APPENDIX A

MATERIAL FOR SAMPLE MANUAL PREDICTION PROBLEM

This appendix contains the charts and nomograms referenced in chapter 2 in connection with manual ionospheric propagation prediction procedures.

Except for figures A-5 and A-6, these materials were taken from references, 2, 5, 9, 12 and 13. The F2-layer MUF prediction charts were obtained from the Environmental Science Services Administration, Boulder, Colorado.

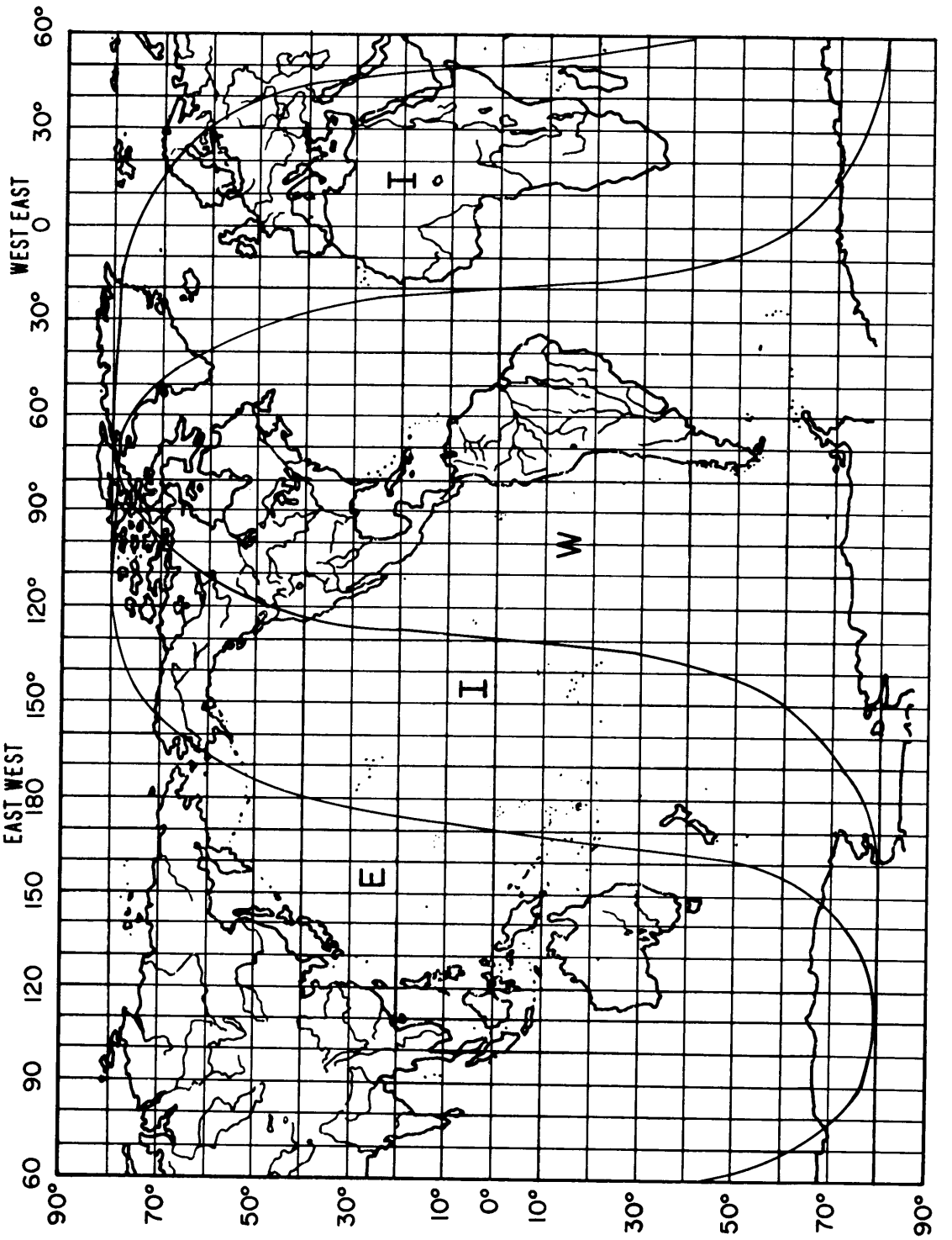


Figure A-1. World Map

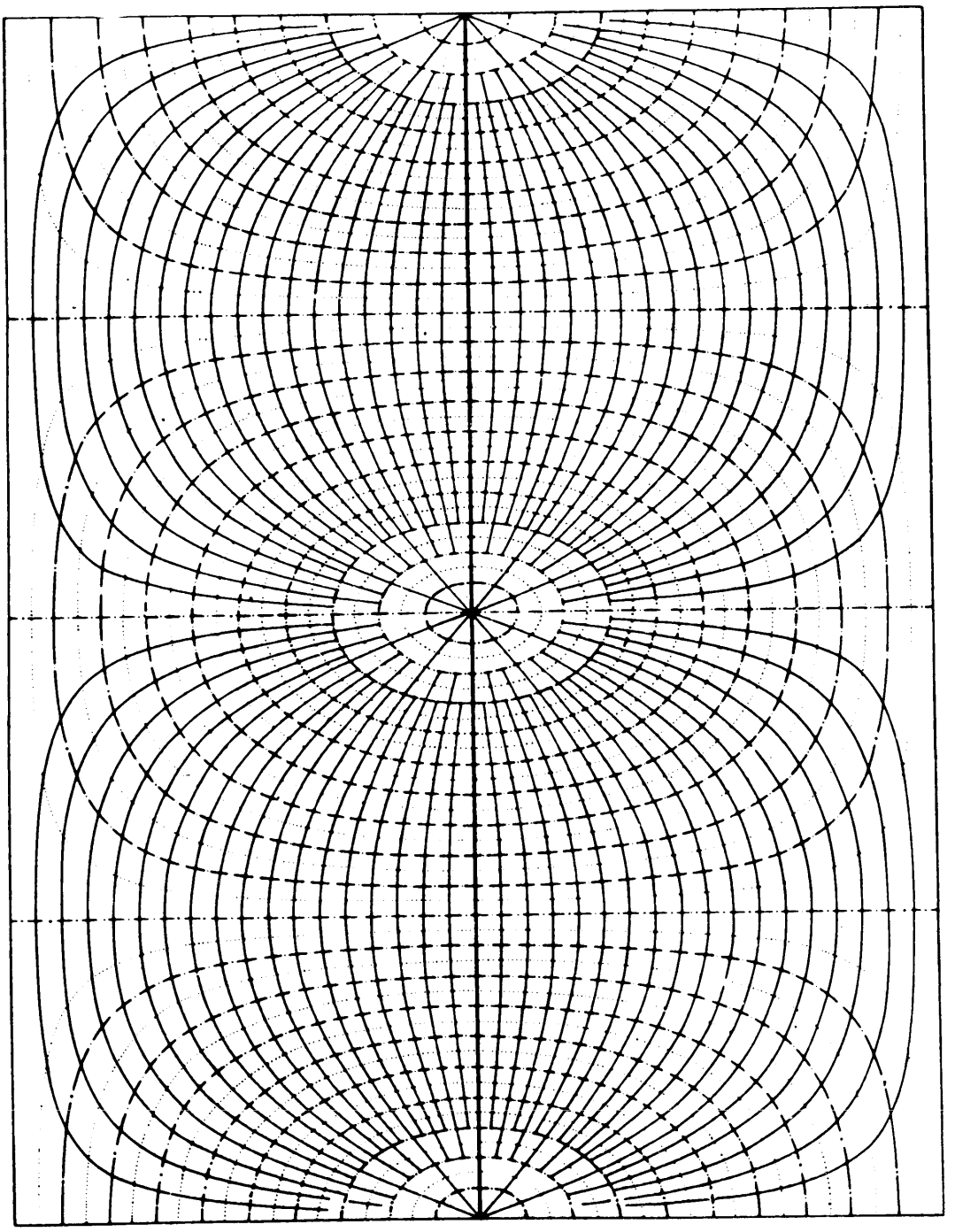


Figure A-2. Great-Circle Chart (Solid Lines Are Great Circles, Dot-Dash Lines Indicate Distance in Thousands of Kilometers)

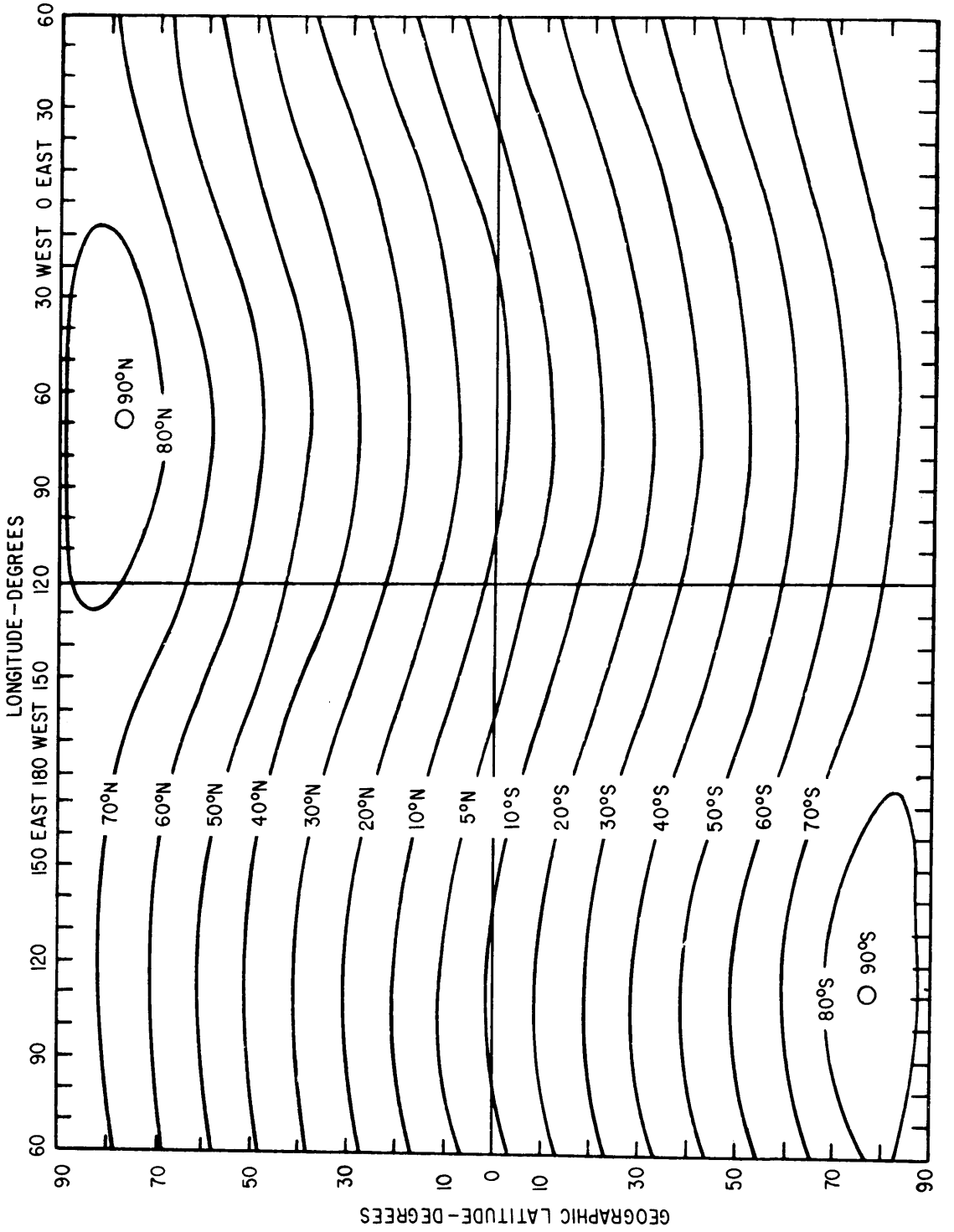


Figure A-3. World Map of Geomagnetic Latitudes

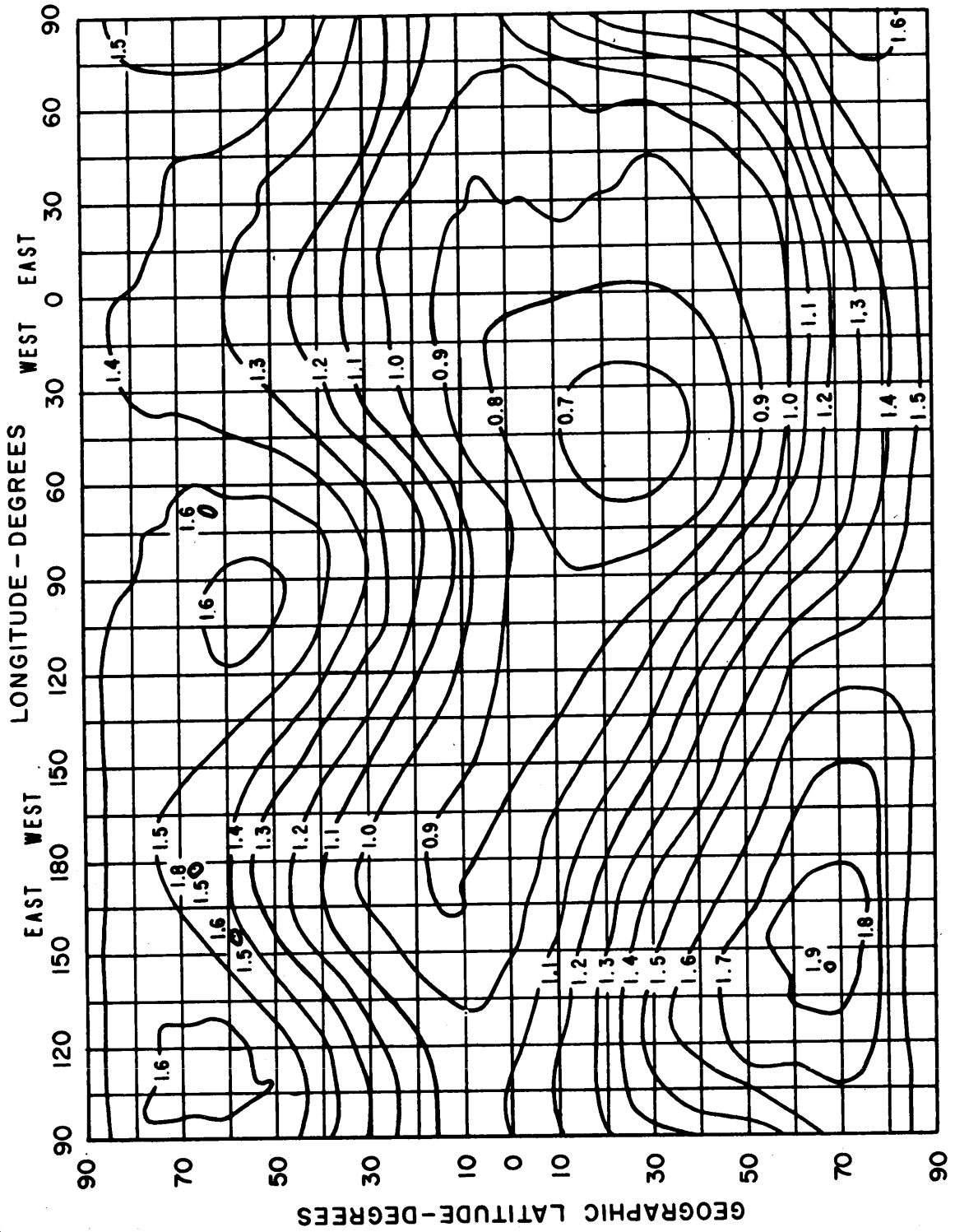


Figure A-4. World Map of E-Region Gyrofrequency, MHz

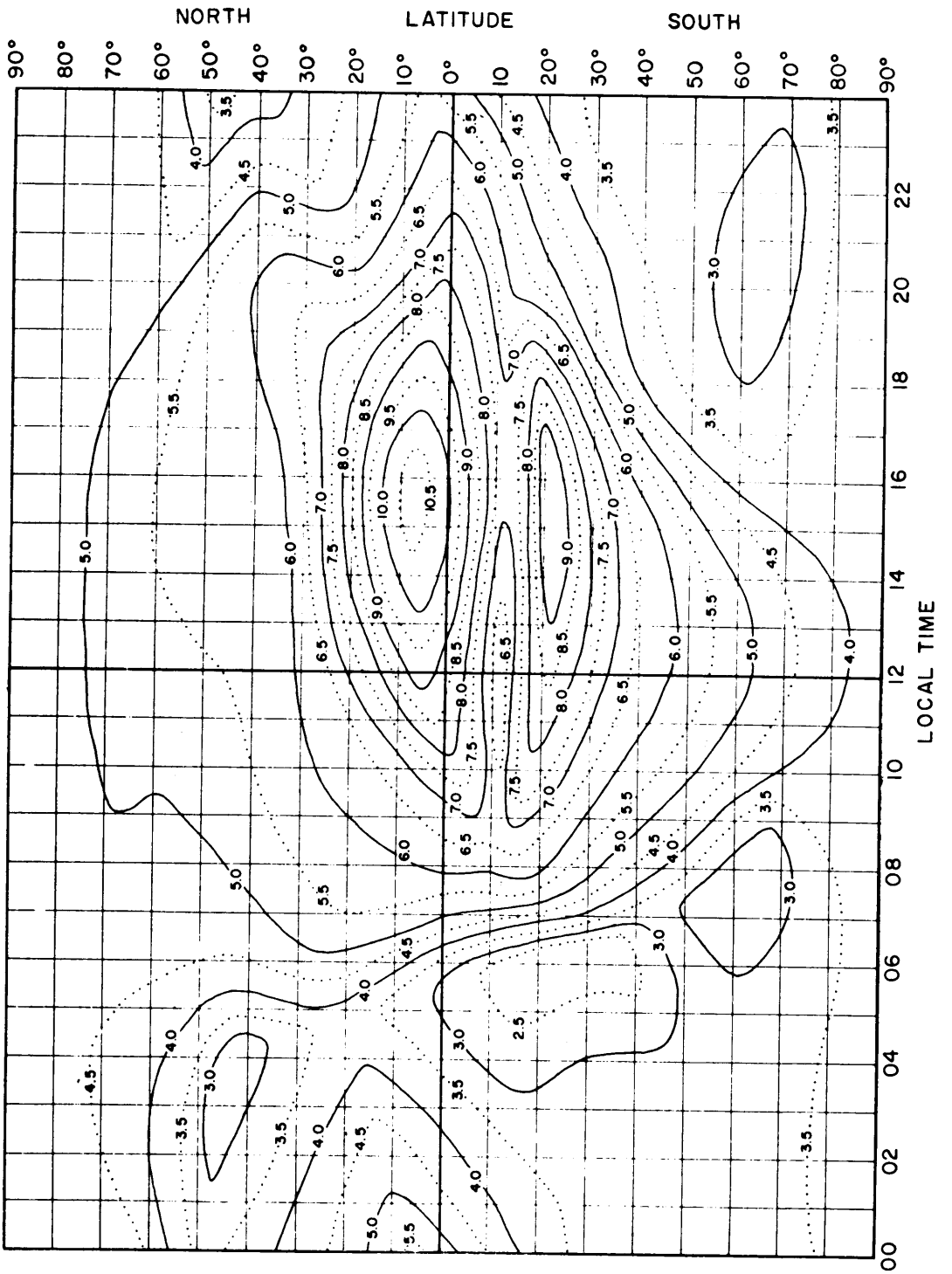


Figure A-5. F2-Zero MUF, Zone W, June, SSN 10

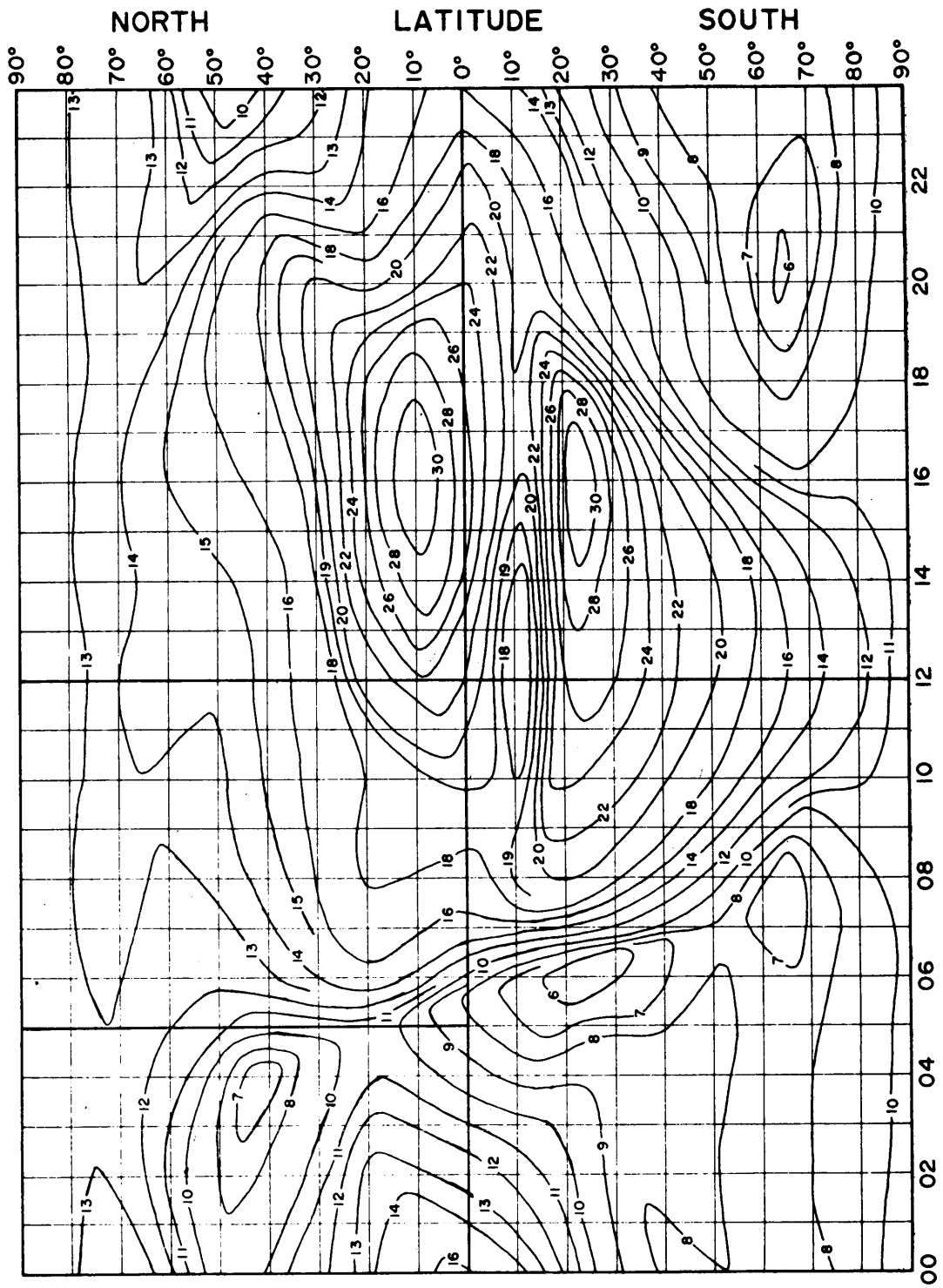


Figure A-6. F2-4000 MUF, Zone W, June, SSN 10

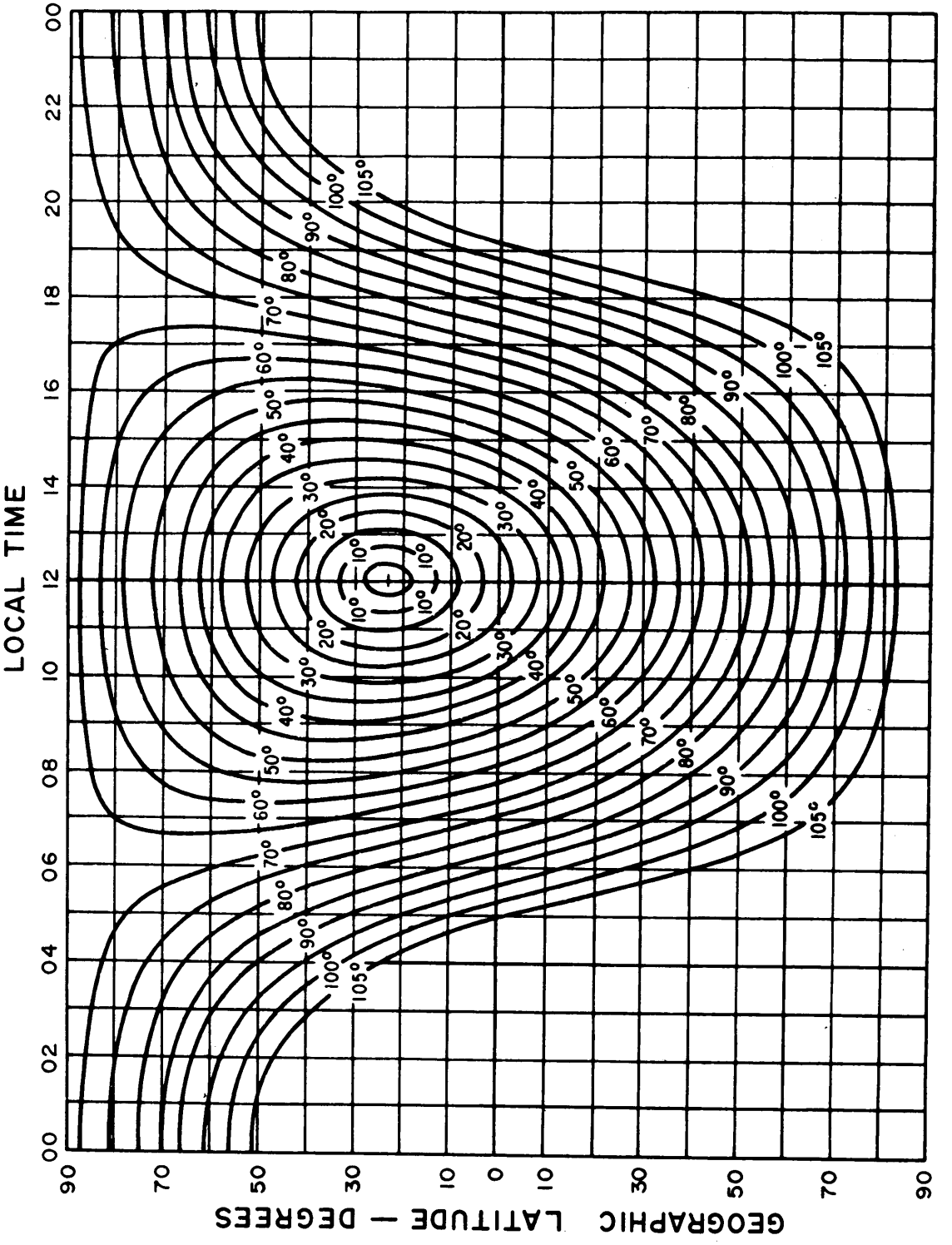


Figure A-7. Sun's Zenith Angle for June

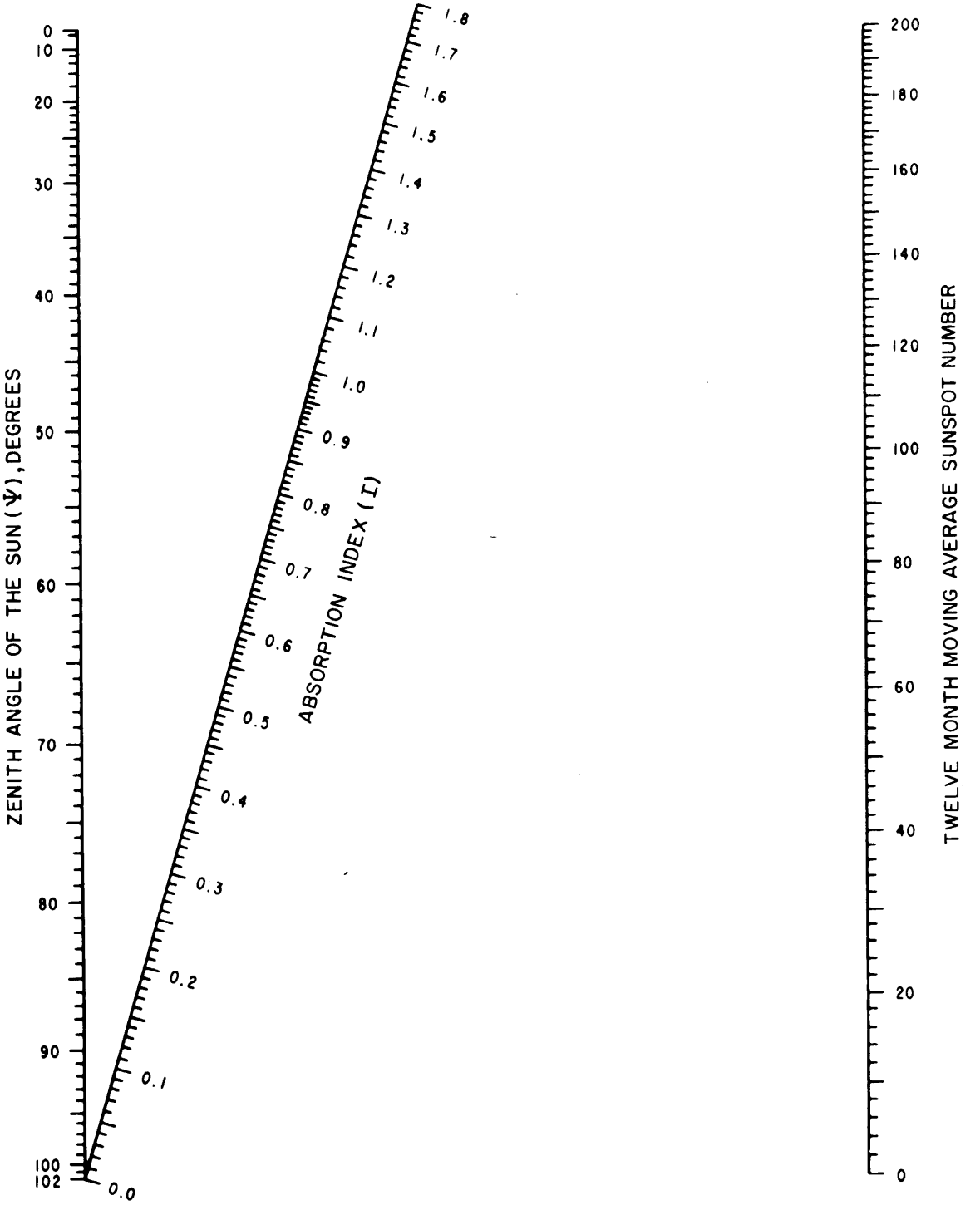


Figure A-8. Nomogram of Ionospheric Absorption Index (I)

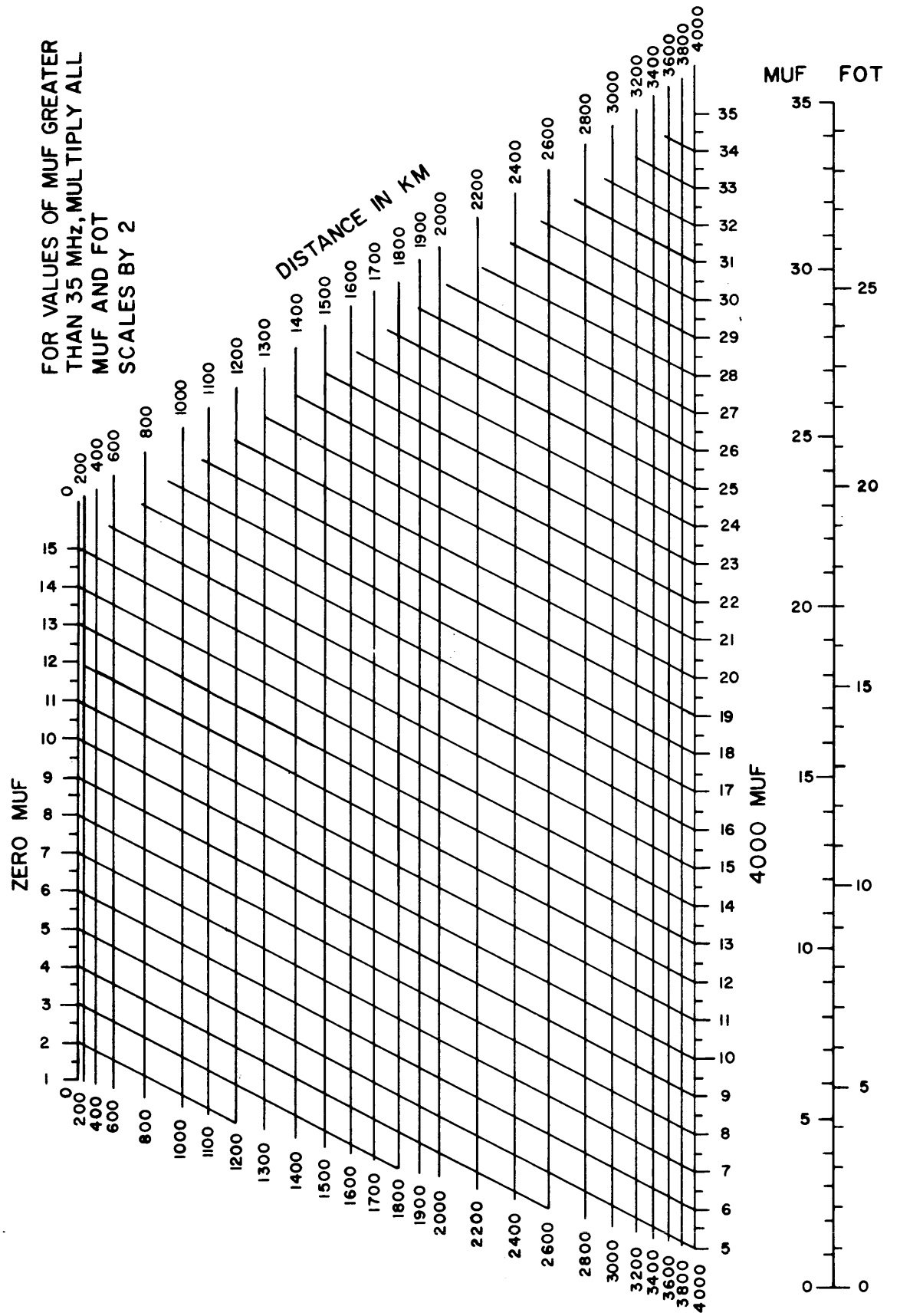


Figure A-9. MUF Conversion Nomogram, F2 Layer

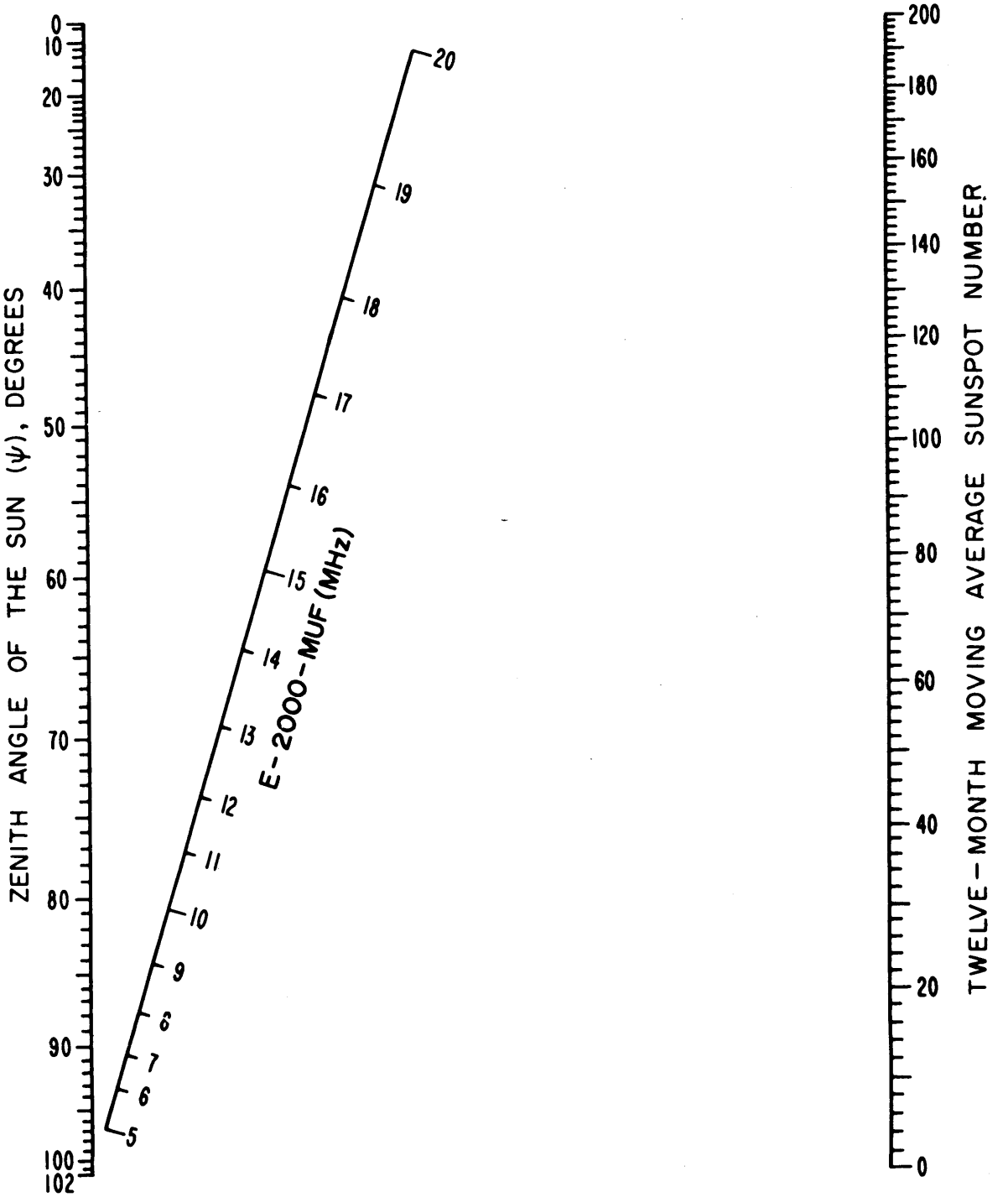


Figure A-10. Nomogram for Obtaining E-Layer 2000 MUF from 12-Month Moving Average Sunspot Number and Zenith Angle of Sun

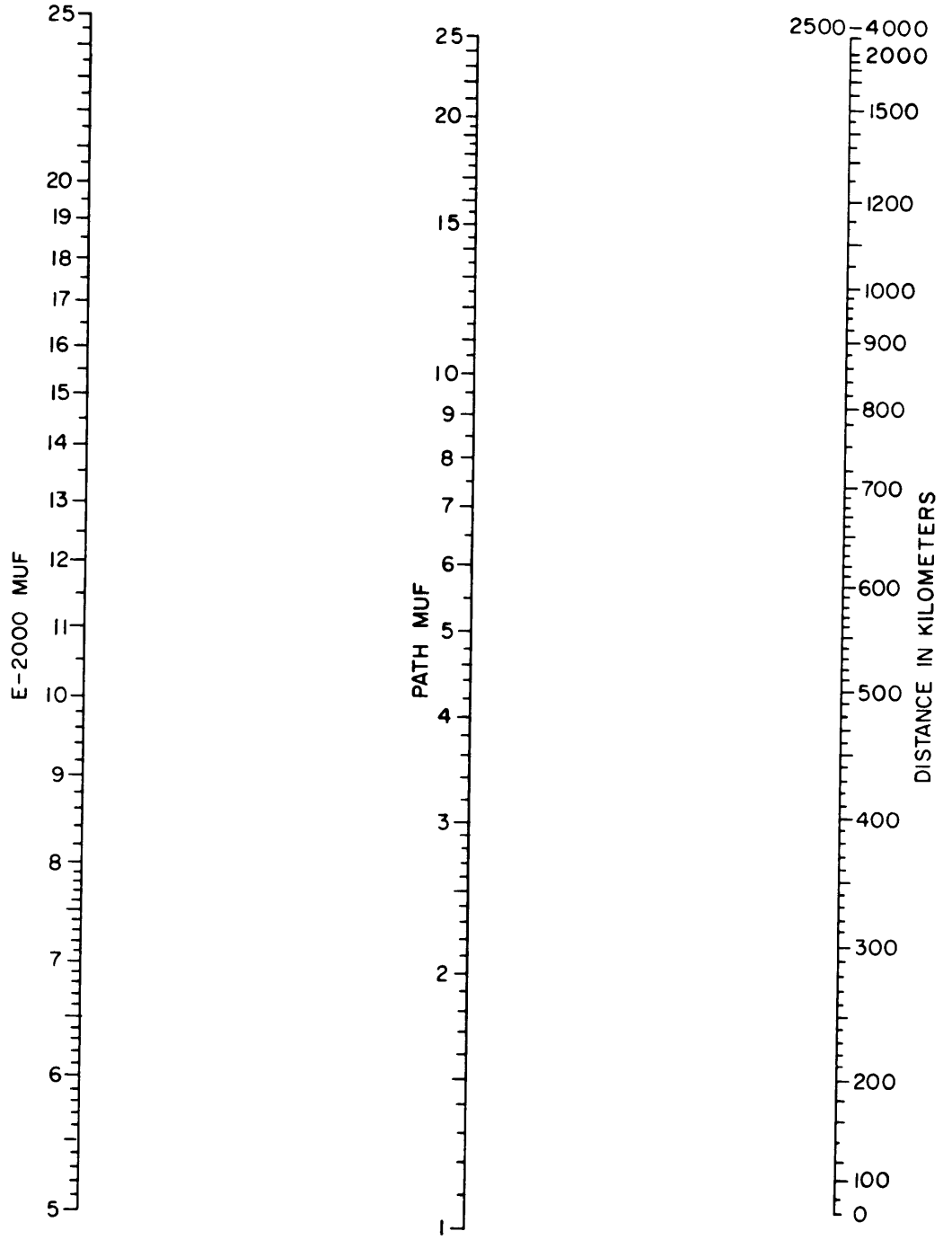


Figure A-11. MUF Conversion Nomogram, F1 and E Layers

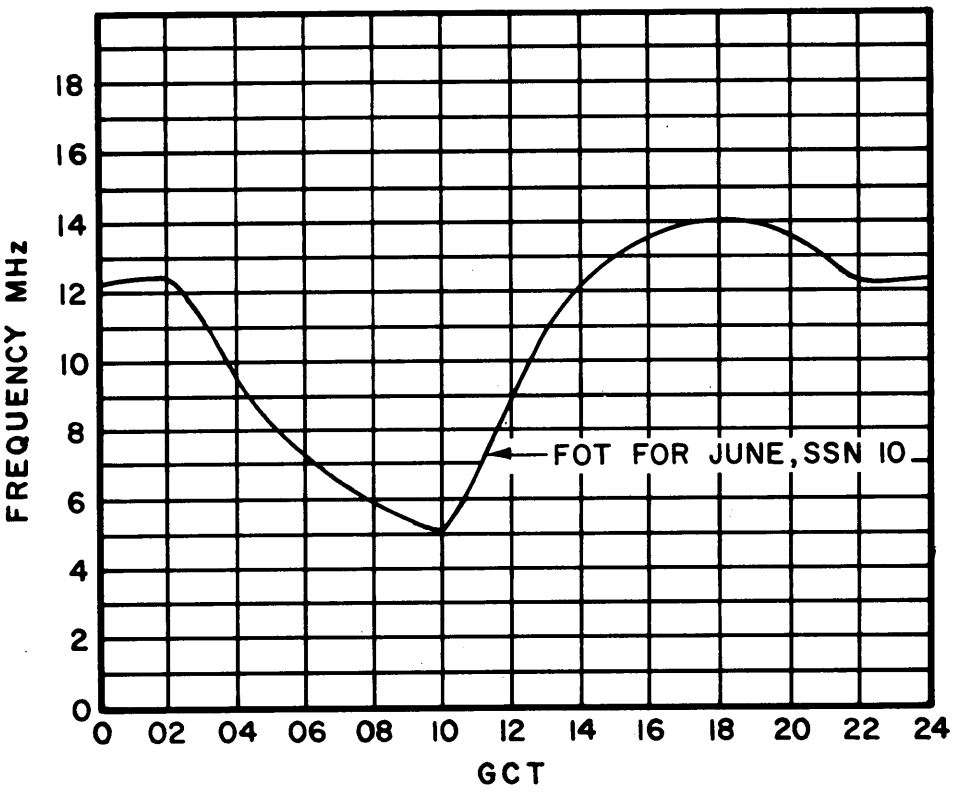


Figure A-12. FOT Curve for Cincinnati-Baton Rouge Path

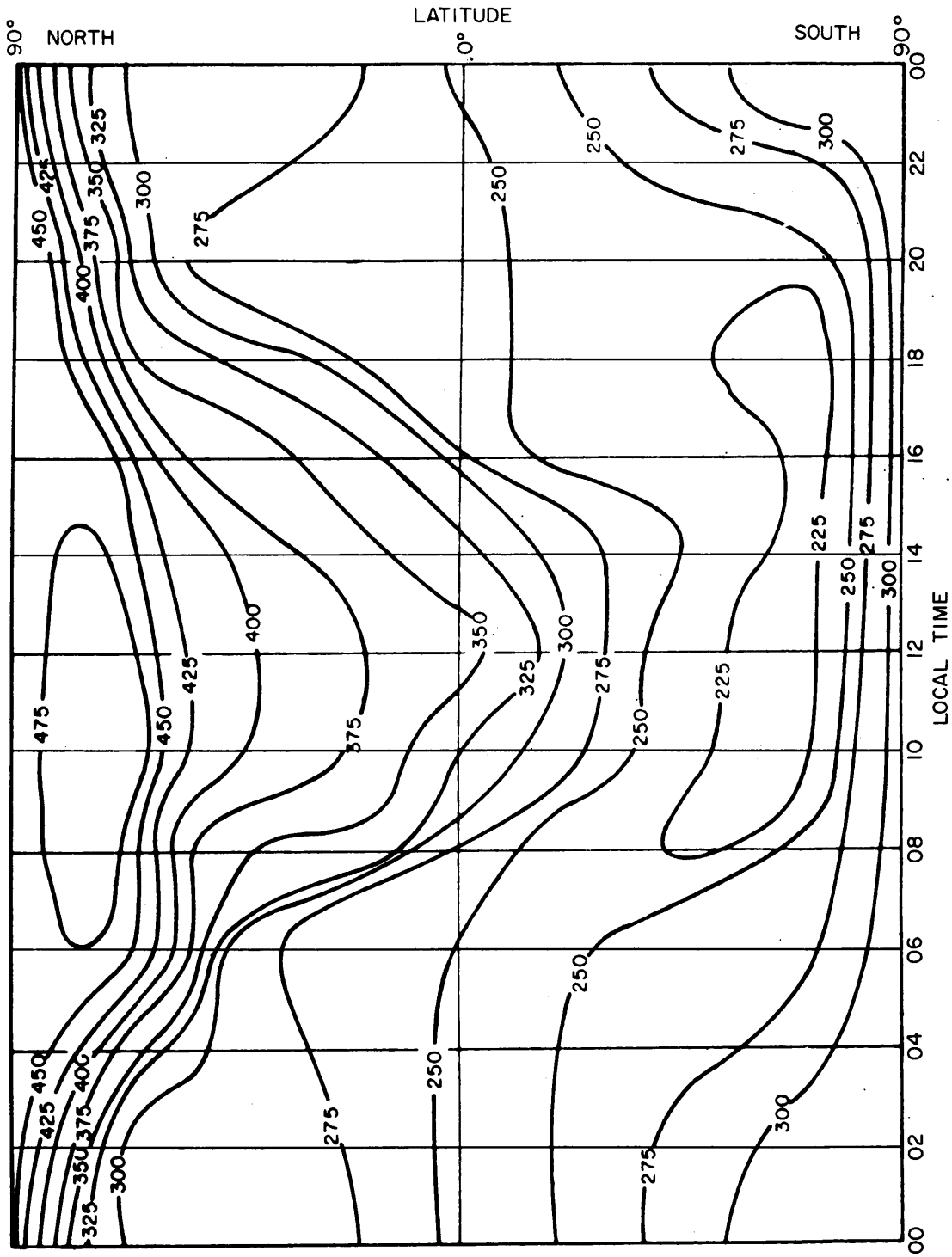


Figure A-13. Typical Height of the F2 Layer in June (Kilometers)

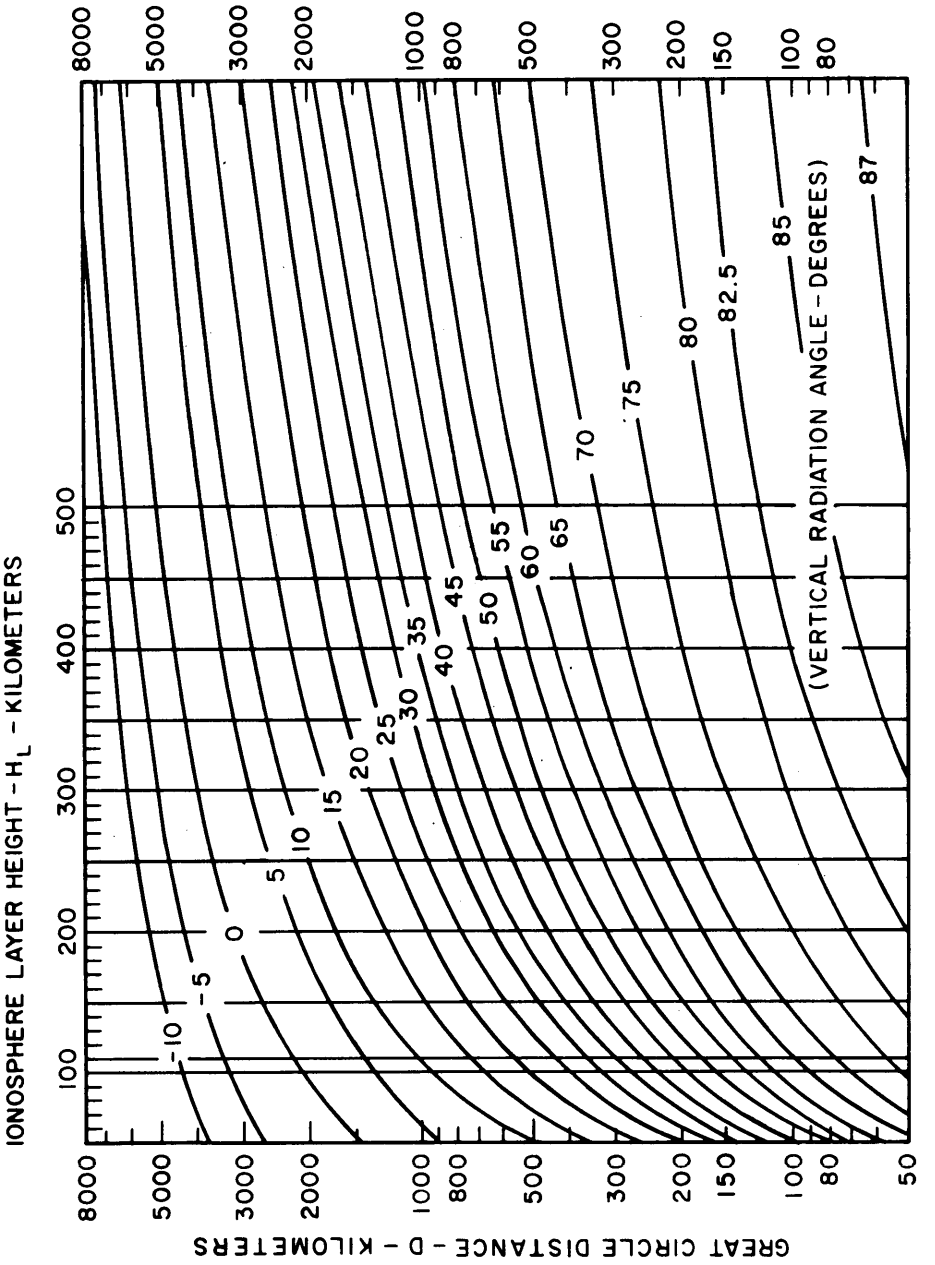


Figure A-14. Radiation Angle (Δ) as a Function of Great-Circle Distance and Ionospheric Layer Height

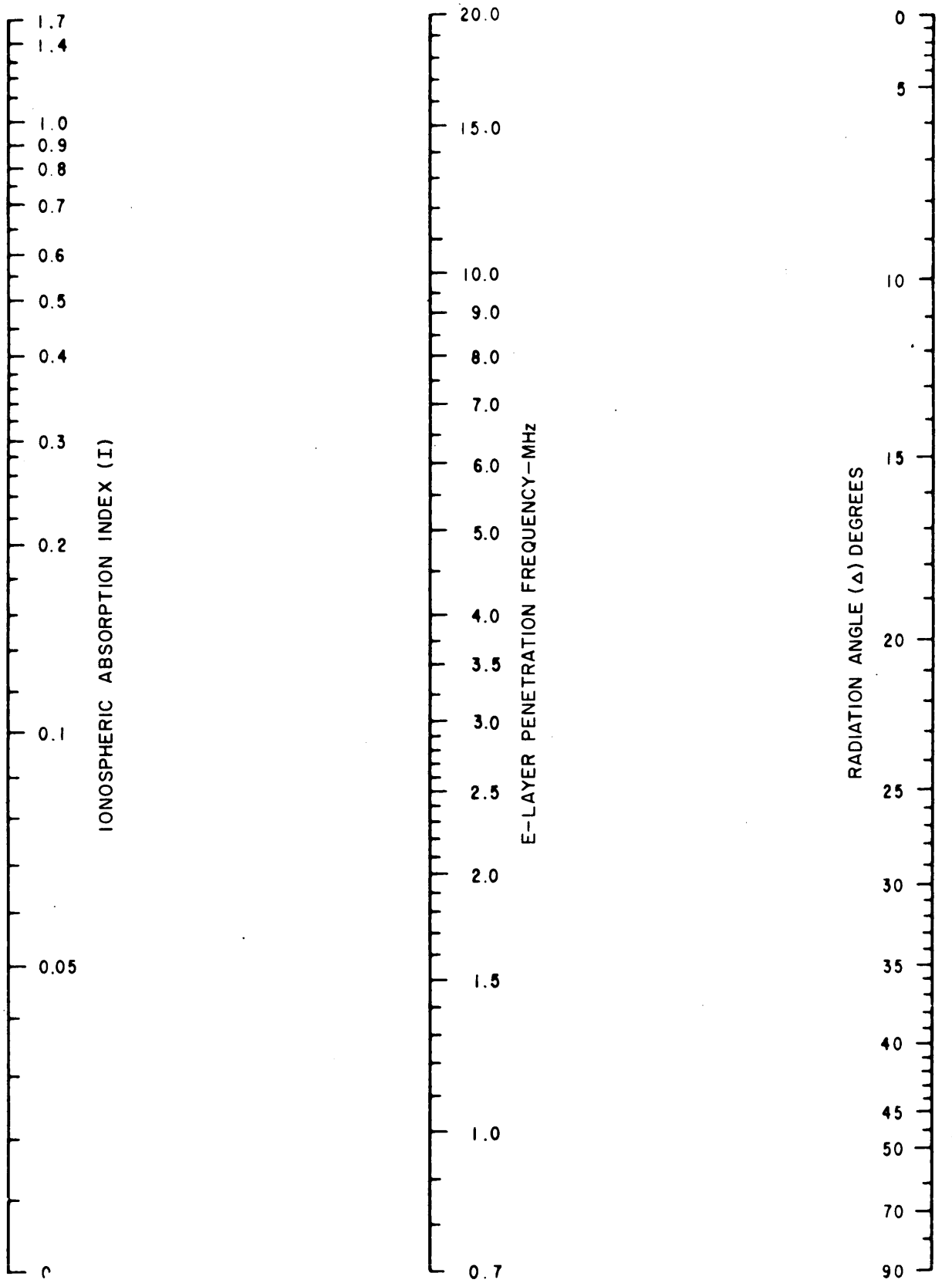


Figure A-15. Nomogram to Estimate E-Layer Penetration Frequency at any Radiation Angle

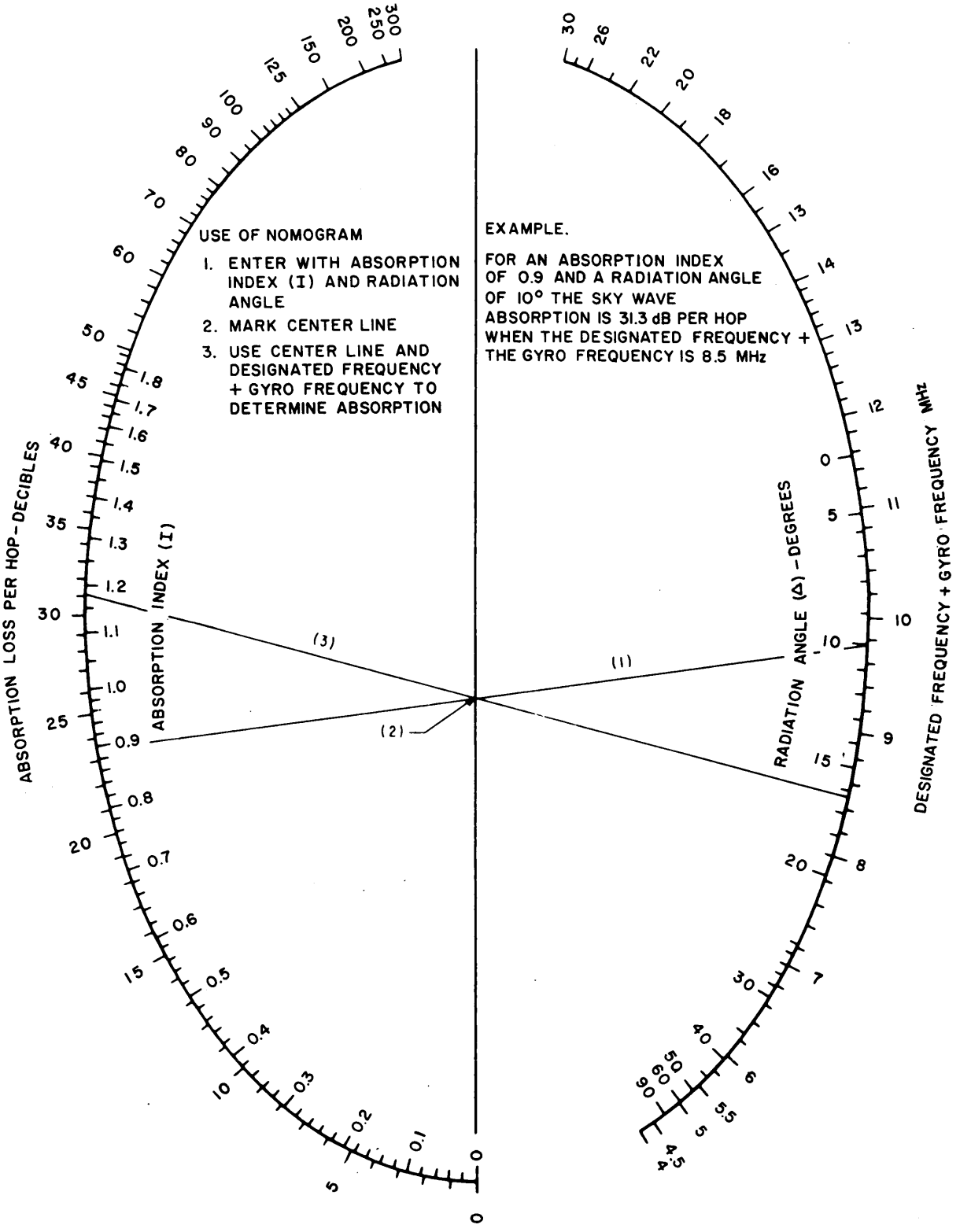


Figure A-16. Nomogram of Ionospheric Absorption

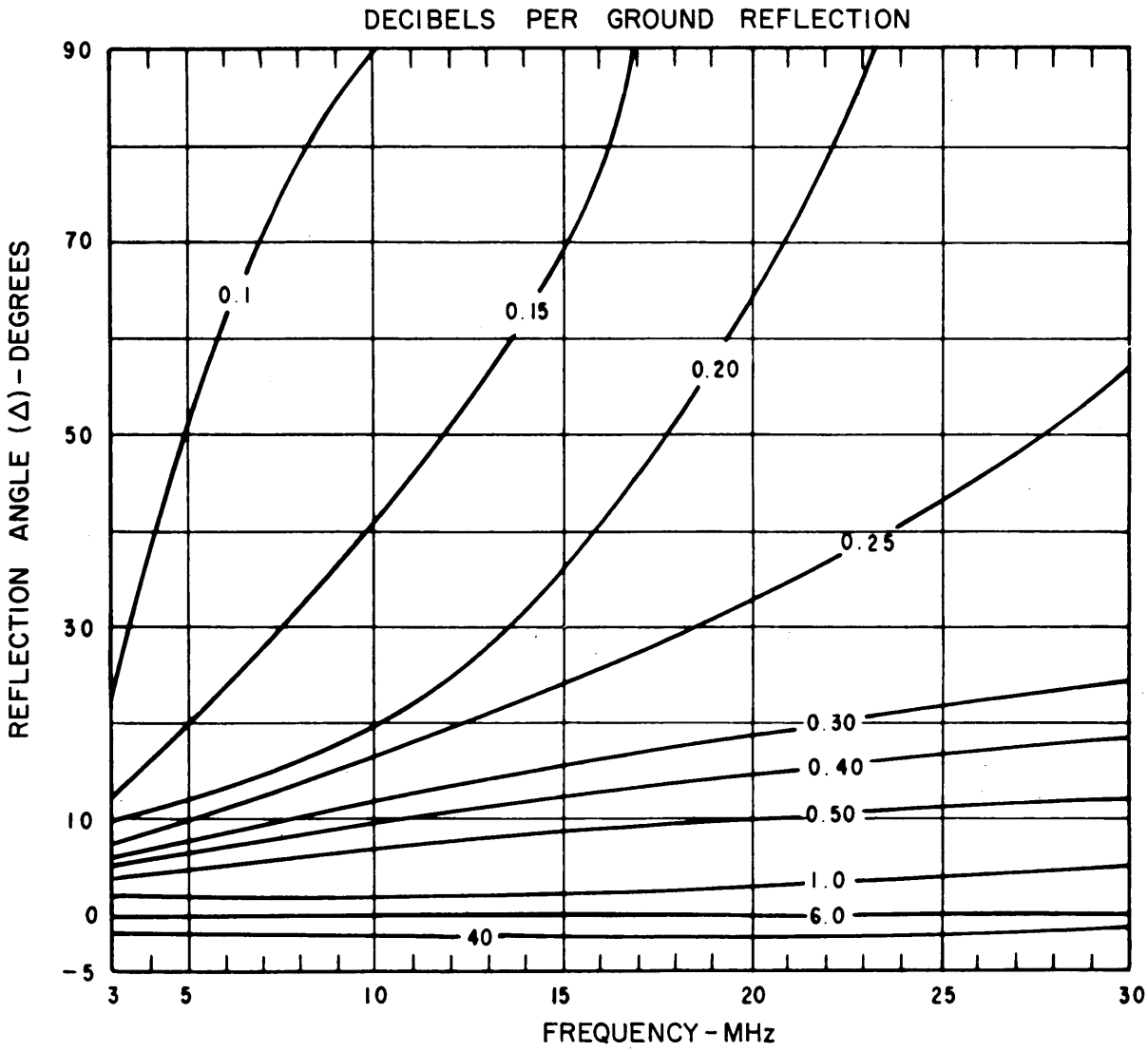


Figure A-17. Sea Water Reflection Loss

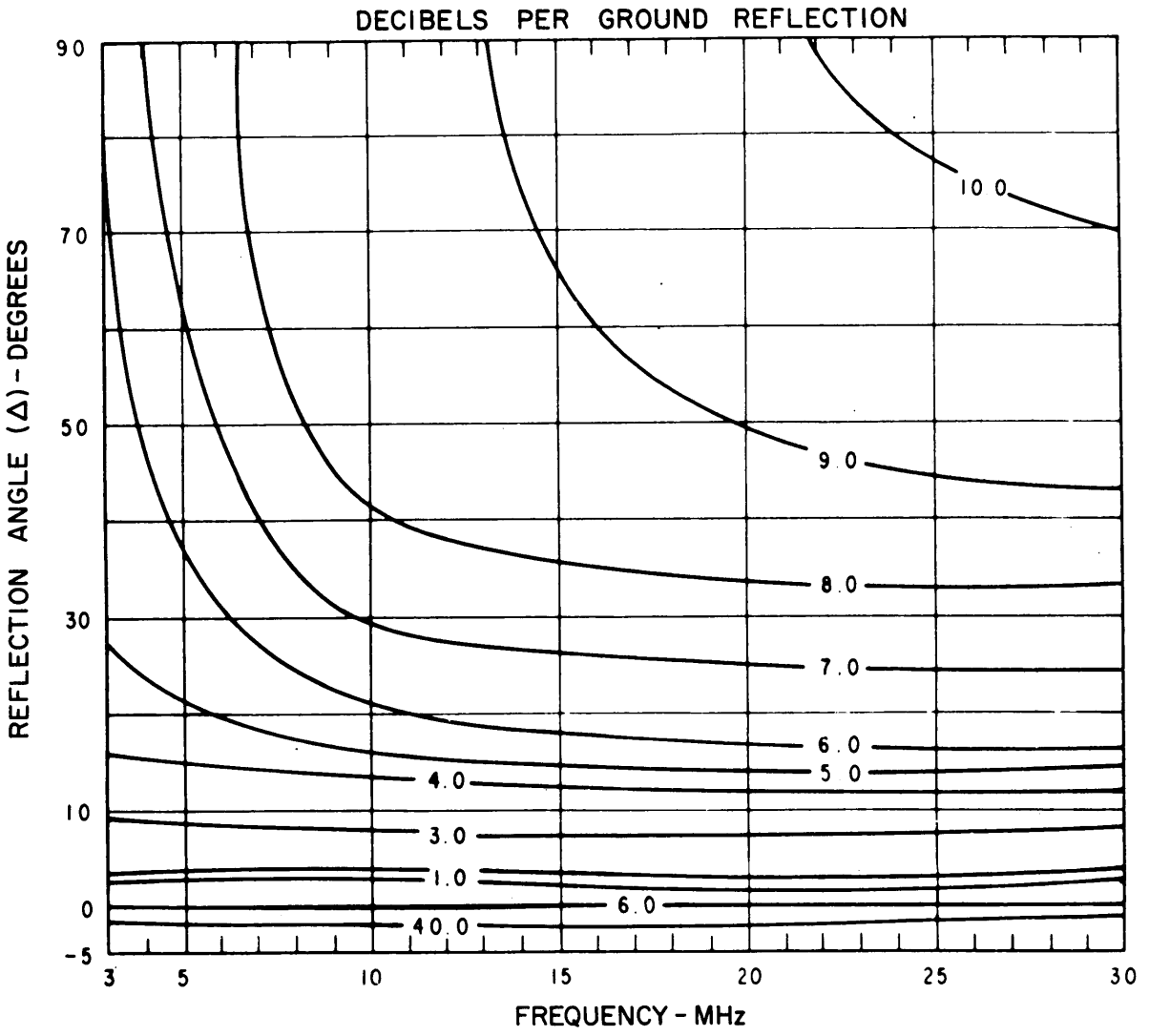


Figure A-18. Poor Earth Reflection Loss

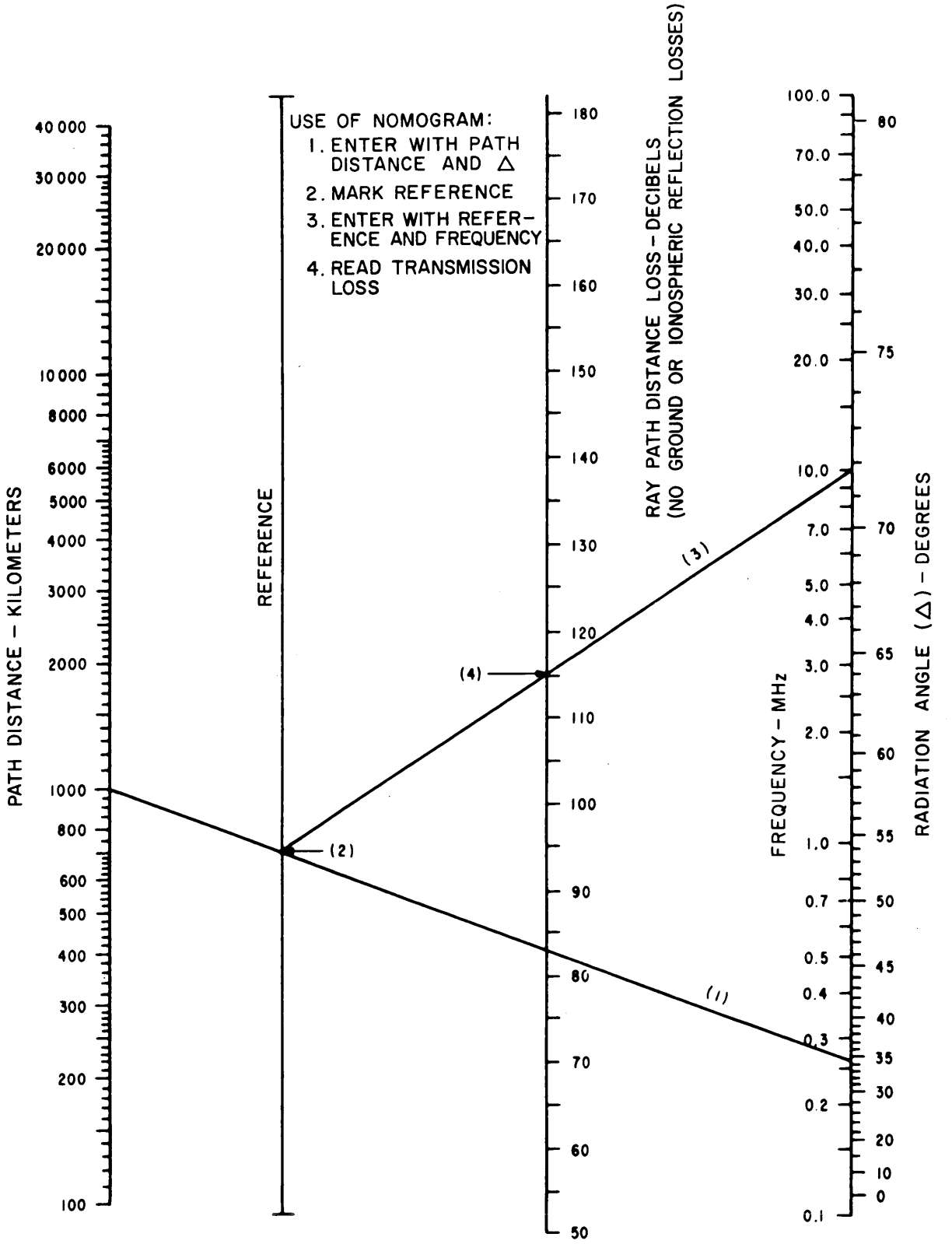
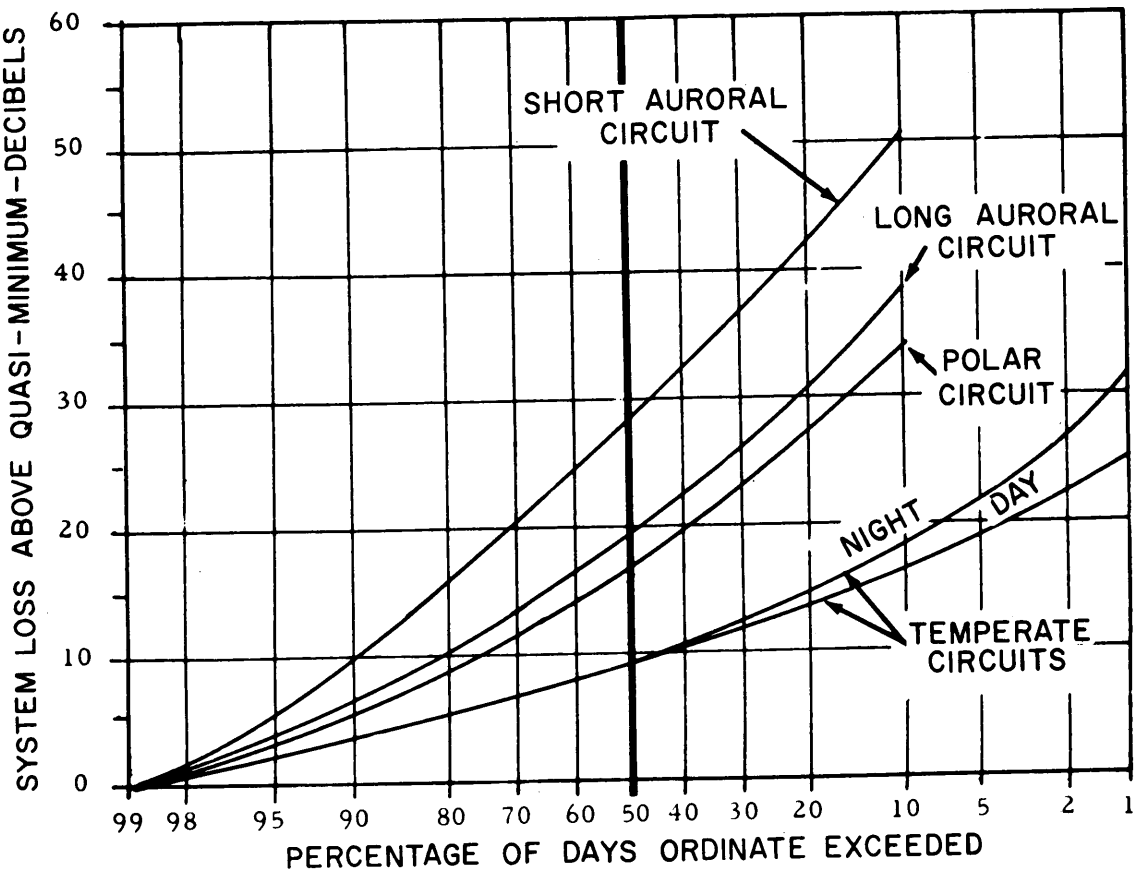


Figure A-19. Nomogram of Transmission Loss Due to Ray-Path Distance



Polar Circuit.	All Circuit Control Points above 70° Geomagnetic Latitude
Short Auroral Circuit. . .	Circuits 4000 Km or Less with the Circuit Mid Point Between 60° & 70° Geomagnetic Latitude
Long Auroral Circuit . . .	Circuits 4000 Km or Greater with one or both Control Points Between 60° and 70° Geomagnetic Latitude

Figure A-20. Typical Probability Distribution of Hourly Median Sky-Wave System Loss

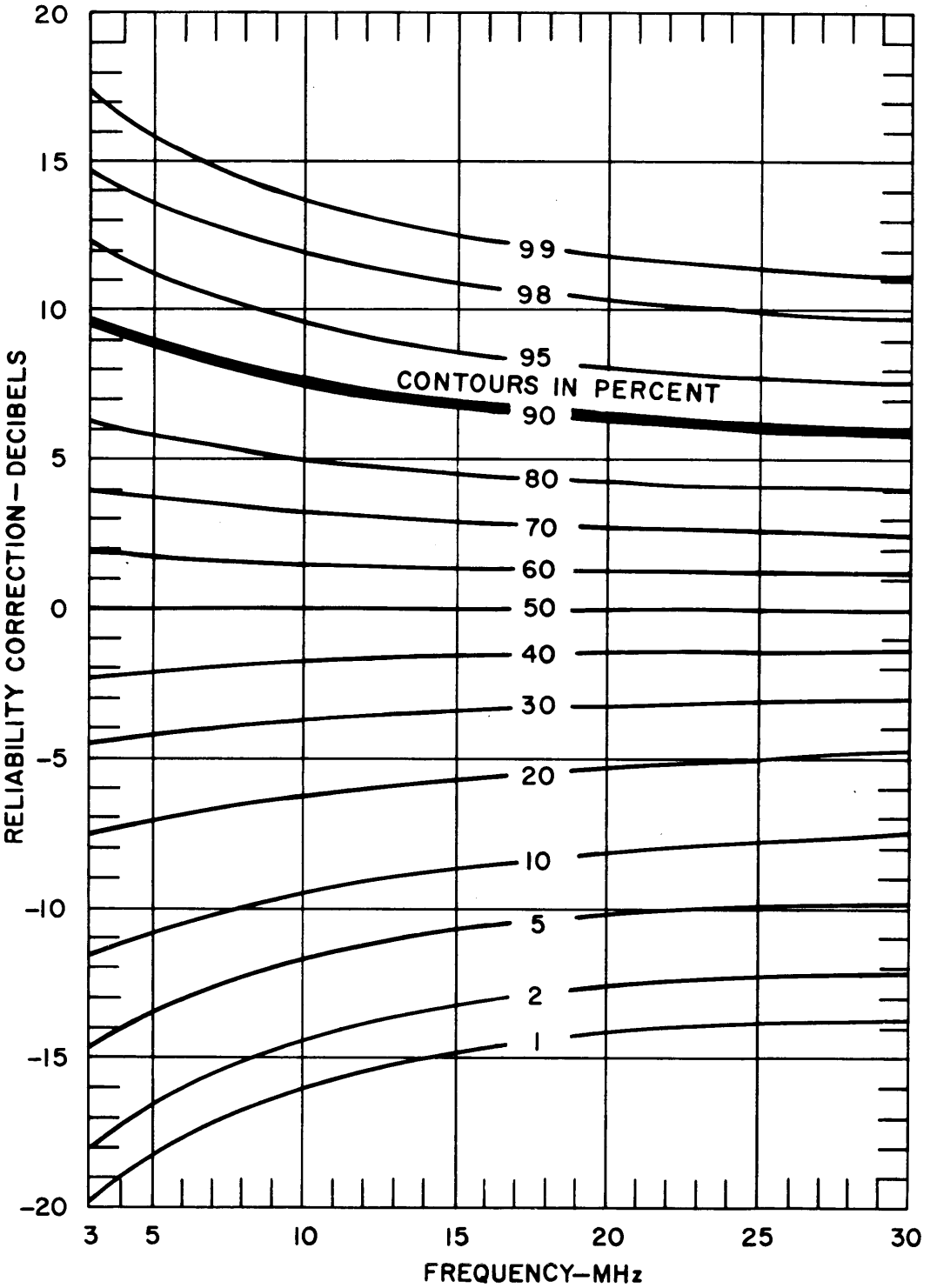


Figure A-21. Chart to Estimate Daytime Reliability of Sky-Wave Circuits Below 60° Geomagnetic Latitude

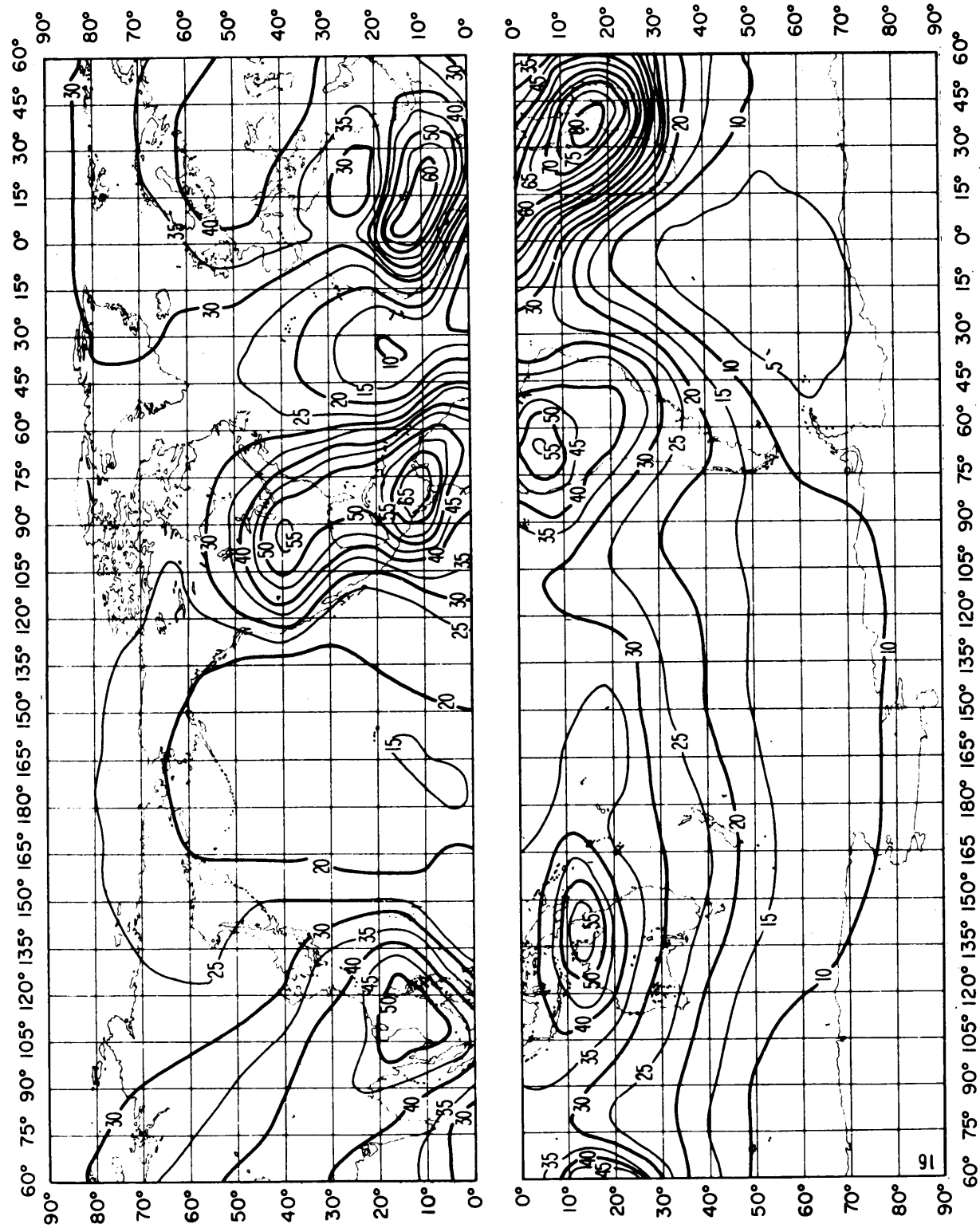


Figure A-22. Expected Values of Atmospheric Radio Noise (dB above kTb at 1 MHz)
(Summer 0400-0800)

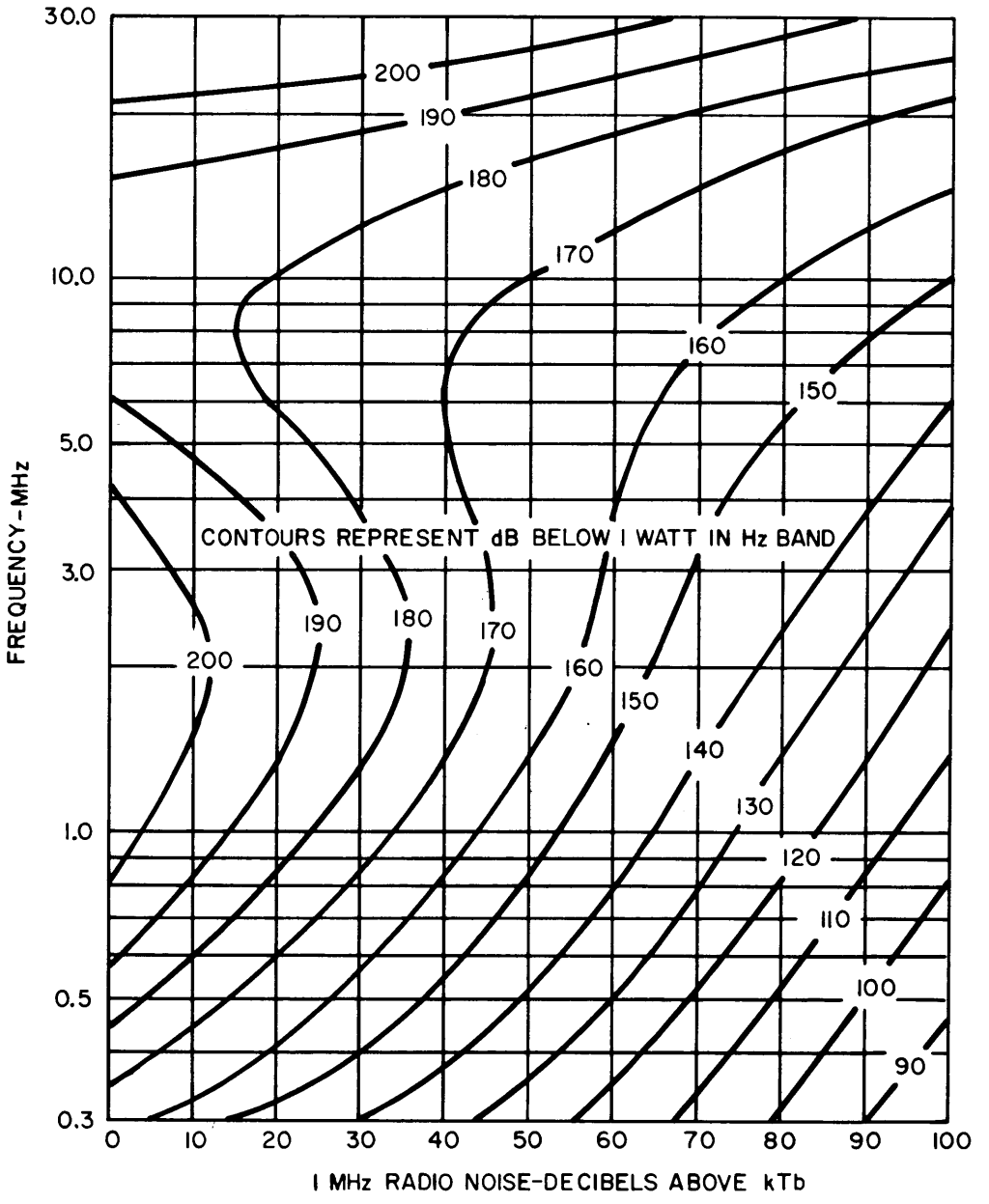


Figure A-23. Daytime Atmospheric Radio Noise — Median Values Expected for the Time Blocks 08-12 and 12-16 for all Seasons, 04-08 and 16-20 for Spring and Summer

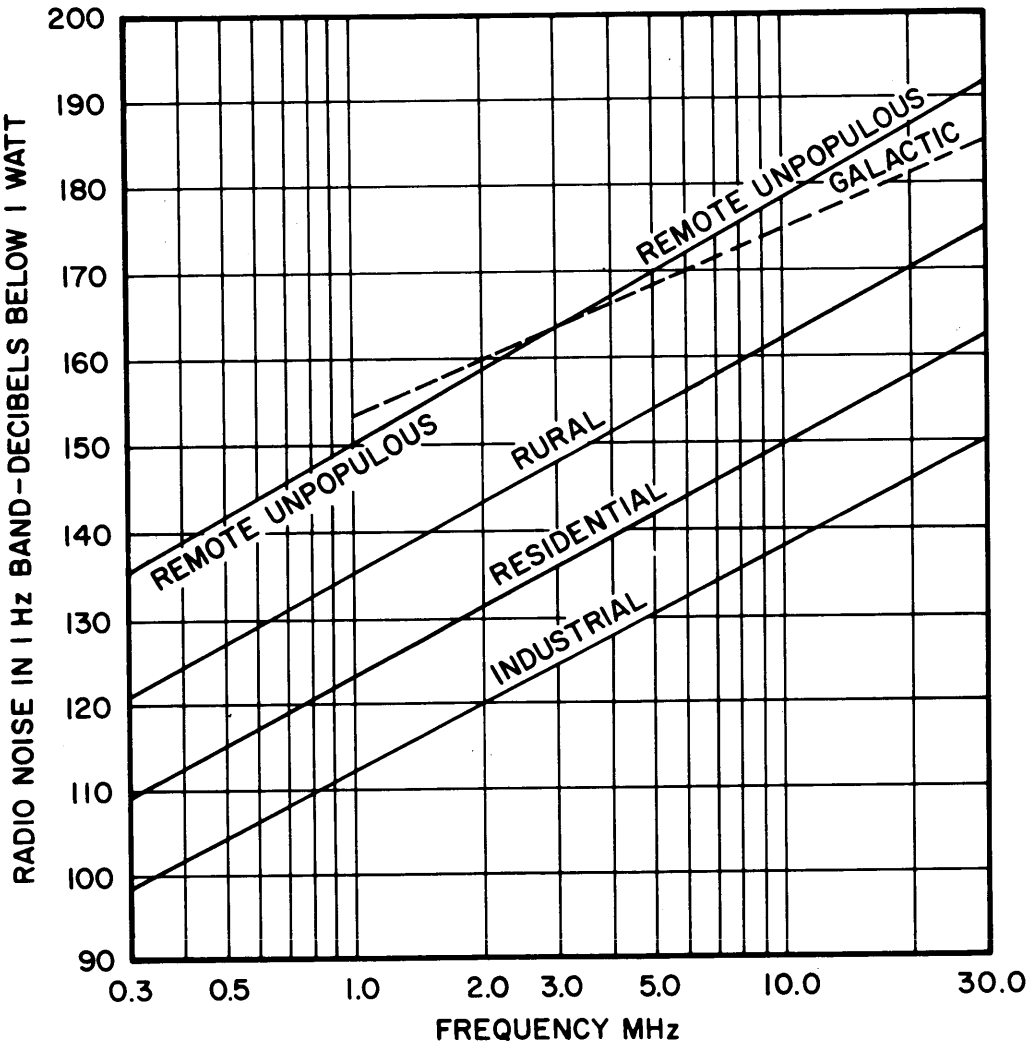


Figure A-24. Typical Man-Made and Galactic Radio Noise (from NBS Report 7249, November 1962)

APPENDIX B

HF RECEIVER SITE SURVEY

1. GENERAL SUITABILITY (Comment on each item. Attach separate sheets as necessary.)

a. Logistic support accessibility —
   (1) Remoteness of area (air, rail, truck, bus)
   (2) Proximity to paved roads
   (3) Access road requirement
   (4) Availability of naval supply facilities
   (5) Availability of other government facilities (25 mile radius)
   (6) Availability of commercial supply facilities
   (7) Other comments

b. Utility services availability —
   (1) Availability of commercial power
   (2) Availability of station power
   (3) Availability of water supply
   (4) Availability of sewage services
   (5) Availability of fire protection services
   (6) Availability of telephone services

c. Climatological conditions —
   (1) Extremes of climate to be expected
   (2) Frequency of hurricanes, typhoons, or blizzards
   (3) Other comments

d. Future continuing suitability —
   (1) Stability of existing conditions
   (2) Anticipated industrial encroachment
   (3) Government ownership
   (4) Treaty arrangements
   (5) Political stability
   (6) Area future planning
   (7) Other comments

e. Defensibility —
   (1) Physical defense features
   (2) Security arrangements
   (3) Proximity to primary targets
   (4) Other comments

f. Recreation availability
   (1) Availability of recreational facilities
   (2) Types of facilities available
   (3) Proximity to facilities
   (4) Other comments

g. Personnel logistics availability —
   (1) Proximity to established naval station
   (2) Availability of on-base personnel housing
   (3) Availability of off-base personnel housing
   (4) Mess facilities
   (5) Exchange facilities
   (6) Other comments

2. LAND AREA REQUIRED (Attach separate sheets for comments as necessary.)

a. Topographic map of area (minimum scale — 1:50,000)

b. Acreage under consideration

c. Adequacy of site to meet requirements

d. Restricted area situation

e. Present ownership of site and restricted area

f. Proposed acquisition arrangements

g. Host/tenant agreements required

h. Treaty arrangements required

i. Advantages of proposed site

j. Limitations of proposed site

k. Estimated costs of acquisition

l. Other comments

3. INTERFACE ASPECTS

a. Distance, azimuth, and measured field intensity from existing and planned radio transmitters: (Note 1)

	Distance	Azimuth	Freq. (Note 3)	μV/m
(1) Navy VLF transmitter site	—			
(2) Navy LF-HF transmitter site (Note 2)	—			
(3) Other military transmitters (Note 2)	—			
(4) Non-military transmitters (identify)	—			

b. Distance, azimuth, and measured field intensity from: (Note 1) (Note 4)

	Distance	Azimuth	Freq.	μV/m
(1) Navy (specify type)				
(2) Other (specify)				

c. Distance, azimuth, and measured field intensity from man-made noise sources: (Note 1)

	Distance	Azimuth	μV/m
(1) Teletype/electromechanical systems			
(2) Primary power plant			
(3) Highways/roads (vehicles per hour average)			
(4) Industrial area			
(5) Commercial area			
(6) Residential area			
(7) Overhead power lines			
(8) Airfield (including glide path)			
(9) Other (specify)			

4. TERRAIN CHARACTERISTICS

(Attach separate sheets for comments as necessary.)

a. Unobstructed 5° wavepath (vertical angle) above horizontal plane for all antennas. Attach horizon plot and photograph keyed to site topographic map. Site map is desired with scale of 1:24,000 and contour intervals of not more than 10 feet. — ☐ Yes ☐ No ☐ Comment

b. Scraping, grading, earth-moving required — ☐ Extensive ☐ Minimal ☐ Comment

c. Type of soil as related to ground conductivity and uniformity. (If soil characteristics are not uniform provide a descriptive sketch.) — (comment)

d. Soil conductivity measurement data.

e. Water table depth and variability. (If not uniform or excessive seasonal variability, provide descriptive information.)

f. Buildings on or adjacent to site and within restricted zone. Locate on site or area map. Describe, identify ownership and land usage, and evaluate interference capability. Identify land use covenants.

g. Undergound structures. Identify and locate underground facilities such as cables and pipe lines.

5. MICROWAVE LINK LINE-OF-SIGHT DISTANCE: (Attach separate sheets for comments as necessary.)

a. Miles to transmitter site —

b. Miles to communications center —

c. Path obstructions — (Comment)

6. POTENTIAL ENCROACHMENT: (Comment on each item. Attach separate sheets as necessary.)

a. Military

b. Industrial

c. Commercial

d. Residential

e. Highways/roads

f. Power lines

g. Airfields

h. Other (specify)

7. MAXIMUM FUTURE EXPANSION CAPABILITY: (Attach separate sheets for comments as necessary.)

a. Receiver buildings (sq. ft.) —

b. Logistics buildings (sq. ft. each building) —

c. Antenna park (acres) —

d. Vehicle parking (sq. ft.) —

e. Recreation area (acres) —

NOTE 1: Field intensity measurements are made at the center of the proposed site. For the man-made noise survey a number of spectrum scans must be made at various times throughout the day and should cover the full range of operating frequencies expected to be used by the proposed receiver station during the various periods of a day.

NOTE 2: Field intensity measurements made at planned antenna location to evaluate signal reception from distant transmitters.

NOTE 3: Field intensity measurements must include low, middle and high frequencies of the band (minimum).

NOTE 4: Measurements must include pulse repetition rate.

APPENDIX C

HF TRANSMITTER SITE SURVEY

1. GENERAL SUITABILITY (Comment on each item. Attach separate sheets as necessary).

a. Logistic support accessibility —
   (1) Remoteness of area (air, rail, truck, bus)
   (2) Proximity to paved roads
   (3) Access road requirement
   (4) Availability of naval supply facilities
   (5) Availability of other government facilities (25-mile radius)
   (6) Availability of commercial supply facilities
   (7) Other comments

b. Utility services availability —
   (1) Availability of commercial power
   (2) Availability of station power
   (3) Availability of water supply
   (4) Availability of sewage services
   (5) Availability of fire protection services
   (6) Availability of telephone services

c. Climatological conditions —
   (1) Extremes of climate to be expected
   (2) Frequency of hurricanes, typhoons, or blizzards
   (3) Other comments

d. Future continuing suitability —
   (1) Stability of existing conditions
   (2) Anticipated industrial encroachment
   (3) Government ownership
   (4) Treaty arrangements
   (5) Political stability
   (6) Area future planning
   (7) Other comments

e. Defensibility —
   (1) Physical defense features
   (2) Security arrangements
   (3) Proximity to primary targets
   (4) Other comments

f. Recreation availability —
   (1) Availability of recreational facilities
   (2) Types of facilities available
   (3) Proximity to facilities
   (4) Other comments

g. Personnel logistics availability —
   (1) Proximity to established naval station
   (2) Availability of on-base personnel housing
   (3) Availability of off-base personnel housing
   (4) Mess facilities
   (5) Exchange facilities
   (6) Other comments

2. LAND AREA REQUIRED (Attach separate sheets for comments as necessary.)

a. Topographic map of area (minimum scale — 1:50,000)

b. Acreage under consideration

c. Adequacy of site to meet requirements

d. Present ownership of site

e. Proposed acquisition arrangements

f. Host/tenant agreements required

g. Treaty arrangements required

h. Advantages of proposed site

i. Limitations of proposed site

j. Estimated costs of acquisition

k. Other comments

3. INTERFACE ASPECTS

a. Distance and azimuth to existing and planned communications facilities:

	Distance	Azimuth
(1) Communications center	—	
(2) Navy receiver site	—	
(3) Other military/government receivers (identify)	—	
(4) Other transmitters (identify)	—	

b. Distance and azimuth to other significant locations:

	Distance	Azimuth
(1) Main highways		
(2) Airfield (including glide path)		
(3) Residential area		
(4) Industrial area		

	Distance	Azimuth
(5) Commercial area —		
(6) Overhead power lines —		
(7) Other (specify) —		

4. TERRAIN CHARACTERISTICS:

a. Unobstructed 5° wavepath (vertical angle) above horizontal plane for all antennas. Attach horizon plot and photograph keyed to site topographic map. Site maps desired with scale of 1:24,000 and contour intervals of not more than 10 feet. — ☐ Yes ☐ No ☐ Comment

b. Scraping, grading, earth moving, required — ☐ Extensive ☐ Minimal ☐ Comment

c. Type of soil as related to ground conductivity and uniformity. (If soil characteristics are not uniform, provide a descriptive sketch.) — (Comment)

d. Soil conductivity measurement data. —

e. Water table depth and variability. (If not uniform or excessive seasonal variability, provide descriptive information.) —

f. Underground structures. Identify and locate underground facilities such as cables and pipelines. —

5. MICROWAVE LINK LINE-OF-SIGHT DISTANCE: (Attach separate sheets for comments as necessary.)

a. Miles to receiver site —

b. Miles to communications center —

c. Path obstructions — (Comment)

6. POTENTIAL ENCROACHMENT: (Comment on each item. Attach separate sheets for comments as necessary.)

a. Military —

b. Industrial —

c. Commercial —

d. Residential —

e. Highways/roads —

f. Power lines —

g. Airfields —

h. Other (specify) —

7. MAXIMUM FUTURE EXPANSION CAPABILITY: (Attach separate sheets for comments as necessary.)

a. Transmitter building (sq. ft.) —

b. Logistics buildings (sq. ft. each) —

c. Antenna park (acres) —

d. Vehicle parking (sq. ft.) —

e. Recreation area (acres) —

APPENDIX D

COMMUNICATIONS CENTER SITE SURVEY

1. GENERAL SUITABILITY (Comment on each item. Attach separate sheets as necessary.)

a. Logistic support accessibility —
   (1) Remoteness of area (air, rail, truck, bus)
   (2) Proximity to paved roads
   (3) Access road requirement
   (4) Availability of naval supply facilities
   (5) Availability of other government facilities (25 mile radius)
   (6) Availability of commercial supply facilities
   (7) Other comments

b. Utility services availability —
   (1) Availability of commercial power
   (2) Availability of station power
   (3) Availability of water supply
   (4) Availability of sewage services
   (5) Availability of fire protection services
   (6) Availability of telephone services
   (7) Other comments

c. Climatological conditions —
   (1) Extremes of climate to be expected
   (2) Frequency of hurricanes, typhoons, or blizzards
   (3) Other comments

d. Future continuing suitability —
   (1) Stability of existing conditions
   (2) Anticipated industrial encroachment
   (3) Government ownership
   (4) Treaty arrangements
   (5) Political stability
   (6) Area future planning
   (7) Other comments

e. Defensibility —
   (1) Physical defense features
   (2) Security arrangements
   (3) Proximity to primary targets
   (4) Other comments

f. Recreation availability —
   (1) Availability of recreational facilities
   (2) Types of facilities available
   (3) Proximity to facilities
   (4) Other comments

g. Personnel logistics availability —
   (1) Proximity to established naval station
   (2) Availability of on-base personnel housing
   (3) Availability of off-base personnel housing
   (4) Mess facilities
   (5) Exchange facilities
   (6) Other comments

2. LAND AREA REQUIRED (Attach separate sheets for comment as necessary)

a. Topographic map of area (minimum scale — 1:50,000)

b. Acreage under consideration

c. Adequacy of site to meet requirements

d. Present ownership of site

e. Proposed acquisition arrangements

f. Host/tenant agreements required

g. Treaty arrangements required

h. Advantages of proposed site

i. Limitations of proposed site

j. Estimated costs of acquisition

k. Other comments

3. INTERFACE ASPECTS

a. Distance, azimuth, and measured field intensity from existing and planned communications facilities: (Note 1)

	Distance	Azimuth	Freq. (Note 2)	μV/M
(1) Navy VLF transmitters —				
(2) Navy LF-HF transmitters —				
(3) Other military transmitters —				
(4) Non-military transmitters (identify) —				
(5) Navy receiver site —				N/A
(6) Other military/government receivers —				N/A

b. Distance, azimuth, and measured field intensity from radar: (Note 1) (Note 3)

	Distance	Azimuth	Freq.	μV/m
(1) Navy (specify type)				
(2) Other (specify)				

c. Distance, azimuth, and measured field intensity from man-made noise sources: (Note 1)

	Distance	Azimuth	Freq.	μV/m
(1) Primary power plant —				
(2) Highways/roads —				
(3) Industrial area —				
(4) Commercial area —				
(5) Residential area —				
(6) High-tension power lines—				
(7) Airfield (including glide path) —				
(8) Other (specify) —				

4. TERRAIN CHARACTERISTICS: (Attach separate sheets for comments)

	Extensive	Minimal	Comment
a. Scraping, grading, earth moving required —			
b. Water table depth and variability. (If not uniform or excessive seasonal variability, provide descriptive information.) —			
c. Underground structures. Identify and locate underground facilities such as cables and pipe lines. —			

5. MICROWAVE LINK LINE-OF-SIGHT DISTANCE: (Attach separate sheets for comments)

a. Miles to transmitter site —

b. Miles to receiver site —

c. Path obstructions — (Comment)

6. POTENTIAL ENCROACHMENT: (Comment on each item. Attach separate sheets for comments.)

a. Military —

b. Industrial —

c. Commercial —

d. Residential —

e. Highways/roads —

f. Power lines —

g. Airfields —

h. Other (specify) —

7. MAXIMUM FUTURE EXPANSION CAPABILITY: (Attach separate sheets for comments)

a. Message center (sq. ft.) —

b. Relay/automatic switching center (sq. ft.) —

c. Control link area (sq. ft.) —

d. Cryptographic center (sq. ft.) —

e. Logistics buildings (sq. ft. each) —

f. Vehicle parking (sq. ft.) —

g. Recreation area (sq. ft.) —

8. PROXIMITY TO SUBSCRIBERS:

a. Navy (specify activities) —

b. Other military/government (specify) —

NOTE 1: Field intensity measurements made at planned building site.

NOTE 2: Field intensity measurements must include low, middle, and high frequencies of the band (minimum).

NOTE 3: Measurements must include pulse repetition rate.

APPENDIX E

REFERENCES

1. Radio Spectrum Utilization, A Report of the Joint Technical Advisory Committee of the Institute of Electrical and Electronics Engineers and the Electronic Industries Association, New York: IEEE, 1964.

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WORKSHEET FOR PATHS ≤4000 km

BASIC DATA, MUF AND FOT

PATH DISTANCE 2400 km MONTH June SSN 10

TRANSMITTER Washington, D.C.	38.9°N 77.0°W	LAND
LOCATION	COORDINATES	TERRAIN
RECEIVER Boulder Colorado	40.0°N 105.0W	LAND
LOCATION	COORDINATES	TERRAIN
MIDPATH 40.4°N 91.0°W	49°N	LAND
COORDINATES	GEOMAGNETIC LATITUDE	TERRAIN

MIDPATH ZONE W, GYRO FREQUENCY 1.5 MHz

	GMT	00	02	04	06	08	10	12	14	16	18	20	22
1	MIDPATH LOCAL TIME	1756	1956	2156	2356	0156	0356	0556	0756	0956	1156	1356	1556
2	F2-ZERO MUF	6.0	6.1	5.0	3.8	3.2	3.0	4.5	5.2	5.5	5.7	5.8	5.9
3	F2-4000 MUF	18.0	18.1	13.6	10.4	8.5	7.0	12.9	14.5	15.1	15.3	15.6	16.9
4	SUN'S ZENITH ANGLE	75	96	-	-	-	96	75	53	31	17	33	55
5	ABSORPTION INDEX	0.32	0.05	-	-	-	0.05	0.32	0.63	0.88	0.99	0.89	0.61
6	F2-MUF	14.4	14.6	11.0	8.5	7.0	6.0	10.4	11.7	12.3	12.5	12.7	13.7
7	F2-FOT	12.2	12.4	9.4	7.2	5.9	5.1	8.8	10.0	10.5	10.6	10.8	11.6
8	E-2000 MUF	11.0	5.2	-	-	-	5.2	11.0	14.6	16.6	17.2	16.7	14.7
9	E-MUF	9.0	4.3	—	—	—	4.3	9.0	12.0	13.6	14.0	13.7	12.1
10	CIRCUIT FOT	12.2	12.4	9.4	7.2	5.9	5.1	9.0	12.0	13.6	14.0	13.7	12.1

Foldout 2-1. Basic Data, MUF and FOT Worksheet for Paths ≤ 4000 km

PATH LOSS WORKSHEET FOR PATHS ≤4000 km

TRANSMITTER Washington, D.C. RECEIVER Boulder Colorado

PATH DISTANCE 2400 km MONTH June SSN 10

GMT 1200 MIDPATH LOCAL TIME 0556

11	OPERATING FREQUENCY	9.0				
12	F2-LAYER HEIGHT	285				
13	MODES CONSIDERED	1E	2E	1F	2F	3F
14	DISTANCE PER HOP	2400	1200	2400	1200	800
15	RADIATION ANGLE Δ	-2	7	8	23	33
16	MAXIMUM EΔ, MINIMUM FΔ	7.7				
17	MINIMUM F DISTANCE			1850		
18	IONOSPHERIC LOSS PER HOP, dB	—	8.5	8.3	—	—
19	TOTAL IONOSPHERIC LOSS, dB	—	17.0	8.3	—	—
20	GROUND LOSS PER REFLECTION, dB		2.0		—	—
21	TOTAL GROUND LOSS, dB		4.0		—	—
22	RAY PATH DISTANCE LOSS, dB	—	120	120	—	—
23	QUASI-MINIMUM PATH LOSS, dB	—	141	128	—	—
24	ADJUSTMENT TO MEDIAN, dB	9				
25	MEDIAN PATH LOSS, dB	137				
26	ADJUSTMENT FOR 90% SERVICE, dB	8				
27	PATH LOSS FOR 90% SERVICE, dB	145				

Foldout 2-2. Path Loss Worksheet for Paths ≤ 4000 km

RADIO NOISE AND SIGNAL POWER WORKSHEET

RECEIVER Boulder, Colorado (LOCATION) 40.°0 N 105°W (COORDINATES)

GMT 1200 MONTH JUNE FREQUENCY 9.0 MHz

28	LOCAL TIME	0500
29	F2-ZERO MUF	4.5
30	1 MHz NOISE LEVEL, dB ABOVE kTb	59
31	ATMOSPHERIC NOISE, 1 Hz BANDWIDTH, dBW	−167
32	GALACTIC NOISE, dBW	−174
33	MAN-MADE NOISE, dBW	−161
34	NOISE AT RECEIVING ANTENNA, 1 Hz BANDWIDTH, dBW	−161
35	NOISE, 3 kHz BANDWIDTH, dBW	−126
36	REQUIRED S/N, dB	32
37	SIGNAL REQUIRED, dBW	−94
38	PATH LOSS, 90% SERVICE, dB	145
39	PATH EFFECTIVE POWER, dBW	51

Foldout 2-3. Radio Noise and Signal Power Worksheet