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EMC ANALYSIS OF THE PROPOSED AEROSAT VHF SUBSYSTEM WITH CURRENT--ETC(U)
MAY 77 J G PREIS   F19628-76-C-0017

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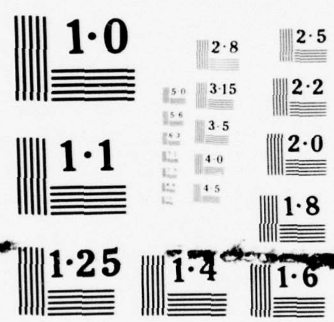
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EMC ANALYSIS OF THE PROPOSED AEROSAT VHF SUBSYSTEM WITH CURRENT INBAND COMMUNICATIONS SYSTEMS VOLUME II (WORLDWIDE)

IIT Research Institute
Under Contract to
DEPARTMENT OF DEFENSE
Electromagnetic Compatibility Analysis Center
Annapolis, Maryland 21402

May 1977

FINAL REPORT

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Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, DC 20590

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16. Abstract
Information and guidelines are presented pertaining to the electromagnetic compatibility (EMC) of ground and airborne equipments in the Aeronautical Mobile VHF Service with the proposed AEROSAT VHF avionics. Volume I provides general guidelines for AEROSAT avionics compatibility with the VHF environment and predicted interactions with aeronautical mobile VHF equipments in the United States and Canada. Volume II addresses the worldwide VHF environment. The frequency bands considered are 125.4-126.0 MHz and 131.4-132.0 MHz.

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PREFACE

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

This report was prepared for the Systems Research and Development Service of the Federal Aviation Administration in accordance with Interagency Agreement DOT-FA70WAI-175, as part of AF Project 649E under Contract F-19628-76-C-0017, by the staff of the IIT Research Institute at the Department of Defense Electromagnetic Compatibility Analysis Center.

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

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METRIC CONVERSION FACTORS

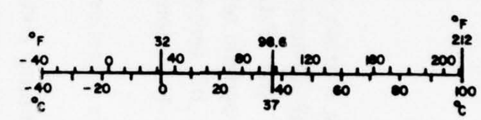
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
SPECTRUM MANAGEMENT STAFF

STATEMENT OF MISSION

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

This objective is achieved through the following services:

- Planning and defending the acquisition and retention of sufficient radio-frequency spectrum to support the aeronautical interests of the nation, at home and abroad, and spectrum standardization for the world's aviation community.

- Providing research, analysis, engineering, and evaluation in the development of spectrum related policy, planning, standards, criteria, measurement equipment, and measurement techniques.

- Conducting electromagnetic compatibility analyses to determine intra/inter-system viability and design parameters, to assure certification of adequate spectrum to support system operational use and projected growth patterns, to defend the aeronautical services spectrum from encroachment by others, and to provide for the efficient use of the aeronautical spectrum.

- Developing automated frequency-selection computer programs/routines to provide frequency planning, frequency assignment, and spectrum analysis capabilities in the spectrum supporting the National Airspace System.

- Providing spectrum management consultation, assistance, and guidance to all aviation interests, users, and providers of equipment and services, both national and international.

EXECUTIVE SUMMARY

As a joint venture of the United States (US), Canada, and the European Agency (ESA), an experimental aeronautical satellite (AEROSAT) system is presently being developed. AEROSAT will provide an evaluation of communications and position-fixing techniques for aircraft flying transoceanic routes.

The Federal Aviation Administration (FAA) is directing US participation in the program. FAA requested that the DoD Electromagnetic Compatibility Analysis Center (ECAC) determine means by which the AEROSAT satellite-to-aircraft VHF link can operate compatibly with the inband international air-to-ground communications system (terrestrial system).

Operational conditions were evaluated to determine possible interactions between AEROSAT and the VHF user community. Usage in the VHF frequency band (125.4-132.0 MHz) was ascertained and representative VHF equipment electrical parameters were determined. AEROSAT electromagnetic compatibility (EMC) equipment specifications and operational constraints were established to preclude interference to the VHF-user community. The FAA-proposed frequency plan, whereby AEROSAT frequencies would be assigned midway between the 50-kHz channels presently used in the 125.4-126.0 and 131.4-132.0 MHz frequency bands, was shown to be feasible.

In Volume I of this report, only the US and Canadian environments were addressed. This volume extends the analysis to include a worldwide environment based on terrestrial-system information available to ECAC. The final results show that by: (1) developing AEROSAT avionic and satellite receivers to meet recommended adjacent channel rejections; (2) preventing use of the AEROSAT system near

EXECUTIVE SUMMARY (Continued)

European coastlines and ground stations located in the Pacific area; and (3) coordinating operationally with a small number of terrestrial ground stations, the AEROSAT system may operate as intended and have a full complement of frequencies available for use over the Atlantic and Pacific Oceans.

Co-channel operation of Aerosat and other VHF-users was **not** considered in this analysis.

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SECTION 1

INTRODUCTION

BACKGROUND

The United States, Canada, and the European Space Agency (ESA) are cooperating in the development of an aeronautical satellite program designated AEROSAT.[1] The Federal Aviation Administration (FAA) is directing the US participation in the AEROSAT program.

The Electromagnetic Compatibility Analysis Center (ECAC) has been tasked by FAA to perform an electromagnetic compatibility (EMC) analysis, a portion of which is concerned with the interactions of AEROSAT VHF links with existing VHF usage in the 118-136 MHz aeronautical mobile band. The purpose of the analysis is to determine the compatibility of the AEROSAT-VHF system with the terrestrial VHF system and, if required, to develop methods that will provide for compatible operation.

The initial analysis (Volume 1) of the results of the AEROSAT VHF analysis was completed by ECAC in November, 1975. Volume 1 contains detailed system descriptions of the AEROSAT and terrestrial VHF systems, as well as characterizations of propagation, antenna patterns, and degradation thresholds; results and recommendations provide guidelines for AEROSAT aircraft receiver development that are applicable worldwide, and guidelines for satellite receiver development that pertain only to the environment in the US and Canada.

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[1] *Memorandum of Understanding on a Joint Programme of Experimentation and Evaluation Using an Aeronautical Satellite Capability Between the US Department of Transportation, Federal Aviation Administration (FAA), the European Space Research Organization (ESRO), and the Government of Canada*, August 2, 1974.

OBJECTIVES

The objectives of the study were to complete the analysis of AEROSAT VHF compatibility with the terrestrial VHF system, based on available worldwide data concerning the terrestrial system, and to provide any necessary guidelines in addition to those given in Volume 1.

APPROACH

Information concerning frequencies and technical characteristics of stations now using the AEROSAT VHF bands was collected from several sources available to ECAC, and the information was correlated to provide the worldwide environment in which AEROSAT VHF links must operate.

In order to determine the effect of VHF transmitters on the AEROSAT satellite, interfering power levels at the satellite were calculated and compared with maximum allowable interfering signal levels. The results were combined with results contained in Volume 1 to develop a required satellite selectivity characteristic.

Potential interference from AEROSAT aircraft to equipments in the aeronautical mobile service was analyzed by considering the selectivity of the aeronautical mobile equipments, the coupling between AEROSAT aircraft and aeronautical mobile equipments, and the locations of ground stations and aircraft that are potential victims. Recommendations concerning geographical operating areas for AEROSAT aircraft were made based on the distance separation required to avoid receiver degradation.

SECTION 2

ANALYSIS

PROCEDURE

System descriptions and technical characteristics of the AEROSAT VHF and terrestrial VHF systems are provided in Volume 1.

Four potential interference situations, depicted in FIGURES 1 through 4, are considered in this analysis. These situations are:

1. Terrestrial system potential interference to the AEROSAT satellite;
2. Terrestrial system potential interference to AEROSAT avionics;
3. AEROSAT satellite potential interference to terrestrial system receivers; and
4. AEROSAT avionics potential interference to terrestrial system receivers.

These situations, except for interactions involving US/Canada ground equipments, are discussed in the following subsections.

TERRESTRIAL SYSTEM POTENTIAL INTERFERENCE TO THE AEROSAT SATELLITE

General

Each AEROSAT satellite will receive up to four carriers containing voice or data; carrier center frequencies will be chosen from the following set of frequencies: 131.425, 131.475, 131.525, 131.575, 131.625, 131.675, 131.725, 131.775, 131.825, 131.875, 131.925, and 131.975 MHz. The satellite VHF-to-C-band (5.0-5.25 GHz) repeater will be channelized

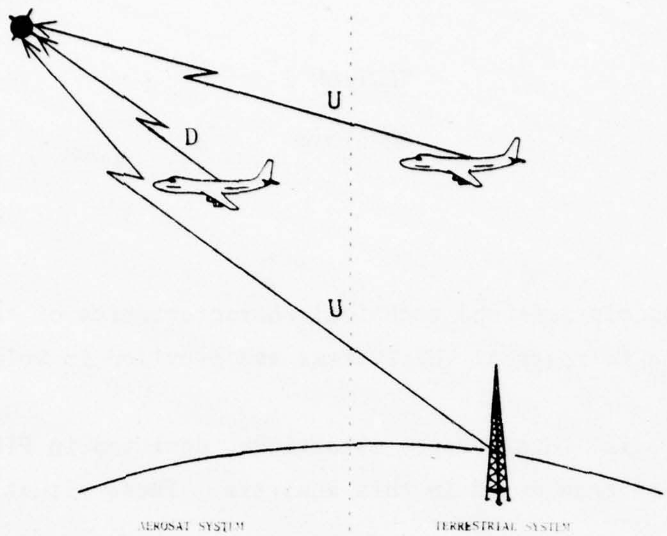

FIGURE 1. TERRESTRIAL SYSTEM POTENTIAL INTERFERENCE TO THE SATELLITE RECEIVER.

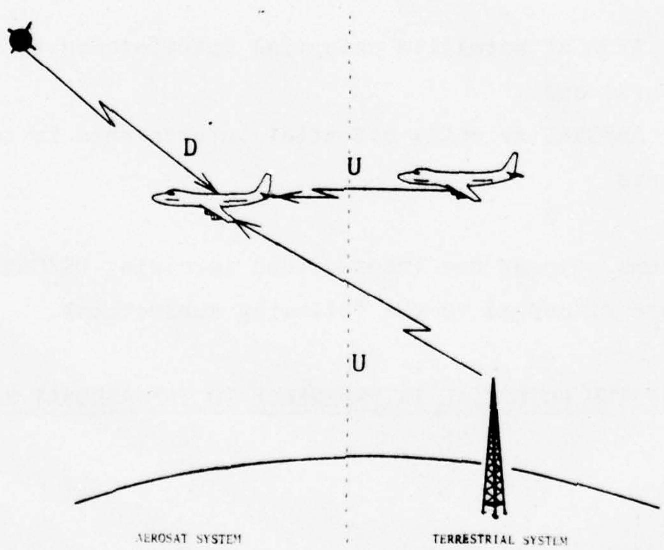

FIGURE 2. TERRESTRIAL SYSTEM POTENTIAL INTERFERENCE TO THE AEROSAT AVIONICS RECEIVER.

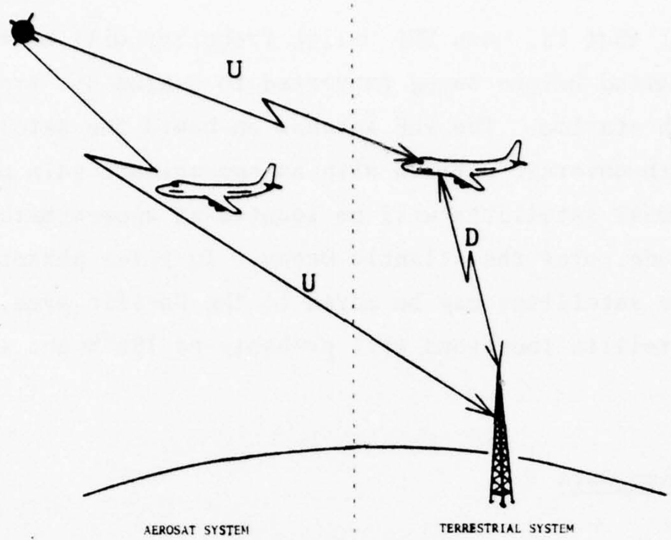

FIGURE 3. AEROSAT SATELLITE POTENTIAL INTERFERENCE TO THE TERRESTRIAL SYSTEM RECEIVERS.

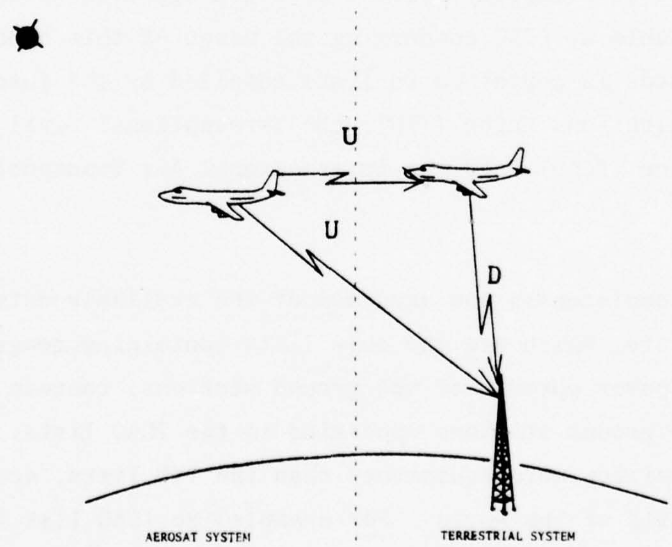

FIGURE 4. AEROSAT AIRBORNE TRANSMITTER POTENTIAL INTERFERENCE TO THE TERRESTRIAL SYSTEM RECEIVERS.

and limited; that is, each VHF uplink frequency will be filtered and hard-limited before being converted to C-band and transmitted to the earth station. The VHF antenna on-board the satellite will have an earth-coverage pattern with an approximate gain of 10 dBi. The two AEROSAT satellites will be located at approximately 15°W and 40°W longitude, over the Atlantic Ocean. In later phases of the program, the satellites may be moved to the Pacific area, in which case the satellite locations will probably be 155°W and 180°W longitude.

Ground Station Data

Since each satellite antenna pattern will cover a large portion of the earth's surface, and since both Atlantic and Pacific satellite locations are contemplated, a world-wide environment of terrestrial system ground stations must be considered. The 131.4-132.0 MHz band of interest is primarily used by civilian agencies worldwide. The data available at ECAC concerning the usage of this band outside the US and Canada is contained in lists compiled by the International Telecommunications Union (ITU), the International Civil Aviation Organization (ICAO), and the International Air Transport Association (IATA).

The completeness and accuracy of the available data is questionable. The ITU lists, which are the only lists containing geographical coordinates and power outputs of the ground stations, contain only a small subset of the ground stations appearing in the ICAO lists. The ICAO lists, while containing more equipments than the ITU lists, are not available for all parts of the world. For example, no ICAO list is published for Australia and New Zealand. In addition, several of the ICAO and IATA lists are not recent (South America: June 1971, South East Asia/Pacific: December 1970). The ICAO and IATA lists of European ground stations, however, are recent (1975) and contain essentially the same information.

In order to proceed with the analysis, certain assumptions[2] were made concerning the characteristics of the ground stations: geographical coordinates of the ground transmitting antenna were assumed to be the coordinates of the airport serving the listed city; if no airport was in the vicinity of the listed city, center-city coordinates were used. Except for the few instances where transmitter power was available from ITU lists, the assumption was made that power was 50 watts for all stations except extended range stations, which were assumed to use 1000-watt transmitters. All antennas were assumed to be omnidirectional. It was assumed that no frequency offsets were used by the ground stations.

The selected ground station coordinates are sufficiently accurate for calculation of received power levels at the satellite, considering the large distance between the earth's surface and the geostationary orbit. The assumptions concerning transmitter power, antenna gain, and frequency offset, however, are based on equipment usage in the US and Canada, and are subject to verification. It is quite possible, for example, that highly directional antennas are used by European extended range stations and that frequency offsets, similar to those used by Aeronautical Radio Inc. (ARINC) in the US, are used by closely situated European stations on the same frequency.

<u>Interference Power Received by the Satellite</u>

General. Ground stations in the 131.4-132.0 MHz band are presently assigned to frequencies at integral multiples of 50 kHz; that is, at 131.4 MHz, 131.45 MHz, 131.50 MHz...., with the exception of two stations in France. One station is listed[3] as operating at

[2]ECAC (ACV) Letter to FAA dated December 15, 1975, Subject: Support Data for AEROSAT.

[3]*Frequency Assignments in the Band 117.975-136 MHz, European Area*, Paris Office Com List No. 3, Eighteenth Edition, International Civil Aviation Organization, June 1975.

131.425 MHz (Paris, Le Bourget Airport), and the other is listed at 131.975 MHz (Calvi, Corsica).

The interference power received at the satellite from each ground station and from a typical aircraft communicating with each ground station was calculated as follows: slant range from ground stations to each potential satellite location was calculated, and free-space propagation loss was determined for each path. Maximum scintillation gain expected one percent of the time and maximum multipath gain of the interfering signal were calculated based on elevation angle and ground station location (see Volume 1). Satellite antenna gain of 10 dBi, polarization loss of 3 dB (linear to circular), and assumed ground-station power and antenna gain were added to the modified propagation loss to determine the interference power at the satellite antenna terminals. The results of these calculations are presented in detail in the computer listings contained in APPENDIXES A and B.

On-Tune Interference. The interference power level listed in APPENDIX A for both 131.425 MHz and 131.975 MHz is -135 dBW, resulting from emissions of stations at these frequencies. The level of the desired carrier at the satellite ranges[4] from -157 to -135 dBW/m^2, which may be expressed in terms of power level at the satellite antenna terminals by utilizing the following expression:

$$P_r = P_d \left(\frac{G\lambda^2}{4\pi}\right) \tag{1}$$

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[4]*Satellite Specifications*, AEROSAT Space Segment Program Office, Issue D, January 12, 1976.

where

P_r = the received power level, in watts

P_d = the power density at the antenna, in watts/m^2

G = the antenna gain, in dBi

λ = the signal wavelength, in meters.

Using the satellite antenna gain of 10 dBi, the desired signal level is calculated to be in the range from -151 dBW to -129 dBW. Thus, the interference power of -135 dBW may exceed the carrier power by up to 16 dB. This ratio will cause interference to the satellite link, since the maximum acceptable interference level is 1.2 dB below the carrier power.[5]

Atlantic Satellite Selectivity. The maximum interference power levels shown in APPENDIX A occur at frequencies of 131.4, 131.55, 131.6, and 131.75 MHz, which correspond to the frequencies used by the extended range stations; power level at these frequencies is -122 dBW at the output of the satellite antenna. Typical interference power level, as shown in APPENDIX A, is -135 dBW with interfering signals from numerous ground stations 25 kHz above and 25 kHz below each possible AEROSAT frequency.

Since scintillation and multipath are rarely at a maximum simultaneously, the maximum undesired signal strength from a particular transmitter (as calculated in APPENDIX A) occurs only a tenth of a percent of the time. The probability that the undesired signals from two transmitters would be at a maximum

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[5] *Interference Considerations for the AEROSAT Satellite Specification*, AEROSAT Space Segment Program Office, Noordwijk, Holland, December 17, 1975.

simultaneously is extremely low. Therefore, although there are many transmitters in each terrestrial system channel, it is assumed that they do not combine to produce a higher undesired signal strength at a satellite than the highest undesired signal strength from any single transmitter.

To determine the total environment (subject to data limitations) in which the Atlantic satellite must operate, the results of APPENDIX A were examined along with the results of similar calculations detailed in Volume 1 for the US and Canada. Results from Volume 1 were modified to reflect future plans[6] of ARINC to reduce high-power (100, 200, and 500 W) stations to approximately 50 watts. The combining of these results shows that any of the twelve possible AEROSAT channels (131.425 MHz, 131.475 MHz, 131.525 MHz...) may be used if the selectivity around the channel is designed to operate in the presence of the following signals:

-135 dBW at ±17 kHz
-122 dBW at ±25 kHz.

This selectivity requirement, however, does not take into account the possible instability of the interfering transmitter. ICAO standards[7] for VHF ground and airborne stations require a stability of ±.005% unless an offset carrier system is used. An offset carrier may never be more than 8 kHz from the nominal frequency; in a 4-carrier offset system (carriers at plus and minus

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[6]Meeting, R. Jones, FAA, S. Nardone, ARINC, and J. Preis, ECAC, October 6, 1975.

[7]*International Standards and Recommended Practices, Aeronautical Telecommunications, Annex 10 to the Convention on International Civil Aviation*, Volume 1, Third Edition, International Civil Aviation Organization, Montreal, Canada, July 1974.

2.5 kHz and plus and minus 7.5 kHz), stability required is ±0.5 kHz; in a 5-carrier system (carriers at zero, plus and minus 4 kHz and plus and minus 8 kHz), stability required is ±40 Hz. Interfering signals at ±17 kHz from AEROSAT frequencies are from offset carrier (5-carrier) systems and are thus relatively stable, but interfering signals at ±25 kHz from AEROSAT frequencies are required only to be within approximately ±6 kHz of the nominal center frequencies. The selectivity of the satellite repeater must allow for the ±6 kHz instability in the interfering signal; satellite repeater stability is ±1 part in 10^7 and does not contribute significantly to frequency drift. The resulting interfering signal environment is:

-135 dBW at ±17 kHz
-122 dBW at ±19 kHz.

In order to reduce the interference power to 1.2 dB below the carrier power (-151 dBW minimum), the selectivity of each channel in the satellite must be as follows:

minimum 17 dB rejection at ±17 kHz
minimum 30 dB rejection at ±19 kHz.

TABLE 1 provides a tabulation of the number of ground stations in the field of view of an Atlantic satellite. As indicated in this table, not all AEROSAT frequencies will be subject to interfering signals at ±17 kHz. In particular, if a wider satellite receiver bandpass is desired for surveillance experiments, either 131.425 or 131.975 MHz may be used, since the closest interfering signals are at -21 kHz and ±25 kHz respectively (assuming that operational coordination with the two on-tune ground stations is possible).

TABLE 1

GROUND STATIONS, IN 131.4-132 MHz BAND, WITHIN VIEW OF ATLANTIC SATELLITES

Number of Stations at:				Possible AEROSAT Frequency, f (MHz)	Number of Stations at:			
f-25 kHz	f-21 kHz	f-19 kHz	f-17 kHz		f+17 kHz	f+19 kHz	f+21 kHz	f+25 kHz
68[a]	1	0	0	131.425[b]	0	0	0	54
54	0	0	0	131.475	1	0	1	70
70	1	0	1	131.525	0	2	0	42[a]
42[a]	0	1	0	131.575	4	2	0	49[a]
49[a]	4	2	0	131.625	1	0	1	37
37	1	0	2	131.675	0	3	0	86
86	0	6	0	131.725	0	0	0	73[a]
73[a]	0	0	0	131.775	3	0	0	75
75	0	1	4	131.825	0	4	0	47
47	0	0	5	131.875	0	8	0	72
72	0	4	2	131.925	0	0	0	57
57	0	0	0	131.975[b]	0	0	0	104

[a] Extended range stations at this frequency.

[b] One ground station in France at this frequency.

Pacific Satellite Selectivity. Typical received power levels at Pacific satellite locations will be similar to those at Atlantic satellite locations, with the exceptions that received power at 131.944 MHz may be as high as -113 dBW (see Volume 1) and received power at 132.0 MHz may be as high as -117 dBW, as shown in APPENDIX B. The satellite selectivity recommended for the Atlantic satellites (above) will not necessarily be sufficient to allow interference-free operation on 131.925 or 131.975 MHz in the Pacific area. However, since the satellites will primarily be used in the Atlantic area, with Pacific area use only a possibility, general selectivity requirements should not be based on signals that will only occur in Pacific areas. The recommended selectivity will be acceptable if 131.925 and 131.975 MHz are not used in the Pacific or if operational coordination with the two stations at 131.944 MHz and 132.0 MHz is possible.

TERRESTRIAL SYSTEM POTENTIAL INTERFERENCE TO AEROSAT AVIONICS

The AEROSAT aircraft will receive transmissions from the satellite in the 125.4-126.0 MHz band. Each satellite will transmit up to two carriers; carrier center frequencies will be chosen from the following set: 125.425, 125.475, 125.525, 125.575, 125.625, 125.675, 125.725, 125.775, 125.825, 125.875, 125.925, and 125.975 MHz.

Analysis of possible interference from the large number of ground stations now operating in the 125.4-126.0 MHz band was presented in Volume 1. Since the possibility that frequency offsets are used in Europe was taken into account in the analysis, no modification of results is required. The AEROSAT avionics receiver should be designed so that the lock-in range of the phase-lock loop is within ±17 kHz of the desired frequency, and the receiver should be designed to operate in the presence of undesired signals, 17 to 25 kHz away, 51 dB above the desired signal. Undesired signals up to 84 dB above the desired signal are possible during unrestricted system operation.

AEROSAT SATELLITE POTENTIAL INTERFERENCE TO TERRESTRIAL SYSTEM RECEIVERS

This potential interference path in the 125.4-126.0 MHz band was considered in Volume 1. No degradation of terrestrial system receivers is expected, because of the low interfering signal levels available from the satellite at the earth's surface.

AEROSAT AVIONICS POTENTIAL INTERFERENCE TO TERRESTRIAL SYSTEM RECEIVERS

General

Aircraft equipped with AEROSAT VHF avionics will transmit to the satellite in the 131.4-132.0 MHz band. An individual aircraft will transmit on one frequency only, but up to eight frequencies may be in use simultaneously in the Atlantic area since each satellite may receive up to four VHF channels. The frequencies to be used will be chosen from the following set: 131.425, 131.475, 131.525,..., 131.975 MHz.

As indicated in APPENDIXES A and B, ground stations in the terrestrial system operate at integral multiples of 50 kHz in the 131.4-132.0 MHz band. Potential interference from AEROSAT avionics to the receiver at the terrestrial system ground stations and to the receivers on-board the aircraft communicating with the ground stations will depend to a great extent on whether the receivers are designed to reject adjacent channel signals 25 kHz away. The present assignments in the 131.4-132.0 MHz band are at 50-kHz increments, and no information concerning receiver selectivity is contained in the ITU, ICAO, or IATA frequency lists. Information presented in ICAO documents (Reference 7) shows that ground and aircraft receivers must be capable of rejecting the next assignable frequency, which is normally

±50 kHz, but that 25-kHz channelization is possible in certain unspecified areas of the world after 1 January 1977. In the US and Canada, most commercial aircraft and ground stations in the 131.4-132.0 MHz band are expected to be converted to 25-kHz selectivity by 1977 (see Volume 1). However, definite information is lacking regarding the intentions of airlines to convert to 25-kHz selectivity in the rest of the world.

Interference on North Atlantic Routes

Since AEROSAT-equipped aircraft will primarily be flying North Atlantic air routes, potential interference to aircraft and ground stations in the North America/Europe area must be considered. In Volume 1, it was shown that interference to ground stations and aircraft on the North American side of the Atlantic is not likely to occur. Interference to European aircraft and ground stations is analyzed in this volume.

Since European frequency assignments in the 131.4-132.0 MHz band are at 50-kHz intervals, and since the normal selectivity required by ICAO is rejection of adjacent channels 50 kHz away, it is assumed that all ground stations in this band and VHF radios in all aircraft flying routes within Europe are equipped with 50-kHz selectivity.

Some additional information is available with regard to aircraft flying trans-Atlantic routes. It is indicated in the ICAO and IATA frequency lists[8] (Reference 3) that European ground stations in the 131.4-132.0 MHz band are operated by and provide service to only certain airline companies. All of the twenty IATA members providing

[8] *Airline Company VHF Operational Control Facilities Frequency Plan for Europe and Middle East Region*, International Air Transport Association, May 1975.

scheduled service to and from Europe on North Atlantic routes utilize this band, but the companies providing charter-only North Atlantic service are not listed as utilizing the band. Of the North Atlantic carriers that use the band, a significant number have indicated that 25-kHz equipment will be installed by 1977.[9] Based on a listing of North Atlantic flight statistics,[10] nine of the top eleven North Atlantic carriers will be equipped for 25-kHz selectivity by 1977. Information concerning the plans of the other airlines using the 131.4-132.0 MHz band in the North Atlantic is not available. Based upon present statistics (July, 1975), 4992 flights out of the total 6456 flights were operated by the nine carriers that will be equipped for 25-kHz selectivity; if the present distribution of flights continues, approximately 80% of the aircraft will definitely be so equipped, and other airlines may also be equipped.

Calculations performed in Volume 1 indicate that AEROSAT-equipped aircraft will not interfere with terrestrial-system aircraft when the terrestrial-system aircraft is equipped for 25-kHz selectivity. Thus, interference to aircraft flying trans-Atlantic routes into and out of Europe is unlikely, based on the percentage of aircraft that will be so equipped.

<u>Interference on European Routes</u>

Interference by AEROSAT-equipped aircraft to terrestrial system ground stations in Europe, and to terrestrial system aircraft flying

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[9]TELCON between J. Preis, ECAC, and R. Sollien, ARINC, October 1975.

[10]"North Atlantic Passenger Traffic, July 1975," *Aviation Week and Space Technology*, October 27, 1975, p. 33.

European routes was analyzed. As stated above, these receivers are assumed to be equipped with 50-kHz selectivity, as defined by ICAO in Reference 7. Specific ICAO technical requirements are presented in TABLE 2.

TABLE 2

VHF COMMUNICATION SYSTEM CHARACTERISTICS

	Sensitivity	Stability	Adjacent-Channel Rejection
Ground Station	20 μV/m (-120 dBW/m^2)	.005%	60 dB at ±50 kHz
Airborne Station	75 μV/m (-109 dBW/m^2)	.005%	50 dB at ±50 kHz 40 dB at ±35 kHz

Using Equation 1, the sensitivity of the receivers may be expressed in terms of power level at the receiver input terminals. Utilizing an effective antenna gain of 0 dBi to account for line losses, the sensitivity of the ground receiver was calculated to be -124 dBW, and the sensitivity of the airborne receiver -113 dBW. The receiver bandwidth (-3 dB) was estimated to be 37 kHz in each case, based on a survey of existing equipments and a calculation of requirements to account for signal bandwidth and instability.

In order to predict the effect of an FM interfering signal (from an AEROSAT aircraft) on the ground and airborne receivers, an existing ECAC computer model was used. Inputs to the program include descriptions of the receivers and of the undesired AEROSAT signal, and indicate that the undesired signal is 25 kHz away from the desired signal. Program outputs were used to generate curves showing desired-to-undesired signal relationships for a constant Articulation Index (AI) of 0.5. Choice of this AI is explained in Volume 1. FIGURE 5 shows the resulting curves.

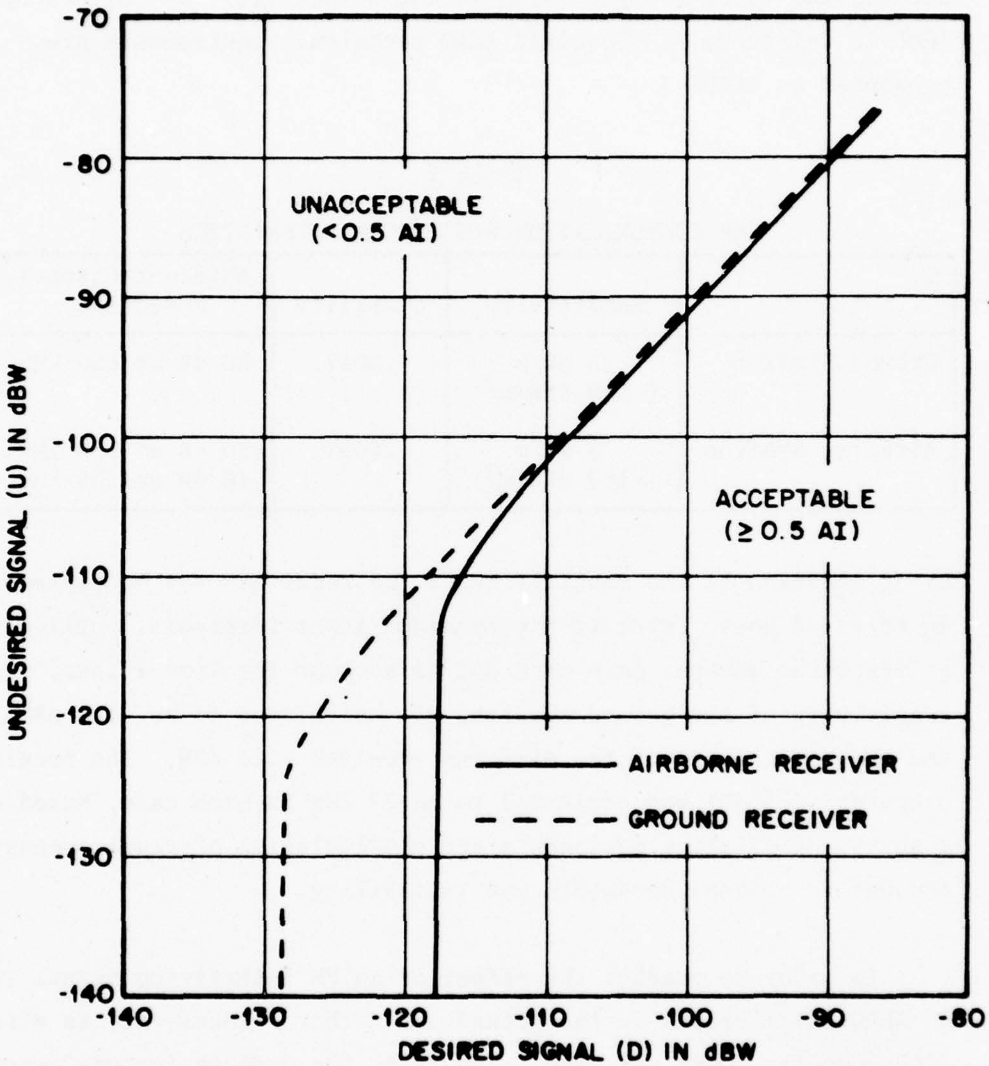

FIGURE 5. DEGRADATION THRESHOLD CURVES - AEROSAT AIRCRAFT INTERFERENCE TO TERRESTRIAL SYSTEM RECEIVERS 25 kHz AWAY.

Effect on Ground Stations. The minimum desired signal (sensitivity) at a ground station receiver is -124 dBW. From FIGURE 5 (dashed curve), it is seen that the maximum allowable U for a D of -124 is -116 dBW. The propagation loss required to ensure that U will be less than -116 dBW at a ground station may be calculated from the following equation:

$$L_p = P_t + G_t + G_r - U \qquad (2)$$

where

L_p = the required propagation loss, in dB

P_t = the AEROSAT aircraft power, in dBW

G_t = the AEROSAT aircraft antenna gain, in dBi

G_r = the ground station antenna gain, in dBi

U = the maximum allowable undesired signal, in dBW.

AEROSAT aircraft power level at the aircraft antenna terminals is 19 dBW and the AEROSAT aircraft antenna gain in the horizontal direction and measured at the polarization of the ground-station antenna (see FIGURE 11, Volume 1) is -2 dBi. Using an effective ground-station antenna gain of 0 dBi in Equation 2 results in a required propagation loss of 133 dB to prevent interference to the ground station. Calculations of the distance required to obtain a loss of 133 dB were made using ECAC's Master Propagation System. After examining the possible effect of ground-station antenna height variation and of aircraft altitude variation, it was determined that a propagation loss of 133 dB will be exceeded 90% of the time when the distance between the AEROSAT aircraft and the ground station is 244 nmi or more. This is the distance from a ground station within which the AEROSAT aircraft should not operate when tuned to a channel adjacent to (25 kHz away from) the ground station.

Effect on Aircraft Receivers. Minimum D at the terrestrial system aircraft receiver is -113 dBW, and from FIGURE 5, the maximum allowable U for a D of -113 dBW is -104 dBW. In Volume 1, coupling factors (CF) were calculated that account for both propagation loss and aircraft antenna gains on aircraft-to-aircraft paths. Required CF is calculated from the following equation:

$$CF = U - P_t \qquad (3)$$

where

CF = the coupling factor, in dB

and other symbols have previously been defined.

From Equation 3, the required CF is -123 dB. From FIGURE 6, which is reproduced from Volume 1, it is seen that separation distance should exceed 160 nmi to prevent interference. This is the distance from an aircraft within which the AEROSAT aircraft should not operate when tuned to a channel adjacent to (25 kHz away from) the aircraft transceiver.

Geographical Constraints on AEROSAT Aircraft. An AEROSAT aircraft operating on one of the twelve possible channels in the 131.4-132.0 MHz band should not transmit when within 244 nmi of an adjacent-frequency ground station in Europe or within 160 nmi of an adjacent-frequency aircraft flying a European air route. In order to identify those geographical areas that are to be avoided, European ground stations adjacent to each possible AEROSAT frequency were plotted on a series of maps. For example, stations operating at 131.4 MHz and 131.45 MHz were plotted on one map, since both frequencies are adjacent to 131.425 MHz; stations operating at 131.45 MHz and 131.5 MHz were plotted on one map, since both frequencies are adjacent to 131.475 MHz; etc. On each map is

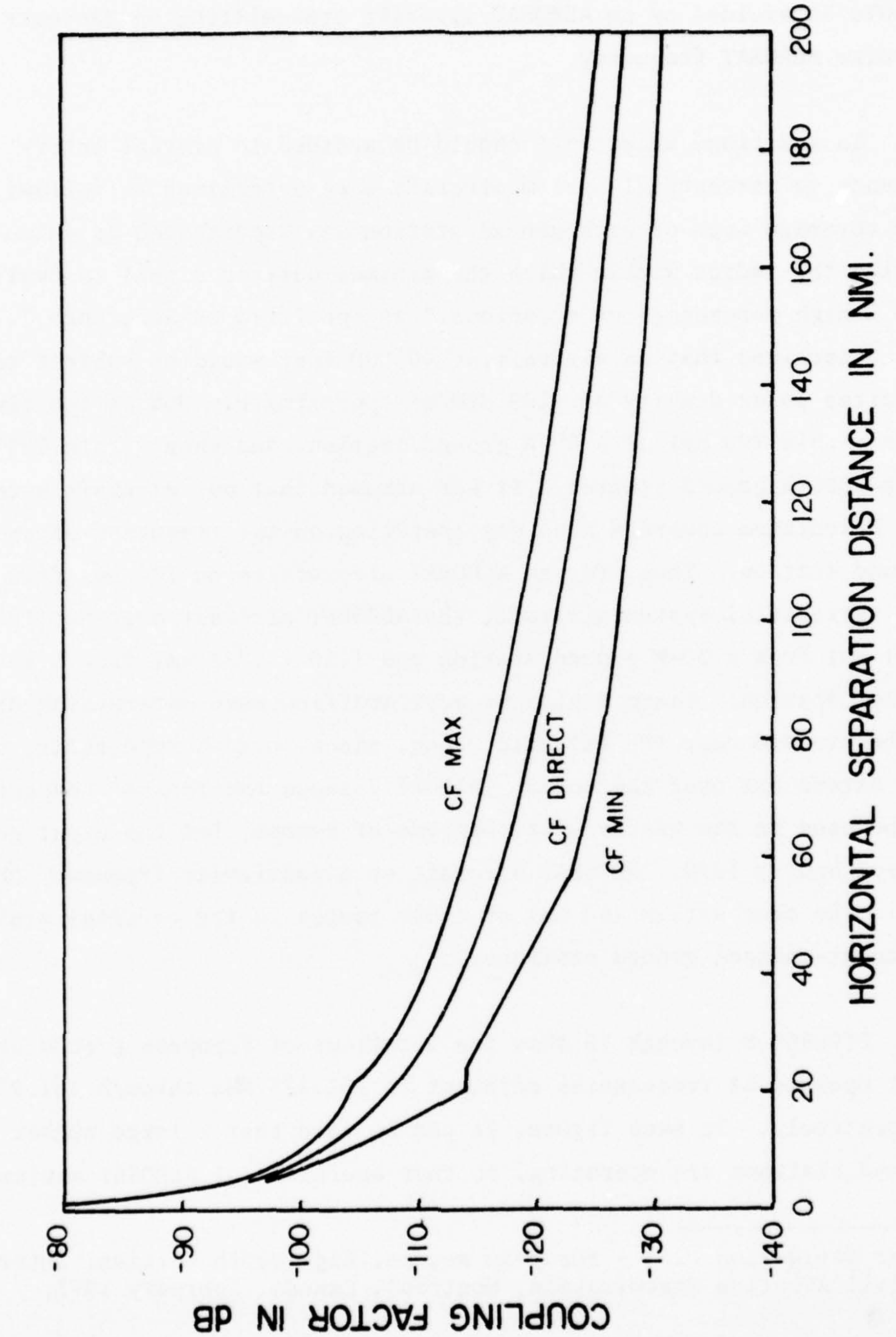

FIGURE 6. PROPAGATION BETWEEN AN AEROSAT AIRPLANE AND A TERRESTRIAL SYSTEM AIRPLANE.

shown the area within 244 nmi of each ground-station symbol that should be avoided by an AEROSAT aircraft transmitting on the particular AEROSAT frequency.

In addition, areas that should be avoided to prevent interference to terrestrial-system aircraft were determined as follows. The coverage area of each ground station was ascertained by calculating the radius within which the minimum desired signal is available "on a high percentage of occasions," as specified in Reference 7. It was determined that an aircraft at 40,000 feet would be subject to the required power density of -109 dBW/m^2 approximately 90% of the time when within 190 nmi of a 50-W ground station, and when within 225 nmi of a 1000-W ground station. It was assumed that any aircraft within the calculated coverage area was operating on the frequency of the ground station. Thus, for an AEROSAT aircraft to be 160 nmi from the terrestrial-system aircraft, the AEROSAT aircraft must be (160 + 190) nmi from a 50-W ground station and (160 + 225) nmi from a 1000-W ground station. These distances were modified when determining areas to be avoided near the Atlantic Ocean, since intra-Europe routes do not extend out over the ocean. FIGURE 7 shows the routes[11] expected to be used in the westernmost portions of Europe, for the eight year period ending 1979. AEROSAT aircraft on a particular frequency should avoid the area within 160 nmi of those routes in the coverage area of adjacent-channel ground stations.

FIGURES 8 through 19 show the locations of European ground stations that operate at frequencies adjacent to 131.425 MHz through 131.975 MHz, respectively. In each figure, it can be seen that a large number of ground stations are operating, so that operation of AEROSAT equipment

[11] *Air Navigation Plan - European Region*, Eighteenth Edition, International Civil Aviation Organization, Montreal, Canada, February 1973.

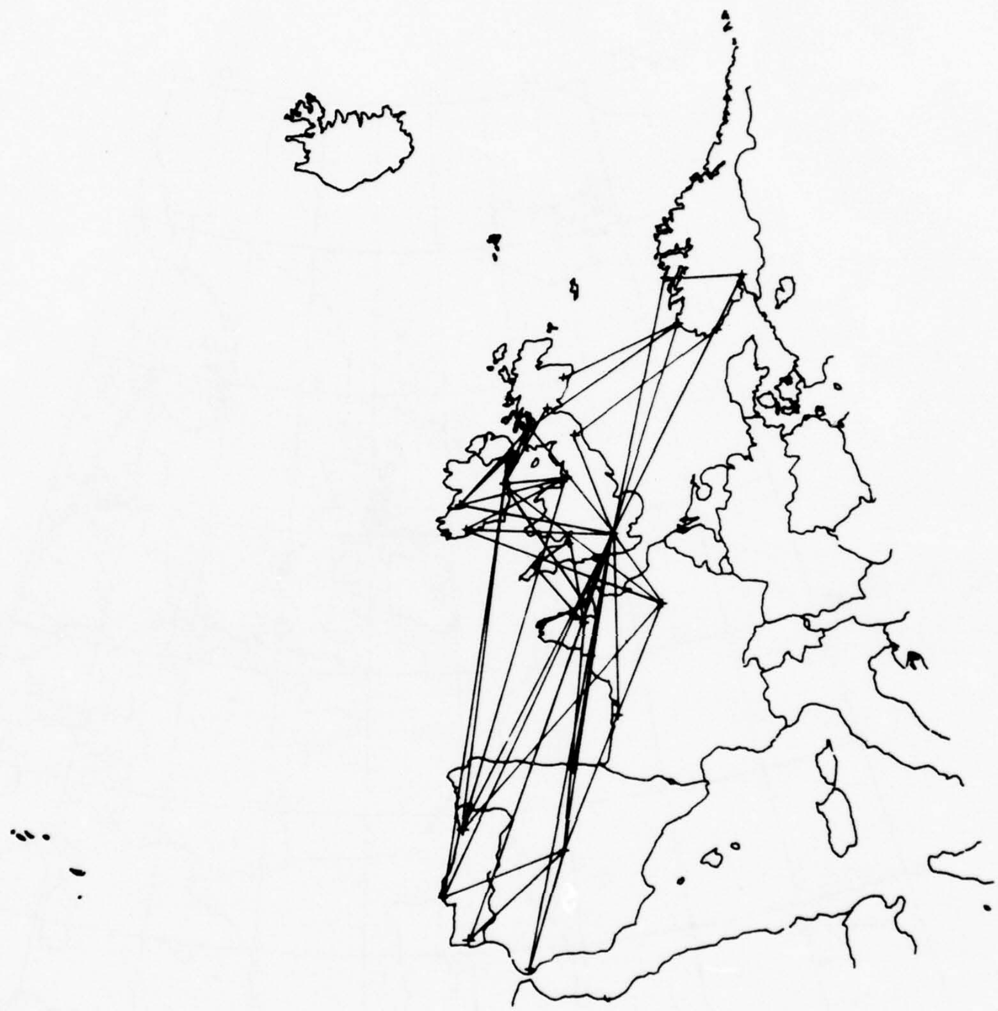

FIGURE 7. WESTERNMOST EUROPEAN AIR ROUTES.

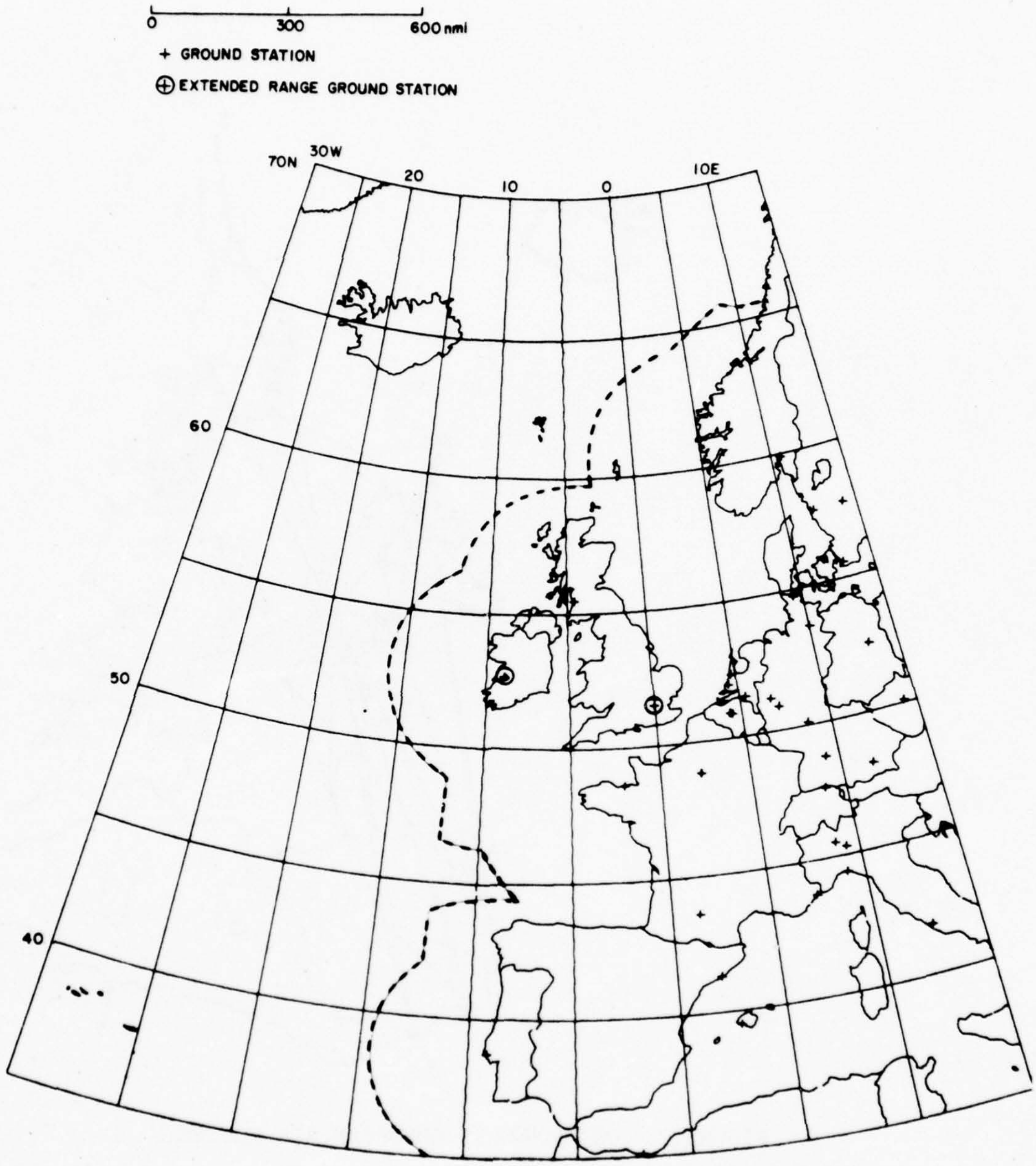

FIGURE 8. GROUND STATIONS ADJACENT TO 131.425 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

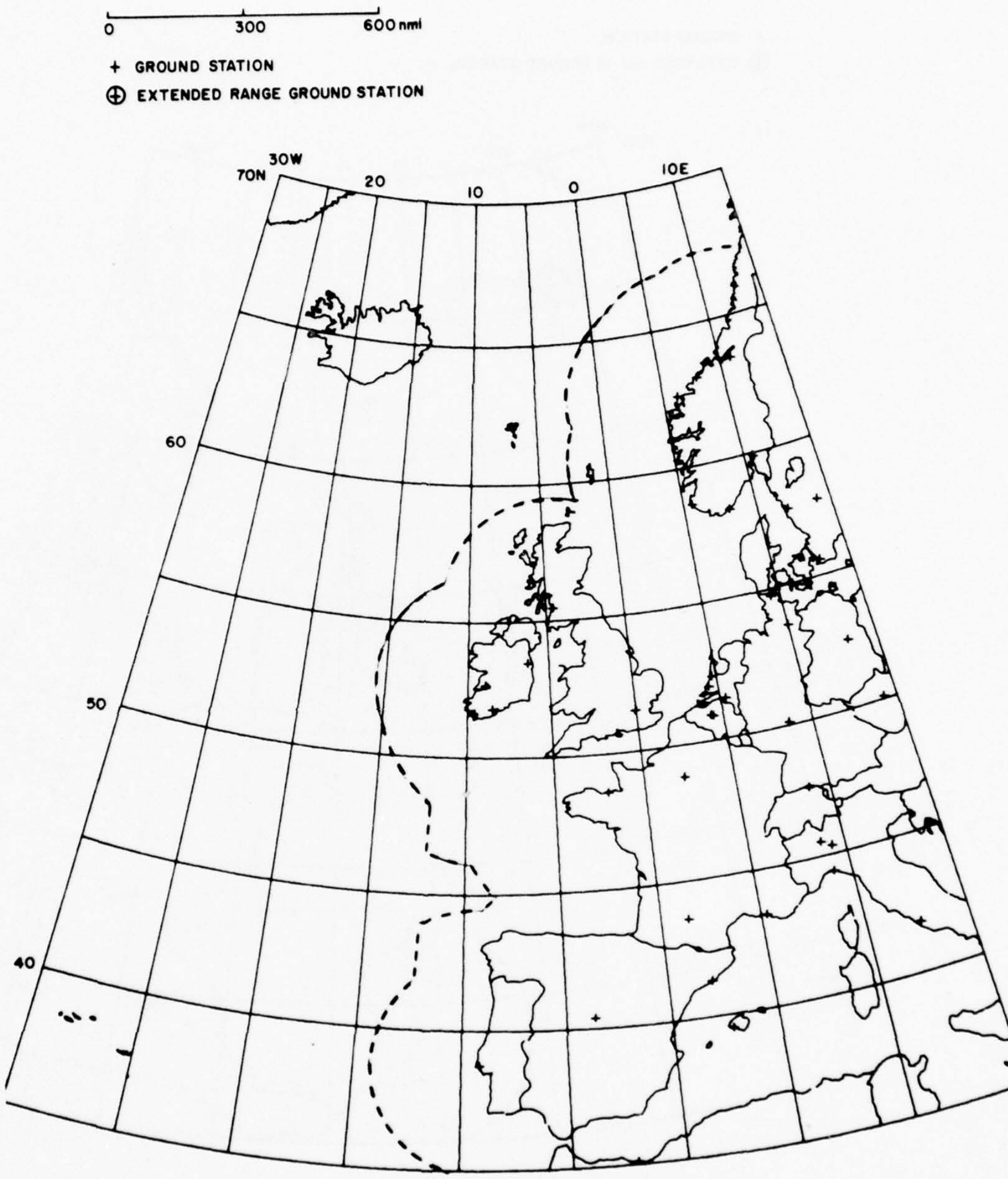

FIGURE 9. GROUND STATIONS ADJACENT TO 131.475 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

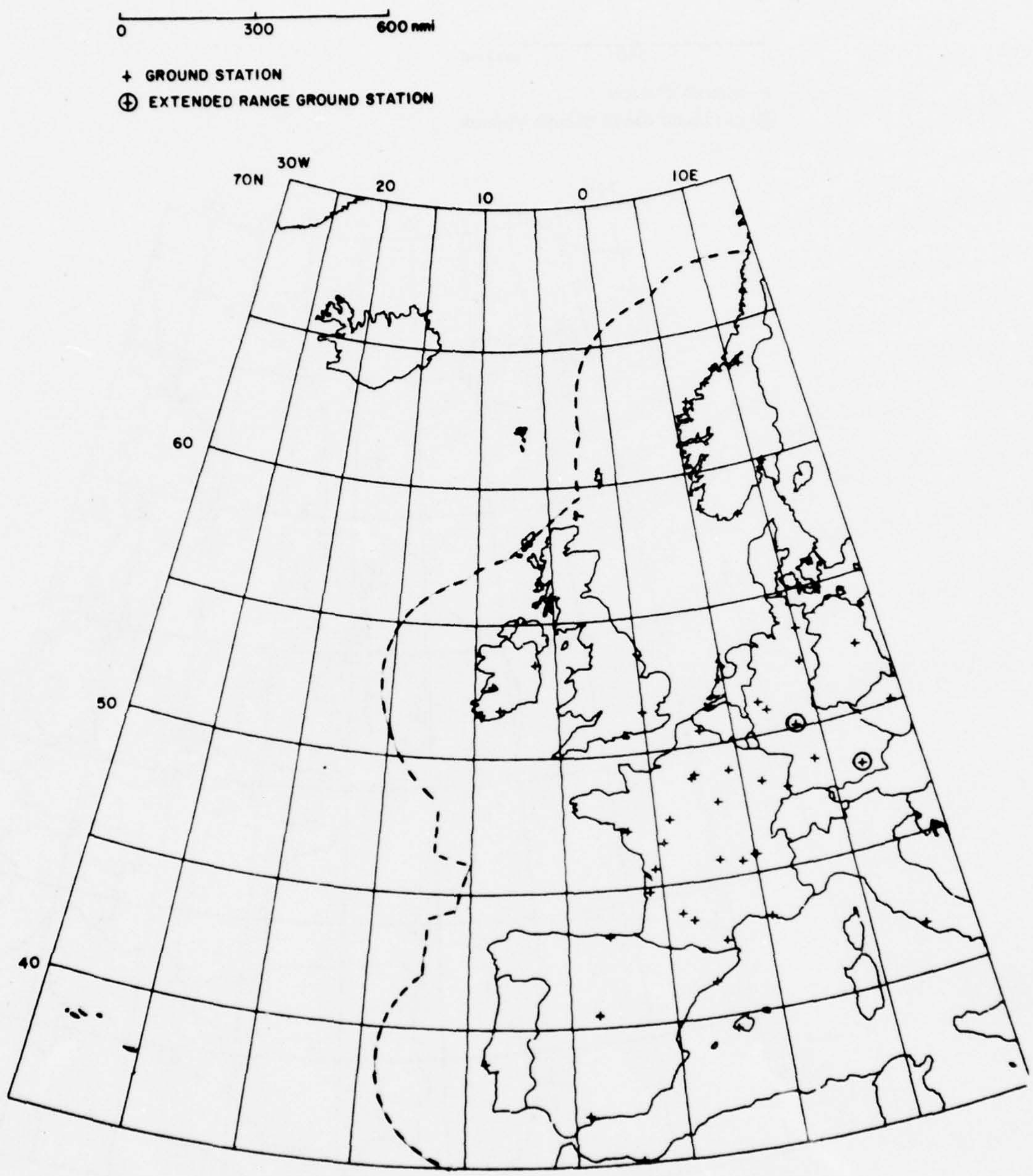

FIGURE 10. GROUND STATIONS ADJACENT TO 131.525 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

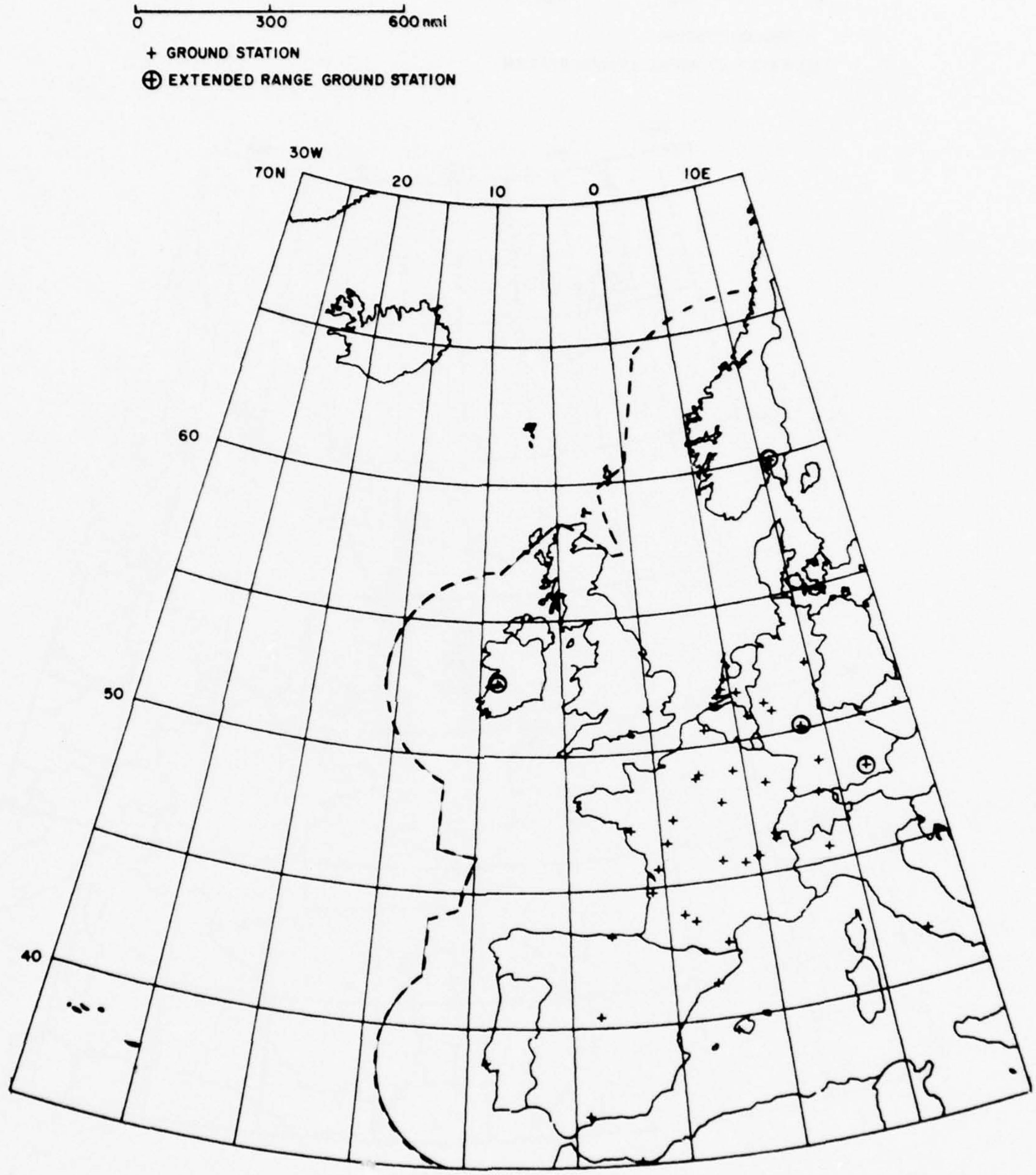

FIGURE 11. GROUND STATIONS ADJACENT TO 131.575 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

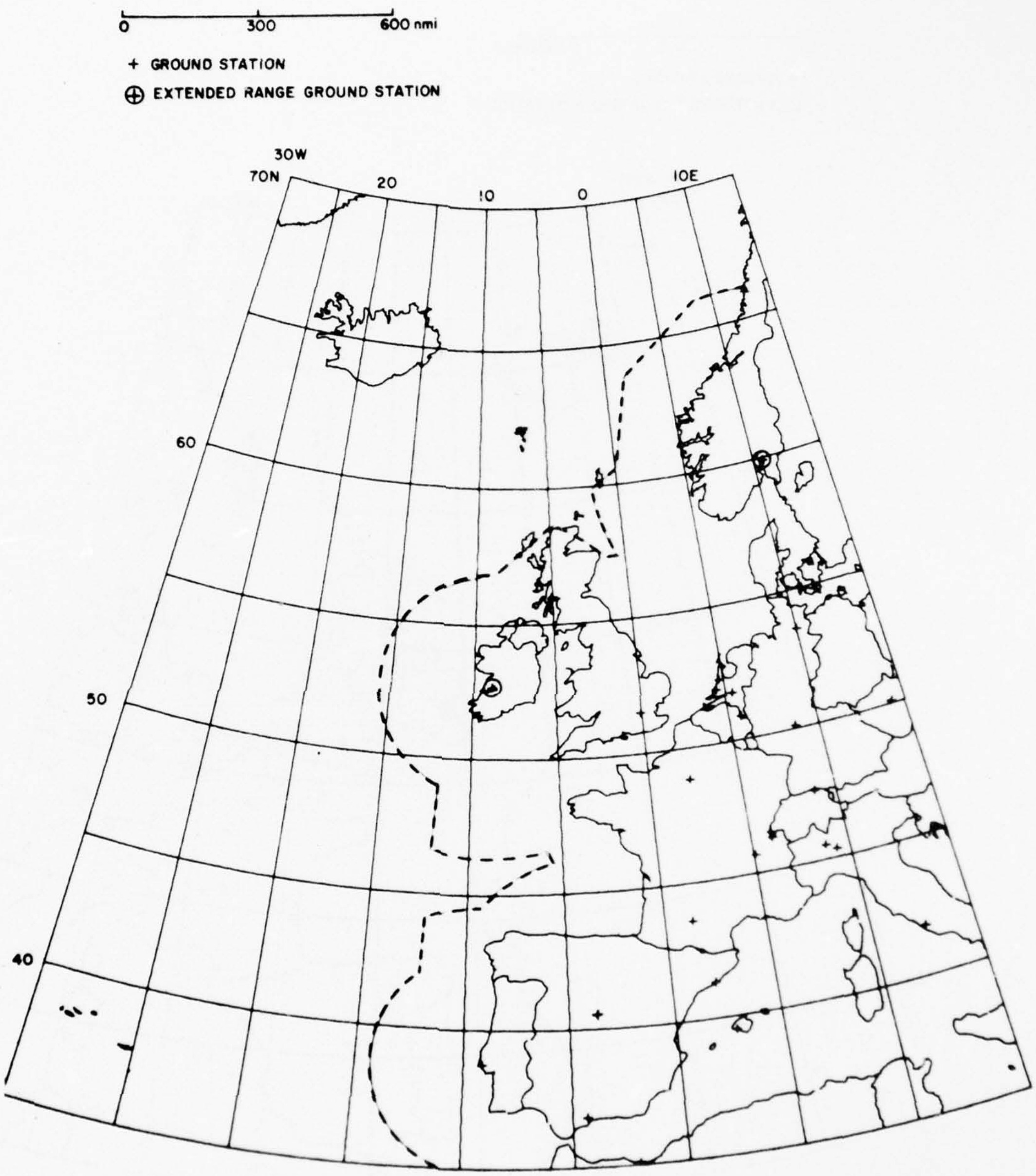

FIGURE 12. GROUND STATIONS ADJACENT TO 131.625 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

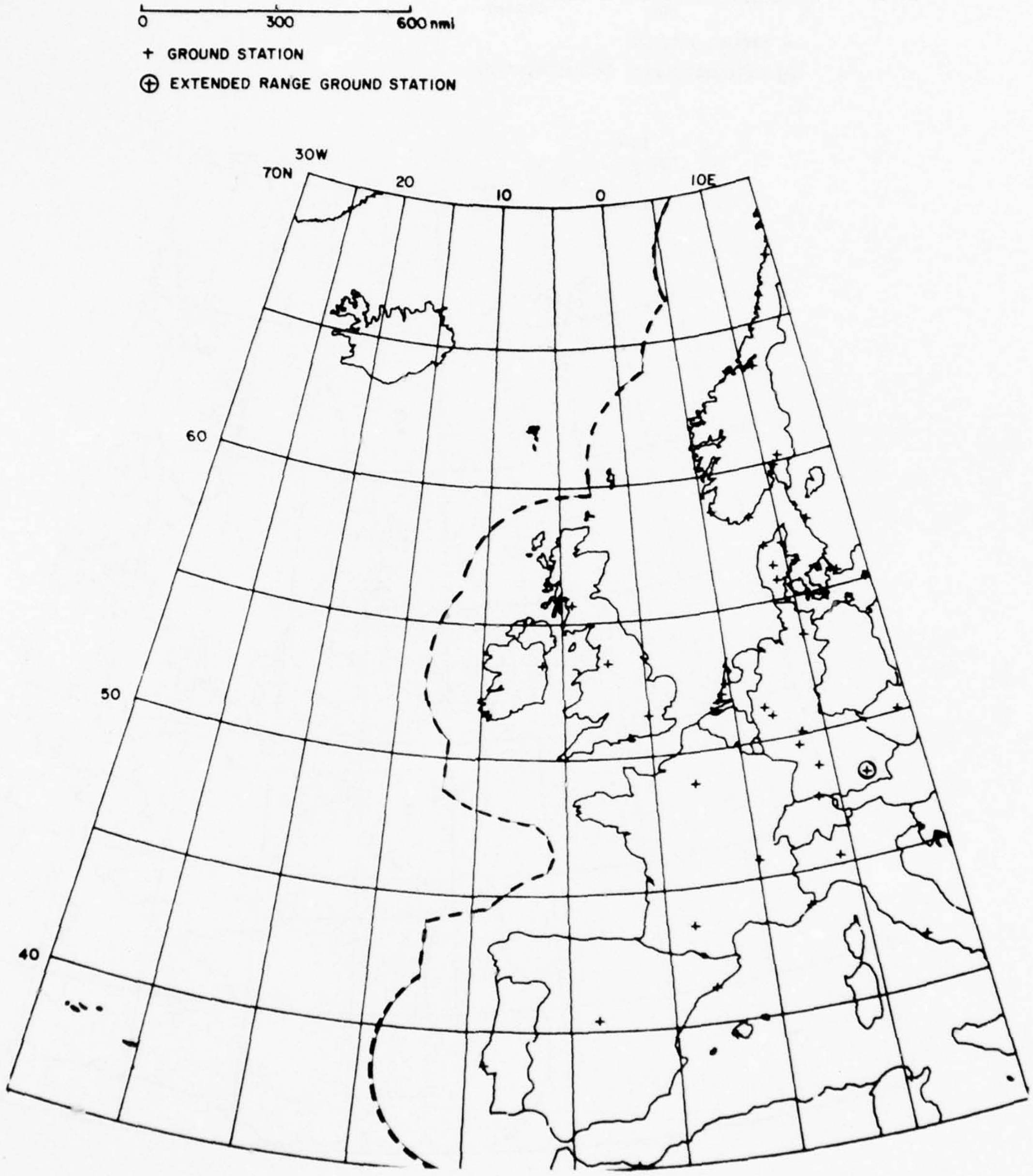

FIGURE 13. GROUND STATIONS ADJACENT TO 131.675 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

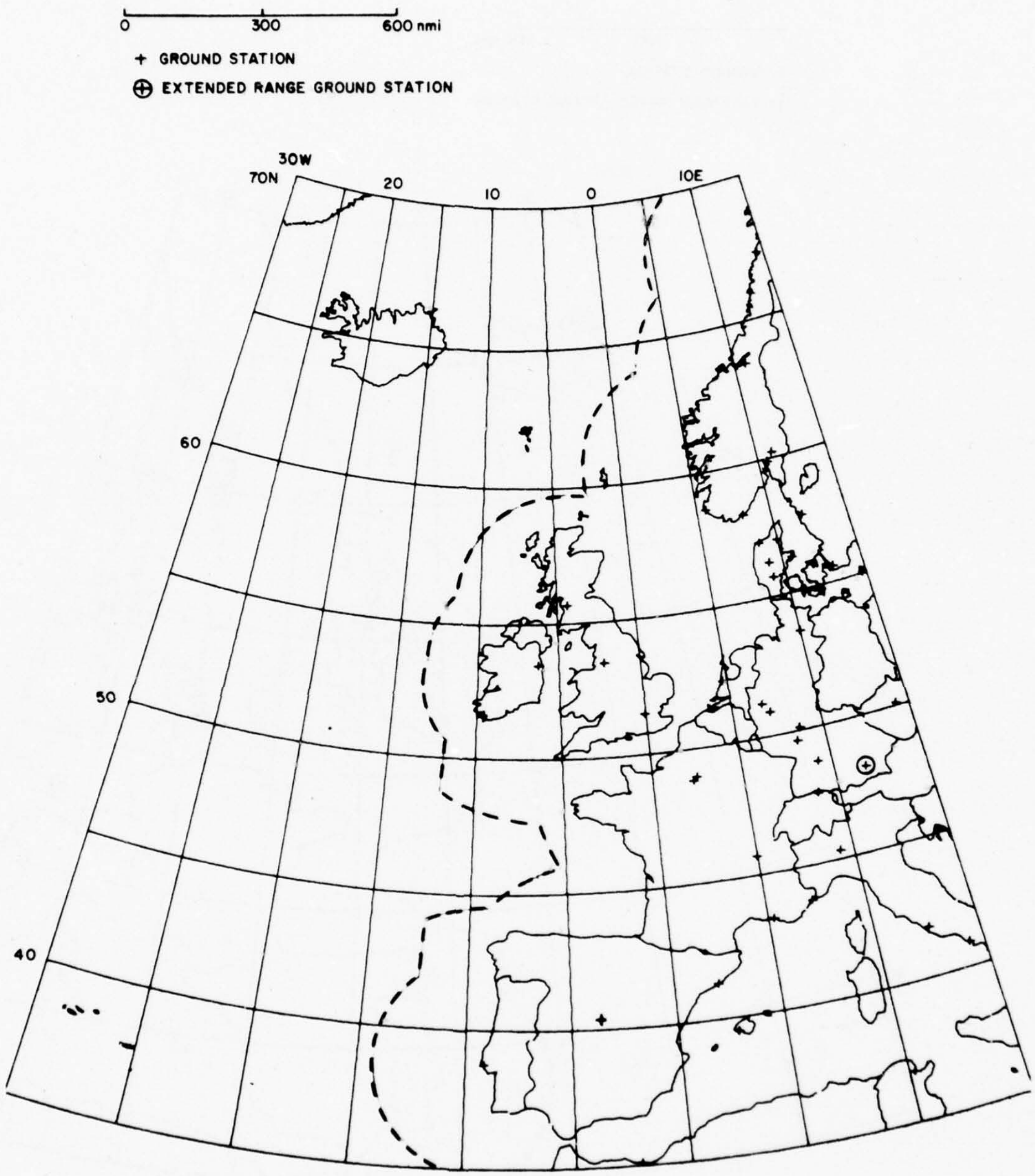

FIGURE 14. GROUND STATIONS ADJACENT TO 131.725 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

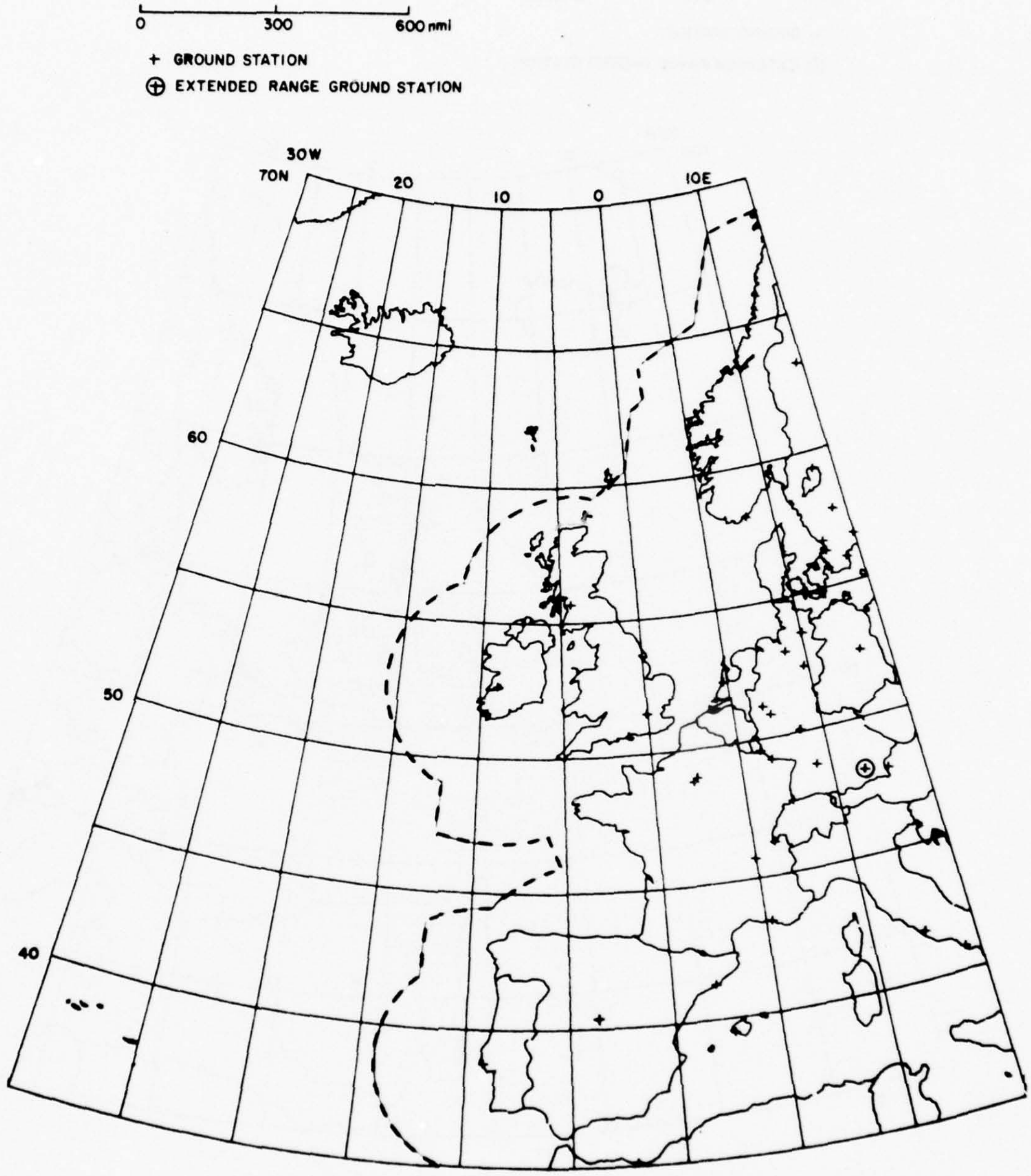

FIGURE 15. GROUND STATIONS ADJACENT TO 131.775 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

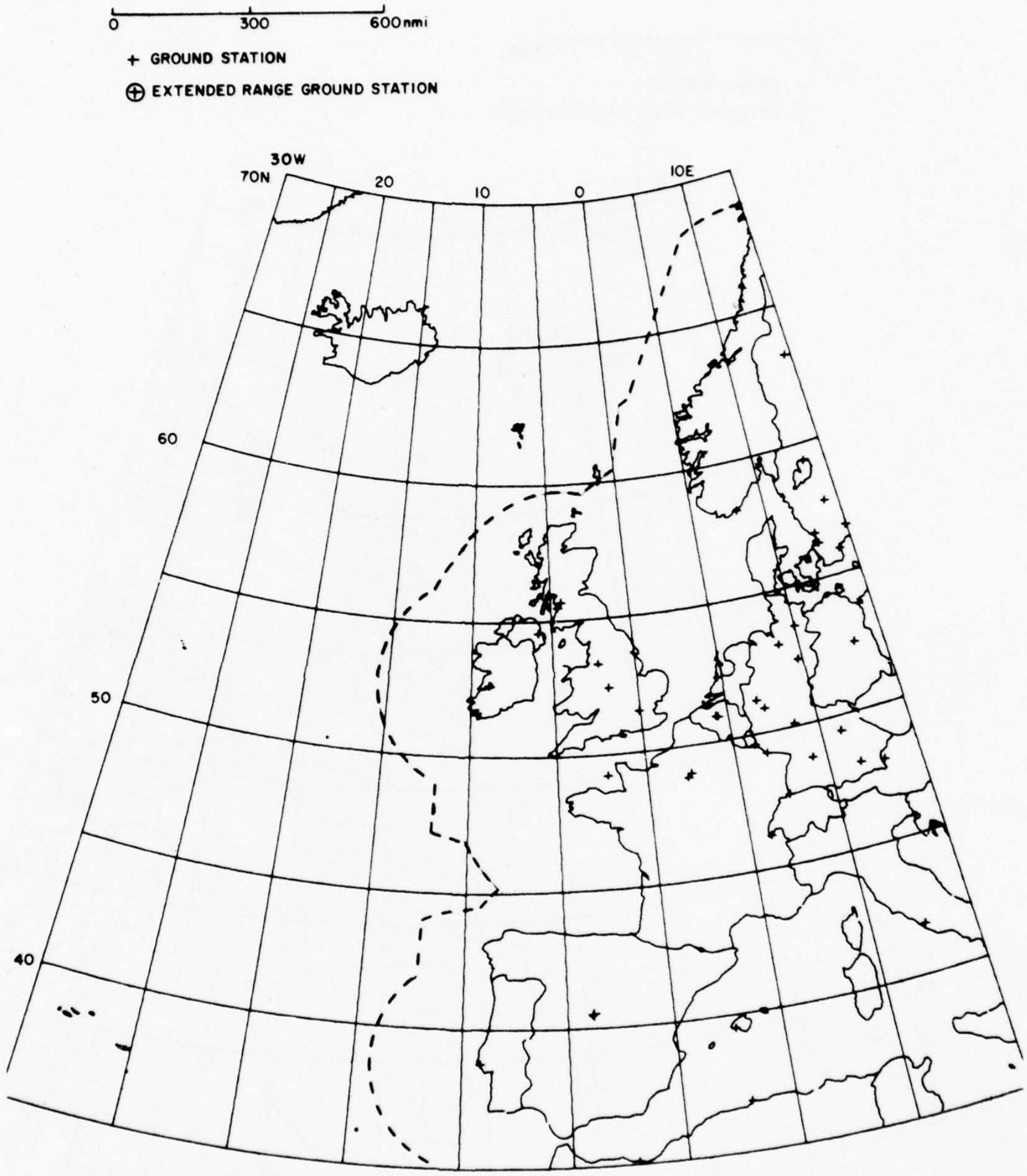

FIGURE 16. GROUND STATIONS ADJACENT TO 131.825 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

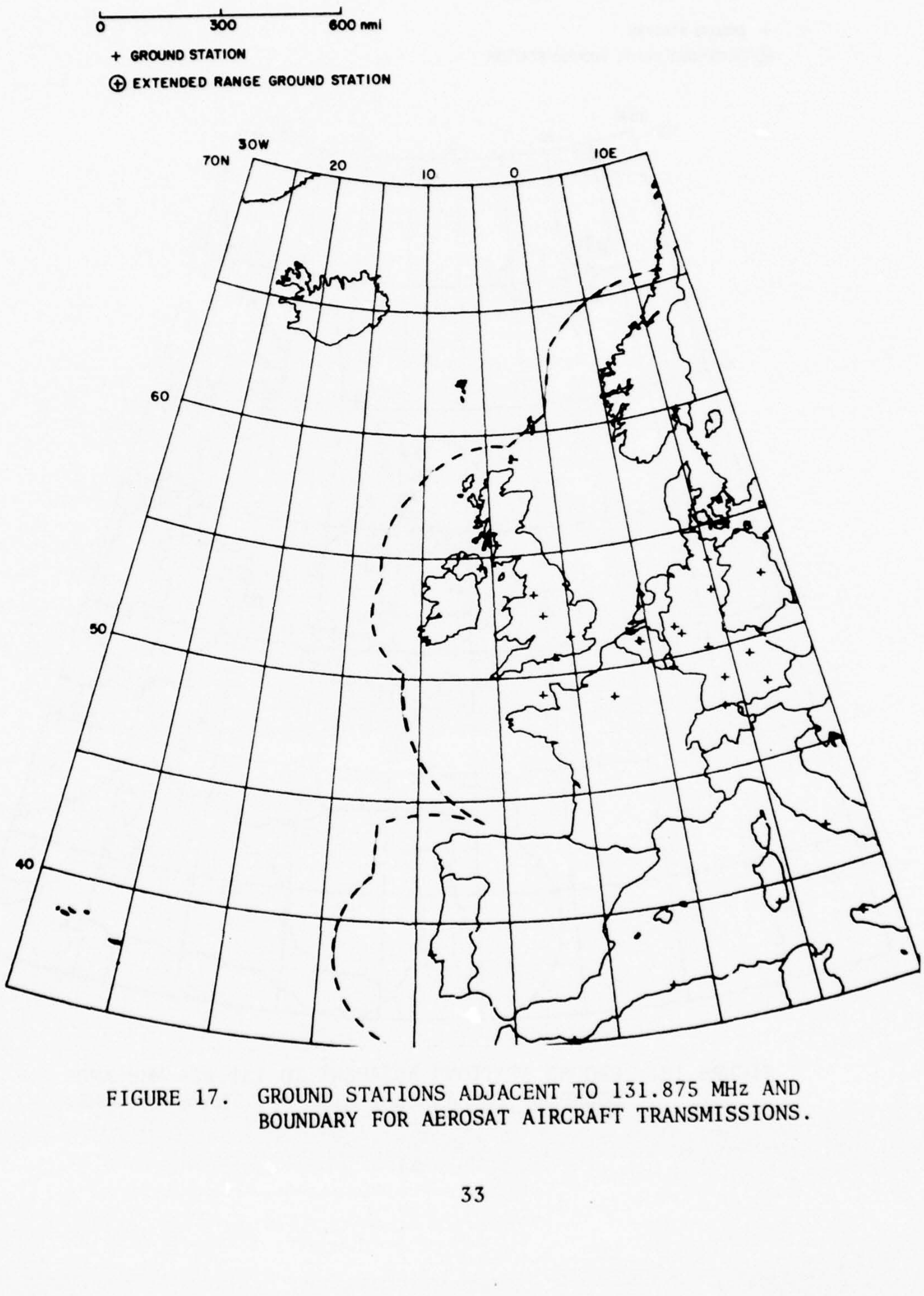

FIGURE 17. GROUND STATIONS ADJACENT TO 131.875 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

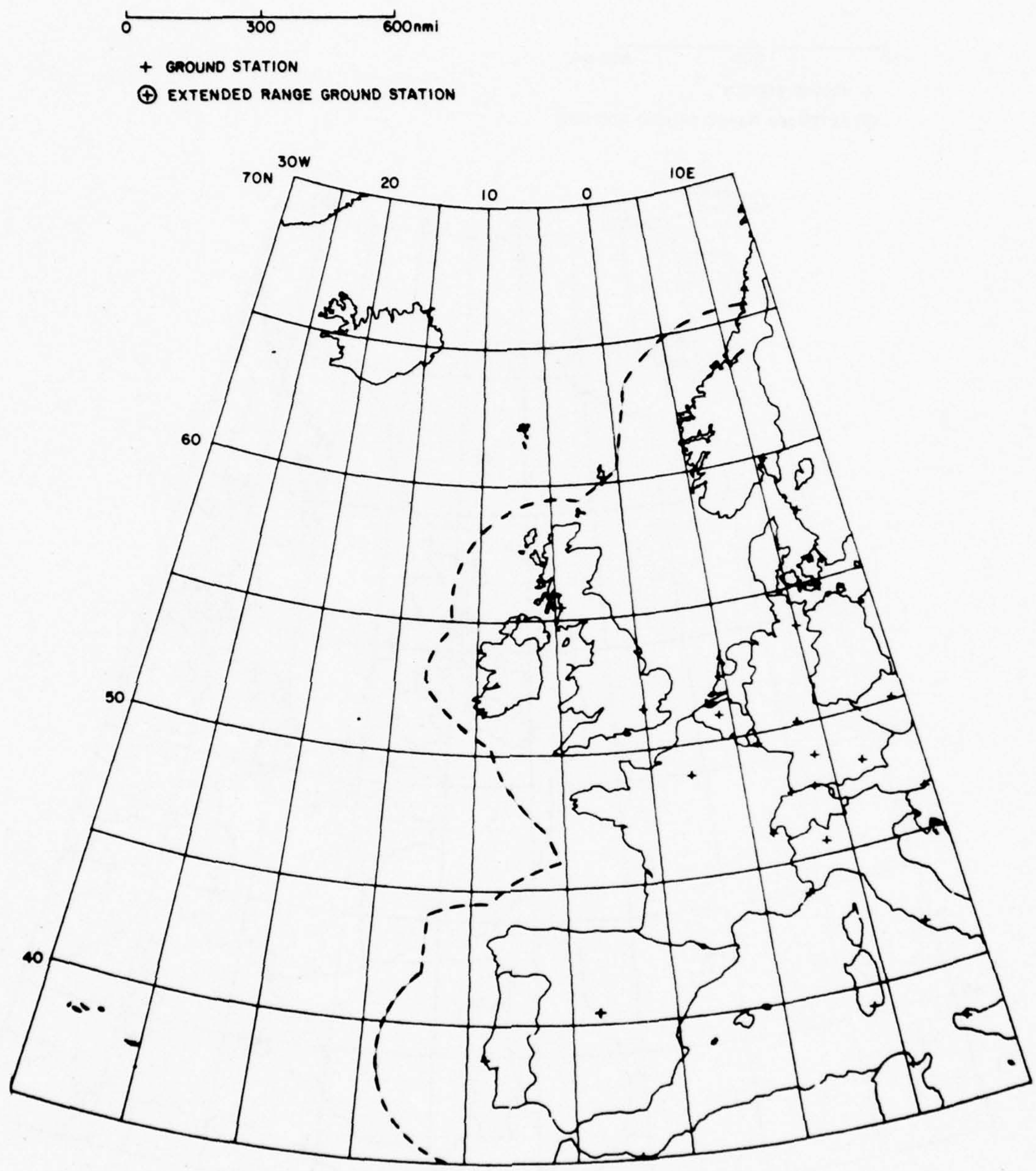

FIGURE 18. GROUND STATIONS ADJACENT TO 131.925 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

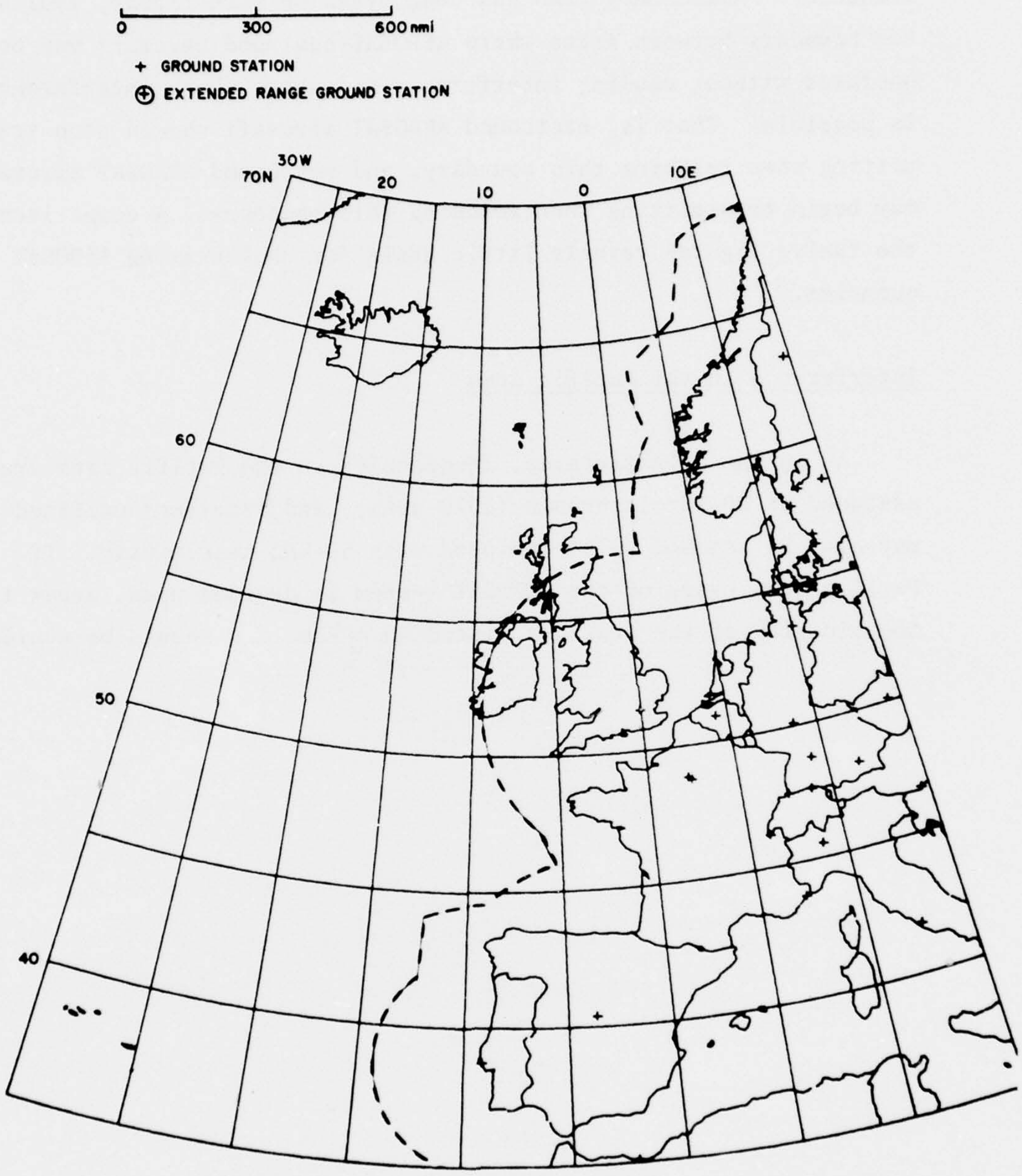

FIGURE 19. GROUND STATIONS ADJACENT TO 131.975 MHz AND BOUNDARY FOR AEROSAT AIRCRAFT TRANSMISSIONS.

in aircraft over the European continent is not recommended at any frequency. A boundary line has been drawn on each figure, indicating the boundary between areas where AEROSAT-equipped aircraft may be operated without causing interference and areas where interference is possible. That is, eastbound AEROSAT aircraft should stop transmitting when reaching this boundary, and westbound AEROSAT aircraft may begin transmitting when reaching this boundary. A comparison of the twelve figures reveals little basis for choice among AEROSAT frequencies.

Interference in the Pacific Area

As in the Atlantic area, frequencies in the Pacific area are assigned at 50-kHz intervals (1970 data), and receivers utilized may also be assumed to be equipped with 50-kHz selectivity. If Pacific area usage of the AEROSAT system is decided upon, areas in the vicinity of the stations listed in APPENDIX B should be avoided.

SECTION 3

RESULTS

GENERAL

The following results and recommendations are based on the best estimate of the world-wide VHF environment that will be encountered by AEROSAT in the 1980's, as indicated by data sources available to ECAC.

RESULTS

Atlantic Area Satellites and Aircraft

1. On-tune interference to the AEROSAT VHF-to-C-band link is likely to occur if either 131.425 MHz or 131.975 MHz is chosen as a VHF uplink carrier frequency. One on-tune ground station operates in France at each frequency; operational coordination with these stations will eliminate this interference.

2. With the exception of the two on-tune stations, all potential interference sources to the VHF uplink will be separated in frequency from the AEROSAT frequencies by at least 17 kHz. Interference will be avoided if the selectivity of the VHF-to-C-band repeater in the satellite meets the following requirements:

> a minimum rejection of 17 dB at ±17 kHz, and
> a minimum rejection of 30 dB at ±19 kHz,

with respect to each VHF uplink carrier frequency.

3. Interference by AEROSAT-equipped aircraft to terrestrial system VHF receivers in Europe is possible on all AEROSAT frequencies if the AEROSAT aircraft transmits over European land areas. Interference to the terrestrial system receivers may be avoided by restricting the geographical area in which AEROSAT aircraft transmissions are allowed, as shown in FIGURES 8 through 19.

Pacific Area Satellites and Aircraft

1. Adjacent-signal interference to the AEROSAT VHF-to-C-band link is likely to occur if either 131.925 MHz or 131.975 MHz is chosen as an uplink carrier frequency. High levels of interference will be received from two stations, one at 131.944 MHz and one at 132.0 MHz; operational coordination with these stations will eliminate this interference.

2. With the exception of the two stations at 131.944 MHz and 132.0 MHz, the selectivity requirements for Atlantic area satellites will be sufficient to avoid interference in the Pacific area.

3. Interference by AEROSAT-equipped aircraft to terrestrial system VHF receivers in the Pacific area (except in the US and Canada) is possible on all AEROSAT frequencies. Interference to the terrestrial system receivers may be avoided by restricting the geographical area in which AEROSAT aircraft transmissions are allowed.

APPENDIX A

GROUND STATIONS IN THE 131.4 TO 132.0 MHz BAND IN VIEW OF ATLANTIC SATELLITES

Column headings are described below:

FREQ IN MHz - gives the carrier frequency of each transmitter. The transmitters are listed by frequency.

CITY - ground-station location.

STATE OR COUNTRY - ground-station location.

LATITUDE - estimated ground-station location.

LONGITUDE - estimated ground-station location.

TRANSMITTER POWER IN WATTS - assumed ground-station transmitter power.

SATELLITE AT 15 DEG. W. - for the geostationary satellite at 15° West longitude, calculated values are given for the elevation angle from the ground station to the satellite (ELEV. ANGLE), received signal strength (RECEIVED POWER in dBW) from both the ground station (GROUND) and an aircraft in the vicinity of the ground station (ACFT). The received signal strength is the maximum received signal strength at the satellite antenna terminals including:

1. The transmitter power - for the airborne transmitters, the maximum power of 50 watts is used.
2. The transmitting antenna gain and line losses.
3. The free-space propagation factor.
4. Multipath - for maximum signal strength, the factor is 20 log (1 + RD) where R is the reflection coefficient for sea water and D is the divergence factor.
5. Scintillation - the values that are exceeded 1% of the time in TABLE 1 are used.
6. Satellite antenna gain.

The scintillation and multipaths are such that the "received power in dBW" is exceeded approximately 0.1% of the time. For elevation angles less than 10°, the elevation angles are not accurate due to atmospheric refraction and the received signal strengths are unpredictable and are therefore not shown.

SATELLITE AT 40 DEG. W. - similar to the satellite at 15° W., for the satellite at 40° West longitude.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W: ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W: RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W: RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W: ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W: RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W: RECEIVED POWER IN DBW ACFT
131.4000	BRUSSELS	BEL	5055 0N	418 0E	50.0	28.94	-135.	-136.	18.61	-136.	-137.
131.4000	DUSSELDORF	GER	5113 0N	646 0E	50.0	27.92	-135.	-136.	17.13	-136.	-137.
131.4000	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.4000	HAMBURG	GER	5335 0N	10 0 0E	50.0	24.68	-135.	-136.	14.02	-136.	-137.
131.4000	COLOGNE	GER	505240N	7 848E	50.0	28.14	-135.	-136.	17.15	-136.	-137.
131.4000	MUNICH	GER	48 8 0N	1142 0E	50.0	29.03	-135.	-136.	16.11	-136.	-137.
131.4000	STUTTGART	GER	4844 0N	912 0E	50.0	29.44	-135.	-136.	17.25	-136.	-137.
131.4000	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.4000	BERLIN	GER	5228 0N	1316 0E	50.0	24.57	-135.	-136.	12.92	-136.	-137.
131.4000	BARCELONA	SPA	4118 0N	2 5 0E	50.0	39.19	-135.	-136.	26.11	-135.	-136.
131.4000	NICE	FRA	4346 0N	720 0E	50.0	34.80	-135.	-136.	21.23	-136.	-137.
131.4000	PARIS/CH. DE GAULLE	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.4000	LONDON	GBR	5131 0N	0 5 0W	1000.0	29.42	-122.	-136.	20.39	-123.	-137.
131.4000	PRESTWICK	GBR	5530 0N	435 0W	50.0	26.07	-134.	-135.	19.31	-135.	-136.
131.4000	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.4000	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.4000	SHANNON	IRL	5242 0N	855 0W	1000.0	29.52	-122.	-136.	23.31	-122.	-136.
131.4000	BERGEN	NOR	6018 0N	513 0E	50.0	19.54	-136.	-137.	11.95	-136.	-137.
131.4000	OSLO/FORNEBU	NOR	5954 0N	1037 0E	50.0	18.68	-136.	-137.	10.02	-136.	-137.
131.4000	LISBON	POR	3845 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.4000	PRAGUE	CZE	50 5 0N	1415 0E	50.0	26.28	-135.	-136.	13.59	-136.	-137.
131.4000	VIENNA	AUT	4812 0N	1622 0E	50.0	26.97	-135.	-136.	13.23	-136.	-137.
131.4000	WARSAW	POL	5213 0N	21 0 0E	50.0	21.66	-136.	-137.	8.71		
131.4000	STOCKHOLM/ARLANDA	SWE	5940 0N	1756 0E	50.0	16.78	-136.	-137.	6.95		
131.4000	BELGRADE	YUG	4449 0N	2025 0E	50.0	27.64	-135.	-136.	12.02	-136.	-137.
131.4000	HELSINKI	FNL	6020 0N	2458 0E	50.0	13.88	-136.	-137.	3.43		
131.4000	BEIRUT	LBN	3355 0N	3531 0E	1000.0	23.93	-122.	-136.	3.33		
131.4000	BENGHAZI	LBY	32 7 0N	20 3 0E	50.0	36.98	-135.	-136.	16.72	-136.	-137.
131.4000	TEHRAN	IRN	3530 0N	5140 0E	50.0	10.28	-136.	-137.	-9.89		
131.4000	TRIPOLI	LBY	3230 0N	13 8 0E	50.0	41.58	-135.	-136.	22.39	-136.	-137.
131.4000	SCHEIBLING STATION	AUT	4815 0N	1612 0E	50.0	27.00	-135.	-136.	13.31	-136.	-137.
131.4000	DAKAR	SEN	1444 0N	1738 0W	50.0	72.44	-134.	-135.	58.97	-135.	-136.
131.4000	BELEM	BZL	123 0S	4829 0W	50.0	51.06	-135.	-136.	79.89	-134.	-135.
131.4000	BRASILIA	BZL	1552 0S	48 1 0W	50.0	47.98	-135.	-136.	69.21	-134.	-135.
131.4000	GALEAO	BZL	2249 0S	4315 0W	50.0	48.57	-135.	-136.	63.05	-135.	-135.
131.4000	VIRACOPOS	BZL	23 0 0S	47 8 0W	50.0	45.11	-135.	-136.	61.91	-135.	-136.
131.4000	TOCUMEN	PAN	9 5 4N	792229W	50.0	17.01	-136.	-137.	43.49	-135.	-136.
131.4000	ASUMCION	PGY	2516 0S	5741 0W	50.0	34.54	-135.	-136.	54.48	-135.	-136.
131.4000	ZANDERIJ	SUR	527 0N	5518 0W	50.0	43.08	-135.	-136.	70.97	-134.	-135.
131.4000	MONTEVIDEO	URG	3453 5S	5611 0W	50.0	30.68	-135.	-136.	45.97	-135.	-136.
131.4000	MAIQUETIA	VEN	1036 0N	67 0 0W	50.0	29.72	-135.	-136.	56.35	-135.	-136.
131.4000	MARACAIBO	VEN	1044 0N	7137 0W	50.0	24.67	-135.	-136.	51.40	-135.	-136.
131.4000	ARUBA	ATN	1230 0N	70 1 0W	50.0	26.20	-135.	-136.	52.44	-135.	-136.
131.4000	CURACAO	ATN	12 8 0N	6855 0W	50.0	27.48	-135.	-136.	53.73	-135.	-136.
131.4000	ST. MARTIN	ATN	18 2 0N	63 7 0W	50.0	32.07	-135.	-136.	56.18	-135.	-136.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW GROUND	ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	ACFT
131.4000	SEAWELL	BRB	1314 0N	5929 0W	50.0	37.09	-135.	-136.	62.62	-135.	-136.
131.4000	MERIDA	MEX	2059 0N	8938 0W	50.0	5.70			29.69	-135.	-136.
131.4000	MEXICO CITY	MEX	1925 0N	99 7 0W	50.0	-3.10			20.86	-136.	-137.
131.4000	TEPEXPAN	MEX	1935 0N	9850 0W	50.0	-2.94			21.00	-136.	-137.
131.4000	SAN JUAN	PTR	1827 0N	66 0 0W	50.0	29.09	-135.	-136.	53.33	-135.	-136.
131.4000	CARRASCO	URG	3450 0S	56 1 0W	50.0	30.83	-135.	-136.	46.09	-135.	-136.
131.4000	ST. CROIX	VIR	1742 0N	6448 0W	100.0	30.49	-132.	-136.	54.89	-132.	-136.
131.4000	ST. THOMAS	VIR	1820 0N	6459 0W	50.0	30.13	-135.	-136.	54.32	-135.	-136.
131.4250	PARIS/LE BOURGET	FRA	4858 0N	226 0E	50.0	31.39	-135.	-136.	20.89	-136.	-137.

FREQ IN MHZ	CITY	STATE OF COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW ACFT
131.4500	BRUSSELS	BEL	5055 0N	418 0E	50.0	28.94	-135.	-136.	18.61	-136.	-137.
131.4500	FRANKFORT	GER	50 5 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.4500	BARCELONA	SPA	4118 0N	2 5 0E	50.0	39.19	-135.	-136.	26.11	-135.	-136.
131.4500	PARIS/CH. DE GAULLE	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.4500	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.4500	PRESTWICK	GBR	5530 0N	435 0W	50.0	26.07	-134.	-135.	19.31	-135.	-136.
131.4500	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.4500	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.4500	LISBON	POR	3846 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.4500	PRAGUE	CZE	50 5 0N	1415 0E	50.0	26.28	-135.	-136.	13.59	-136.	-137.
131.4500	FLENSBURG	GER	5446 0N	923 0E	50.0	23.77	-135.	-136.	13.64	-136.	-137.
131.4500	SONDERBORG	DNK	5458 0N	948 0E	50.0	23.46	-135.	-136.	13.31	-136.	-137.
131.4500	PALMA DE MALLORCA	SPA	3930 0N	245 0E	50.0	40.74	-135.	-136.	26.78	-135.	-136.
131.4500	DINARD	FRA	4835 0N	2 5 0W	50.0	32.88	-135.	-136.	23.52	-135.	-136.
131.4500	PARIS/ORLY	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.4500	TOULOUSE	FRA	4338 0N	122 0E	50.0	37.08	-135.	-136.	25.05	-135.	-136.
131.4500	EINDHOVEN	HOL	5127 0N	520 0E	50.0	28.12	-135.	-136.	17.73	-136.	-137.
131.4500	ROTTERDAM	HOL	5158 0N	427 0E	50.0	27.86	-135.	-136.	17.84	-136.	-137.
131.4500	GENOVA	ITY	4425 0N	9 5 0E	50.0	33.48	-135.	-136.	19.74	-136.	-137.
131.4500	MILAN/LINATE	ITY	452040N	91710E	50.0	32.55	-135.	-136.	19.11	-136.	-137.
131.4500	MILAN/MALPENSA	ITY	453242N	84523E	50.0	32.58	-135.	-136.	19.33	-136.	-137.
131.4500	GOTHENBURG	SWE	5743 0N	1158 0E	50.0	20.30	-136.	-137.	10.70	-136.	-137.
131.4500	JONKOPING	SWE	5745 0N	14 5 0E	50.0	19.64	-136.	-137.	9.70		
131.4500	MALMO	SWE	5536 0N	13 4 0E	50.0	21.86	-136.	-137.	11.35	-136.	-137.
131.4500	ZURICH	SWI	4736 0N	849 0E	50.0	30.64	-135.	-136.	18.12	-136.	-137.
131.4500	ZAVENTEM	BEL	5053 0N	425 0E	50.0	28.94	-135.	-136.	18.57	-136.	-137.
131.4500	VIENNA	AUT	4812 0N	1622 0E	50.0	26.47	-135.	-136.	13.23	-136.	-137.
131.4500	STOCKHOLM/ARLANDA	SWE	5940 0N	1756 0E	50.0	16.78	-136.	-137.	6.95		
131.4500	BELGRADE	YUG	4449 0N	2025 0E	50.0	27.64	-135.	-136.	12.02	-136.	-137.
131.4500	NORRKOPING	SWE	5835 0N	1615 0E	50.0	18.23	-136.	-137.	8.25		
131.4500	ZAGREB	YUG	4554 0N	1619 0E	50.0	28.90	-135.	-136.	14.31	-136.	-137.
131.4500	BEIRUT	LBN	3355 0N	3531 0E	50.0	23.93	-135.	-136.	3.33		
131.4500	TEHRAN	IRN	3530 0N	5140 0E	50.0	10.28	-136.	-137.	-9.89		
131.4500	BAHRAIN	BAH	2616 0N	5037 0E	50.0	13.29	-136.	-137.	-9.11		
131.4500	DAMASCUS	SYR	3322 0N	3628 0E	50.0	23.40	-135.	-136.	2.61		
131.4500	JEDDAH	ARS	2130 0N	3914 0E	50.0	25.10	-135.	-136.	1.35		
131.4500	KUWAIT	KWT	2915 0N	4745 0E	50.0	15.18	-136.	-137.	-6.64		
131.4500	MUHURROQ	BHR	2617 0N	5017 0E	50.0	13.59	-136.	-137.	-8.82		

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW ACFT
131.5000	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.5000	HAMBURG	GER	5335 0N	10 0 0E	50.0	24.68	-135.	-136.	14.02	-136.	-137.
131.5000	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.5000	BERLIN	GER	5228 0N	1316 0E	50.0	24.57	-135.	-136.	12.92	-136.	-137.
131.5000	BARCELONA	SPA	4118 0N	2 5 0E	50.0	39.19	-135.	-136.	26.11	-135.	-136.
131.5000	PARIS/CH. DE GAULLE	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.5000	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.5000	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.5000	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.5000	BERGEN	NOR	6018 0N	513 0E	50.0	19.54	-136.	-137.	11.95	-136.	-137.
131.5000	OSLO/FORNEBU	NOR	5954 0N	1037 0E	50.0	18.68	-136.	-137.	10.02	-136.	-137.
131.5000	PARIS/ORLY	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.5000	TOULOUSE	FRA	4338 0N	122 0E	50.0	37.08	-135.	-136.	25.05	-135.	-136.
131.5000	MADRID	SPA	4024 0N	340 0W	50.0	41.86	-135.	-136.	30.37	-135.	-136.
131.5000	MARSEILLE	FRA	4322 0N	517 0E	50.0	35.99	-135.	-136.	22.78	-136.	-136.
131.5000	CORK	IRL	5150 0N	830 0W	50.0	30.41	-135.	-136.	25.87	-135.	-136.
131.5000	DUBLIN	IRL	5330 0N	618 0W	50.0	28.40	-135.	-136.	21.61	-135.	-136.
131.5000	SHANNON	IRL	5242 0N	855 0W	50.0	29.52	-135.	-136.	23.31	-135.	-136.
131.5000	AALESUND	NOR	6234 0N	6 7 0E	50.0	17.18	-136.	-137.	10.09	-136.	-137.
131.5000	KRISTIANSAND/KJEVIK	NOR	5812 0N	8 5 0E	50.0	20.90	-136.	-137.	12.14	-136.	-137.
131.5000	KRISTIANSUND/KVERN.	NOR	63 7 0N	751 0E	50.0	16.31	-136.	-137.	9.11		
131.5000	STAVANGER	NOR	5838 0N	536 0E	50.0	21.07	-136.	-137.	12.91	-136.	-137.
131.5000	TRONDHEIM	NOR	6332 0N	1053 0E	50.0	15.28	-136.	-137.	7.74		
131.5000	HELSINKI	FNL	6020 0N	2458 0E	50.0	13.88	-136.	-137.	3.43		
131.5000	STOCKHOLM/ARLANDA	SWE	5940 0N	1756 0E	50.0	16.78	-136.	-137.	6.95		
131.5000	GRAZ	AUT	4657 0N	1527 0E	50.0	28.43	-135.	-136.	14.38	-136.	-137.
131.5000	BEIRUT	LBN	3355 0N	3531 0E	50.0	23.93	-135.	-136.	3.33		
131.5000	JEDDAH	ARS	2130 0N	3914 0E	50.0	25.10	-135.	-136.	1.35		
131.5000	KUWAIT	KWT	2915 0N	4745 0E	50.0	15.18	-136.	-137.	-6.64		
131.5000	OULU	FNL	6456 0N	2522 0E	50.0	10.30	-136.	-137.	1.50		
131.5000	TURKU	FNL	6031 0N	2226 0E	50.0	14.62	-136.	-137.	4.52		
131.5000	ATHENS	GRC	3759 0N	2344 0E	50.0	30.48	-135.	-136.	11.94	-136.	-137.
131.5000	TEL AVIV	ISR	32 438N	3446 3E	50.0	25.36	-135.	-136.	4.22		
131.5000	AKTYUBINSK	URS	5017 0N	5710 0E	50.0	2.62			-13.02		
131.5000	ALMA-ATA	URS	4315 0N	7657 0E	50.0	-9.96			-26.99		
131.5000	MOSCOW	URS	5545 0N	3718 0E	50.0	11.64	-136.	-137.	-1.56		
131.5000	ODESSA	URS	4628 0N	3044 0E	50.0	20.63	-136.	-137.	4.49		
131.5000	VILNYUS	URS	5441 0N	2519 0E	50.0	17.91	-136.	-137.	5.34		
131.5000	ALGIERS	ALG	3650 0N	3 0 0E	50.0	43.27	-135.	-136.	28.20	-135.	-136.
131.5000	ANKARA	TUR	3956 0N	3252 0E	50.0	22.98	-135.	-136.	4.41		
131.5000	CASABLANCA	MRC	3331 0N	741 0W	50.0	50.26	-135.	-136.	37.97	-135.	-136.
131.5000	DHAHRAN	ARS	2618 0N	5010 0E	50.0	13.70	-136.	-137.	-8.71		
131.5000	ISTANBUL	TUR	41 1 0N	2858 0E	50.0	25.04	-135.	-136.	7.11		

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W			SATELLITE AT 40 DEG W		
						ELEV ANGLE IN DEG	RECEIVED POWER IN DBW		ELEV ANGLE IN DEG	RECEIVED POWER IN DBW	
							GROUND	ACFT		GROUND	ACFT
131.5000	RIYADH	ARS	2444 0N	4641 0E	50.0	17.24	-136.	-137.	-5.61		
131.5000	YESILKOY	TUR	4058 0N	2851 0E	250.0	25.15	-128.	-136.	7.21		
131.5000	ESENBOGA	TUR	40 8 0N	33 0 0E	250.0	22.78	-129.	-136.	4.27		
131.5000	CUMAOVASI	TUR	3814 0N	2713 0E	250.0	27.92	-128.	-136.	9.15		
131.5000	ADANA	TUR	3659 0N	3517 0E	250.0	22.70	-129.	-136.	3.05		
131.5000	MAIQUETIA	VEN	1036 0N	67 0 0W	50.0	29.72	-135.	-136.	56.35	-135.	-136.
131.5000	BUENOS AIRES/EZEIZA	ARG	3440 0S	5830 0W	50.0	29.06	-135.	-136.	45.16	-135.	-136.
131.5000	GALEAO	BZL	2249 0S	4315 0W	50.0	48.57	-135.	-136.	63.05	-135.	-135.
131.5000	VIRACOPOS	BZL	23 0 0S	47 6 0W	50.0	45.11	-135.	-136.	61.91	-135.	-136.
131.5000	GUAYAQUIL	ECU	212 0S	7953 0W	50.0	16.81	-136.	-137.	43.83	-135.	-136.
131.5000	QUITO	ECU	013 0S	7830 0W	50.0	18.28	-136.	-137.	45.43	-135.	-136.
131.5000	LIMA	PER	12 3 0S	77 3 0W	50.0	19.10	-136.	-137.	45.22	-135.	-136.
131.5000	DAKAR	SEN	1444 0N	1738 0W	50.0	72.44	-134.	-135.	58.97	-135.	-136.
131.5000	KANO	NIG	12 3 0N	833 0E	50.0	59.29	-135.	-136.	33.09	-135.	-136.
131.5000	LAGOS	NIG	625 0N	327 0E	50.0	67.15	-134.	-135.	39.50	-135.	-136.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW ACFT
131.5500	DUSSELDORF	GER	5113 0N	646 0E	50.0	27.92	-135.	-136.	17.13	-136.	-137.
131.5500	FRANKFORT	GER	50 6 0N	838 0E	1000.0	28.37	-122.	-136.	16.79	-123.	-137.
131.5500	COLOGNE	GER	505240N	7 848E	50.0	28.14	-135.	-136.	17.15	-136.	-137.
131.5500	MUNICH	GER	48 8 0N	1142 0E	1000.0	29.03	-122.	-136.	16.11	-123.	-137.
131.5500	STUTTGART	GER	4844 0N	912 0E	50.0	29.44	-135.	-136.	17.25	-136.	-137.
131.5500	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.5500	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.5500	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.5500	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.5500	LISBON	POR	3846 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.5500	PRAGUE	CZE	50 5 0N	1415 0E	50.0	26.28	-135.	-136.	13.59	-136.	-137.
131.5500	PALMA DE MALLORCA	SPA	3930 0N	245 0E	50.0	40.74	-135.	-136.	26.78	-135.	-136.
131.5500	TOULOUSE	FRA	4338 0N	122 0E	50.0	37.08	-135.	-136.	25.05	-135.	-136.
131.5500	MADRID	SPA	4024 0N	340 0W	50.0	41.86	-135.	-136.	30.37	-135.	-136.
131.5500	HANNOVER	GER	5222 0N	943 0E	50.0	25.90	-135.	-136.	14.88	-136.	-137.
131.5500	AGEN	FRA	4355 0N	050 0E	50.0	36.95	-135.	-136.	25.19	-135.	-136.
131.5500	AUXERRE	FRA	4751 0N	330 0E	50.0	32.20	-135.	-136.	21.04	-136.	-137.
131.5500	BORDEAUX	FRA	4450 0N	043 0W	50.0	36.45	-135.	-136.	25.47	-135.	-136.
131.5500	CHALONS SUR MARNE	FRA	4857 0N	422 0E	50.0	30.85	-135.	-136.	19.85	-138.	-137.
131.5500	CLERMONT FERRAND	FRA	4543 0N	3 7 0E	50.0	34.43	-135.	-136.	22.65	-136.	-136.
131.5500	COGNAC	FRA	4540 0N	019 0W	50.0	35.48	-135.	-136.	24.66	-135.	-136.
131.5500	COLMAR HOUSSEN	FRA	4756 0N	724 0E	50.0	30.84	-135.	-136.	18.76	-136.	-137.
131.5500	EPINAL	FRA	4820 0N	6 4 0E	50.0	30.91	-135.	-136.	19.29	-136.	-137.
131.5500	LILLE	FRA	5034 0N	3 5 0E	50.0	29.61	-135.	-136.	19.47	-136.	-137.
131.5500	LYON/BRON	FRA	4544 0N	457 0E	50.0	33.81	-135.	-136.	21.54	-136.	-137.
131.5500	NANTES	FRA	47 9 0N	136 0W	50.0	34.27	-135.	-136.	24.31	-135.	-136.
131.5500	PARIS/LE BOURGET	FRA	4858 0N	226 0E	50.0	31.39	-135.	-136.	20.89	-136.	-137.
131.5500	PERPIGNAN	FRA	4245 0N	252 0E	50.0	37.47	-135.	-136.	24.69	-135.	-136.
131.5500	POITIERS	FRA	4635 0N	018 0E	50.0	34.38	-135.	-136.	23.68	-135.	-136.
131.5500	ST. ETIENNE	FRA	4532 0N	418 0E	50.0	34.23	-135.	-136.	22.06	-136.	-137.
131.5500	TOURS	FRA	4725 0N	044 0E	50.0	33.41	-135.	-136.	22.86	-135.	-136.
131.5500	BILBAO	SPA	4318 0N	256 0W	50.0	38.61	-135.	-136.	27.84	-135.	-136.
131.5500	MALAGA	SPA	3649 0N	422 0W	50.0	45.87	-135.	-136.	33.36	-135.	-136.
131.5500	LYON/SATOLAS	FRA	4542 0N	5 5 0E	50.0	33.80	-135.	-136.	21.49	-136.	-137.
131.5500	HELSINKI	FNL	6020 0N	2458 0E	50.0	13.88	-136.	-137.	3.43		
131.5500	ZAGREB	YUG	4554 0N	1619 0E	50.0	28.90	-135.	-136.	14.31	-136.	-137.
131.5500	CAIRO	EGY	30 9 0N	3125 0E	50.0	29.02	-135.	-136.	7.40		

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	ATELLITE AT 15 DEG W ELEV ANGLE IN DEG	RECEIVED POWER IN DBW GROUND	ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	RECEIVED POWER IN DBW GROUND	ACFT
131.6000	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.6000	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.6000	BARCELONA	SPA	4118 0N	2 5 0E	50.0	39.19	-135.	-136.	26.11	-135.	-136.
131.6000	PARIS/CH. DE GAULLE	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.6000	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.6000	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.6000	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.6000	SHANNON	IRL	5242 0N	855 0W	1000.0	29.52	-122.	-136.	23.31	-122.	-136.
131.6000	OSLO/FORNEBU	NOR	5954 0N	1037 0E	1000.0	18.68	-123.	-137.	10.02	-123.	-137.
131.6000	LISBON	POR	3846 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.6000	PRAGUE	CZE	50 5 0N	1415 0E	50.0	26.28	-135.	-136.	13.59	-136.	-137.
131.6000	ROTTERDAM	HOL	5158 0N	427 0E	50.0	27.86	-135.	-136.	17.84	-136.	-137.
131.6000	MILAN/MALPENSA	ITY	453242N	84523E	50.0	32.58	-135.	-136.	19.33	-136.	-137.
131.6000	ZURICH	SWI	4736 0N	849 0E	50.0	30.64	-135.	-136.	18.12	-136.	-137.
131.6000	MADRID	SPA	4024 0N	340 0W	50.0	41.86	-135.	-136.	30.37	-135.	-136.
131.6000	CASABLANCA	MRC	3331 0N	741 0W	50.0	50.26	-135.	-136.	37.97	-135.	-136.
131.6000	MALAGA	SPA	3649 0N	422 0W	50.0	45.87	-135.	-136.	33.36	-135.	-136.
131.6000	MAASTRICHT	HOL	505123N	54210E	50.0	28.60	-135.	-136.	17.92	-136.	-137.
131.6000	MIDDEN ZEELAND	HOL	5146 0N	522 0E	50.0	27.80	-135.	-136.	17.51	-136.	-137.
131.6000	GENEVA	SWI	4614 0N	6 7 0E	50.0	32.92	-135.	-136.	20.54	-136.	-137.
131.6000	LA DOLE	SWI	4626 0N	6 6 0E	50.0	32.73	-135.	-136.	20.43	-136.	-137.
131.6000	BEIRUT	LBN	3355 0N	3531 0E	50.0	23.93	-135.	-136.	3.33		
131.6000	HELSINKI	FNL	6020 0N	2458 0E	50.0	13.88	-136.	-137.	3.43		
131.6000	BAHRAIN	BAH	2616 0N	5037 0E	50.0	13.29	-136.	-137.	-9.11		
131.6000	KUWAIT	KWT	2915 0N	4745 0E	50.0	15.18	-136.	-137.	-6.64		
131.6000	ATHENS	GRC	3759 0N	2344 0E	50.0	30.48	-135.	-136.	11.94	-136.	-137.
131.6000	TEL AVIV	ISR	32 438N	3446 3E	50.0	25.36	-135.	-136.	4.22		
131.6000	CAIRO	EGY	30 9 0N	3125 0E	50.0	29.02	-135.	-136.	7.40		
131.6000	KAZAN	URS	3931 0N	6349 0E	50.0	-.07			-18.82		
131.6000	GALEAO	BZL	2249 0S	4315 0W	50.0	48.57	-135.	-136.	63.05	-135.	-135.
131.6000	VIRACOPOS	BZL	23 0 0S	47 8 0W	50.0	45.11	-135.	-136.	61.91	-135.	-136.
131.6000	MAIQUETIA	VEN	1036 0N	67 0 0W	50.0	29.72	-135.	-136.	56.35	-135.	-136.
131.6000	PAYSANDU	URG	3220 0S	58 2 0W	50.0	30.70	-135.	-136.	47.63	-135.	-136.
131.6000	CURACAO	ATN	12 8 0N	6855 0W	50.0	27.48	-135.	-136.	53.73	-135.	-136.
131.6000	BONAIRE	ATN	12 9 0N	6817 0W	50.0	28.13	-135.	-136.	54.38	-135.	-136.
131.6000	VILLAGUAY	ARG	3151 0S	59 5 0W	50.0	30.11	-135.	-136.	47.56	-135.	-136.
131.6000	VICTORIA	ARG	3224 0S	6012 0W	50.0	28.93	-135.	-136.	46.45	-135.	-136.
131.6000	PARANA	ARG	3147 0S	6029 0W	50.0	29.01	-135.	-136.	46.87	-135.	-136.
131.6000	NOGOYA	ARG	3224 0S	5945 0W	50.0	29.29	-135.	-136.	46.69	-135.	-136.
131.6000	LA PAZ	ARG	3047 0S	5939 0W	50.0	30.19	-135.	-136.	48.25	-135.	-136.
131.6000	BUENOS AIRES	ARG	3435 0S	5825 0W	50.0	29.17	-135.	-136.	45.28	-135.	-136.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW ACFT
131.6500	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.6500	HAMBURG	GER	5335 0N	10 0 0E	50.0	24.68	-135.	-136.	14.02	-136.	-137.
131.6500	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.6500	PARIS/CH. DE GAULLE	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.6500	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.6500	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.6500	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.6500	OSLO/FORNEBU	NOR	5954 0N	1037 0E	50.0	18.68	-136.	-137.	10.02	-136.	-137.
131.6500	PRAGUE	CZE	50 5 0N	1415 0E	50.0	26.28	-135.	-136.	13.59	-136.	-137.
131.6500	PALMA DE MALLORCA	SPA	3930 0N	245 0E	50.0	40.74	-135.	-136.	26.78	-135.	-136.
131.6500	PARIS/ORLY	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.6500	TOULOUSE	FRA	4338 0N	122 0E	50.0	37.08	-135.	-136.	25.05	-135.	-136.
131.6500	ROTTERDAM	HOL	5158 0N	427 0E	50.0	27.86	-135.	-136.	17.84	-136.	-137.
131.6500	MILAN/LINATE	ITY	452040N	91718E	50.0	32.55	-135.	-136.	19.11	-136.	-137.
131.6500	ZURICH	SWI	4736 0N	849 0E	50.0	30.64	-135.	-136.	18.12	-136.	-137.
131.6500	MADRID	SPA	4024 0N	340 0W	50.0	41.86	-135.	-136.	30.37	-135.	-136.
131.6500	LYON/SATOLAS	FRA	4542 0N	5 5 0E	50.0	33.80	-135.	-136.	21.49	-136.	-137.
131.6500	BEIRUT	LBN	3355 0N	3531 0E	50.0	23.93	-135.	-136.	3.33		
131.6500	TEHRAN	IRN	3530 0N	5140 0E	50.0	10.28	-136.	-137.	-9.89		
131.6500	CAIRO	EGY	30 9 0N	3125 0E	50.0	29.02	-135.	-136.	7.40		
131.6500	ATHENS	GRC	3759 0N	2344 0E	50.0	30.48	-135.	-136.	11.94	-136.	-137.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W: ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W: RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W: RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W: ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W: RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W: RECEIVED POWER IN DBW ACFT
131.7000	DUSSELDORF	GER	5112 0N	646 0E	50.0	27.92	-135.	-136.	17.13	-136.	-137.
131.7000	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.7000	HAMBURG	GER	5335 0N	10 0 0E	50.0	24.68	-135.	-136.	14.02	-136.	-137.
131.7000	COLOGNE	GER	505240N	7 848E	50.0	28.14	-135.	-136.	17.15	-136.	-137.
131.7000	MUNICH	GER	48 8 0N	1142 0E	50.0	29.03	-135.	-136.	16.11	-136.	-137.
131.7000	STUTTGART	GER	4844 0N	912 0E	50.0	29.44	-135.	-136.	17.25	-136.	-137.
131.7000	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.7000	BARCELONA	SPA	4118 0N	2 5 0E	50.0	39.19	-135.	-136.	26.11	-135.	-136.
131.7000	NICE	FRA	4346 0N	720 0E	50.0	34.80	-135.	-136.	21.23	-136.	-137.
131.7000	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.7000	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.7000	BERGEN	NOR	6018 0N	513 0E	50.0	19.54	-136.	-137.	11.95	-136.	-137.
131.7000	OSLO/FORNEBU	NOR	5954 0N	1037 0E	50.0	18.68	-136.	-137.	10.02	-136.	-137.
131.7000	WARSAW	POL	5213 0N	21 0 0E	50.0	21.66	-136.	-137.	8.71		
131.7000	LISBON	POR	3846 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.7000	PRAGUE	CZE	50 5 0N	1415 0E	50.0	26.28	-135.	-136.	13.59	-136.	-137.
131.7000	PALMA DE MALLORCA	SPA	3930 0N	245 0E	50.0	40.74	-135.	-136.	26.78	-135.	-136.
131.7000	PARIS/ORLY	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.7000	MILAN/LINATE	ITY	452040N	91714E	50.0	32.55	-135.	-136.	19.11	-136.	-137.
131.7000	GOTHENBURG	SWE	5743 0N	1158 0E	50.0	20.30	-136.	-137.	10.70	-136.	-137.
131.7000	MALMO	SWE	5536 0N	13 4 0E	50.0	21.86	-136.	-137.	11.35	-136.	-137.
131.7000	ZURICH	SWI	4736 0N	840 0E	50.0	30.64	-135.	-136.	18.12	-136.	-137.
131.7000	MADRID	SPA	4024 0N	340 0W	50.0	41.86	-135.	-136.	30.37	-135.	-136.
131.7000	DUBLIN	IRL	5330 0N	616 0W	50.0	28.40	-135.	-136.	21.61	-135.	-136.
131.7000	KRISTIANSAND/KJEVIK	NOR	5812 0N	8 5 0E	50.0	20.90	-136.	-137.	12.14	-136.	-137.
131.7000	STAVANGER	NOR	5853 0N	536 0E	50.0	21.07	-136.	-137.	12.91	-136.	-137.
131.7000	TRONDHEIM	NOR	6332 0N	1053 0E	50.0	15.28	-136.	-137.	7.74		
131.7000	ANTWERP	BEL	4938 0N	422 0E	50.0	23.90	-135.	-136.	17.21	-136.	-137.
131.7000	ALBORG	DNK	57 3 0N	956 0E	50.0	21.49	-136.	-137.	12.02	-136.	-137.
131.7000	ARHUS	DNK	5618 0N	1037 0E	50.0	21.99	-136.	-137.	12.14	-136.	-137.
131.7000	BILLUND	DNK	5544 0N	9 9 0E	50.0	22.94	-135.	-136.	13.17	-136.	-137.
131.7000	KARUP	DNK	5617 0N	9 8 0E	50.0	22.45	-136.	-137.	12.88	-136.	-137.
131.7000	RONNE	DNK	55 4 0N	1446 0E	50.0	21.76	-136.	-137.	10.78	-136.	-137.
131.7000	GLASGOW	GBR	5542 0N	421 0W	50.0	25.63	-134.	-135.	19.06	-135.	-136.
131.7000	MANCHESTER	GBR	5330 0N	213 0W	50.0	27.80	-135.	-136.	19.89	-135.	-136.
131.7000	BODO	NOR	6716 0N	1422 0E	50.0	11.18	-136.	-137.	4.37		
131.7000	OSLO/GARDERMOEN	NOR	6012 0N	11 5 0E	50.0	18.28	-136.	-137.	9.65		
131.7000	TUNIS	TUN	3651 0N	1014 0E	50.0	39.72	-135.	-136.	22.80	-136.	-136.
131.7000	TIRSTRUP	DNK	5615 0N	1037 0E	50.0	21.99	-136.	-137.	12.14	-136.	-137.
131.7000	THISTED	DNK	57 4 0N	842 0E	50.0	21.81	-136.	-137.	12.57	-136.	-137.
131.7000	VIENNA	AUT	4812 0N	1622 0E	50.0	26.97	-135.	-136.	13.23	-136.	-137.
131.7000	HELSINKI	FNL	6020 0N	2458 0E	50.0	13.88	-136.	-137.	3.43		
131.7000	BEIRUT	LBN	3355 0N	3531 0E	50.0	23.93	-135.	-136.	3.33		

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	RECEIVED POWER IN DBW GROUND	ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	RECEIVED POWER IN DBW GROUND	ACFT
131.7000	STOCKHOLM/ARLANDA	SWE	5940 0N	1756 0E	50.0	16.78	-136.	-137.	6.95		
131.7000	TEHRAN	IRN	3530 0N	5140 0E	50.0	10.28	-136.	-137.	-9.89		
131.7000	NORRKOPING	SWE	5835 0N	1615 0E	50.0	18.23	-136.	-137.	8.25		
131.7000	ATHENS	GRC	3759 0N	2344 0E	50.0	30.48	-135.	-136.	11.94	-136.	-137.
131.7000	ANKARA	TUR	3956 0N	3252 0E	50.0	22.98	-135.	-136.	4.41		
131.7000	ISTANBUL	TUR	41 1 0N	2858 0E	50.0	25.04	-135.	-136.	7.11		
131.7000	CAIRO	EGY	30 9 0N	3125 0E	50.0	29.02	-135.	-136.	7.40		
131.7000	ALTA	NOR	70 0 0N	2318 0E	50.0	6.97			.17		
131.7000	ANDOYA	NOR	691447N	16 228E	50.0	9.13			2.77		
131.7000	BANAK	NOR	70 4 0N	2458 0E	50.0	6.53			-.38		
131.7000	BARDUFOSS	NOR	69 3 0N	1835 0E	50.0	8.76			2.08		
131.7000	KIRKENES	NOR	6943 0N	2953 0E	50.0	5.59			-1.82		
131.7000	THROMSO	NOR	6942 0N	19 0 0E	50.0	8.14			1.63		
131.7000	KIRUNA	SWE	6748 0N	2019 0E	50.0	9.41			2.12		
131.7000	LULEA	SWE	6532 0N	22 8 0E	50.0	10.77	-136.	-137.	2.50		
131.7000	SIMFEROPOL	URS	4447 0N	34 6 0E	50.0	19.52	-136.	-137.	2.55		
131.7000	ABADAN	IRN	3022 0N	4814 0E	50.0	14.47	-136.	-137.	-7.08		
131.7000	ANDENES	NOR	6915 0N	16 3 0E	50.0	9.11			2.75		
131.7000	ANKARA	TUR	40 413N	32483eE	50.0	22.96	-135.	-136.	4.44		
131.7000	EVENES	NOR	682731N	272718E	50.0	7.12			-.57		
131.7000	LONGYEARBYEN	NOR	7815 4N	152530E	50.0	1.45			-2.03		
131.7000	DUBAI AIRPORT	UAE	2515 0N	5520 0E	50.0	9.16			-13.25		
131.7000	YESILKOY	TUR	4058 0N	2815 0E	250.0	25.55	-128.	-136.	7.66		
131.7000	GALEAO	BZL	2249 0S	4315 0W	50.0	48.57	-135.	-136.	63.05	-135.	-135.
131.7000	MAIQUETIA	VEN	1036 0N	67 0 0W	50.0	29.72	-135.	-136.	56.35	-135.	-136.
131.7000	BUENOS AIRES/EZEIZA	ARG	3440 0S	5830 0W	50.0	29.06	-135.	-136.	45.16	-135.	-136.
131.7000	CARRASCO	URG	3451 0S	56 1 0W	50.0	30.82	-135.	-136.	46.07	-135.	-136.
131.7000	TAMUIN SLP	MEX	22 2 0N	9846 0W	50.0	-2.88			20.62	-136.	-137.
131.7000	MEXICO DF	MEX	1925 0N	99 8 0W	200.0	-3.12			20.84	-130.	-137.
131.7000	CD VICTORIA TM	MEX	2344 0N	99 7 0W	50.0	-3.26			19.88	-136.	-137.
131.7000	C TIMIRIS	MTN	1922 0N	1630 0W	200.0	67.24	-128.	-135.	54.94	-129.	-136.
131.7000	PT. ETIENNE	MTN	2055 0N	17 3 0W	200.0	65.39	-128.	-135.	54.29	-129.	-136.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW ACFT
131.7500	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.7500	HAMBURG	GER	5335 0N	10 0 0E	50.0	24.68	-135.	-136.	14.02	-136.	-137.
131.7500	MUNICH	GER	48 8 0N	1142 0E	1000.0	29.03	-122.	-136.	16.11	-123.	-137.
131.7500	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.7500	BARCELONA	SPA	4118 0N	2 5 0E	50.0	39.19	-135.	-136.	26.11	-135.	-136.
131.7500	PARIS/CH. DE GAULLE	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.7500	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.7500	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.7500	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.7500	LISBON	POR	3846 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.7500	PALMA DE MALLORCA	SPA	3930 0N	245 0E	50.0	40.74	-135.	-136.	26.78	-135.	-136.
131.7500	PARIS/ORLY	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.7500	MADRID	SPA	4024 0N	340 0W	50.0	41.86	-135.	-136.	30.37	-135.	-136.
131.7500	MARSEILLE	FRA	4322 0N	517 0E	50.0	35.99	-135.	-136.	22.78	-136.	-136.
131.7500	CASABLANCA	MRC	3331 0N	741 0W	50.0	50.26	-135.	-136.	37.97	-135.	-136.
131.7500	LYON/BRON	FRA	4544 0N	457 0E	50.0	33.81	-135.	-136.	21.54	-136.	-137.
131.7500	PARIS/LE BOURGET	FRA	4858 0N	226 0E	50.0	31.39	-135.	-136.	20.89	-136.	-137.
131.7500	NAPLES	ITY	405245N	141720E	50.0	34.10	-135.	-136.	17.95	-136.	-137.
131.7500	DAMASCUS	SYR	3322 0N	3628 0E	50.0	23.40	-135.	-136.	2.61		
131.7500	ATHENS	GRC	3759 0N	2344 0E	50.0	30.48	-135.	-136.	11.94	-136.	-137.
131.7500	MONTEVIDEO	URG	3454 0S	5611 0W	50.0	30.67	-135.	-136.	45.95	-135.	-136.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	RECEIVED POWER IN DBW		SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	RECEIVED POWER IN DBW	
							GROUND	ACFT		GROUND	ACFT
131.8000	DUSSELDORF	GER	5113 0N	646 0E	50.0	27.92	-135.	-136.	17.13	-136.	-137.
131.8000	FRANKFORT	GER	50 7 0N	838 0E	50.0	28.37	-135.	-136.	[illegible]	-136.	-137.
131.8000	HAMBURG	GER	5335 0N	10 0 0E	50.0	24.68	-135.	-136.	[illegible]	-136.	-137.
131.8000	COLOGNE	GER	505240N	7 848E	50.0	28.14	-135.	-136.	17.15	-136.	-137.
131.8000	MUNICH	GER	48 8 0N	1142 0E	50.0	29.03	-135.	-136.	16.11	-136.	-137.
131.8000	STUTTGART	GER	4844 0N	912 0E	50.0	29.44	-135.	-136.	17.25	-136.	-137.
131.8000	BERLIN	GER	5228 0N	1316 0E	50.0	24.57	-135.	-136.	12.92	-136.	-137.
131.8000	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.8000	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.8000	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.8000	PALMA DE MALLORCA	SPA	3930 0N	245 0E	50.0	40.74	-135.	-136.	26.78	-135.	-136.
131.8000	JONKOPING	SWE	5745 0N	14 5 0E	50.0	19.64	-136.	-137.	9.70		
131.8000	MADRID	SPA	4024 0N	340 0W	50.0	41.86	-135.	-136.	30.37	-135.	-136.
131.8000	KRISTIANSAND/KJEVIK	NOR	5812 0N	8 5 0E	50.0	20.90	-136.	-137.	12.14	-136.	-137.
131.8000	HANNOVER	GER	5222 0N	943 0E	50.0	25.90	-135.	-136.	14.88	-136.	-137.
131.8000	GENEVA	SWI	4614 0N	6 7 0E	50.0	32.92	-135.	-136.	20.54	-136.	-137.
131.8000	GLASGOW	GBR	5542 0N	421 0W	50.0	25.83	-134.	-135.	19.06	-135.	-136.
131.8000	PARIS/LE BOURGET	FRA	4858 0N	226 0E	50.0	31.39	-135.	-136.	20.89	-136.	-137.
131.8000	BALE/MULHOUSE	FRA	4735 0N	732 0E	50.0	31.12	-135.	-136.	18.89	-136.	-137.
131.8000	BALE/MULHOUSE	SWI	4735 0N	732 0E	50.0	31.12	-135.	[illegible]	[illegible]	-136.	-137.
131.8000	SALZBURG	AUT	48 0 0N	13 0 0E	50.0	28.61	-135.	[illegible]	15.39	-136.	-137.
131.8000	ANGELHOLM	SWE	5618 0N	1252 0E	50.0	21.30	-136.	[illegible]	11.66	-136.	-137.
131.8000	HALMSTED	SWE	5641 0N	1249 0E	50.0	20.97	-136.	[illegible]	10.88	-136.	-137.
131.8000	KARLSTAD	SWE	5922 0N	1328 0E	50.0	18.39	-136.	-137.	9.10		
131.8000	KRISTIANSTAD	SWE	5555 0N	14 5 0E	50.0	21.25	-136.	-137.	10.67	-136.	-137.
131.8000	OSTERSUND	SWE	6312 0N	1430 0E	50.0	14.72	-136.	-137.	6.57		
131.8000	VAXJO	SWE	5641 0N	1457 0E	50.0	20.29	-136.	-137.	9.85		
131.8000	BREMEN	GER	53 000N	847 0E	50.0	25.60	-135.	-136.	14.99	-136.	-137.
131.8000	SAARBRUCKEN	GER	4914 0N	645 0E	50.0	29.82	-135.	-136.	18.35	-136.	-137.
131.8000	LUXEMBURG	LUX	4937 0N	612 0E	50.0	29.63	-135.	-136.	18.42	-136.	-137.
131.8000	SHANNON	IRL	5241 0N	855 0W	50.0	29.54	-135.	-136.	23.32	-135.	-136.
131.8000	VIENNA	AUT	4812 0N	1622 0E	50.0	26.97	-135.	-136.	13.23	-136.	-137.
131.8000	HELSINKI	FNL	6020 0N	2458 0E	50.0	13.88	-136.	-137.	3.43		
131.8000	TEHRAN	IRN	3530 0N	5140 0E	50.0	10.28	-136.	-137.	-9.89		
131.8000	ATHENS	GRC	3759 0N	2344 0E	50.0	30.48	-135.	-136.	11.94	-136.	-137.
131.8000	MOSCOW	URS	5545 0N	3718 0E	50.0	11.64	-136.	-137.	-1.56		
131.8000	NICOSIA	CYP	3511 0N	3316 0E	50.0	25.12	-135.	-136.	4.98		
131.8000	KALMAR	SWE	5641 0N	1617 0E	50.0	19.85	-136.	-137.	9.19		
131.8000	ORNSKOLDSVIK	SWE	6324 0N	19 0 0E	50.0	13.36	-136.	-137.	4.69		
131.8000	RONNEBY	SWE	5616 0N	1516 0E	50.0	20.55	-136.	-137.	9.91		
131.8000	SKELLEFTEA	SWE	6438 0N	21 5 0E	50.0	11.77	-136.	-137.	3.30		
131.8000	STOCKHOLM/BROMMA	SWE	5940 0N	1756 0E	50.0	16.78	-136.	-137.	6.95		
131.8000	SUNDSVALL	SWE	6232 0N	1727 0E	50.0	14.52	-136.	-137.	5.74		

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN FBW GROUND	SATELLITE AT 15 DEG W RECEIVED POWER IN FBW ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW ACFT
131.8000	UMEA	SWE	6347 0N	2017 0E	50.0	12.68	-136.	-137.	4.00		
131.8000	VISBY	SWE	5740 0N	1821 0E	50.0	18.31	-136.	-137.	7.71		
131.8000	ESFAHAN	IRN	3242 0N	5140 0E	50.0	10.96	-136.	-137.	-9.94		
131.8000	MASHHAD	IRN	3615 0N	5937 0E	50.0	3.70			-16.07		
131.8000	TABRIZ	IRN	3758 0N	46 8 0E	50.0	13.96	-136.	-137.	-5.58		
131.8000	ZAHEDAN	IRN	2928 0N	6054 0E	50.0	3.50			-17.73		
131.8000	KRAMFORS	SWE	63 6 0N	1746 0E	50.0	13.95	-136.	-137.	5.33		
131.8000	DAKAR	SEN	1444 0N	1736 0W	50.0	72.44	-134.	-135.	58.97	-135.	-136.
131.8000	GALEAO	BZL	2249 0S	4315 0W	50.0	48.57	-135.	-136.	63.05	-135.	-135.
131.8000	MAIQUETIA	VEN	1036 0N	67 0 0W	50.0	29.72	-135.	-136.	56.35	-135.	-136.
131.8000	BUENOS AIRES/EZEIZA	ARG	3440 0S	5830 0W	50.0	29.06	-135.	-136.	45.16	-135.	-136.
131.8000	QUITO	ECU	013 0S	7830 0W	50.0	18.28	-136.	-137.	45.43	-135.	-136.
131.8000	BUENOS AIRES/AEROPA	ARG	3440 0S	5830 0W	50.0	29.06	-135.	-136.	45.16	-135.	-136.
131.8000	PORTO ALEGRE	BZL	2959 0S	5110 0W	50.0	37.50	-135.	-136.	52.98	-135.	-136.
131.8000	SAO PAULO	BZL	2335 0S	4639 0W	50.0	45.18	-135.	-136.	61.42	-135.	-136.
131.8000	TOCUMEN	PAN	9 5 0N	79228E	50.0	-12.76			-35.96		
131.8500	BRUSSELS	BEL	5055 0N	418 0E	50.0	28.94	-135.	-136.	18.61	-136.	-137.
131.8500	DUSSELDORF	GER	5113 0N	646 0E	50.0	27.92	-135.	-136.	17.13	-136.	-137.
131.8500	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.8500	HAMBURG	GER	5335 0N	10 0 0E	50.0	24.68	-135.	-136.	14.02	-136.	-137.
131.8500	COLOGNE	GER	505240N	7 848E	50.0	28.14	-135.	-136.	17.15	-136.	-137.
131.8500	MUNICH	GER	48 8 0N	1142 0E	50.0	29.03	-135.	-136.	16.11	-136.	-137.
131.8500	STUTTGART	GER	4844 0N	912 0E	50.0	29.44	-135.	-136.	17.25	-136.	-137.
131.8500	BERLIN	GER	5228 0N	1316 0E	50.0	24.57	-135.	-136.	12.92	-136.	-137.
131.8500	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.8500	PRESTWICK	GBR	5530 0N	435 0W	50.0	26.07	-134.	-135.	19.31	-135.	-136.
131.8500	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.8500	LISBON	POR	3846 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.8500	PARIS/ORLY	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.8500	ALGIERS	ALG	3650 0N	3 0 0E	50.0	43.27	-135.	-136.	28.20	-135.	-136.
131.8500	HANNOVER	GER	5222 0N	943 0E	50.0	25.90	-135.	-136.	14.88	-136.	-137.
131.8500	NUREMBURG	GER	4925 0N	11 5 0E	50.0	28.11	-135.	-136.	15.78	-136.	-137.
131.8500	BELFAST	IRL	5435 0N	552 0W	50.0	27.20	-135.	-136.	20.55	-135.	-136.
131.8500	BIRMINGHAM	GBT	5227 0N	145 0W	50.0	28.80	-135.	-136.	20.48	-136.	-137.
131.8500	JERSEY	GBT	4913 0N	213 0W	50.0	32.25	-135.	-136.	23.11	-135.	-136.
131.8500	MANCHESTER	GBT	5321 0N	217 0W	50.0	27.96	-135.	-136.	20.04	-135.	-136.
131.8500	ZAVENTEM	BEL	5053 0N	425 0E	50.0	28.94	-135.	-136.	18.57	-136.	-137.
131.8500	HELSINKI	FNL	6020 0N	2458 0E	50.0	13.88	-136.	-137.	3.43		
131.8500	STOCKHOLM/ARLANDA	SWE	5940 0N	1756 0E	50.0	16.78	-136.	-137.	6.95		
131.8500	CAIRO	EGY	30 9 0N	3125 0E	50.0	29.02	-135.	-136.	7.40		
131.8500	STOCKHOLM/BROMMA	SWE	5940 0N	1756 0E	50.0	16.78	-136.	-137.	6.95		
131.8500	BAGHDAD	IRQ	3313 0N	4415 0E	50.0	17.04	-136.	-137.	-3.84		
131.8500	LAZCANO	URG	3343 0S	5430 0W	50.0	32.64	-135.	-136.	47.83	-135.	-136.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W: ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W: RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W: RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W: ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W: RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W: RECEIVED POWER IN DBW ACFT
131.9000	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.9000	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.9000	PARIS/CH. DE GAULLE	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.9000	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.9000	PRESTWICK	GBR	5530 0N	435 0W	50.0	26.07	-134.	-135.	19.31	-135.	-136.
131.9000	AMSTERDAM	HOL	521900N	44400E	50.0	27.44	-135.	-136.	17.47	-136.	-137.
131.9000	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.9000	OSLO/FORNEBU	NOR	5954 0N	1037 0E	50.0	18.68	-136.	-137.	10.02	-136.	-137.
131.9000	LISBON	POR	3846 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.9000	TRIPOLI	LBY	3230 0N	13 8 0E	50.0	41.58	-135.	-136.	22.39	-136.	-137.
131.9000	PARIS/ORLY	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.9000	GOTHENBURG	SWE	5743 0N	1158 0E	50.0	20.30	-136.	-137.	10.70	-136.	-137.
131.9000	ZURICH	SWI	4736 0N	849 0E	50.0	30.64	-135.	-136.	18.12	-136.	-137.
131.9000	TUNIS	TUN	3651 0N	1014 0E	50.0	39.72	-135.	-136.	22.80	-136.	-136.
131.9000	PALERMO	ITY	38 2 0N	1311 0E	50.0	37.06	-135.	-136.	20.02	-136.	-137.
131.9000	CAGLIARI	ITY	3913 0N	9 8 0E	50.0	38.19	-135.	-136.	22.45	-136.	-137.
131.9000	LUXEMBURG	LUX	4937 0N	612 0E	50.0	29.63	-135.	-136.	18.42	-136.	-137.
131.9000	HELSINKI	FNL	6020 0N	2458 0E	50.0	13.88	-136.	-137.	3.43		
131.9000	STOCKHOLM/ARLANDA	SWE	5940 0N	1756 0E	50.0	16.78	-136.	-137.	6.95		
131.9000	TEHRAN	IRN	3530 0N	5140 0E	50.0	10.28	-136.	-137.	-9.89		
131.9000	BAHRAIN	BAH	2616 0N	5037 0E	50.0	13.29	-136.	-137.	-9.11		
131.9000	KUWAIT	KWT	2915 0N	4745 0E	50.0	15.18	-136.	-137.	-6.64		
131.9000	TEL AVIV	ISR	32 438N	3446 3E	50.0	25.36	-135.	-136.	4.22		
131.9000	BAGHDAD	IRQ	3313 0N	4415 0E	50.0	17.04	-136.	-137.	-3.84		
131.9000	BUDAPEST	HNG	4730 0N	19 5 0E	50.0	26.26	-135.	-136.	11.83	-136.	-137.
131.9000	ABU DHABI	EGY	2426 0N	5428 0E	50.0	10.09	-136.	-137.	-12.52		
131.9000	DOHA	QAT	2516 5N	5113 6E	50.0	12.94	-136.	-137.	-9.64		
131.9000	DUBAI	EGY	2515 0N	5521 0E	50.0	9.15			-13.27		
131.9000	HOEGGUMPEN	NOR	69 4 0N	18 0 0E	50.0	8.87			2.25		
131.9000	DUBAI AIRPORT	UAE	2515 0N	5520 0E	50.0	9.16			-13.25		
131.9000	BELEM	BZL	123 0S	4829 0W	50.0	51.06	-135.	-136.	79.89	-134.	-135.
131.9000	GALEAO	BZL	2249 0S	4315 0W	50.0	48.57	-135.	-136.	63.05	-135.	-135.
131.9000	MAIQUETIA	VEN	1036 0N	67 0 0W	50.0	29.72	-135.	-136.	56.35	-135.	-136.
131.9000	BUENOS AIRES/EZEIZA	ARG	3440 0S	5830 0W	50.0	29.06	-135.	-136.	45.16	-135.	-136.
131.9000	LIMA	PER	12 3 0S	77 3 0W	50.0	19.10	-136.	-137.	45.22	-135.	-136.
131.9000	PORTO ALEGRE	BZL	2959 0S	5110 0W	50.0	37.50	-135.	-136.	52.98	-135.	-136.
131.9000	SAO PAULO	BZL	2335 0S	4639 0W	50.0	45.18	-135.	-136.	61.42	-135.	-136.
131.9000	CAMPINOS	BZL	23 0 0S	47 8 0W	50.0	45.11	-135.	-136.	61.91	-135.	-136.
131.9000	MANAUS	BZL	3 8 0S	5959 0W	50.0	38.13	-135.	-136.	66.31	-134.	-135.
131.9000	RECIFE	BZL	8 8 0S	3455 0W	50.0	64.89	-134.	-135.	78.74	-134.	-135.
131.9000	PUDAHUEL	CHI	3323 0S	7047 0W	50.0	19.86	-136.	-137.	39.12	-135.	-136.
131.9000	GEORGETOWN	GUY	649 0N	5810 0W	50.0	39.75	-135.	-136.	67.31	-134.	-135.
131.9000	SANTIAGO	CHI	3327 0S	7039 0W	50.0	19.94	-136.	-137.	39.16	-135.	-136.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW ACFT
131.9500	BRUSSELS	BEL	5055 0N	418 0E	50.0	28.94	-135.	-136.	18.61	-136.	-137.
131.9500	FRANKFORT	GER	50 6 0N	838 0E	50.0	28.37	-135.	-136.	16.79	-136.	-137.
131.9500	HAMBURG	GER	5335 0N	10 0 0E	50.0	24.68	-135.	-136.	14.02	-136.	-137.
131.9500	MUNICH	GER	48 8 0N	1142 0E	50.0	29.03	-135.	-136.	16.11	-136.	-137.
131.9500	STUTTGART	GER	4844 0N	912 0E	50.0	29.44	-135.	-136.	17.25	-136.	-137.
131.9500	COPENHAGEN	DNK	5542 0N	1240 0E	50.0	21.90	-136.	-137.	11.49	-136.	-137.
131.9500	NICE	FRA	4346 0N	720 0E	50.0	34.80	-135.	-136.	21.23	-136.	-137.
131.9500	PARIS/CH. DE GAULLE	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.9500	LONDON	GBR	5131 0N	0 5 0W	50.0	29.42	-135.	-136.	20.39	-136.	-137.
131.9500	ROME	ITY	4148 0N	1236 0E	50.0	34.19	-135.	-136.	18.72	-136.	-137.
131.9500	LISBON	POR	3846 0N	9 8 0W	50.0	44.71	-135.	-136.	34.91	-135.	-136.
131.9500	PRAGUE	CZE	50 5 0N	1415 0E	50.0	26.28	-135.	-136.	13.59	-136.	-137.
131.9500	PARIS/ORLY	FRA	4850 0N	214 0E	50.0	31.58	-135.	-136.	21.08	-136.	-137.
131.9500	ZURICH	SWI	4736 0N	849 0E	50.0	30.64	-135.	-136.	18.12	-136.	-137.
131.9500	MADRID	SPA	4024 0N	340 0W	50.0	41.86	-135.	-136.	30.37	-135.	-136.
131.9500	GENEVA	SWI	4614 0N	6 7 0E	50.0	32.92	-135.	-136.	20.54	-136.	-137.
131.9500	BALE/MULHOUSE	SWI	4735 0N	732 0E	50.0	31.12	-135.	-136.	18.89	-136.	-137.
131.9500	KLAGENFURT	AUT	4636 0N	1434 0E	50.0	29.13	-135.	-136.	15.11	-136.	-137.
131.9500	MILAN/MALPENSA	ITY	453242N	84523E	50.0	32.58	-135.	-136.	19.33	-136.	-137.
131.9500	VIENNA	AUT	4812 0N	1622 0E	50.0	26.97	-135.	-136.	13.23	-136.	-137.
131.9500	TEHRAN	IRN	3530 0N	5140 0E	50.0	10.28	-136.	-137.	-9.89		
131.9500	ATHENS	GRC	3759 0N	2344 0E	50.0	30.48	-135.	-136.	11.94	-136.	-137.
131.9500	ISTANBUL	TUR	41 1 0N	2858 0E	50.0	25.04	-135.	-136.	7.11		
131.9500	WARSAW	POL	5213 0N	21 0 0E	100.0	21.65	-133.	-137.	8.71		
131.9500	CARRASCO	URG	3450 0S	56 1 0W	50.0	30.83	-135.	-136.	46.09	-135.	-136.
131.9750	CALVI	FRA	4232 0N	848 0E	50.0	35.33	-135.	-136.	20.95	-136.	-137.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 15 DEG W ELEV ANGLE IN DEG	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 15 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 40 DEG W ELEV ANGLE IN DEG	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 40 DEG W RECEIVED POWER IN DBW ACFT
132.0000	SATENAES	SWE	5826 ON	1242 OE	50.0	19.44	-136.	-137.	9.96		
132.0000	OSTERSUND	SWE	6311 ON	1431 OE	50.0	14.73	-136.	-137.	6.57		
132.0000	KALSBORG	SWE	5331 ON	1432 OE	50.0	18.82	-136.	-137.	9.08		
132.0000	HALMSTAD	SWE	5641 ON	1249 OE	50.0	20.97	-136.	-137.	10.88	-136.	-137.
132.0000	GOTENBURG	SWE	5752 ON	1154 OE	50.0	20.18	-136.	-137.	10.64	-136.	-137.
132.0000	AENGELHOLM	SWE	5618 ON	1251 OE	50.0	21.31	-136.	-137.	11.07	-136.	-137.
132.0000	PARIS/ORLY	FRA	4844 ON	223 OE	50.0	31.64	-135.	-136.	21.07	-136.	-137.
132.0000	VAESTERAS	SWE	5935 ON	1638 OE	50.0	17.26	-136.	-137.	7.57		
132.0000	UPSALA	SWE	5954 ON	1735 OE	50.0	16.70	-136.	-137.	6.99		
132.0000	TULLINGE	SWE	5911 ON	1755 OE	50.0	17.19	-136.	-137.	7.19		
132.0000	STOCKHOLM	SWE	5925 ON	1752 OE	50.0	17.01	-136.	-137.	7.10		
132.0000	SOEDERHAMN	SWE	6116 ON	17 7 OE	50.0	15.68	-136.	-137.	6.52		
132.0000	RONNEBY	SWE	5629 ON	1522 OE	50.0	20.33	-136.	-137.	9.75		
132.0000	NYKOEPING	SWE	5847 ON	1655 OE	50.0	17.85	-136.	-137.	7.85		
132.0000	NORKOPING	SWE	5837 ON	16 5 OE	50.0	18.26	-136.	-137.	8.32		
132.0000	LULEA KALLAX	SWE	6532 ON	22 9 OE	50.0	10.76	-136.	-137.	2.49		
132.0000	LINKOEPING	SWE	5824 ON	1530 OE	50.0	18.63	-136.	-137.	8.70		
132.0000	KALMAR	SWE	5641 ON	1618 OE	50.0	19.84	-136.	-137.	9.19		
132.0000	GUATEMALA	GTM	1434 ON	9031 OW	50.0	5.38			30.52	-135.	-136.
132.0000	VEDADO	CUB	23 7 ON	8221 OW	80.0	2.28	-134.	-137.	35.80	-133.	-136.
132.0000	RANCHO BOYEROS	CUB	2258 ON	8220 OW	50.0	12.32	-136.	-137.	35.88	-135.	-136.
132.0000	SATENAES	SWE	5826 ON	1242 OE	50.0	19.44	-136.	-137.	9.96		
132.0000	OSTERSUND	SWE	6311 ON	1431 OE	50.0	14.73	-136.	-137.	6.57		
132.0000	KALSBORG	SWE	5831 ON	1432 OE	50.0	18.82	-136.	-137.	9.08		
132.0000	HALMSTAD	SWE	5641 ON	1249 OE	50.0	20.97	-136.	-137.	10.88	-136.	-137.
132.0000	GOTENBURG	SWE	5752 ON	1154 OE	50.0	20.18	-136.	-137.	10.64	-136.	-137.
132.0000	AENGELHOLM	SWE	5618 ON	1251 OE	50.0	21.31	-136.	-137.	11.07	-136.	-137.
132.0000	PARIS/ORLY	FRA	4844 ON	223 OE	50.0	31.64	-135.	-136.	21.07	-136.	-137.
132.0000	VAESTERAS	SWE	5935 ON	1638 OE	50.0	17.26	-136.	-137.	7.57		
132.0000	UPSALA	SWE	5954 ON	1735 OE	50.0	16.70	-136.	-137.	6.99		
132.0000	TULLINGE	SWE	5911 ON	1755 OE	50.0	17.19	-136.	-137.	7.19		
132.0000	STOCKHOLM	SWE	5925 ON	1752 OE	50.0	17.01	-136.	-137.	7.10		
132.0000	SOEDERHAMN	SWE	6116 ON	17 7 OE	50.0	15.68	-136.	-137.	6.52		
132.0000	RONNEBY	SWE	5629 ON	1522 OE	50.0	20.33	-136.	-137.	9.75		
132.0000	NYKOEPING	SWE	5847 ON	1655 OE	50.0	17.85	-136.	-137.	7.85		
132.0000	NORKOPING	SWE	5837 ON	16 5 OE	50.0	18.26	-136.	-137.	8.32		
132.0000	LULEA KALLAX	SWE	6532 ON	22 9 OE	50.0	10.76	-136.	-137.	2.49		
132.0000	LINKOEPING	SWE	5824 ON	1530 OE	50.0	18.63	-136.	-137.	8.70		
132.0000	KALMAR	SWE	5641 ON	1618 OE	50.0	19.84	-136.	-137.	9.19		
132.0000	GUATEMALA	GTM	1434 ON	9031 OW	50.0	5.38			30.52	-135.	-136.
132.0000	VEDADO	CUB	23 7 ON	8221 OW	80.0	12.28	-134.	-137.	35.80	-133.	-136.
132.0000	RANCHO BOYEROS	CUB	2258 ON	8220 OW	50.0	12.32	-136.	-137.	35.88	-135.	-136.

APPENDIX B

GROUND STATIONS IN 131.4-132.0 MHz BAND IN VIEW OF PACIFIC SATELLITES

Column headings are the same as defined in APPENDIX A, except that satellite locations are at 155 degrees West and 180 degrees West.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 155 DEG W ELEV ANGLE IN DEG	SATELLITE AT 155 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 155 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 180 DEG W ELEV ANGLE IN DEG	SATELLITE AT 180 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 180 DEG W RECEIVED POWER IN DBW ACFT
131.4000	MERIDA	MEX	2059 0N	8938 0W	50.0	14.48	-136.	-137.	-8.93		
131.4000	MEXICO CITY	MEX	1925 0N	99 7 0W	50.0	23.99	-135.	-136.	-.10		
131.4000	TEPEXPAN	MEX	1935 0N	9856 0W	50.0	23.78	-135.	-136.	-.29		
131.4000	GARLAND	KOR	3650 0N	12724 0E	50.0	1.20			20.97	-136.	-137.
131.4000	FALEOLO	SMO	1349 0S	172 0 0W	50.0	64.53	-132.	-133.	71.29	-132.	-133.
131.4000	AUCKLAND	NZL	37 1 0S	17448 0E	50.0	36.68	-135.	-136.	46.74	-135.	-136.
131.4000	BANGKOK	THA	14 0 0N	10039 0E	50.0	-21.98			1.64		
131.4000	CALCUTTA	IND	2239 0N	8827 0E	50.0	-31.75			-9.99		
131.4000	DELHI	IND	2835 0N	77 0 0E	50.0	-39.44			-19.58		
131.4000	DJAKARTA	INS	6 0 0S	10649 0E	50.0	-16.48			8.11		
131.4000	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.4000	KADENA	RYU	262133N	1274533E	50.0	2.72			25.42	-130.	-131.
131.4000	KARACHI	PAK	2455 0N	6711 0E	50.0	-48.03			-28.24		
131.4000	MANILA	PHL	143036N	121 136E	50.0	-2.87			21.85	-130.	-131.
131.4000	OSAKA	JAP	344657N	1352628E	50.0	8.06			28.16	-135.	-136.
131.4000	PAGO PAGO	SMA	142048S	1704425W	50.0	65.25	-132.	-133.	70.02	-133.	-134.
131.4000	RANGOON	BRM	1647 0N	9610 0E	50.0	-25.83			-2.78		
131.4000	SAIGON	VTN	1046 0N	10639 0E	50.0	-16.54			7.73		
131.4000	SINGAPORE	SNG	12237N	1035118E	150.0	-19.35			5.18		
131.4000	SYDNEY	AUS	3357 0S	15111 0E	50.0	21.22	-136.	-137.	39.97	-135.	-136.
131.4000	TAHI.I	OCE	1733 0S	14926 0W	50.0	68.43	-134.	-135.	49.54	-135.	-136.
131.4000	TAIPEI	TAI	25 4 0N	12133 0E	50.0	-2.76			20.13	-130.	-131.
131.4000	TOKYO	JAP	3542 0N	13946 0E	50.0	11.36	-136.	-137.	30.86	-135.	-136.
131.4000	WAKE IS.	WAK	191653N	1663811E	50.0	41.20	-129.	-130.	62.72	-129.	-130.
131.4000	NAKHON PHANOM WEST	THA	1722 0N	10439 0E	50.0	-18.14			5.31		
131.4500	PAYA LEBAR	SNG	122 0N	10355 0E	50.0	-19.29			5.25		
131.4500	BANGKOK	THA	14 0 0N	10039 0E	50.0	-21.98			1.64		
131.4500	CALCUTTA	IND	2239 0N	8827 0E	50.0	-31.75			-9.99		
131.4500	DELHI	IND	2835 0N	77 0 0E	50.0	-39.44			-19.58		
131.4500	DJAKARTA	INS	6 0 0S	10649 0E	50.0	-16.48			8.11		
131.4500	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.4500	RANGOON	BRM	1647 0N	9610 0E	50.0	-25.83			-2.78		
131.4500	SAIGON	VTN	1046 0N	10639 0E	50.0	-16.54			7.73		
131.4500	SYDNEY	AUS	3357 0S	15111 0E	50.0	21.22	-136.	-137.	39.97	-135.	-136.
131.4500	BOMBAY	IND	19 5 0N	7252 0E	50.0	-45.44			-24.10		
131.4500	COLOMBO	CLN	649 0N	7953 0E	50.0	-41.35			-18.30		
131.4500	KUALA LUMPUR	MAL	3 9 0N	10139 0E	50.0	-21.42			2.94		
131.4500	SINGAPORE	SNG	12237N	1035118E	50.0	-19.35			5.18		

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 155 DEG W ELEV ANGLE IN DEG	SATELLITE AT 155 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 155 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 180 DEG W ELEV ANGLE IN DEG	SATELLITE AT 180 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 180 DEG W RECEIVED POWER IN DBW ACFT
131.5000	KHABAROVSK/ACC	URS	55 0 0N	134 0 0E	50.0	2.08			15.10	-136.	-137.
131.5000	KHABAROVSK/EKIMEHAN	URS	53 4 0N	13258 0E	50.0	2.00			15.82	-136.	-137.
131.5000	PAYA LEBAR	SNG	122 0N	10355 0E	250.0	-19.29			5.25		
131.5000	TAIPEI	TAI	2511 0N	12131 0E	50.0	-2.79			20.07	-130.	-131.
131.5000	BANGKOK	THA	14 0 0N	10039 0E	50.0	-21.98			1.64		
131.5000	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.5000	KADENA	RYU	262133N	1274533E	50.0	2.72			25.42	-130.	-131.
131.5000	MANILA	PHL	143036N	121 136E	50.0	-2.87			21.85	-130.	-131.
131.5000	OSAKA	JAP	344657N	1352628E	50.0	8.06			28.16	-135.	-136.
131.5000	SAIGON	VTN	1046 0N	10639 0E	50.0	-16.54			7.73		
131.5000	SYDNEY	AUS	3357 0S	15111 0E	50.0	21.22	-136.	-137.	39.97	-135.	-136.
131.5000	TAIPEI	TAI	25 4 0N	12133 0E	50.0	-2.76			20.13	-130.	-131.
131.5000	TOKYO	JAP	3542 0N	13946 0E	50.0	11.36	-136.	-137.	30.86	-135.	-136.
131.5000	BOMBAY	IND	19 5 0N	7252 0E	50.0	-45.44			-24.10		
131.5000	KUALA LUMPUR	MAL	3 9 0N	10139 0E	50.0	-21.42			2.94		
131.5000	SINGAPORE	SNG	12237N	1035118E	50.0	-19.35			5.18		
131.5000	FUKUOKA	JAP	3340 0N	13024 0E	50.0	4.09			24.75	-135.	-136.
131.5000	NAHA	RYU	261135N	1273915E	50.0	2.64			25.39	-130.	-131.
131.5000	OKINAWA	RYU	2630 0N	128 0 0E	50.0	2.93			25.59	-130.	-131.
131.5000	SEOUL	KOR	373139N	1265919E	50.0	.78			20.35	-136.	-137.
131.5500	PAYA LEBAR	SNG	122 0N	10355 0E	50.0	-19.29			5.25		
131.5500	BANGKOK	THA	14 0 0N	10039 0E	50.0	-21.98			1.64		
131.5500	CALCUTTA	IND	2239 0N	8827 0E	50.0	-31.75			-9.99		
131.5500	DELHI	IND	2835 0N	77 0 0E	50.0	-39.44			-19.58		
131.5500	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.5500	SYDNEY	AUS	3357 0S	15111 0E	50.0	21.22	-136.	-137.	39.97	-135.	-136.
131.5500	TAIPEI	TAI	25 4 0N	12133 0E	50.0	-2.76			20.13	-130.	-131.
131.5500	TOKYO	JAP	3542 0N	13946 0E	50.0	11.36	-136.	-137.	30.86	-135.	-136.
131.5500	SINGAPORE	SNG	12237N	1035118E	50.0	-19.35			5.18		
131.6000	PAYA LEBAR	SNG	122 0N	10355 0E	250.0	-19.29			5.25		
131.6000	BARISAL	BGD	2242 0N	9023 0E	50.0	-30.12			-8.25		
131.6000	BANGKOK	THA	14 0 0N	10039 0E	50.0	-21.98			1.64		
131.6000	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.6000	KADENA	RYU	262133N	1274533E	50.0	2.72			25.42	-130.	-131.
131.6000	KARACHI	PAK	2455 0N	6711 0E	50.0	-48.03			-28.24		
131.6000	MANILA	PHL	143036N	121 136E	50.0	-2.87			21.85	-130.	-131.
131.6000	SYDNEY	AUS	3357 0S	15111 0E	50.0	21.22	-136.	-137.	39.97	-135.	-136.
131.6000	TAIPEI	TAI	25 4 0N	12133 0E	50.0	-2.76			20.13	-130.	-131.
131.6000	COLOMBO	CLN	649 0N	7953 0E	50.0	-41.35			-18.30		
131.6000	NAHA	RYU	261135N	1273915E	50.0	2.64			25.39	-130.	-131.
131.6000	DACCA	BGD	23 6 0N	9023 0E	50.0	-30.05			-8.25		
131.6000	GUAM	GUM	14 0 0S	145 0 0E	50.0	20.89	-136.	-137.	46.67	-135.	-136.
131.6000	LAHORE	PAK	3133 0N	7435 0E	50.0	-40.18			-21.20		
131.6000	RAWALPINDI	PAK	3335 0N	73 7 0E	50.0	-40.41			-22.06		

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 155 DEG W ELEV ANGLE IN DEG	RECEIVED POWER IN DBW GROUND	RECEIVED POWER IN DBW ACFT	SATELLITE AT 180 DEG W ELEV ANGLE IN DEG	RECEIVED POWER IN DBW GROUND	RECEIVED POWER IN DBW ACFT
131.6500	BANGKOK	THA	14 0 0N	10039 0E	50.0	-21.98			1.64		
131.6500	CALCUTTA	IND	2239 0N	8827 0E	50.0	-31.75			-9.99		
131.6500	DELHI	IND	2835 0N	77 0 0E	50.0	-39.44			-19.58		
131.6500	KARACHI	PAK	2455 0N	6711 0E	50.0	-48.03			-28.24		
131.6500	MANILA	PHL	143036N	121 136E	50.0	-2.87			21.85	-130.	-131.
131.6500	SYDNEY	AUS	3357 0S	15111 0E	50.0	21.22	-136.	-137.	39.97	-135.	-136.
131.6500	TOKYO	JAP	3542 0N	13946 0E	50.0	11.36	-136.	-137.	30.86	-135.	-136.
131.6500	KUALA LUMPUR	MAL	3 9 0N	10139 0E	50.0	-21.42			2.94		
131.6500	SINGAPORE	SNG	12237N	1035118E	50.0	-19.35			5.18		
131.7000	TAMUIN SLP	MEX	22 2 0N	9846 0W	50.0	23.01	-135.	-136.	-.58		
131.7000	MEXICO DF	MEX	1925 0N	99 8 0W	200.0	24.01	-129.	-136.	-.09		
131.7000	CD VICTORIA TM	MEX	2344 0N	99 7 0W	50.0	22.89	-135.	-136.	-.36		
131.7000	KIMPO	KOR	3733 0N	12648 0E	50.0	.63			20.20	-136.	-137.
131.7000	PAYA LEBAR	SNG	121 0N	10355 0E	50.0	-19.29			5.25		
131.7000	KARACHI	PAK	2451 0N	67 4 0E	50.0	-48.14			-28.35		
131.7000	BANGKOK	THA	14 0 0N	10039 0E	50.0	-21.98			1.64		
131.7000	CALCUTTA	IND	2239 0N	8827 0E	50.0	-31.75			-9.99		
131.7000	DELHI	IND	2835 0N	77 0 0E	50.0	-39.44			-19.58		
131.7000	DJAKARTA	INS	6 0 0S	10649 0E	50.0	-16.48			8.11		
131.7000	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.7000	KARACHI	PAK	2455 0N	6711 0E	50.0	-48.03			-28.24		
131.7000	MANILA	PHL	143036N	121 136E	50.0	-2.87			21.85	-130.	-131.
131.7000	OSAKA	JAP	344657N	1352628E	50.0	8.06			28.16	-135.	-136.
131.7000	RANGOON	BRM	1647 0N	9610 0E	50.0	-25.83			-2.78		
131.7000	SAIGON	VTN	1046 0N	10639 0E	50.0	-16.54			7.73		
131.7000	TAIPEI	TAI	25 4 0N	12133 0E	50.0	-2.76			20.13	-130.	-131.
131.7000	TOKYO	JAP	3542 0N	13946 0E	50.0	11.36	-136.	-137.	30.86	-135.	-136.
131.7000	BOMBAY	IND	19 5 0N	7252 0E	50.0	-45.44			-24.10		
131.7000	COLOMBO	CLN	649 0N	7953 0E	50.0	-41.35			-18.30		
131.7000	KUALA LUMPUR	MAL	3 9 0N	10139 0E	50.0	-21.42			2.94		
131.7000	SINGAPORE	SNG	12237N	1035118E	50.0	-19.35			5.18		
131.7000	FUKUOKA	JAP	3340 0N	13024 0E	50.0	4.09			24.75	-135.	-136.
131.7000	NAHA	RYU	261135N	1273915E	50.0	2.64			25.39	-130.	-131.
131.7000	SEOUL	KOR	373139N	1265919E	50.0	.78			20.35	-136.	-137.
131.7000	DACCA	BGD	23 6 0N	9023 0E	50.0	-30.05			-8.25		
131.7000	AVALON	AUS	38 221S	1442748E	50.0	14.36	-136.	-137.	32.54	-135.	-136.
131.7000	PENANG	MAL	525 0N	10020 0E	50.0	-22.63			1.59		
131.7500	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.7500	TOKYO	JAP	3542 0N	13946 0E	50.0	11.36	-136.	-137.	30.86	-135.	-136.

FREQ IN MHZ	CITY	STATE OR COUNTRY	LATITUDE	LONGITUDE	TRANSMITTER POWER IN WATTS	SATELLITE AT 155 DEG W ELEV ANGLE IN DEG	SATELLITE AT 155 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 155 DEG W RECEIVED POWER IN DBW ACFT	SATELLITE AT 180 DEG W ELEV ANGLE IN DEG	SATELLITE AT 180 DEG W RECEIVED POWER IN DBW GROUND	SATELLITE AT 180 DEG W RECEIVED POWER IN DBW ACFT
131.8000	BANGKOK	THA	14 0 ON	10039 OE	50.0	-21.98			1.64		
131.8000	CALCUTTA	IND	2239 ON	8827 OE	50.0	-31.75			-9.99		
131.8000	DELHI	IND	2835 ON	77 0 OE	50.0	-39.44			-19.58		
131.8000	DJAKARTA	INS	6 0 OS	10649 OE	50.0	-16.48			8.11		
131.8000	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.8000	KADENA	RYU	262133N	1274533E	50.0	2.72			25.42	-130.	-131.
131.8000	KARACHI	PAK	2455 ON	6711 OE	50.0	-48.03			-28.24		
131.8000	MANILA	PHL	143036N	121 136E	50.0	-2.87			21.85	-130.	-131.
131.8000	SINGAPORE	SNG	12237N	1035118E	150.0	-19.35			5.18		
131.8000	SYDNEY	AUS	3357 OS	15111 OE	50.0	21.22	-136.	-137.	39.97	-135.	-136.
131.8000	TAIPEI	TAI	25 4 ON	12133 OE	50.0	-2.76			20.13	-130.	-131.
131.8000	BOMBAY	IND	19 5 ON	7252 OE	50.0	-45.44			-24.10		
131.8000	NAHA	RYU	261135N	1273915E	50.0	2.64			25.39	-130.	-131.
131.9000	AUCKLAND	NZL	37 1 OS	17448 OE	50.0	36.68	-135.	-136.	46.74	-135.	-136.
131.9000	BANGKOK	THA	14 0 ON	10039 OE	50.0	-21.98			1.64		
131.9000	CALCUTTA	IND	2239 ON	8827 OE	50.0	-31.75			-9.99		
131.9000	DELHI	IND	2835 ON	77 0 OE	50.0	-39.44			-19.58		
131.9000	DJAKARTA	INS	6 0 OS	10649 OE	50.0	-16.48			8.11		
131.9000	HONG KONG	HKG	221156N	1141311E	50.0	-9.31			13.88	-131.	-132.
131.9000	KARACHI	PAK	2455 ON	6711 OE	50.0	-48.03			-28.24		
131.9000	MANILA	PHL	143036N	121 136E	50.0	-2.87			21.85	-130.	-131.
131.9000	OSAKA	JAP	344657N	1352628E	50.0	8.06			28.16	-135.	-136.
131.9000	SAIGON	VTN	1046 ON	10639 OE	50.0	-16.54			7.73		
131.9000	SYDNEY	AUS	3357 OS	15111 OE	50.0	21.22	-136.	-137.	39.97	-135.	-136.
131.9000	TOKYO	JAP	3542 ON	13946 OE	50.0	11.36	-136.	-137.	30.86	-135.	-136.
131.9000	BOMBAY	IND	19 5 ON	7252 OE	50.0	-45.44			-24.10		
131.9000	COLOMBO	CLN	649 ON	7953 OE	50.0	-41.35			-18.30		
131.9000	KUALA LUMPUR	MAL	3 9 ON	10139 OE	50.0	-21.42			2.94		
131.9000	SINGAPORE	SNG	12237N	1035118E	50.0	-19.35			5.18		
131.9000	FUKUOKA	JAP	3340 ON	13024 OE	50.0	4.09			24.75	-135.	-136.
131.9000	NAHA	RYU	261135N	1273915E	50.0	2.64			25.39	-130.	-131.
131.9000	OKINAWA	RYU	2630 ON	128 0 OE	50.0	2.93			25.59	-130.	-131.
131.9000	DACCA	BGD	23 6 ON	9023 OE	50.0	-30.05			-8.25		
131.9000	GUAM	GUM	14 0 OS	145 0 OE	50.0	20.89	-136.	-137.	46.67	-135.	-136.
131.9000	AVALON	AUS	38 221S	1442748E	50.0	14.36	-136.	-137.	32.54	-135.	-136.
131.9000	BRISBANE	AUS	2726 OS	153 5 OE	50.0	25.33	-135.	-136.	46.32	-135.	-136.
131.9000	DARWIN	AUS	122719S	1304856E	50.0	6.78			32.30	-135.	-136.
131.9000	MADRAS	IND	1258 ON	8013 OE	50.0	-40.39			-17.81		
131.9000	MELBOURNE	AUS	3740 OS	14450 OE	50.0	14.78	-136.	-137.	33.05	-135.	-136.
131.9000	NANDI	FJI	1739 OS	17724 OE	50.0	52.30	-135.	-136.	69.08	-134.	-135.
131.9000	PERTH	AUS	315554S	11558 6E	50.0	-7.80			13.36	-136.	-137.
131.9000	AGANA	GUM	1329 ON	14448 OE	50.0	20.76	-130.	-131.	46.65	-129.	-130.
132.0000	GUATEMALA	GTM	1434 ON	9031 OW	50.0	16.29	-136.	-137.	-8.11		
132.0000	TOKYO	JAP	3532 ON	13947 OE	50.0	11.42	-136.	-137.	30.97	-135.	-136.
132.0000	NAGOYA	JAP	3510 ON	13654 OE	50.0	9.17			29.05	-135.	-136.
132.0000	KANAZAWA	JAP	3634 ON	13639 OE	50.0	8.64			28.07	-135.	-136.
132.0000	DJAJARURA	INS	232 ON	14045 OE	50.0	17.42	-130.	-131.	44.48	-129.	-130.
132.0000	CLARK AIR BASE	PHL	151030N	1203342E	1000.0	-3.33			21.28	-117.	-131.

REFERENCES

1. *Memorandum of Understanding on a Joint Programme of Experimentation and Evaluation Using an Aeronautical Satellite Capability Between the US Department of Transportation, Federal Aviation Administration (FAA), the European Space Research Organization (ESRO), and the Government of Canada*, August 2, 1974.

2. ECAC (ACV) Letter to FAA dated December 15, 1975, Subject: Support Data for AEROSAT.

3. *Frequency Assignments in the Band 117.975-136 MHz, European Area*, Paris Office Com List No. 3, Eighteenth Edition, International Civil Aviation Organization, June 1975.

4. *Satellite Specifications*, AEROSAT Space Segment Program Office, Issue D, January 12, 1976.

5. *Interference Consdierations for the AEROSAT Satellite Specification*, AEROSAT Space Segment Program Office, Noordwijk, Holland, December 17, 1975.

6. Meeting, R. Jones, FAA, S. Nardone, ARINC, and J. Preis, ECAC, October 1975.

7. *International Standards and Recommended Practices, Aeronautical Telecommunications, Annex 10 to the Convention on International Civil Aviation*, Volume 1, Third Edition, International Civil Aviation Organization, Montreal, Canada, July 1974.

8. *Airline Company VHF Operational Control Facilities Frequency Plan for Europe and Middle East Region*, International Air Transport Association, May 1975.

9. TELCON between J. Preis, ECAC, and R. Sollien, ARINC, October 1975.

10. "North Atlantic Passenger Traffic, July 1975," *Aviation Week and Space Technology*, October 27, 1975, p. 33.

11. *Air Navigation Plan - European Region*, Eighteenth Edition, International Civil Aviation Organization, Montreal, Canada, February 1973.