direct path. It is interesting to note the effect on the excluded area of varying G_{EH}. If it is increased to -19 db, ρ_2 will then become 132 db and the area which will avoid this type of interference is shown in Figure 4.4. Comparison of Figures 4.3 and 4.4 emphasizes the need for effective site shielding and low antenna side-lobe gain in a metropolitan area.

Figure 4.5 shows the excluded areas for Case 4 interference via the scatter path considering stations out to 150 miles from the edges of the area

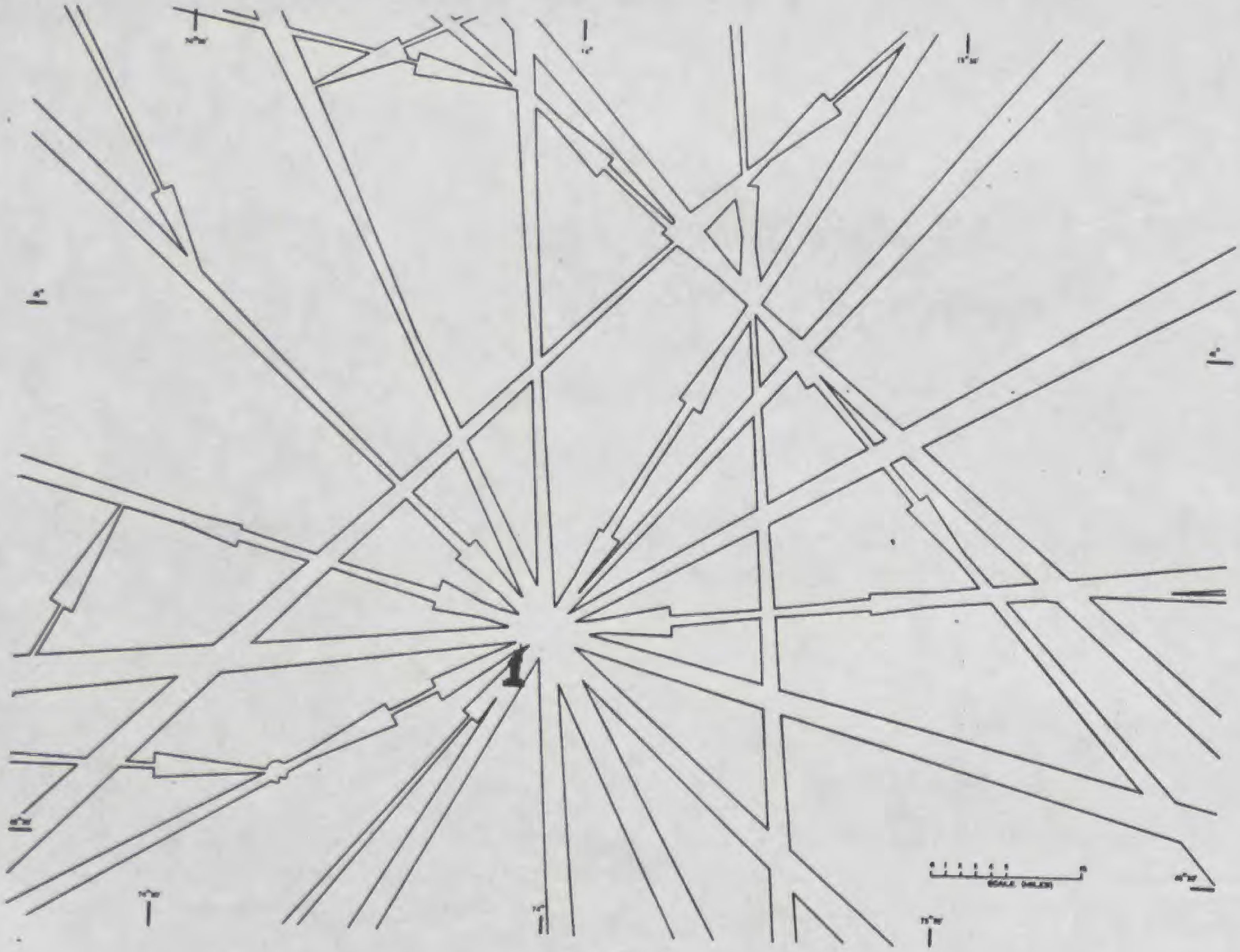


Figure 4.2 Area Excluded Due to Direct 6 Gc/s Interference, $\rho_{\ell} = 116$ db

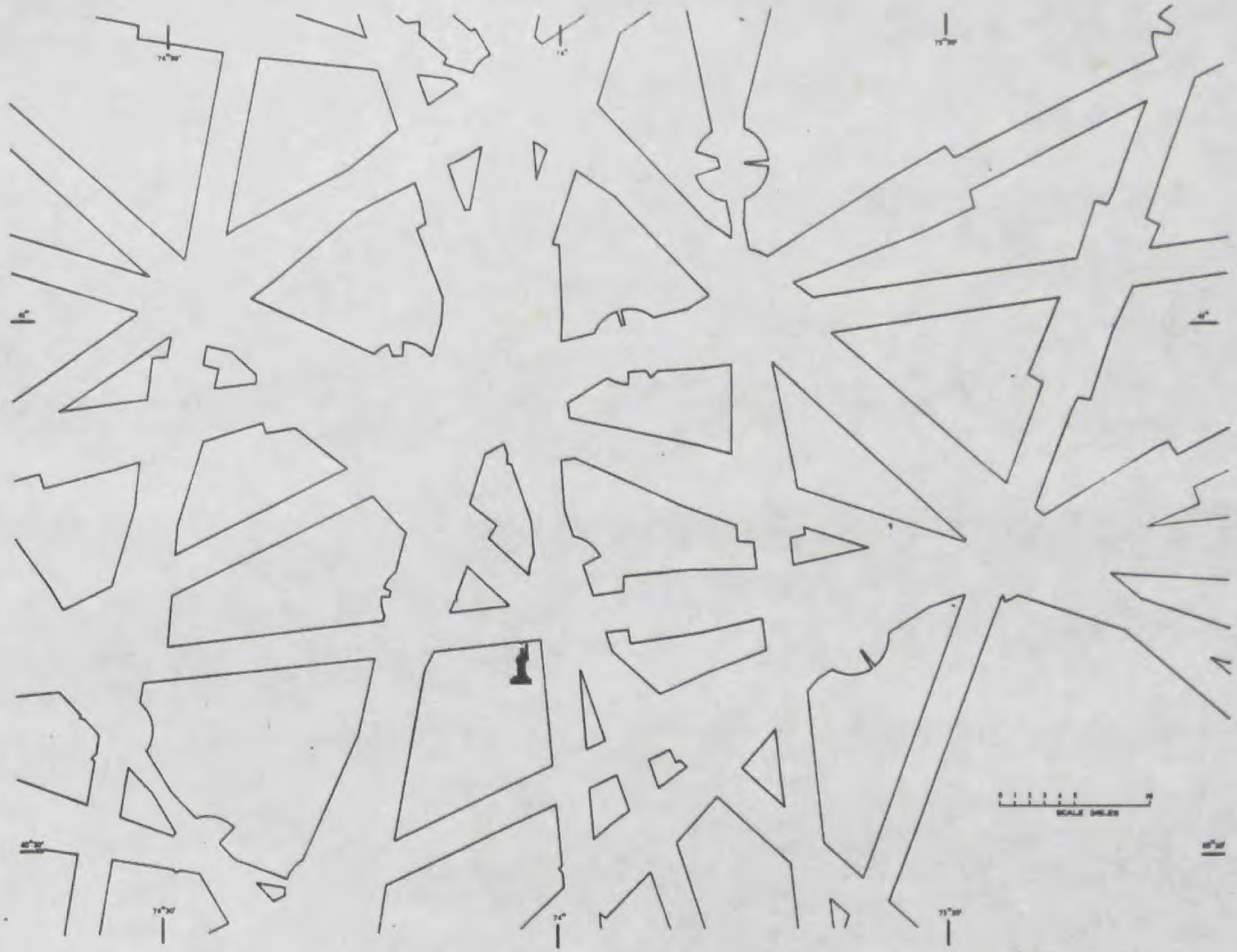


Figure 4.3 Area Excluded Due to Direct 4 Gc/s Interference, ρ_2 = 127 db

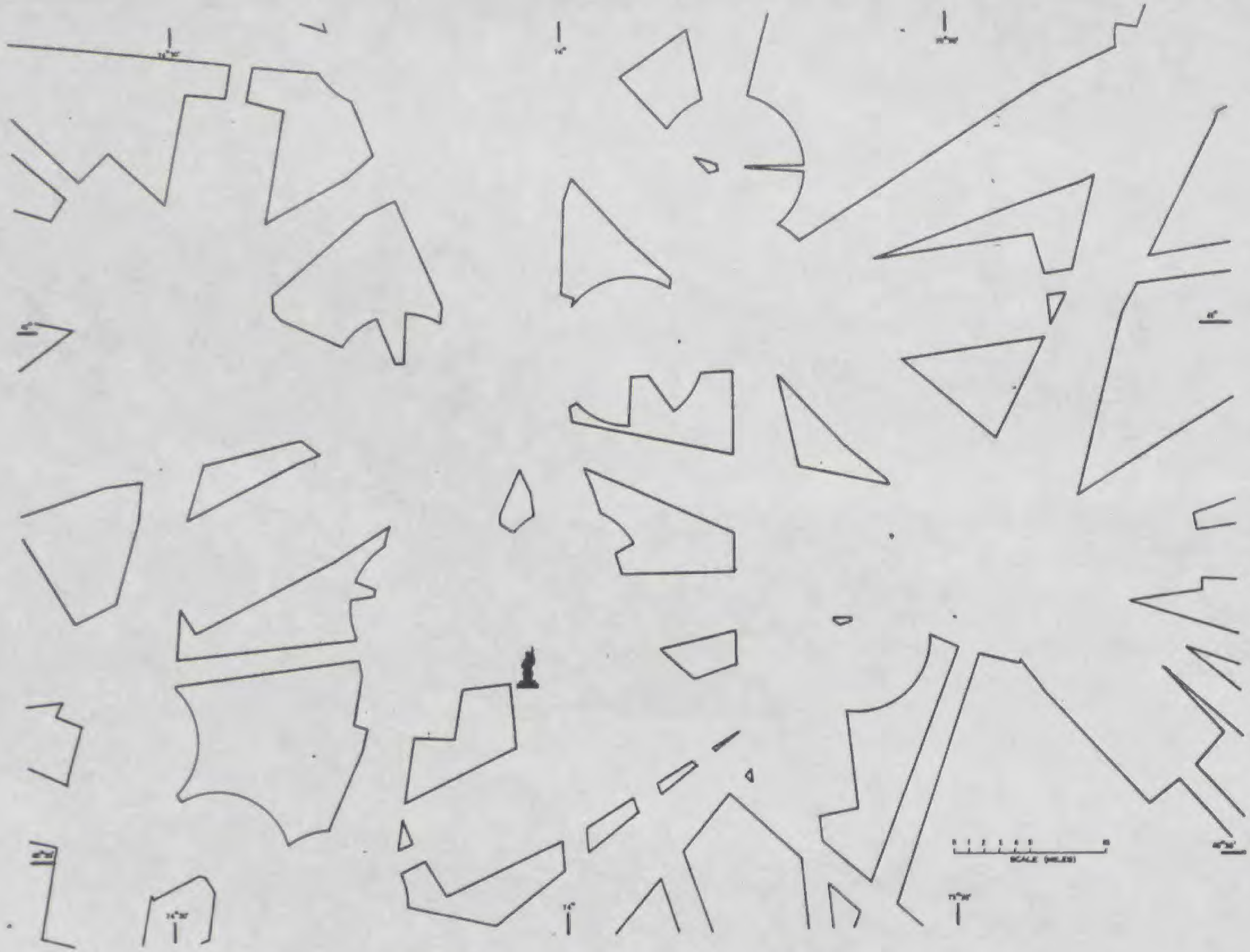


Figure 4.4 Area Excluded Due to Direct 4 Gc/s Interference, ρ_2 = 132 db

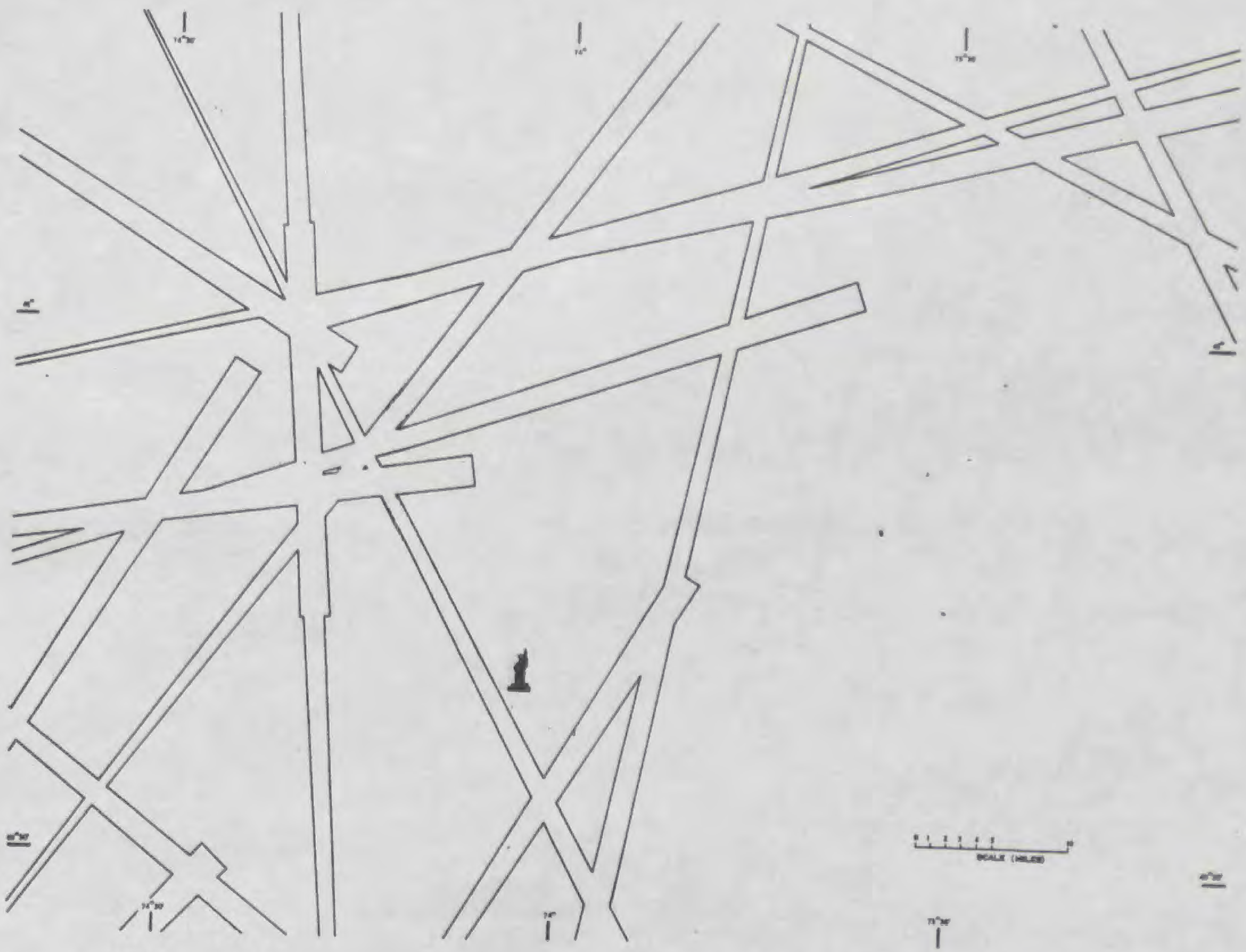


Figure 4.5 Area Excluded Due to Scatter into TH Stations at Ranges up to 100 mi.

considered for siting. This radius of consideration errs in the direction of increased interference, as seems appropriate pending more complete measurements.

Figure 4.6 shows the areas which are excluded due to Case 2 interference via the scatter path for interfering stations located within 100 miles of the edges of the area considered. Figure 4.7 shows the areas which are excluded by considering precipitation scatter interference from stations located between 150 to 275 miles from the siting area. Because of the distance of the transmitter stations and the width of their beams in the vicinity of New York, a large area is excluded from consideration due to interference from the more distant microwave facilities. It is important to realize that less pessimistic assumptions in defining the scatter characteristics reduces the radius of consideration of interference sources and increases freedom of site selection. The approximate distance to each of the stations can be estimated by the width of the beam shown within the New York area. The increase in acceptable area resulting from eliminating interference from these stations can then be estimated.

It is also important to note that some of the interfering beams considered can be eliminated by topographic considerations. For the purpose of this preliminary study, a conservative estimate of acceptable siting areas was desired and topographic considerations were not employed.

Figure 4.8 shows the area that is not excluded by any of these considerations and, therefore, open to consideration for siting an earth station. The net

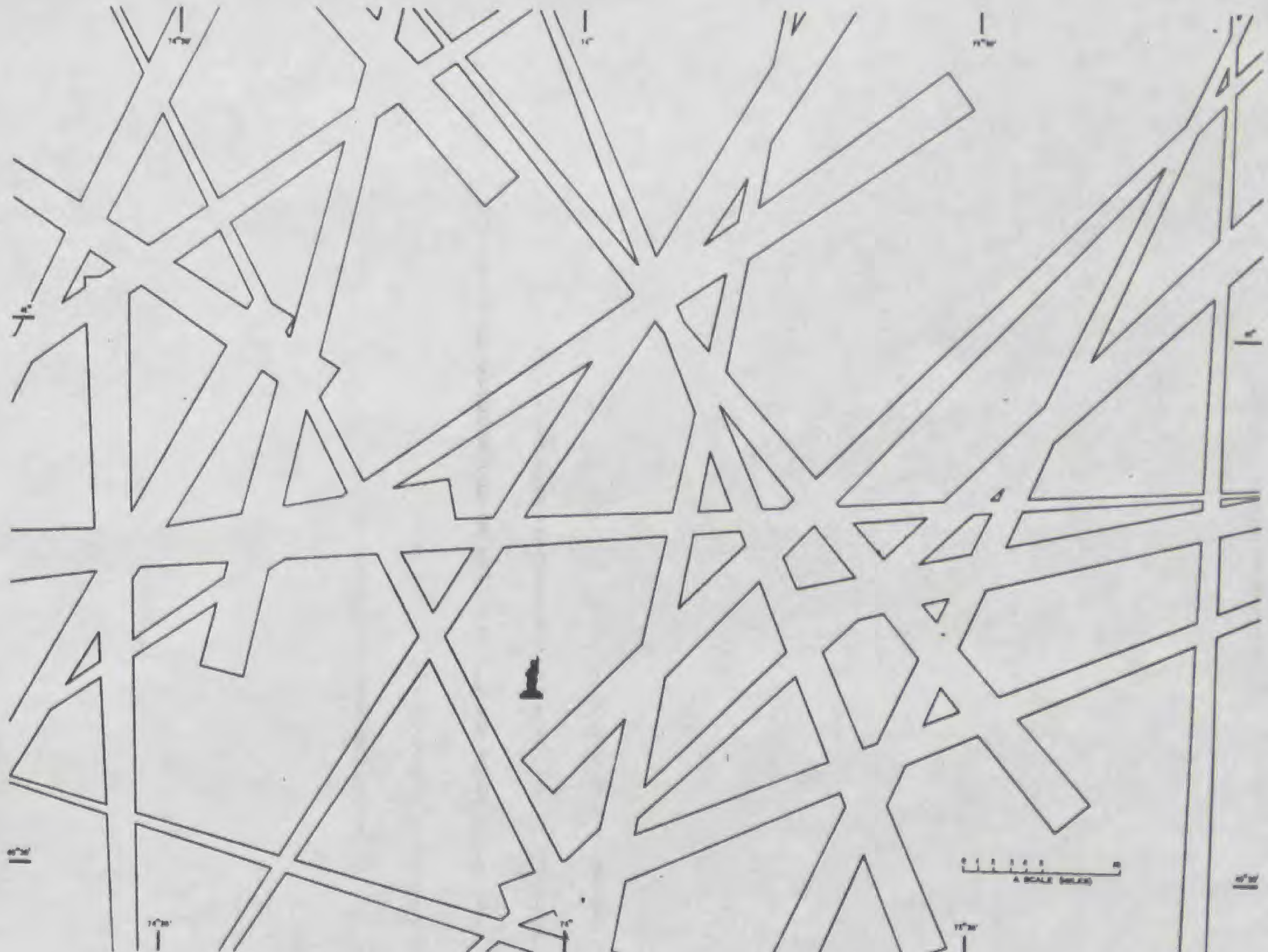


Figure 4.6 Area Excluded Due to Scatter from TD-2 Stations at Ranges up to 100 mi.

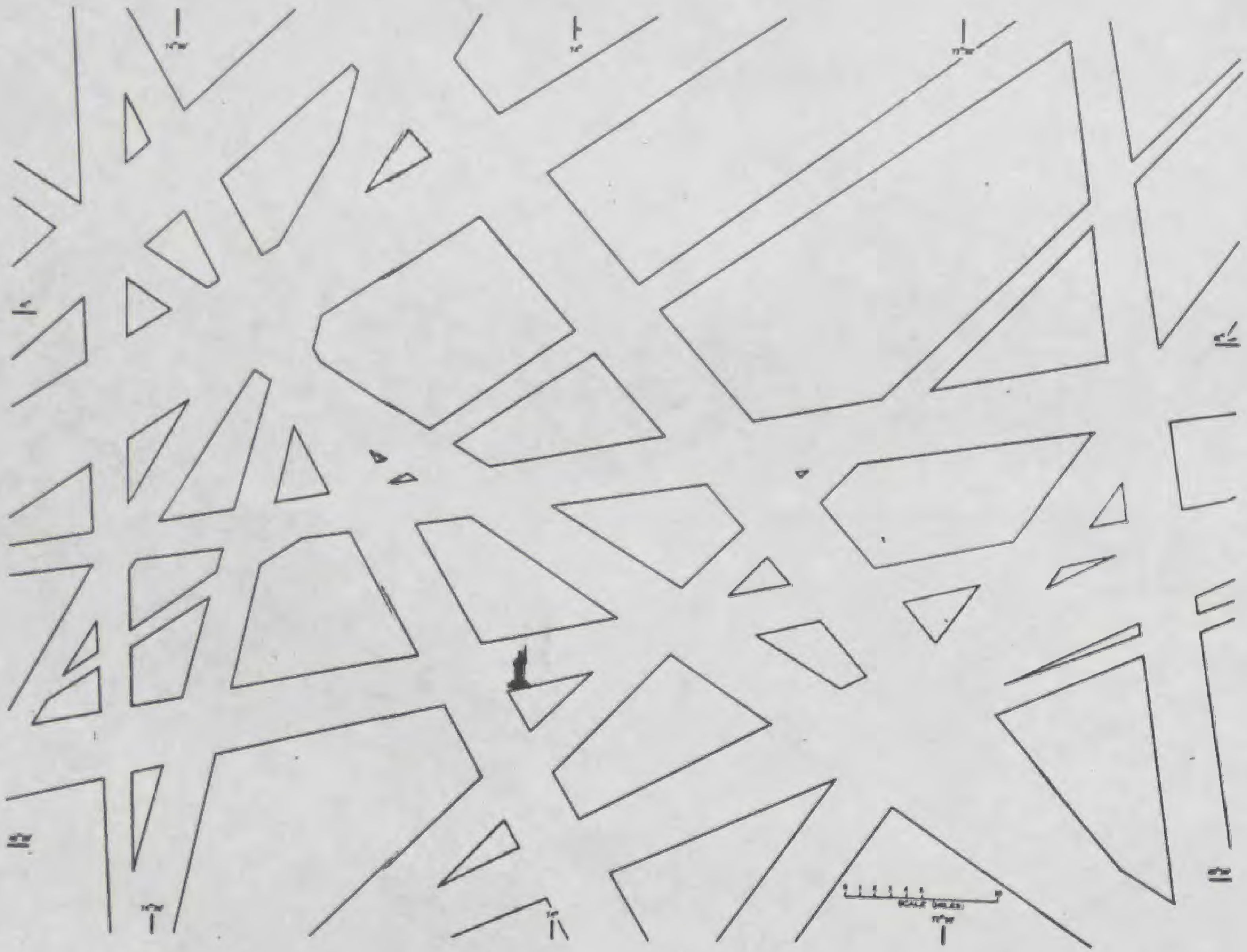


Figure 4.7 Area Excluded Due to Scatter from TD-2 Stations at Ranges of 100 to 275 mi.

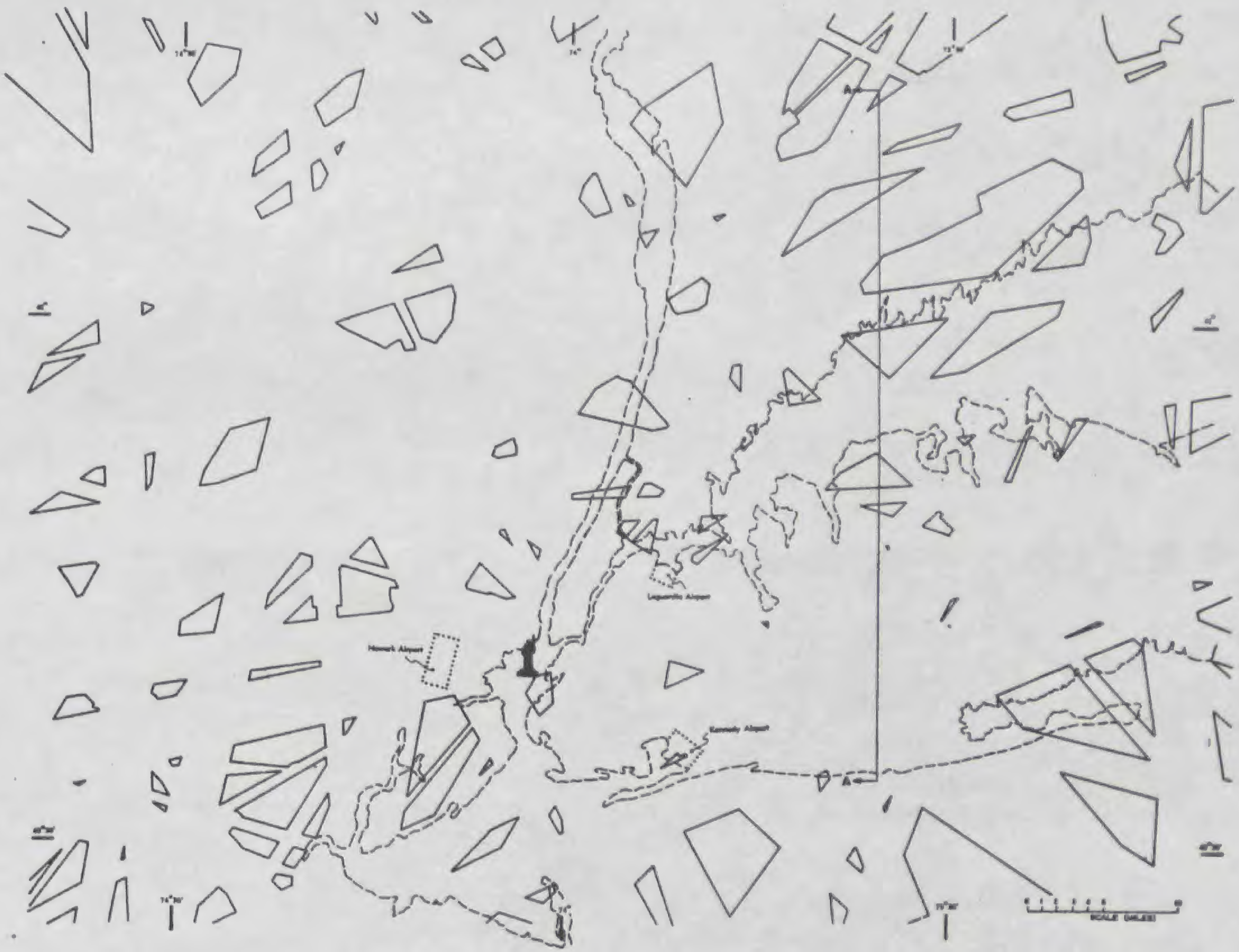


Figure 4.8 Areas for Consideration in Siting BNS Earth Stations

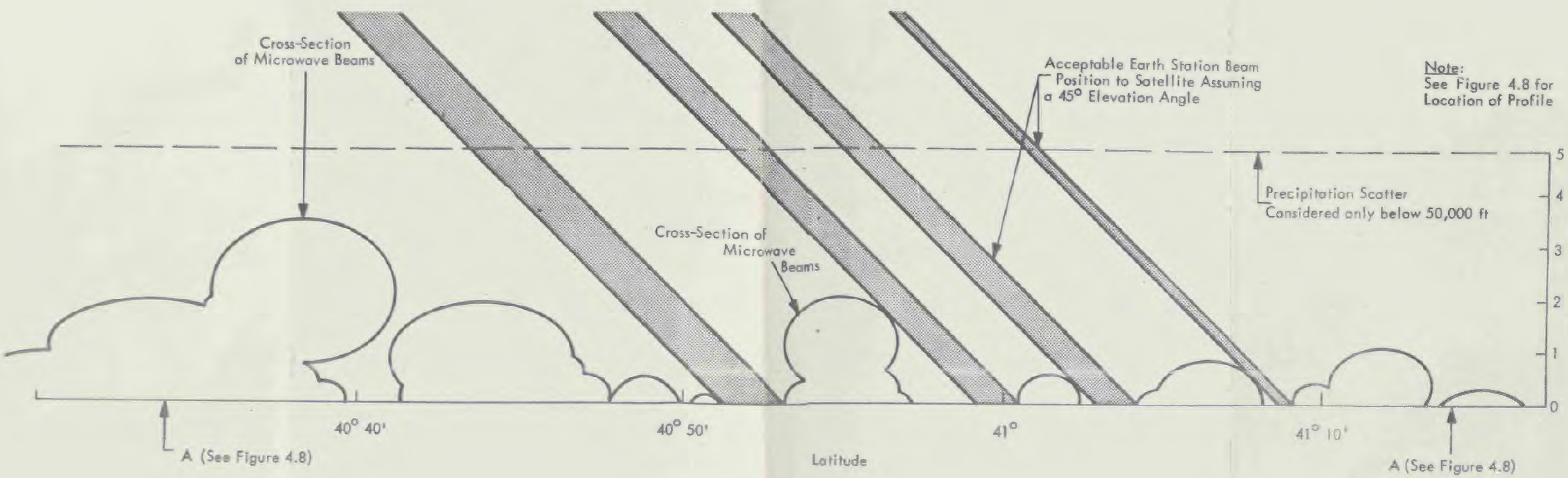


Figure 4.9 Profile of Volumes Excluded to the Main Beam of the Earth Station

area in Figure 4.8 is obtained by blocking out the interference contours shown on Figures 4.2, 4.3, 4.5-4.7. Figure 4.2 is based on the assumption that the carrier dispersion signal will reduce the effect of Case 2 interference by 5 db. Since experimental results are not presently available to support this assumption, a more conservative estimate of the area available for consideration is obtained by using Figure 4.4 in place of 4.3 in the mapping procedure employed here. Figure 4.4 is drawn for a value of ρ_2 that is 5 db higher than that used in Figure 4.3 and, therefore, corresponds to the assumption that no reduction of interference effects is provided by the carrier dispersion signal. The net area resulting from merging Figures 4.2, 4.4-4.7 is shown in Figure 1.1.

To this point, interference contours have been described in the horizontal plane. For distant stations the beams will actually be elevated and a profile drawing must be constructed or an equivalent calculation performed to ensure that the earth station beam will not intersect a common-carrier beam at any point. Figure 4.9 shows such profiles which cut through several potential siting regions indicated by Section A-A in Figure 4.8. As illustrated in the figure, some of these regions are truly acceptable for siting, while others are blocked by elevated beams which intersect the line of sight to the satellite. In other cases, a profile view would disclose regions available for siting which might have been obscured in the plan view.

Figure 4.9 is an example based on a smooth earth approximation. To predict the beam elevation accurately, the site elevations, antenna heights, and pointing angles must be taken into account. The beams that produce most of the adjacent blockage are wide beams from distant sources with beam centers at 10,000 feet or greater. The elevation and antenna height of most common-carrier facilities are small. For this reason, it is felt that the adjacent blockage problem is fairly accurately represented here, and, that only minor changes in beam elevation will be found when antenna heights and pointing angles are taken into account.

Figure 4.9 was constructed with the assumption that the cross-section of the common-carrier beams were circular, when actually they are elliptical with the major axis in the vertical plane. A safety region should be placed around each beam to account for variation in beam bending due to changes in air pressure and temperature.

In the sample problem, data was accumulated on the types of antennas used by common-carrier facilities in the New York local area. It was found that at least four antennas of 4 and 6 Gc/s facilities did not use horn reflectors. Considering antenna data filed with the FCC and presented in Figures 3.2 and 3.3 led to coordination distances much larger than the horn reflector stations. If required for satisfactory siting, these antennas could be replaced by horn reflectors at an additional expense small in comparison to the incremental cost of locating a BNS terminal in an exurban area.

The sample problem has dealt with siting major BNS terminals in a metropolitan area. For completeness, the problems involved in temporarily siting the BNS remote pick-up stations must be considered. The significant features of these stations are a 15-ft parabolic antenna (gain = 46 db), a transmitter power of 50 watts and single-channel operation in a transmit-only mode of operation. For the most part, it can be assumed that the remote pick-ups will operate in areas at a considerable distance from a BNS earth terminal. In locating the pick-ups, interference from the pick-up transmitter to the common-carrier 6 Gc/s receivers must be considered (Case 4 interference). For a 15-ft antenna with a main-lobe gain of 46 db, a G_{EH} of -5 db can be obtained. From Equation 4.2, $\rho_4 = 132$ db. The size of each of the interference contours surrounding the common-carrier facilities is approximately the same as is shown in Figure 4.4, allowing for the difference in frequency. Approximately 90% of the 6 Gc/s common-carrier facilities in the vicinity of the remote pick-up will be eliminated from interference consideration due to the difference in the frequencies of operation. The area for possible siting of the remote pick-up will be quite large. Since the remote pick-up employs a transmitter power less than that of the BNS earth station terminal, interference to the common-carrier facilities via the precipitation scatter path should be less than for the BNS earth station terminal. Since the range of consideration for precipitation scatter interference from the BNS earth station terminal was quite small, it is not necessary to consider precipitation scatter from the remote pick-up facility.

4.3 Critique and Conclusions

The potential siting regions shown in Figure 4.8 are small relative to the total area of consideration and are well dispersed. The inclusion of the effect of the beams of common-carrier stations which may have been overlooked or are presently under construction should not appreciably affect the potential siting area. Approximately 86% of the area considered lies under one or more microwave relay beams. About half of the remaining area is blocked by elevated beams as shown in Figure 4.9. A small amount of area is available under beams and does not show up in Figure 4.8. It can be estimated that approximately 7% of the total area considered is available for siting -- on the basis of interference considerations alone.

In the example G_{EH} was considered omni-directional. It actually has a directivity associated with it and some points on this pattern result in much lower side lobes than the omni-directional envelope considered in the example. In the construction of the site these optimum suppression lobes can be oriented toward stations of greatest potential interference.

Consideration of the aircraft scatter problem requires that areas of several square miles near the three major airports near New York City be excluded for siting purposes along with smaller areas near other airports. Using the net area shown on Figure 4.8 as a basis, exclusion of the three major airports eliminates a negligible fraction of the area available for siting. Exclusion of circles five miles and ten miles in radius and centered on these airports eliminates 0.7% and 10.2% of the net area respectively.

Preliminary study of flight profiles indicates that the probability of flying through the BNS beam can be reduced to tolerable levels if the BNS earth station is located at least five miles from the end of a runway. Detailed study of plan views of traffic patterns at each airport is necessary to determine the best shape for the area to be excluded around each airport. Clearly, circular areas of exclusion are not optimal as it is desirable also to exclude areas under the most heavily traveled corridors into and out of each airport.

Thus, aircraft scatter considerations are largely included in the precipitation scatter problem as far as New York City is concerned. Adding aircraft scatter to the problem results in a significant increase in the excluded area, but an adequate number of sites remain even in the dense New York City situation.

From the example for New York City, it is possible to judge the difficulty in siting at other locations by considering the number and density of microwave facilities in their immediate vicinity. Most locations will have fewer local common-carrier facilities than New York. The areas excluded in Figures 4.2 and 4.3 due to local interference will be much less for the same set of BNS system parameters. Most locations will also have many fewer distant common-carrier facilities that must be considered for precipitation effects, since New York City is located near many other metropolitan areas. A comparison of the FCC maps of microwave facilities for Atlanta, Denver and Washington, D.C. with those of

New York City indicates that the siting problem in the Washington area will be slightly less constrained than in New York City and that siting in Atlanta and Denver will be much less constrained.

Other conclusions of this preliminary study of the BNS siting problem in the New York area are as follows.

- A gain of -24 db in the direction of a potentially interfering common-carrier station must be achieved through antenna design and side-lobe suppression techniques for the BNS earth station in dense metropolitan areas to obtain sufficient freedom in site selection.

- The potential interference is greater in the case of interference to the BNS terminal than for the case of interference to the common-carrier facility.

- For the case of precipitation scatter interference to the BNS earth station receiver, potentially interfering common-carrier facilities must be considered out to a range of 275 miles.

- Measurements of scatter cross-section of large aircraft are needed for all angles of scattering particularly for scattering angles between 45° and 135°.

- The degree of area exclusion from siting consideration due to each important interference case is given in Table 4.2.

- Measurements of the psychophysical effects of the common-carrier interference with the BNS down-link signal are required to determine: (1) the degree of Case 2 interference reduction provided by the proposed carrier-dispersion technique, and (2) the best assignment of BNS carrier frequencies relative to TD-2 carrier frequencies.

  In order to achieve sufficient freedom in site selection, it may be necessary to replace as many as two or three common-carrier antennas having insufficient side-lobe suppression with horn reflectors for each metropolitan area where a BNS earth station is to be located.

Table 4.2 Areas Excluded by Interference Effects

Interference Situation	Range of Consideration (mi)	Area Eliminated (%)	Figure Number
Case 2			
Direct	0-40	60	4.3, 4.4
Precipitation	40-100	50	4.6
Precipitation	100-275	50	4.7
Case 4			
Direct	0-40	25	4.2
Direct and Precipitation	40-100	25	4.5

- Regulatory agencies may wish to consider allocating not only spectrum and transmitter locations but also beam width, power, azimuth, altitude and elevation.

- The terrestrial microwave system tends to grow by adding spectrum to the existing links, much of which presently occurs outside the shared bands. Thus, this growth need not obliterate the areas presently open to metropolitan siting of BNS earth stations, provided that early decisions are made to reserve some of these allocations for the proposed use.

- Preliminary studies of aircraft scatter indicate that short intervals (less than 1 second) of interference will occur rarely. The system design considerations used to control precipitation scatter will also greatly reduce aircraft scatter. If the BNS earth terminal is located so that the main beam does not intersect low-altitude airways, the interference via aircraft scatter will occur for a tolerably small fraction of the time.

- For small fractions of the time (e.g., 0.02%), BNS signals will be noticeably below the high quality expected most of the time. Present network signals experience outages for similar fractions of the time.

- Of the total area considered for possible siting in the vicinity of New York City, 86% is found to be under one or more common-carrier beams as shown in Figure 4.8. Of the remaining 14%, about half of the sites will pass the profile check illustrated in Figure 4.9 and, thus, be acceptable for siting as far as interference considerations are concerned.

- The acceptable area is well dispersed throughout the region of consideration. Several different types of locations will then be acceptable for siting the earth stations.

- New York City is a severe example of potential interference, probably the worst in the country, considering both the direct path and the scatter path.

Before actually siting an earth station a more detailed siting study must be undertaken, including the considerations outlined in the sample problem above. Measurements of common-carrier field strengths must be made at various altitudes and locations near potential sites. However, the study conducted here for the New York metropolitan area -- in a communications sense, probably the most congested in the United States -- shows that it is feasible with only moderate difficulty to find a number of areas for BNS sites. Some of these areas may lie within only one microwave hop of the Empire State Building. There will be even less difficulty in siting the other BNS terminals since the preponderance of these will be located away from the major metropolitan areas.

5. Glossary

α	Angle of arrival of satellite signal relative to the main beam of a common-carrier antenna
Case 1	Common carrier interfering with satellite receiver
Case 2	Common carrier interfering with BNS earth station
Case 3	BNS satellite interfering with common carrier
Case 4	BNS earth station interfering with common carrier
CCIR	Comité Consultatif International Radio
C/I	Ratio of carrier power to interference power
cm	Centimeter
c/s	Cycle per second
db	Decibel, a logarithmic unit of power ratio (the number of db corresponding to a power ratio r is given by $10 \log_{10} r$)
dbw	A unit of power expressed in db above one watt
ERP	Effective radiated power or, more exactly, equivalent isotropic radiated power, i.e., radiated power multiplied by antenna gain above an isotropic radiator
F_B	Received power density scattered from the volume of a rainstorm, common to the main beams of interfering and interfered antennas.
F_L	Received power density scattered from the volume of a rainstorm in the main beam of the earth station, visible from a common carrier facility.

G_{CH}	Gain of common-carrier antenna in horizontal plane
Gc/s	Gigacycle per second = 10^9 c/s
G_{EH}	Gain of BNS earth station antenna in horizontal plane
hr	Hour
ITU	International Telecommunications Union
Kc/s	Kilocycle per second = 10^3 c/s
λ	Wavelength
m	Meter
Mc/s	Megacycle per second = 10^6 c/s
mi	Statute mile
mm	Millimeter
pwp	Picowatt (10^{-12}w), psophometrically weighted, a unit of power which weights interference at various frequencies to account for psychophysical effects
Q	Rainfall rate (mm/hr)
R_i	Separation required between a common-carrier facility and a BNS earth station to control Case i interference, $i = 2, 4$
p_i	G_{EH} (Transmitted Power)/(Tolerable Interference) for Case i interference, $i = 2, 4$
s	Scattering cross-section (m^2), i.e., ratio of scattered power to the power density incident on the scatterer

TD-2	Common-carrier system operating in the 3.700-4.200 Gc/s band
TH	Common-carrier system operating in the 5.925-6.425 Gc/s band
w	Watt, a unit of power

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Respectfully submitted,

The Ford Foundation

by McGeorge Bundy

McGeorge Bundy, President

BIOGRAPHICAL STATEMENT
Dan Connor Ross
President, Ross Telecommunications Engineering Corporation

Prior to forming RossTEC in June 1969, Dr. Ross held a number of engineering and management positions in the IBM Federal Systems Division, 1953-1969. He was Director of Command Systems, an organization of more than 500 analysts, engineers, programmers and support personnel in three major areas: programming systems for the military and intelligence community, ruggedized van-mounted computers and information-storage equipment, preliminary systems design and analysis efforts toward major new systems projects. Most of the personnel in these activities were in the Washington metropolitan area and the others were located at major military headquarters throughout the world. As a result of previous assignments in the development of telecommunications systems and techniques, he also served on a part-time basis as a consultant to the division management and as liaison with the corporate staff on matters of telecommunications policy. He also served as an IBM representative on the EIA Satellite Telecommunications Subdivision and continues as a member of the IEEE Subcommittee on Signal Theory and of Working Group IV of the Comité Consultatif International Radio.

From 1962 through 1967, Dr. Ross managed a group of about 25 advanced development engineers and mathematicians in the practical application of modern statistical communication theory and digital technology to advanced telecommunications equipment and systems. Major projects included: error control through coding, pseudo-noise modulation techniques, digital matched filters, modulation techniques for satellite communications, satellite communication and navigation systems, modems for digital data transmission, communication switching systems and electromagnetic interference studies.

In May 1966, Dr. Ross arranged an IBM exhibit at the State Department Seminar on Satellite Communications in which remote computing, text processing and computer-assisted instruction via trans-Atlantic satellite were demonstrated. Under contract with the Ford Foundation in the latter half of 1966, he supervised the study of potential interference between the proposed Broadcasters' Nonprofit Satellite and terrestrial common-carrier microwave systems. From September 1966 to January 1968, he directed a corporate study of the internal telecommunications needs of IBM. Another assignment related to the problems of spectrum crowding in land-mobile communications and the possible use of digital techniques to alleviate this problem. During the first half of 1967, Dr. Ross served on a corporate study of data transmission products and directed a divisional task force in gathering data to be used in response to the FCC inquiry on computers and communications. During the latter half of 1967, he was assigned to the corporate staff as technical assistant to the IBM executive responsible for the completion of that response.

During the summer of 1967, Dr. Ross served on the Point-to-Point Communications Panel of the National Academy of Science's study of Useful Applications of Space. In August 1968, he was invited to consult with the Presidential Task Force on Communications Policy and successfully defended the results of the interference study performed for the Ford Foundation in 1966.

Turning now to earlier history, Dan Connor Ross was born in Indianapolis on 20 April 1923. His father was Connor D. Ross, Deputy Attorney General of Indiana for many years. In 1933, he moved to Whiteland in Johnson County and graduated from high school there in 1940. He studied electrical engineering at Purdue University until leaving in February 1943 for the U. S. Army Signal Corps. While a student at Purdue, he became the Captain of the Purdue Military and Symphonic Band and was active in many other organizations. He had nearly completed Signal Corps OCS in September 1943 when he was selected as one of 360 candidates from the Army to attend the U. S. Military Academy program at Amherst College to compete for 120 openings in the class entering West Point in July 1944. He completed this program successfully, but was unable to enter USMA because of a slight deficiency in visual acuity. He served as a communication sergeant in the 97th Infantry Division on maneuvers and then completed Infantry OCS in October 1945. He returned to Purdue in April 1946 and graduated in June 1946, majoring in communications engineering.

Dr. Ross served on the faculty of the School of Electrical Engineering on a full-time basis until July 1951 and completed his MSEE by part-time study in February 1949. During several of the terms at Purdue, he worked on the 350 Mev-Synchrotron Project. During the Korean War, he returned to active duty and served as an instructor of electrical engineering at the U. S. Military Academy. During this period, he took further graduate courses in mathematics, physics and electrical engineering at Columbia University on a part-time basis.

In May 1953, Dr. Ross joined IBM as a member of the systems planning group on the SAGE project. He became the manager of the systems planning activity during the development of the production models of the SAGE computers. During this period, he contributed to a number of patents related to the data-transmission and input-output subsystems. Following the organization of the Military Products Division of IBM, he became Manager of Systems Engineering at the IBM facility in Kingston, N. Y. From early 1956 to mid-1958, he directed the IBM activities in air traffic control and invented an automatic data-acquisition technique for use in such systems. During this period, he was active in several professional societies including the AIEE Computing Devices Committee and the AIEE-IRE-ACM Joint Computer Committee. He was also a delegate to the Radio Technical Commission on Aeronautics. His next assignment was Manager of Technical Planning reporting to the Manager of the Engineering Laboratory at Kingston.

IBM initiated its Resident Graduate Study Program in 1959, and Dr. Ross was selected as one of the first employees to participate in this program. During the summer of 1959, he studied modern languages at Columbia and entered The Johns Hopkins University in the fall of 1959. While at Johns Hopkins, he taught a graduate course in signal theory and continued to serve IBM on a part-time consulting basis. In late 1960, he assisted in the planning and staffing of an organization to be responsible for development of communication techniques and systems for military applications. In early 1962, he completed all of the formal requirements for the doctorate in engineering, with the exception of the dissertation, and returned to regular duties at IBM. His dissertation "Vector and Tensor Algebra of Signals Applied to Satellite Navigation" was completed early in 1964, and he received the doctorate (with distinction) in June of that year. During the two academic years immediately following receipt of the doctorate, he served the university on a part-time basis as a lecturer in engineering by presenting a seminar in computer science and a graduate course in signal theory. He is currently a consultant to the faculty and administration of The Johns Hopkins University on new programs of instruction and research related to the application of engineering talent to the solution of real-world problems.

In addition to the organizations mentioned above, Dr. Ross is a member of the Society for General Systems Research, American Society for Engineering Education, American Association for the Advancement of Science, Eta Kappa Nu, Tau Beta Pi, Sigma Xi and the Maryland Academy of Sciences. He has published and presented a number of professional papers on the use of digital computers in systems research, data-acquisition systems for air traffic control, signal theory, satellite navigation and applied mathematics.

On 12 October 1945, Dan Ross was married to the former Deen Dunn, AB Franklin College 1944. They live at 6308 Maiden Lane, Bethesda, Maryland 20034. They have six children: Douglas, a 1969 graduate of Haverford College and a teacher in the Philadelphia public schools; Keith, a sophomore at The Johns Hopkins University; Kenneth, a freshman at Franklin College; Alan, Glen and Elizabeth, students in the Montgomery County public schools.

BIOGRAPHICAL STATEMENT
F. Richard Zitzmann
Vice President, Ross Telecommunications Engineering Corporation

Mr. Zitzmann comes to RossTEC from the Communications Satellite Corporation, where he was Director, Analysis and Evaluation Division. This Division is one of six under the Vice President, Operations. The Analysis and Evaluation Division is comprised of two Departments, one for each major function. The Analysis Department collects, analyzes, and publishes reports and special studies on pertinent operational data such as system utilization by class of service, causes of service interruptions and equipment failures, Earth station operating costs, etc. Monthly reports are prepared for the COMSAT Board of Directors and for INTELSAT. Detailed quarterly reports are prepared for management and data is provided for various corporation reports, including those to shareholders, the President of the United States, and Congress. Special studies include statistical analyses of growth trends in full-time telephone and TV service, the classification of service outages by durations and causes, correlation analyses of various data such as outage frequencies, time of day, etc. The Department also has management responsibility for the automation of COMSAT Operations. Requirements for automation of the six Divisions are analyzed and consolidated, and efficient programs are designed in coordination with the COMSAT Computer Division. Some advanced activities in the Department include the investigation of computer simulation as a tool for system planning and the use of inventory models for COMSAT spare-parts provisioning.

The Evaluation Department draws upon data from the Analysis Department to pinpoint problem areas and to find more efficient means of operating Earth stations. Problem areas cover the gamut of Operations, from technical matters such as improvements in the antenna tracking system to determination of an optimum spare-parts inventory, and from improvements in operational procedures to the determination of the level of technician manning.

As a senior member of the Vice President's staff, Mr. Zitzmann has also actively participated in several major corporation programs, including the Domestic Satellite Program and the Presidential Task Force Study. His special assignments have included: (1) an operational and technical survey of three Earth stations in Latin America immediately prior to their scheduled operational dates in 1968, and (2) the lead responsibility for establishing minimum manpower and organizational requirements for Earth stations. He was Permanent Chairman of the Service Assurance Committee, comprised of all other Operations Office Directors and the Manager of the INTELSAT Operations Center. He was the primary advisor to the Vice President, Operations, on matters pertaining to system analysis, operations research and digital computers.

Previous positions with COMSAT include that of Special Assistant for Manning and Training to the Vice President, Operations. In this capacity, Mr. Zitzmann was responsible for filling all technical positions in the four new Earth stations and for planning and administering approximately three months of technical training for station technicians and supervisors. From May 1965 to June 1967, Mr. Zitzmann was Manager of the System Support Department which was comprised of three branches: (1) manning and training, (2) engineering support, and (3) logistics and documentation. This Department was the original support arm of the Operations Office for the initial three Earth stations in Maine, Washington and Hawaii. Through this Department were coordinated all Earth-station technical specifications and construction proposals of the Earth-Station Implementation Division of the Technical Office.

Prior to being employed with COMSAT, Mr. Zitzmann was with IBM Federal Systems Division, June 1960 to June 1965, where he worked initially on the design of an advanced electronic message-switching system. He designed and supervised the implementation of digital computer simulation programs to optimize the system design. His simulation of a proposed control center for the Defense Communications System was one of the earliest applications of the IBM General-Purpose Systems Simulator. In 1961, he was appointed Manager of Network Design and Simulation. Several computer programs were developed by his group for the design of lowest-cost telecommunications networks. Subsequent positions with IBM, all within the Communications System Center, included: Manager of Systems Analysis, Manager of the RADAS Simulation Group, and Manager of Tactical Systems. He also contributed to several internal IBM studies, including an assessment of requirements for advanced command and control systems, and he had lead responsibility for developing a five-year communications technology plan.

Mr. Zitzmann's first professional employment as an engineer was at the Bell Telephone Laboratories, June 1956 to June 1960. As a Member of the Technical Staff in the Data Systems Engineering Department, his assignments included exploratory development work on new high-speed storage media, design of store-and-forward switching systems, system design of electronic code translators for advanced message-switching systems, and the mathematical analysis of data-terminal configurations.

Mr. Zitzmann is an alumnus of the Polytechnic Institute of Brooklyn where, in 1956, he received his B.E.E. (summa cum laude) and in 1959 his M.E.E. He has taken additional graduate courses at George Washington University, 1960 and 1965. He graduated from Brooklyn Technical High School in 1950 (with Diploma Merit). At Bell Telephone Laboratories he completed the graduate-level Communications Development Training Program (1959) and a special one-year research program, Digital Techniques Laboratory (1958). Additional training is indicated in the attached supplemental data.

Mr. Zitzmann is a licensed Professional Engineer in the State of Maryland (#6950). He is a member of the IEEE, Tau Beta Pi, Sigma Xi, Eta Kappa Nu, Alpha Phi Omega and the Lutheran Academy for Scholarship.

He has been quite active in several community endeavors including: Associate Director of the Polytechnic Alumni Association (1957-1963), President of the Congregation of Lutheran Church of the Cross (1963-1964), and Chairman of the Montrose Citizens' Group.

Supplemental Data

Personal Data

Born 17 March 1933 in Brooklyn, New York
Married 14 December 1958 to Janet Evelyn Smith
One child: Douglas, born 12 December 1961

Early Employment

1950-1956: Frank Zitzmann Real Estate, Brooklyn, New York

Was licensed salesman at age 17; also managed several apartment houses.

Summer 1955: Sandia Corporation, Albuquerque, New Mexico, Research and Development Assistant

Was part-time salesman for Sidney Pike, Realtor, Albuquerque, New Mexico

Fourth Quarter 1955:
Western Electric Corporation, Jersey City, N.J.
Test-Set Technician

Summers 1956 & 1957:
Polytechnic Institute of Brooklyn
Part-time instructor in Electrical Engineering

Published Papers

"A Treatment of the Reduction of Redundancy in Ordinary English Text" M.S. Thesis, June 1959

"Communications Network Design" 1st Annual IBM Systems Engineering Symposium, New York City, September 1961

"Simulation for RADAS" (Co-authored with B. Beals) Tenth National Communications Symposium, Utica, New York, October 1964 and IEEE Transactions on Communication Technology, October 1966

Published Papers (cont.)

"Personnel Requirements and Training" United States Seminar on Satellite Communications, State Department, Washington, D. C. 16-27 May 1966

Other Education and Training

IBM Out-of-Hours Courses: Decision Theory, fall 1960 and Defense Contract Administration, fall 1962

Summer Session Industrial Program: Advanced Industrial Dynamics, MIT, August 1963

Analysis of Variance and Experimental Design, National Institute of Health, fall 1964

Personnel Techniques Seminar, University of Michigan, summer 1967

NTL Management Workshop, Hershey, Pennsylvania, March 1969

College Honor Honors and Activities

Elected to Tau Beta Pi and Eta Kappa Nu in first semester of junior year; President of local chapter of Tau Beta Pi; member, Who's Who Among Students in American Colleges and Universities (1956 Edition); recipient of 1st Annual Eugene R. Kulka Award for "scholarship and.... contribution to the Institute"; one of 14 members of the Class of 1956 "...designated as Honor Students for advanced study in the senior year"; member, Honor Societies Council (charter president and founder); founder, Polytechnic Lutheran Society; chairman, 1954 Polytechnic Blood Drive; co-chairman, 1955 Faculty Evaluation Poll; member, Student Branch of the AIEE-IRE

BIOGRAPHICAL STATEMENT

Charles E. Sampson

Mr. Sampson comes to RossTEC with wide experience in telecommunication system engineering. From November 1967 to September 1969, he was with Sanders Associates, where he worked on over-the-horizon radar systems. This effort included HF propagation analysis for various system configurations, development of an optimal processing system, system ambiguity analysis, optimal design trade-off procedures, noise-cancellation techniques, etc. During this period he was head of the Computer Programming and Analysis Section and managed classified projects on OTH radar systems.

From March 1966 to October 1967, Mr. Sampson was employed by the IBM Federal Systems Division, where he worked on a number of advanced development projects in telecommunications. He contributed to the design of a pseudo-noise time-division multiple-access terminal for use in satellite communication systems and developed several new circuits for use in such systems. He also contributed to the preliminary system design of a communication system for use in deep space employing large phased arrays controlled by an on-board multiprocessing computer.

Mr. Sampson was the principal investigator on a project performed for the Ford Foundation in support of the proposed Broadcasters' Non-profit Satellite system. The potential interference between the proposed system and the terrestrial common-carrier microwave system was analyzed. The study included a detailed analysis of off-path precipitation scatter effects for all microwave facilities in the proposed bands within several hundred miles of New York City. He also conducted mobile and airborne experiments to measure field strengths of microwave beams in the New York City area. These measurements verified the theoretical predictions that some of the interference effects were present over wide areas but that there were many feasible locations for Earth stations in the proposed satellite TV distribution system.

Prior to joining IBM, Mr. Sampson was employed by Jansky and Bailey in Alexandria, Virginia, as a communications engineer. He worked on a variety of assignments including: prediction of interference processes in communications and radar systems, design of modulation techniques to minimize interference effects, design and testing of electronic countermeasure and counter-countermeasure equipment for use in military aircraft, studies of electromagnetic compatibility of air navigation systems, economic analysis of satellite TV broadcast systems and the determination of the effect of the choice of modulation technique on the cost of such systems. Mr. Sampson also participated in a study for the Office of the Director of Telecommunications Management to determine the required spectrum allocations and sharing criteria for use by space communication systems of the future. He has been active in the development of digital computer techniques for use in studies of electromagnetic interference, modulation techniques and spectrum management.

Mr. Sampson received his engineering education at the George Washington University. He was awarded the BSE degree in June 1959 and the MSE in June 1964. The title of his thesis was "The Feasibility of a Dynamic Adaptive Filter System". He is a member of several professional societies and has been active as an inventor in the field of telecommunications and electronic circuits. He is the principal author of a number of reports on government-supported projects and the following publications in the professional society literature:

"Earth Stations for the Reception of Satellite TV"
AIAA Convention Record, Washington, D. C., May 1966

"An Adaptive Multiple-Access System"
IEEE Convention Record, Washington, D. C., October 1967

"Probability of Detection of OTH Radar Systems"
OTH Symposium Proceedings, Monterey, California, October 1968

September 5, 1969

To: Mr. Roy Easley

From: Eva Daughtrey
Tom Whitehead's office

Mr. Whitehead asked me to send you a copy of the letter and attachment which you requested.

No decision has been reached yet as to whether or not meetings will be held with interested parties to discuss these matters -- but we will be in touch.

Attachment

Friday 9/5/69

9:[redacted] Had a call from

Roy Easley Di. 7-5412
Assistant Executive Director
Maximum Service Telecasters
1735 DeSales Street, N. W.
Washington, D. C. 20036

It is an association of approximately 160 TV stations all over the country. Indicated that in an article in this week's Broadcasting Magazine, mention was made that the Task Force was looking into domestic satellite field and had sent letters to industry, etc., attaching a set of issues.

He said his association has been very heavily involved in all the spectrum allocation in management matters and a heavy participant with the FCC in all phases including CATV regulation, manned mobile radio, etc.

Would like very much to have a copy of the letter and issues. Also wondered if they might be able to meet with you to discuss the matters.

September 9, 1969

Mr. Whitehead met with the following to discuss telecommunications:

Walter Routson
Consumers TVC

Edward Hinkley
Consultant to Consumers TVC

J. Robert Burns
Director of Operations
Arvin Defense Systems

Orie Fritts
Manager, Administrative Services
Arvin Defense Systems

September 26, 1969

Dear Mr. Ebel:

Thank you for your letter of September 23rd. I was pleased to have the opportunity to meet with you and Mr. Goldberg and to hear the views of the CBS Television Network Affiliates Association with respect to satellite communications in the United States.

I understand fully your concern about the potential impact of direct satellite to home broadcasting, although this appears to be some time in the future.

Please be assured that your views will be fully considered and feel free to get in touch at any time.

Sincerely,

Clay T. Whitehead
Staff Assistant

Mr. A. James Ebel
Vice President and General Manager
Cornhusker Television Corporation
KOLN-TV/KGIN-TV
Lincoln, Nebraska

cc: Mr. Whitehead
Central Files

CTWhitehead:ed

KOLN-TV
CORNHUSKER TELEVISION CORPORATION
CHANNEL 10
CHANNEL 11
KGIN-TV
TELEPHONE 434-8251 · 40TH & W STREETS · LINCOLN, NEBRASKA · 68501

tape

September 23, 1969

Dr. Clay T. Whitehead
Executive Office Building
Room 110
17th & Pennsylvania Avenue
Washington, D. C.

Dear Dr. Whitehead:

On behalf of the CBS Television Network Affiliates Association, I would like to thank you very much for providing Mr. Goldberg and me with the opportunity to speak with you on September 18, 1969, concerning certain aspects of a future domestic communications satellite system and integration of satellite technology into the present distribution system for television broadcast programming.

The CBS Television Affiliates believe that communications satellites offer great potential for improvements over the present terrestrial wire and microwave system for interconnecting television broadcast stations for purposes of networking. It is for this reason that the CBS Television Affiliates have urged before the Federal Communications Commission that local television broadcast stations should be authorized to own the receive-only ground facilities that would be used to provide television interconnection service to them. The Association has also made its views known to the President's Task Force on Communications policy and the National Aeronautics and Space Administration.

I stated the concern of the Affiliates Association, and, I believe, other television broadcasters that satellite technology has a potential which, if allowed to develop into direct satellite-to-home broadcasting or satellite to "wired city" communications, could have a severe adverse impact upon the viability of our present television system. While direct communication to the home or to the "wired city" could very well destroy the local television broadcast station, which is the keystone of our present system, such national, centralized systems could not replace local television broadcast stations or serve the values that they serve or provide the benefits that they provide.

--continued

Dr. Clay T. Whitehead
September 23, 1969

I know that you expect the work of your group to be completed shortly, but if there is any other information the CBS Television Network Affiliates Association can provide to you, please do not hesitate to contact me or Mr. Goldberg. The Association stands willing to cooperate in whatever way you think would be of benefit to your group.

Sincerely,

A. James Ebel

A. James Ebel
Vice President and General Manager
CORNHUSKER TELEVISION CORPORATION
KOLN-TV/KGIN-TV
Lincoln, Nebraska

mtg
9/18
2pm

Monday 9/8/69

3:45 The meeting with Henry Goldberg of Covington & Burling and A. James Ebel, Chairman of the Satellite Communications Committee of the CBS Television Affiliates Association, has been scheduled for Thursday (9/18) at 2 p.m.

September 4, 1969

Dear Mr. Goldberg:

Thank you for your letter of August 27th regarding the interest of the CBS Television Network Affiliates Association in our review of domestic communications satellite policy.

I would be pleased to meet with Mr. Ebel on one of the dates you suggest. You or Mr. Ebel can call my secretary to set up a mutually convenient time.

Sincerely,

Clay T. Whitehead
Staff Assistant

Mr. Henry Goldberg
Covington & Burling
888 Sixteenth Street, N. W.
Washington, D. C. 20006

cc: Mr. Whitehead
Central Files

CTWhitehead:ed

COVINGTON & BURLING
888 SIXTEENTH STREET, N. W.
WASHINGTON, D.C. 20006

TELEPHONE
(202) 293-3300

TELETYPE: (202) 965-0673
CABLE: COVLING

Dr. Clay T. Whitehead
Staff Assistant
Room 110
Executive Office Building
Washington, D.C.

August 27, 1969

Dear Dr. Whitehead:

On August 5, 1969, I wrote to you of the interest that the CBS Television Network Affiliates Association had in the work of the White House group that is investigating future uses of domestic communications satellites.

As I stated in my letter, the CBS Television Affiliates Association would appreciate the opportunity of having one of their members meet with you to discuss certain of the issues involved in providing satellite interconnection service to television broadcast stations. I realize the time constraints that you and your group are working under, but I believe that a meeting in the near future would be fruitful. Mr. A. James Ebel, Chairman of the Satellite Communications Committee of the CBS Television Affiliates Association would be available to meet with you some time between September 17 and September 19. Please advise me as to whether a brief meeting with you could be arranged on one of these dates.

Sincerely yours,

Henry Goldberg

Henry Goldberg

Attorney for
CBS Television Network Affiliates Association

cc: Mr. A. James Ebel

maje

KOLN-TV
KGIN-TV
SATELLITE
CBS

Cornhusker Television Corporation
40TH AND W STREETS
LINCOLN, NEBRASKA

The Best Televis10n
on Televis10n
TV 10

LINCOLN
SEP 24
PM
1969
NEBR.

LINCOLN
NEBR.

VIA AIR MAIL

Dr. Clay T. Whitehead
Executive Office Building
Room 110
17th & Pennsylvania Avenue
Washington, D. C. 20006

PERSONAL

9/18/69

Meeting with

A. James Ebel
Henry Goldberg

SUMMARY OF ... FREE LOCAL TELEVISION BROADCAST SERVICE: AN ESSENTIAL VOICE

INTRODUCTION: Much has been written and said concerning space satellite-to-home broadcasting. On the surface the proposition seems to be attractive to many people, and anything associated with the space program involving the most modern of all technologies must attract a considerable amount of attention. The Satellite Transmission Committee of the CBS Television Network Affiliates Association has spent more than two years in a complete and careful study of satellite broadcasting, its advantages, its disadvantages and its possible future utilization. The Committee developed a so-called 'white paper' containing 26 pages of documented information on this subject. Following is a short summary of the highlights of that document:

I. Free local and area television broadcast service underlies the American system of television broadcasting. This principle of "localism" reflects the American federal tradition of a multitude of diverse local voices serving both local and national purposes in many communities and areas throughout the United States. For example, the United States has no central education system, no central national newspaper and no domestic 'Voice of America' .

II. Congress has long recognized that free local television broadcast service is essential to the development and healthy maintenance of the use of the spectrum. The basic concept of the American system of broadcasting has long been that of free advertiser support of broadcasting anchored in private enterprise at the community level, with many autonomous local station licensees throughout the country seeking to construct program schedules in accordance with taste, needs, and interests of the public in the areas which they serve. For example, when radio broadcasting was first developed in the early 1920s, stations were allocated to individual communities underthe Radio Act of 1912. The Radio Act of 1927 furthered this development. The provisions of the Communications Act of 1934 embodies this concept. In 1962 Congress enacted the All-Channel Receiver Act to foster the development of UHF television broadcasting because it concluded that all communities of appreciable size should have at least one local television broadcast station as an outlet for local self-expression. In 1967 Congress enacted the Public Broadcasting Act which emphasized the establishment and development of local non-commercial educational television stations.

III. The Regulations and policies of the Federal Communications Commission seek to foster free local television and area television broadcast service:

A) through a table of assignments to local communities

B) through encouragement of local program services

C) through the requirement that commission licensees are required to make an effort to ascertain and fulfill program needs and interest of the communities and areas they are licensed to serve.

D) through encouragement of area and local comment on program service provided by local television broadcast stations.

IV. The regulations and policies of the Federal Communications Commission have prohibited communications systems and practices which the Commission believes would impair free local and area television broadcast service. It prohibited super-powered television and the distribution of television signals on a commercial basis from aircraft, because such systems would sharply reduce the number of channels available for local broadcast stations.

V. The Commission regulates cable television based on this concern. It limits network practices that tend to reduce the autonomy of local broadcast stations. And it has promulgated rules which prevent a single entity from owning more than a limited number of television stations or more than one television station covering the same area. During a period in which there has been a significant decrease in the number of local daily newspapers there has been an enormous growth in the number of free local television broadcast stations and the number of communities served by such stations. Under present conditions this growth will continue.

VI. The advancement of free local television broadcast service is essential to the communities provided with such service, and to the nation as a whole. The local television broadcast station performs an essential function as an outlet for local program service in the following manner:

A) through its local news coverage which is expanding each year (a Roper survey indicates that more people look at television as a source of news than to newspapers, and they give TV news more credence than news provided by any other media) .

B) through its public service and public affairs programs. Millions of dollars of free time are contributed by the local stations to local causes annually.

C) through interviews, round table discussions, call-in shows, etc., it provides an opportunity for local and area self-expression.

D) through editorial comment on local community problems.

E) through political broadcasts which provide necessary outlets for local and area political leaders to communicate with their constituents.

F) through weather reports -- weather is local and can be covered best by local television broadcast stations. Because of the popularity of this medium it is the best vehicle for emergency weather warnings.

G) through agricultural programming designed to meet distinct economic needs and interests, which are unique to those farm families residing in the station service area.

H) through religious programs resulting from the efforts of the local stations.

I) through educational and instructional programs for local school children and adults.

J) through programs adapted to the tastes and needs of children -- locally originated and devoted to pre-school and school-age groups.

K) through local sports programs -- amateur and professional sports require local coverage.

L) through special program services to minority groups, ethnic groups, and local economic strata.

M) through special local entertainment programs tailored to the local needs and interests in entertainment.

N) through the development of local talents -- artistic and otherwise. All talent is local at some time.

Free local television also includes free, non-commercial, educational television stations that provide local program service for in-school programming on a local basis and adult programming on a local basis.

VII. The local television station performs other essential functions. A commercial station is an important medium for the local and area advertiser in selling goods and services locally. The most rapid growth in sale of television time has been in the area of local advertising, indicating the economic importance of this media to the local merchant.

VIII. Local television broadcast stations are important as employers in the community in which they are located. In addition to their substantial economic contributions to the community, television station employees demonstrate a high degree of civic responsibility and community involvement. Regardless of ownership, television broadcast stations are locally managed and are responsive to community and area needs and interests.

IX. Free local television broadcast stations perform important services to the nation as a whole. They are an important link in the emergency broadcast system. The multiplicity of local broadcast stations and auxiliary stations, their inter-city relays, their studio-transmitter links, their studio remote pick-up equipment, standby power equipment , and skilled personnel provide back-up facilities and systems to replace destroyed national facilities if needed.

X. Free speech is enhanced by systems comprised of many independent, diverse, and local outlets throughout the United States, as opposed to a more monolithic system of communications, such as direct satellite-to-home broadcasting, in which a very few individuals or entities would control the central outlet.

XI. The present television system with its reliance on local television broadcast stations is the only means of providing free local and area television service to all segments of our society. Although this paper is primarily concerned with satellite-to-home broadcasting, it should be noted that the "wired city" television is no substitute for free over-the-air television service provided by local television stations. The wired system would unfairly discriminate between the wealthy and the poor; it would not provide service of the same depth and diversity; it would eliminate service in sparsely settled areas, or rural areas.

XII. Unlike underdeveloped nations, in the United States space satellite-to-home broadcasting would, as a practical matter, replace our necessary and desirable system of free, local, television broadcast service. Although proponents of direct satellite-to-home broadcasting regard the bypassing and elimination of local television broadcast stations as an economic advantage, this paper has shown that this so-called advantage is not a valid reason for replacing our highly developed system of free, local, television broadcasting. Substitution of direct satellite-to-home broadcasting in place of the present system would endanger free speech, national security, safety and independence. In a direct-to-home satellite system, the nation would be served by a relatively small number of satellites which could be easily destroyed, moved or jammed, leaving no adequate back-up system for national emergency broadcast communications. It is obvious that direct satellite-to-home broadcasting would be unwise technically and economically.

FREE LOCAL TELEVISION BROADCAST SERVICE: AN ESSENTIAL LOCAL VOICE

I. Free local and area television broadcast service underlies the American system of television broadcasting.

A. This principle of "localism" reflects the American "federal" tradition of a multitude of diverse local voices serving both local and national purposes in many communities and areas throughout the United States. For example, the United States has no central educational system, no centralized national newspaper and no domestic "Voice of America."

B. The Congress and the Federal Communications Commission have long recognized that free local television broadcast service is essential to the development and healthy maintenance of the use of the spectrum for television broadcast purposes.

1. Early radio history --

a. Mass communications systems have inherent tendencies to monolithic development. Recognizing this, the Congress attempted to counterbalance these tendencies when radio was initially developed for broadcast uses.

b. The basic concept of the American system of broadcasting has long been that of free, advertiser-supported broadcasting, anchored in private enterprise at the community level, with many autonomous local station licensees throughout the country seeking to construct program schedules in accordance with the tastes, needs and interests of the public in the areas which they serve.

c. When radio broadcasting first developed in the early 1920's under the Radio Act of 1912, local program service was enhanced by licensing radio broadcast facilities to individual communities. This is still the national plan.

d. The Radio Act of 1927 furthered this development. The Federal Radio Commission, which was established by this Act, viewed the public interest standard established by the Act as finding its initial and principal application in terms of the program service provided to the community to which the station is licensed.

2. The provisions of the Communications Act of 1934 embody this basic concept --

a. At the time the Communications Act was being considered, the Congress had an opportunity to review the implementation of its initial determination that broadcast service would be provided by local broadcast stations. Given the technological advances that had been made since 1920, the Congress was faced with two alternatives for broadcast service. One provided for a number of "super power" stations located in large cities to provide this service nationwide. The other provided for stations in a large number of communities, each serving the needs and interests of those communities. The Congress again chose the latter alternative.

b. Section 1 of the Federal Communications Act of 1934 directs the FCC to "make available to <u>all</u> of the people of the United States a rapid, efficient, Nation-wide . . . wire and radio communications service." (Emphasis added) Section 307(b) of the Act requires that "the Commission shall make distribution of licenses, frequencies, hours of operation and of power among the several States and communities as to provide a fair, efficient, and equitable distribution of radio service to each of the same." Section 303(h) of the Act authorizes the FCC "to establish areas or zones to be served by any station."

3. In 1962 the Congress enacted the All-Channel Receiver Act to foster the development of UHF television broadcasting because it concluded that all communities of appreciable size should have at least

one local television broadcast station as an outlet for local self expression, with additional stations proportionate to the size of the population, and that expanded use of UHF channels presented the means of achieving these objectives.

4. In 1967 the Congress enacted the Public Broadcasting Act which emphasizes the establishment and development of local noncommercial educational television broadcast stations to serve communities and areas throughout the nation, the preservation of local control of such stations and protection of the local station's right to decide what programs to broadcast.

C. The regulations and policies of the Federal Communications Commission seek to foster free local and area television broadcast service.

1. The television allocations plan and Table of Assignments --

a. The Commission's Sixth Report and Order on television allocations and the Table of Assignments stated that "the record in this proceeding demonstrates that the desire for broadcasting service from local stations, reflecting local needs and interests, is widespread . . . ." The underlying goal of the Commission was that "as many communities as possible should have the opportunity of enjoying the advantages derived from having local outlets that will be responsive to local needs."

b. Subsequent Commission reports and orders on UHF channel assignments have stated that the primary purpose of providing for expanded use of UHF channels was to provide "for as many outlets of local expression as possible within the available spectrum space."

2. FCC encouragement of local program services --

a. From the early days of broadcast regulation, certain types of local program service, such as weather, crop and market reports, and original programming tied to the needs and interests of the communities served by free, local broadcast stations have been favored by the Federal Radio Commission and the FCC.

b. The Commission emphasizes locally-produced and area-oriented programs, including station editorials and programs dealing with local and area issues of public importance.

3. Commission licensees are required to make an effort to ascertain and fulfill the program needs and interests of the communities and areas they are licensed to serve.

4. Commission rules encourage local and area comment on the program service provided by the local television broadcast stations. This is the rationale of such requirements as local public notice of the filing of license renewal applications and maintenance of a local public file, which is accessible to interested persons within the community and area served by the local broadcast station.

D. The regulations and policies of the Federal Communications Commission have prohibited communications systems and practices which the Commission believed would impair free local and area television broadcast service.

1. The technical means of distributing radio and television signals to the home, other than by local broadcast stations, have long been available. Direct satellite-to-home-broadcasting is merely the latest, although a potentially more damaging, system for bypassing and eliminating local television broadcast stations. The Congress and the FCC have long discouraged such systems because of the loss of local and area broadcast services they would involve.

2. The FCC prohibited "super power" television stations and distribution of television signals from

transmitters located in aircraft (e.g., the Midwest Program for Airborne Television Instruction, Inc.) because such systems would sharply reduce the number of channels available for local broadcast stations, thereby reducing both the number of local stations and the number of communities that could be served by local stations.

3. Commission regulation of cable television systems is based upon its concern that free local television broadcast service could be seriously impaired without such regulation.

4. Limitation of network practices that tend to reduce the autonomy of local broadcast stations --

a. Since the early regulation of broadcasting, the FCC has sought to strike a balance between the national broadcast services provided by television and radio networks, whose programs provide the financial base for local station operations, and the local and area program services provided by local broadcast stations.

b. The FCC prohibited certain network practices, such as restriction of the affiliates' right to reject network programs, which it thought would tend to reduce the autonomy of local television broadcast stations.

5. The FCC has promulgated rules which prevent a single entity from owning more than a sharply limited number of television stations, or more than one television station in the same area, in order to prevent an undue concentration of power in television broadcasting.

II. <u>During a period in which there has been a significant decrease in the number of local, daily newspapers, there has been an enormous growth in the number of free local television broadcast stations and in the number of communities served by such stations. Under present conditions, this growth will continue.</u>

A. The number of free local commercial and educational television broadcast stations on the air increased from 108 in 1952 to approximately 780 in 1967.

B. The number of communities with operating, free, advertiser-supported and educational television broadcast stations assigned to them increased from 66 in 1952 to 478 in 1967.

C. There were outstanding construction permits in late 1967 for 225 additional new, free local commercial and educational television broadcast stations.

D. There were applications pending for approximately 155 new, free local television broadcast stations.

E. The number of new UHF local broadcast stations has grown significantly, especially since the enactment of the All-Channel Receiver Act in 1962. However, the full impact of UHF development on increasing the number of stations on the air is yet to be felt, and, barring adverse developments, it will increase gradually over the next ten years as UHF receiver penetration increases.

F. The number of noncommercial educational television broadcast stations on the air increased from 79 in 1962 when the Educational Television Facilities Act was enacted to 149 in 1967. Moreover, it was estimated that passage of the Public Broadcasting Act of 1967 would add 20 new stations each year in the near future.

III. The advancement of free local television broadcast service is essential to the communities provided with such service and to the nation as a whole.

A. The local television broadcast station performs an essential function as an outlet for local program service.

1. Free, advertiser-supported local program service --

Locally-produced and originated programming, at 16.2 percent of the total operating hours of the average free, commercial local television station, is at its highest level. The balanced local program service of the typical station usually includes the following:

a. Opportunity for local and area self expression --

Local television broadcast stations, by providing opportunity for reply to station editorials, viewer interest pools, viewer call-in shows, news interviews, local round-table discussions and in many other ways, provide an indispensable outlet for local self expression.

b. News --

News comprises the major portion of all locally-produced and originated programming. It has grown from 24.9 percent of local programming in 1964 to 40.9 percent in 1967. Many local stations are now presenting local news programs of one hour in the early evening as well as 30-minute news programs in late evening hours. News of upcoming local events is often necessary to the success of such events. Local news programs generally outrank network news programs that cover only national news. The news programs of local broadcast stations are widely available to all members of the audience, not merely those who can afford to pay for such information. A Roper survey indicates that more people look to television as a source of news than to newspapers and that they give it more credence than news provided by other media. The local television broadcast stations proved to be indispensable as news media during newspaper strikes that have occurred from time to time in various communities. The role of the local television station as a source of local and area news programs has been described as follows:

> "Whether a station is owned by a network, affiliated with a network, or independent, and whatever national news programs it may carry produced by others in New York or Washington or overseas, what gives each station its individuality is the news job it does with its own hands. . . . Led by its news department, the station is of a piece with its community like the local newspaper, the supermarket, the utility companies, and the big electronic parts plant on the outskirts of town. Its newsmen as well as its management are immersed in community affairs along with the businessman, the banker, the labor leader, and the public servant.
>
> "The men of the station's non-entertainment services know their community, its people, its needs, and its problems. They serve the people and the needs and they confront the problems. With their enterprise, their editorials, their investigative work, and their high news standards, the best stations are clearly demonstrating community responsibility." Wood, Electronic Journalism, p. 111 (1967).

c. Public service and public affairs programs --

The nation's urban areas have become too large for "town meetings." Hence intracommunity discussions and involvement have become all the more important now when our cities are confronted with complex new problems that cannot be met by administrative arrangements alone. Such problems demand the involvement of each individual citizen. The public affairs programs of local television broadcast stations provide this essential service because the stations have roots in the community. Local television broadcast stations also lend invaluable assistance in support of local fund raising campaigns, membership drives and announcements of community interest. Most free time for public service announcements is devoted to local and area goals.

d. Editorial comment --

Approximately 53 percent of local television broadcast stations presented editorials in the 1966-67 television season. No nonlocal program suppliers perform this valuable community service. The station editorials stimulate interest in and discussion of local and area problems. This often results in solution of those problems and general improvement of conditions in the area. Most station editorials are concerned with community problems. Virtually none support political candidates as such. In the 1966 election campaign, only 21 television broadcast stations broadcast editorials for or against political candidates and all reported broadcasting reply statements.

e. Political broadcasts --

Local television broadcast stations provide necessary outlets for local and area political leaders to communicate with their constituents and are vital tools in political campaigns at community, county, state and federal congressional levels. Local television broadcast stations provide large amounts of free time for discussion on the political issues involved in such campaigns. Sustaining time was reported by 54 percent of all television stations covered in the 1966 FCC Survey of Political Broadcasting.

f. Weather reports --

Weather is local and can be covered best by local television broadcast stations. Moreover, the needs and interests of community and area residents in various types of weather reports vary from region to region. Therefore, local television broadcast stations tailor their weather reports to the economic and recreational needs of their service areas. In addition, the role of local television broadcast stations in providing emergency weather warnings has contributed immeasurably to the safety of local and area residents. This service cannot be adequately provided by radio stations alone. Television broadcast stations provide an important additional service by giving pictorial presentation of developing weather situations. Local television stations are making increasing use of weather maps and high altitude photographs taken from weather space satellites.

g. Agricultural programming --

Almost all local television broadcast stations present programs designed to meet the distinct economic needs and interests of the farm families residing in the stations' service areas. Such programs are usually presented early in the broadcast day and are comprised of weather reports tailored to agricultural needs, market reports and other subjects of particular interest to farm families.

h. Religious programs --

Most of the religious programming on television today results from the efforts of the local stations. Most local broadcast stations provide a balanced selection of religious programming ranging from the telecast of actual religious services to interfaith panel discussions with religious leaders in the community.

i. Educational and instructional programs --

Many commercial television broadcast stations join with local schools to tailor educational and instructional programs for local school children. The stations also engage in programming devoted to the educational needs of adults.

j. Programs adapted to the tastes and needs of children --

Creative locally-originated programs devoted to preschool and school age children have long been staples of the average television broadcast station.

k. Sports --

Local amateur and professional sports demand local coverage. Such sports events as lacrosse, wrestling, rodeos, track events and local horse shows obtain their principal television coverage on local broadcast stations.

l. Service to minority groups and local economic group interest programs --

Many local television broadcast stations present programs tailored to the interests of minority groups and local economic groups in the community. Programs devoted to the history, culture and music of local ethnic groups have long found a place in local television broadcast station program schedules.

m. Entertainment --

Although programming from outside sources is the primary means whereby local broadcast stations satisfy the entertainment needs of local audiences, most stations present regularly scheduled and "special" entertainment programs using local and area talent to supplement nonlocal entertainment programs.

n. Opportunity for development of local talent, artistic and otherwise --

All talent is "local" at some time. Local television broadcast stations play an important role in developing and using talent drawn from the area served by the station.

2. Free, noncommercial educational television local program service --

a. Approximately 149 local, noncommercial educational television stations are presently licensed to serve over 125 separate communities. There are construction permits outstanding for 47 new stations, which are not yet on the air, and license applications presently pending for 18 more stations.

b. In-school programming constitutes approximately half of program schedules of such stations and is a significant part of the curriculum of over 1400 local and regional school systems and 800 local colleges and universities. Such stations also engage in formal, in-home instructional programming for adults, which ranges from basic education programs for illiterates to college and graduate level extension courses.

c. Locally-produced and originated programming constitutes some 27 percent of the average educational television broadcast station's program schedule.

d. The varied local programming of the average educational television station provides a valuable supplement to the local programming of free, advertiser-supported television broadcast stations. It includes documentaries, news, public affairs forums, children's programs, drama, music, ballet and art.

e. The Public Broadcasting Act of 1967 will further the contribution local noncommercial educational television broadcast stations can make to their communities and regions and to the nation as a whole, since it will result in increases in the number of stations on the air, the number of communities served by such stations and the amount of locally-produced programming originated by such stations.

B. The local television broadcast station performs other essential functions --

1. The commercial station as a medium for local and area advertisers in selling goods and services locally --

a. Time sales by television broadcast stations to local and area advertisers totaled some $346.4 million in 1966. This is approximately double the figure for local time sales in 1956 and 15 percent greater than the 1965 figure.

b. Local and area businesses have the opportunity to expose their products and services on an advertising medium that is unique in its ability to coordinate sound, motion, live demonstration and color at prices competitive with other advertising media.

c. By performing this function of an advertising medium for local and area businesses, the local television broadcast station helps to stimulate demand for local goods and services and, therefore, has a healthy impact on the local economy.

2. The local television broadcast station as an employer in the community --

a. The 608 local commercial television broadcast stations employed some 39,100 individuals in 1966. This averages out to 64 employees per average television broadcast station. A survey covering 12 months of operation in 1965-66 showed that 3,900 persons were employed by 96 educational television broadcast stations.

b. Out of 608 commercial television broadcast stations operating in 1966, 554 reported total salaries and wages paid to employees and fees paid to talent as approximately $336,666,000. The average television broadcast station paid out $560,950 for salaries and wages and $46,700 for talent fees. Ninety-six educational television broadcast stations paid out $17,362,000 in salaries and wages for 12 months of operation during 1965-66.

3. The civic responsibility and community involvement of local station personnel -- Regardless of ownership, television broadcast stations are locally managed and are responsive to community and area needs and interests. Moreover, officials and employees of local television broadcast stations are actively involved in the affairs of the communities and areas in which their stations are located. For example, the average commercial television station manager is actively involved with more than 40 community social and welfare groups.

D. The importance of free local television broadcast stations and the services they perform to the nation as a whole.

1. The role of local stations and their auxiliaries in the Emergency Broadcast System --

The multiplicity of local broadcast stations and their auxiliary stations, such as intercity relays, studio transmitter links, and remote pickups, are essential to national, regional, state and local planning for emergency broadcast communications in times of national disaster and civil emergency. If nationwide communications provided by network interconnections is disrupted, local broadcast stations, their auxiliaries and skilled personnel will provide backup facilities and systems to replace the destroyed national facilities.

2. Free speech is enhanced by a system comprised of many independent, diverse and local outlets throughout the United States as opposed to a more monolithic system of communications, such as direct satellite-to-home-broadcasting, in which very few individuals or entities control the central outlet.

a. It is axiomatic that control of television broadcasting, which is a primary means of mass communications in the United States, must not be allowed to succumb to monopolistic control.

b. The Federal Communications Commission has consistently attempted to decentralize the power over what the public may receive from broadcast media. The basic concept of the Commission's regulatory scheme for broadcasting is to avoid centralization and monopoly in the provision of vital program services to the public.

c. The transfer of control over broadcast communications from a large number of independent broadcasters to a central entity would be disastrous to national freedom and independence. Communication systems like direct satellite-to-home-broadcasting by centralizing the power to determine what communications will be made to the American people and increasing Government involvement would threaten the freedom of expression guaranteed by the First Amendment.

3. By aiding the local economy of their service areas, free, advertiser-supported television stations as advertising media and all television stations as employers contribute to the economic well being of the nation as a whole.

IV. The present television system, with its reliance on local television broadcast stations, is the only means of providing free local and area television service to all segments of our society.

A. There have been suggestions made recently that much or all of the present television broadcast system should be converted to a wired system of distributing television signals to the home. Although this paper is primarily concerned with satellite-to-home-broadcasting and not with wired television, it should be noted that wired television is no substitute for free, over-the-air television service provided by local television stations.

B. A wired system of television service has serious deficiencies. It would unfairly discriminate between the wealthy and the poor, since the poor would not be able to pay the installation costs and service and program charges for wired television service. A nationwide wired television system could not provide service to the public of the same depth and diversity as the multitude of local news, information, public service, public affairs, public health and safety, agricultural, religious, educational and instructional, sports, cultural and entertainment program services that have been developed under the present television broadcast system by relying upon local television broadcast stations. Moreover, providing even the present level of television service by wire would involve enormous capital costa and resolution of serious technical problems in constructing a wire system in sparsely settled areas and in large urban areas.

V. In the United States, unlike underdeveloped nations, space-satellite-to-home-broadcasting would, as a practical matter, constitute a substitute for existing broadcast services.

A. Although the proponents of direct satellite-to-home-broadcasting regard the bypassing and elimination of local television broadcast stations as an "economic" advantage, this paper has shown that this so-called "advantage" is the very reason for rejecting a system of direct satellite-to-home-broadcasting.

B. Direct satellite-to-home-broadcasting would be a substitute for, rather than a supplement to, the present system of free broadcasting in the United States. Such a satellite system would preempt spectrum space and would undermine the capacity of local television stations to operate successfully.

1. Local stations typically establish their program schedules as a blend of both locally-produced and originated programs and of programs obtained from nonlocal sources and must present both to serve the public effectively.

2. Communications satellites would make it technically possible and economically profitable for national program suppliers to bypass local television broadcast stations and broadcast directly to the home. This would undercut the economic base for locally-produced and originated programs, since stations must rely on the programming provided by nonlocal sources to build up the audience and the revenues which allow the station to produce and originate local programming. Such local programming is costly, and, therefore, vulnerable to even relatively slight losses of revenue. The stations must make large expenditures for studio and mobile equipment to produce and originate local and

area-oriented programs. Only those stations that are financially viable can afford to engage in the high cost, but low financial return, programming that is essential to the communities served by the stations.

C. Substitution of direct satellite-to-home-broadcasting in place of the present system would endanger national security, safety and independence.

1. The nation would be served by a relatively small number of satellites which could be easily destroyed, moved or jammed in wartime, leaving no adequate backup system for national emergency broadcast communications.

2. Nuclear-powered satellites could malfunction and contaminate the atmosphere and earth's surface.

3. The monolithic system of communications that would result from direct satellite-to-home-broadcasting would constitute a serious danger of Government thought control and "Big Brotherism."

D. Direct satellite-to-home-broadcasting would be unwise technically and economically.

1. Unlimited use of communications satellites by other Western Hemisphere nations could cause serious interference problems for direct satellite-to-home-broadcasting in the United States.

2. Direct satellite-to-home-broadcasting would render obsolete the 75 million television receivers now in use. Expensive converters or new sets and special antennas would be required.

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<u>FREE LOCAL TELEVISION BROADCAST SERVICE:
AN ESSENTIAL LOCAL VOICE</u>

I. <u>Free local and area television broadcast service underlies the American system of television broadcasting.</u>

A. This principle of "localism" reflects the American "federal" tradition of a multitude of diverse local voices serving both local and national purposes in many communities and areas throughout the United States. For example, the United States has no central educational system, no centralized national newspaper and no domestic "Voice of America."

B. The Congress and the Federal Communications Commission have long recognized that free local television broadcast service is essential to the development and healthy maintenance of the use of the spectrum for television broadcast purposes.

1. Early radio history --

a. Mass communications systems have inherent tendencies to monolithic development. Recognizing this, the Congress attempted to counterbalance these tendencies when radio was initially developed for broadcast uses.

b. The basic concept of the American system of broadcasting has long been that of free, advertiser-supported broadcasting, anchored in private enterprise at the community level, with many autonomous local station licensees throughout the country seeking to construct program schedules in accordance with the tastes, needs and interests of the public in the areas which they serve.

c. When radio broadcasting first developed in the early 1920's under the Radio Act of 1912, local program service was enhanced by licensing radio broadcast facilities to individual communities. This is still the national plan.

d. The Radio Act of 1927 furthered this development. The Federal Radio Commission, which was established by this Act, viewed the public interest standard established by the Act as finding its initial and principal application in terms of the program service provided to the community to which the station is licensed.

2. The provisions of the Communications Act of 1934 embody this basic concept --

a. At the time the Communications Act was being considered, the Congress had an opportunity to review the implementation of its initial determination that broadcast service would be provided by local broadcast stations. Given the technological advances that had been made since 1920, the Congress was faced with two alternatives for broadcast service. One provided for a number of "super power" stations located in large cities to provide this service nationwide. The other provided for stations in a large number of communities, each serving the needs and interests of those communities. The Congress again chose the latter alternative.

b. Section 1 of the Federal Communications Act of 1934 directs the FCC to "make available to <u>all</u> of the people of the United States a rapid, efficient, Nation-wide . . . wire and radio communications service." (Emphasis added) Section 307(b) of the Act requires that "the Commission shall make distribution of licenses, frequencies, hours of operation and of power among the several States and communities as to provide a fair, efficient, and equitable distribution of radio service to each of the same." Section 303(h) of the Act authorizes the FCC "to establish areas or zones to be served by any station."

3. In 1962 the Congress enacted the All-Channel Receiver Act to foster the development of UHF television broadcasting because it concluded that all communities of appreciable size should have at least

one local television broadcast station as an outlet for local self expression, with additional stations proportionate to the size of the population, and that expanded use of UHF channels presented the means of achieving these objectives.

4. In 1967 the Congress enacted the Public Broadcasting Act which emphasizes the establishment and development of local noncommercial educational television broadcast stations to serve communities and areas throughout the nation, the preservation of local control of such stations and protection of the local station's right to decide what programs to broadcast.

C. The regulations and policies of the Federal Communications Commission seek to foster free local and area television broadcast service.

1. The television allocations plan and Table of Assignments --

a. The Commission's Sixth Report and Order on television allocations and the Table of Assignments stated that "the record in this proceeding demonstrates that the desire for broadcasting service from local stations, reflecting local needs and interests, is widespread . . . ." The underlying goal of the Commission was that "as many communities as possible should have the opportunity of enjoying the advantages derived from having local outlets that will be responsive to local needs."

b. Subsequent Commission reports and orders on UHF channel assignments have stated that the primary purpose of providing for expanded use of UHF channels was to provide "for as many outlets of local expression as possible within the available spectrum space."

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B. The local television broadcast station performs other essential functions --

1. The commercial station as a medium for local and area advertisers in selling goods and services locally --

a. Time sales by television broadcast stations to local and area advertisers totaled some $346.4 million in 1966. This is approximately double the figure for local time sales in 1956 and 15 percent greater than the 1965 figure.

b. Local and area businesses have the opportunity to expose their products and services on an advertising medium that is unique in its ability to coordinate sound, motion, live demonstration and color at prices competitive with other advertising media.

c. By performing this function of an advertising medium for local and area businesses, the local television broadcast station helps to stimulate demand for local goods and services and, therefore, has a healthy impact on the local economy.

2. The local television broadcast station as an employer in the community --

a. The 608 local commercial television broadcast stations employed some 39,100 individuals in 1966. This averages out to 64 employees per average television broadcast station. A survey covering 12 months of operation in 1965-66 showed that 3,900 persons were employed by 96 educational television broadcast stations.

b. Out of 608 commercial television broadcast stations operating in 1966, 554 reported total salaries and wages paid to employees and fees paid to talent as approximately $336,666,000. The average television broadcast station paid out $560,950 for salaries and wages and $46,700 for talent fees. Ninety-six educational television broadcast stations paid out $17,362,000 in salaries and wages for 12 months of operation during 1965-66.

3. The civic responsibility and community involvement of local station personnel -- Regardless of ownership, television broadcast stations are locally managed and are responsive to community and area needs and interests. Moreover, officials and employees of local television broadcast stations are actively involved in the affairs of the communities and areas in which their stations are located. For example, the average commercial television station manager is actively involved with more than 40 community social and welfare groups.

D. The importance of free local television broadcast stations and the services they perform to the nation as a whole.

1. The role of local stations and their auxiliaries in the Emergency Broadcast System --

The multiplicity of local broadcast stations and their auxiliary stations, such as intercity relays, studio transmitter links, and remote pickups, are essential to national, regional, state and local planning for emergency broadcast communications in times of national disaster and civil emergency. If nationwide communications provided by network interconnections is disrupted, local broadcast stations, their auxiliaries and skilled personnel will provide backup facilities and systems to replace the destroyed national facilities.

2. Free speech is enhanced by a system comprised of many independent, diverse and local outlets throughout the United States as opposed to a more monolithic system of communications, such as direct satellite-to-home-broadcasting, in which very few individuals or entities control the central outlet.

a. It is axiomatic that control of television broadcasting, which is a primary means of mass communications in the United States, must not be allowed to succumb to monopolistic control.

b. The Federal Communications Commission has consistently attempted to decentralize the power over what the public may receive from broadcast media. The basic concept of the Commission's regulatory scheme for broadcasting is to avoid centralization and monopoly in the provision of vital program services to the public.

c. The transfer of control over broadcast communications from a large number of independent broadcasters to a central entity would be disastrous to national freedom and independence. Communication systems like direct satellite-to-home-broadcasting by centralizing the power to determine what communications will be made to the American people and increasing Government involvement would threaten the freedom of expression guaranteed by the First Amendment.

3. By aiding the local economy of their service areas, free, advertiser-supported television stations as advertising media and all television stations as employers contribute to the economic well being of the nation as a whole.

IV. <u>The present television system, with its reliance on local television broadcast stations, is the only means of providing free local and area television service to all segments of our society.</u>

A. There have been suggestions made recently that much or all of the present television broadcast system should be converted to a wired system of distributing television signals to the home. Although this paper is primarily concerned with satellite-to-home-broadcasting and not with wired television, it should be noted that wired television is no substitute for free, over-the-air television service provided by local television stations.

B. A wired system of television service has serious deficiencies. It would unfairly discriminate between the wealthy and the poor, since the poor would not be able to pay the installation costs and service and program charges for wired television service. A nationwide wired television system could not provide service to the public of the same depth and diversity as the multitude of local news, information, public service, public affairs, public health and safety, agricultural, religious, educational and instructional, sports, cultural and entertainment program services that have been developed under the present television broadcast system by relying upon local television broadcast stations. Moreover, providing even the present level of television service by wire would involve enormous capital costa and resolution of serious technical problems in constructing a wire system in sparsely settled areas and in large urban areas.

V. <u>In the United States, unlike underdeveloped nations, space-satellite-to-home-broadcasting would, as a practical matter, constitute a substitute for existing broadcast services.</u>

A. Although the proponents of direct satellite-to-home-broadcasting regard the bypassing and elimination of local television broadcast stations as an "economic" advantage, this paper has shown that this so-called "advantage" is the very reason for rejecting a system of direct satellite-to-home-broadcasting.

B. Direct satellite-to-home-broadcasting would be a substitute for, rather than a supplement to, the present system of free broadcasting in the United States. Such a satellite system would preempt spectrum space and would undermine the capacity of local television stations to operate successfully.

1. Local stations typically establish their program schedules as a blend of both locally-produced and originated programs and of programs obtained from nonlocal sources and must present both to serve the public effectively.

2. Communications satellites would make it technically possible and economically profitable for national program suppliers to bypass local television broadcast stations and broadcast directly to the home. This would undercut the economic base for locally-produced and originated programs, since stations must rely on the programming provided by nonlocal sources to build up the audience and the revenues which allow the station to produce and originate local programming. Such local programming is costly, and, therefore, vulnerable to even relatively slight losses of revenue. The stations must make large expenditures for studio and mobile equipment to produce and originate local and

area-oriented programs. Only those stations that are financially viable can afford to engage in the high cost, but low financial return, programming that is essential to the communities served by the stations.

C. Substitution of direct satellite-to-home-broadcasting in place of the present system would endanger national security, safety and independence.

1. The nation would be served by a relatively small number of satellites which could be easily destroyed, moved or jammed in wartime, leaving no adequate backup system for national emergency broadcast communications.

2. Nuclear-powered satellites could malfunction and contaminate the atmosphere and earth's surface.

3. The monolithic system of communications that would result from direct satellite-to-home-broadcasting would constitute a serious danger of Government thought control and "Big Brotherism."

D. Direct satellite-to-home-broadcasting would be unwise technically and economically.

1. Unlimited use of communications satellites by other Western Hemisphere nations could cause serious interference problems for direct satellite-to-home-broadcasting in the United States.

2. Direct satellite-to-home-broadcasting would render obsolete the 75 million television receivers now in use. Expensive converters or new sets and special antennas would be required.

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