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FEDERAL COMMUNICATIONS COMMISSION
INTERNATIONAL BUREAU

Satellite and Radiocommunication Division
Satellite Policy Branch

DOCKET FILE COPY ORIGINAL

To: Mr. William F. Caton, Acting Secretary

Date: January 22, 1996

From: Karl Kensinger KK

Re: Ex parte presentation
CC Docket No. 92-297

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This will serve to indicate that on January 19, 1996 the International Bureau's Satellite and Radiocommunication Division convened a meeting with the participants listed in Attachment A to this memorandum.

The attached documents formed a basis for discussion of the possibility of sharing between feeder links for non-geostationary orbit MSS systems and geostationary FSS systems in the 29.1-29.5 GHz bands.

Several attendees questioned the feasibility of such sharing. Representatives of Hughes, for example, indicated that any limitations imposed on geostationary FSS systems could prove prohibitively costly. They also indicated that, even if sharing between TRW's system and geostationary FSS systems were feasible, sharing with Motorola's system presents more significant difficulties. Motorola agreed, and indicated that restrictions on the size of GSO FSS antennas operating in the 29.1-29.5 bands could facilitate sharing. The attendees also discussed other potential methods of facilitating sharing, including MSS system path diversity.

Representatives of Hughes expressed the view that co-frequency sharing between MSS feeder links and GSO FSS systems is impracticable, and indicated they would present an alternative band segmentation plan in the near future. They indicated that the alternative plan would affect potential LMDS operations.

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Attachment A

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1/19/96 TRW / GSO Sharing Issues

Name	Organization	Phone	Fax
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Robert Nelson	GE American	609-987-4321	/4463
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GEORGE HRYCENKO	CONSULTANT FOR HUGHES	310-364-6825	/7004
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Bernard Vecerek	Hughes Comm.	310-607-4585	/4415
Angie Kronenberg	Willkie Farr + Gallagher (Intelsat)	202-429-4726	887-8979
Frank Young	Young / Jatlow for Morningstar	202-663-8080	331-8001
Albert Shuldiner	Vinson & Elkins (NetSat 28)	202-639-6722	-6604
Tom Hayden	Teledesic	206-803-1418	-1404
Larry Williams	Teledesic	202.296.8047	.8953
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JEFF KRAUSS	Consultant / Vision Star	301 309 3703	-9323
Richard Stone	Motorola	(602) 732-3991	-2305
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MEMORANDUM

January 16, 1996

TO: All Interested GSO/FSS Parties (See Distribution List)

FROM: Norman P. Leventhal and Stephen D. Baruch

RE: **Proposal of TRW Inc. for Sharing the Band 29.25-29.5 GHz**

In September 1995, TRW submitted to the Commission a study showing that under certain practicable conditions, co-frequency sharing of the frequency band 29.25-29.5 GHz (Earth-to-space) by nongeostationary mobile satellite service ("NGSO/MSS") feeder link systems and geostationary fixed-satellite service ("GSO/FSS") systems using very-small or ultra-small aperture terminals is achievable. See TRW Comments on Third NPRM in CC Docket No. 92-297, at Attachment 4. TRW's study corroborated the preliminary conclusions of technical study and task groups operating under the auspices of the Radiocommunication Sector of the International Telecommunication Union ("ITU-R"), the results of which were included in the Report of the Conference Preparatory Meeting to the 1995 World Radiocommunication Conference ("WRC-95"). TRW's study was also consistent with the Commission's tentative determination (in the Third NPRM in CC Docket No. 92-297) that co-frequency sharing of the band 29.25-29.5 GHz by NGSO/MSS feeder link systems and GSO/FSS systems is feasible.

The United States went into WRC-95 seeking the global designation of the band 29.1-29.5 GHz (along with companion band 19.3-19.7 GHz) for use by NGSO/MSS feeder links. WRC-95 designated 300 MHz in each direction for such use, and deferred designation of the final 100 MHz to WRC-97. WRC-95 also ordered studies of interservice sharing to be conducted in the interim. Today, with WRC-95 behind us and a global designation of spectrum at 29.1-29.4 GHz for use by NGSO/MSS feeder links in hand, TRW remains convinced that co-frequency sharing between NGSO/MSS feeder links and GSO/FSS systems is practicable. Nevertheless, TRW recognizes that the criteria that will govern sharing between NGSO/MSS feeder link systems and GSO/FSS systems are to be the focus of studies to be conducted over the next 12 months by ITU-R, and that substantial refinement and objectification of the sharing parameters is likely to

be forthcoming. TRW is participating in those efforts, as are many in the GSO/FSS community.

Because the Commission is not prepared to delay the resolution of its rulemaking proceeding in CC Docket No. 92-297 until the outcomes of the ITU-R studies are known — a decision with which TRW is in full accord — and because there should be a number of practicable techniques available to enable NGSO/MSS and GSO/FSS systems equitably to share the burden of mitigating intersystem interference, TRW has prepared the attached set of principles pursuant to which TRW's Odyssey™ system and GSO/FSS systems can share the band, effective immediately. Under this approach, the entire 29.1-29.5 GHz band that was proposed to be made available for use by NGSO/MSS feeder link networks would remain available for that purpose. This desirable outcome is consistent with the Final Acts of WRC-95, and does not prejudice the ability of the United States to secure at WRC-97 the designation for use by NGSO/MSS feeder links of the last 100 MHz of spectrum in each direction. TRW's coordination-based sharing approach also requires no adjustment to the co-primary allocation at 29.25-29.5 GHz that the Commission proposed in its Third NPRM in CC Docket No. 92-297; indeed, it facilitates the timely resolution of this proceeding and paves the way for the final licensing of NGSO/MSS systems that have conditional authorizations to use spectrum in the 30/20 GHz bands.

TRW encourages each of you to consider carefully the positive implications of the attached proposal, and looks forward to having the opportunity to address it with you at Friday's meeting.

Attachments

cc (w/attachment): Scott Blake Harris
Thomas Tycz
Harry Ng
Karl Kensinger
Jennifer Gilsenan
Ronald Repasi
Distribution List

PRINCIPLES FOR SHARING OF THE BAND 29.25-29.5 GHz
BETWEEN NGSO/MSS FEEDER LINKS AND GSO/FSS SYSTEMS

This paper outlines the principles that TRW Inc. ("TRW") believes will suffice to permit a determination of the feasibility of intersystem sharing between geostationary satellite systems in the fixed-satellite service ("GSO/FSS") and feeder links of non-geostationary mobile satellite service systems ("NGSO/MSS feeder links") in the band 29.25-29.5 GHz. TRW is convinced that with the features that TRW has incorporated and is seeking to incorporate into the feeder link operations of its NGSO/MSS system, and under the circumstances described below, it will be possible for affected parties to use one-on-one coordination measures and agreements to avoid most instances of coincident transmission interference between NGSO/MSS feeder link and GSO/FSS systems, and to reduce the remaining instances to negligible levels, with a minimum of burdens that can be borne equitably by the NGSO/MSS feeder link and GSO/FSS operators.

For a medium Earth orbit NGSO/MSS system of the design of TRW's Odyssey™, which requires only 300 MHz of spectrum on a single polarization, and which plans to utilize eight earth station complexes worldwide (including two in North America and one in South America), there are only limited opportunities for either Odyssey™ or GSO/FSS systems to experience unacceptable interference from the other. TRW expects to be licensed by the Commission to use the band 29.1-29.4 GHz for Odyssey™'s feeder link operations. If this occurs, it would leave only 150 MHz of spectrum to be shared with GSO/FSS systems under the Commission's current 28 GHz band plan — rather than the 250 MHz of spectrum that was expected to be shared by Odyssey™ and the GSO/FSS going into WRC-95. This amounts to a relatively modest 15% of the total 1000 MHz of spectrum that is expected to be allocated to the GSO/FSS under the Commission's band segmentation scheme. Even where GSO/FSS systems would operate on a co-frequency basis with Odyssey™ at 29.25-29.4 GHz, many of these GSO/FSS operations will be unaffected by and cause no impact to Odyssey™. Moreover, TRW's review of the system designs proposed by the applicants that comprise the Commission's first Ka-band GSO/FSS processing round reveals that almost half of the 13 applicants have either designed systems that do not contemplate use of the 29.25-29.5 GHz band or that would limit use of that band to large earth stations.

In its ongoing evaluation of the sharing environment, TRW has determined that GSO/FSS systems that operate on the opposite polarization from Odyssey™ can co-locate earth terminals as small as 0.66 meters in diameter with Odyssey™'s ground stations without the risk of unacceptable intersystem interference. In other words, GSO/FSS systems operating in right-hand circular polarization will not be constrained by Odyssey™ at all in the shared bands. Coordination parameters and possible technical constraints need to be identified only for those GSO/FSS systems that seek to operate

earth terminals using left-hand circular polarization in frequency bands designated for use by NGSO/MSS feeder link networks.

For those GSO/FSS systems that seek to operate small earth terminals near an Odyssey™ ground station, some coordination may be required. Interference arises because of the large beamwidths of GSO/FSS earth terminals. Significant interference can occur both from the GSO/FSS earth terminals into the Odyssey™ satellites and from the Odyssey™ satellites into the GSO/FSS earth terminals. For larger (i.e., 1.8 meter diameter) GSO/FSS earth terminals, the permissible angular separation of the GSO/FSS and Odyssey™ satellites as seen from the Odyssey™ earth station, and/or the permissible separation of the GSO/FSS earth terminal from the Odyssey™ earth station, can be smaller than is the case with the 0.66 meter GSO/FSS earth terminals.

Odyssey™ is prepared to share spectrum with GSO/FSS systems based on a set of coordination parameters that may be employed on an as-needed basis to resolve cases of coincident or "in-line" unacceptable interference. The following interference mitigation measures — some of which are features incorporated into the design of the Odyssey™ system or are steps Odyssey™ is prepared to take, and some of which may be required of certain GSO/FSS operators — will combine to resolve all foreseen cases of interference from coincident transmissions:

1. Odyssey™ will use only the 300 MHz at 29.1-29.4 GHz (and the companion 300 MHz downlink band at 19.3-19.6 GHz), and will limit its operations in each segment to a single sense of polarization (left-hand circular polarization in the uplink band and right-hand circular polarization in the downlink band). GSO/FSS systems can be designed to use the opposite sense of polarization in the same band segment(s) or assign a different portion of their 1000 MHz assignment in any beam that overlaps one of the eight worldwide Odyssey™ ground stations without suffering a material penalty in terms of system capacity or earth terminal size/location.

2. In addition to its use of a small number of earth station complexes, Odyssey™ will employ spot beam antennas to limit the coverage region(s) of its feeder links.

3. Odyssey™'s satellites have an orbital period of approximately six hours and are synchronized with the Earth's rotation. The satellites therefore follow repeating ground tracks. As a result, 41% of the possible orbit locations in the geostationary arc will never have any of the 12 Odyssey™ satellites cross within interfering range, and many of the remaining locations will be over ocean areas. With respect to a geostationary location for which in-line crossings do occur, the daily number of such crossings is small, and the maximum duration of any such crossing is two minutes. In the Western Hemisphere, an arbitrarily-selected geostationary location will typically experience in-line crossings from one or two Odyssey™ satellites, with only a single crossing per satellite daily. Moreover, the region affected will be approximately the size of a single beam produced by the GSO/FSS satellite. To the extent that crossings do occur, many will occur at night or during a low-traffic period.

   For those GSO/FSS operators that seek to use the band 29.25-29.5 GHz, it should be possible to select orbital locations that are within the portions of the arc that will not encounter Odyssey™ satellites. In any event, the predictability of the Odyssey™ satellites' ground tracks will simplify intersystem coordination.

Many pro-sharing features have been incorporated into the Odyssey™ feeder link design. Inasmuch as all of the GSO/FSS operators that seek to use the 29.25-29.5 GHz band are at a much earlier point on the system design cycle than Odyssey™, they should have the flexibility and opportunity to make modest design accommodations that will neither increase system costs nor decrease capacity. Through a combination of the active and passive measures outlined above, there are several ways in which the incidences of harmful interference between Odyssey™ satellites and GSO/FSS systems can readily be avoided.

To reiterate, there will be no interference situations between Odyssey™ and GSO/FSS systems that operate from orbital slots that are never intersected by an Odyssey™ satellite. For those GSO/FSS systems that operate at slots that are intersected, there will be no unacceptable interference if the GSO/FSS operator designs its system to include any one of the following interference mitigation measures:

(a) the GSO/FSS system can use a different frequency segment for the beam that covers the Odyssey™ earth station complex;

(b) the GSO/FSS system operating in the band 29.25-29.4 GHz can use the opposite sense of polarization from Odyssey™ in any overlapping beam;

(c) the GSO/FSS system can use only large earth terminals within beams surrounding the Odyssey™ earth station complexes if its design requires it both to operate that beam in the 29.25-29.4 GHz band and to use left-hand circular polarization from its ground terminals; or

(d) the GSO/FSS system can restrict transmissions from small, co-polarized and proximately-located earth terminals during instances of coincidence with an Odyssey™ satellite.

If a GSO/FSS operator that operates at a point on the geostationary arc that is intersected by an Odyssey™ satellite cannot utilize any of these four interference mitigation techniques — most of which are simple design adjustments that will impose no material limitation on system operations or capacity — that operator must be prepared to exclude offending VSATs from a zone around the affected Odyssey™ earth station complex. The size of the zone within which Odyssey™ earth stations must be protected from co-frequency, co-polarized GSO/FSS earth terminals will vary with the off-asix angle of the GSO/FSS satellite, and would be determined on a case-by-case basis. As an example, with a 0.66 meter diameter GSO/FSS earth terminal and an off-axis angle of 0.2°, the required separation distance from the Odyssey earth station would be approximately 500 kilometers. For a 1.8 meter diameter GSO/FSS earth terminal and the same off-axis angle, a substantially smaller "protection zone" would likely suffice.

Even in the worst case (small GSO/FSS earth terminals and very little or no angular separation), protection zones surrounding Odyssey™ earth station complexes worldwide would cover less than 1% of the Earth's surface, leaving more than 99% of the surface area completely unfettered. As noted, the size of each protection zone is such that only one beam of a typical GSO/FSS beam pattern would be affected. In order to minimize the size of the protection zones that would be required for the limited number of GSO/FSS systems that cannot incorporate the penalty-free design features that would allow them to evade a "protection zone" obligation with respect to Odyssey™, TRW is planning, to the extent practicable, to locate at least its North and South American earth station complexes in coastal regions — and thereby have up to half of each protection zone fall over ocean areas that will not have GSO/FSS earth stations.

As for the companion downlink band, TRW believes that the Commission should designate 250 MHz for GSO/FSS systems in the lower 850 MHz of the 17.7-20.2 GHz band (the companion band to the portion of the 27.5-30.0 GHz band that would be used on a primary basis by the proposed Local Multipoint Distribution Service), rather than the 19.45-19.7 GHz band. See TRW Comments on Third NPRM in CC Docket No. 92-297. GSO/FSS access to the latter segment will be complicated by the fact that a substantial portion of that band overlaps with the allocation by WRC-95 of the 19.3-19.6 GHz band to the NGSO/MSS feeder links in the Earth-to-space direction. If GSO/FSS systems are allowed to use the 19.45-19.7 GHz band, however, the coordination principles identified above for the uplink band can be adjusted as appropriate and applied to the downlink band.

In short, there is every reason to believe that informal coordinations between NGSO/MSS systems and GSO/FSS operators should yield arrangements that both types of operators can accept. Obviously, a contingent restriction that will, **at most, affect a small number of earth stations on a single polarization in 15% of the bandwidth available to GSO/FSS systems for very brief periods of time** should not jeopardize any operator's business case — and most GSO/FSS operators should be able to make modest design accommodations that would avoid such a restriction in any event. Assuming operators in both services are prepared to negotiate in good faith, TRW is prepared to accept a general coordination requirement (including guidelines) in the shared band, in lieu of a hard and fast rule or set of constraints that may prove unnecessarily restrictive.

ODYSSEY

TRW

FREQUENCY SHARING BETWEEN ODYSSEY™ FEEDER LINKS AND GSO/FSS SERVICE LINKS IN 29.25-29.4 GHz AND 19.45-19.6 GHz BANDS

P. Cress
H. Ho
M. Horstein
R. Rusch

January 19, 1996

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ODYSSEY

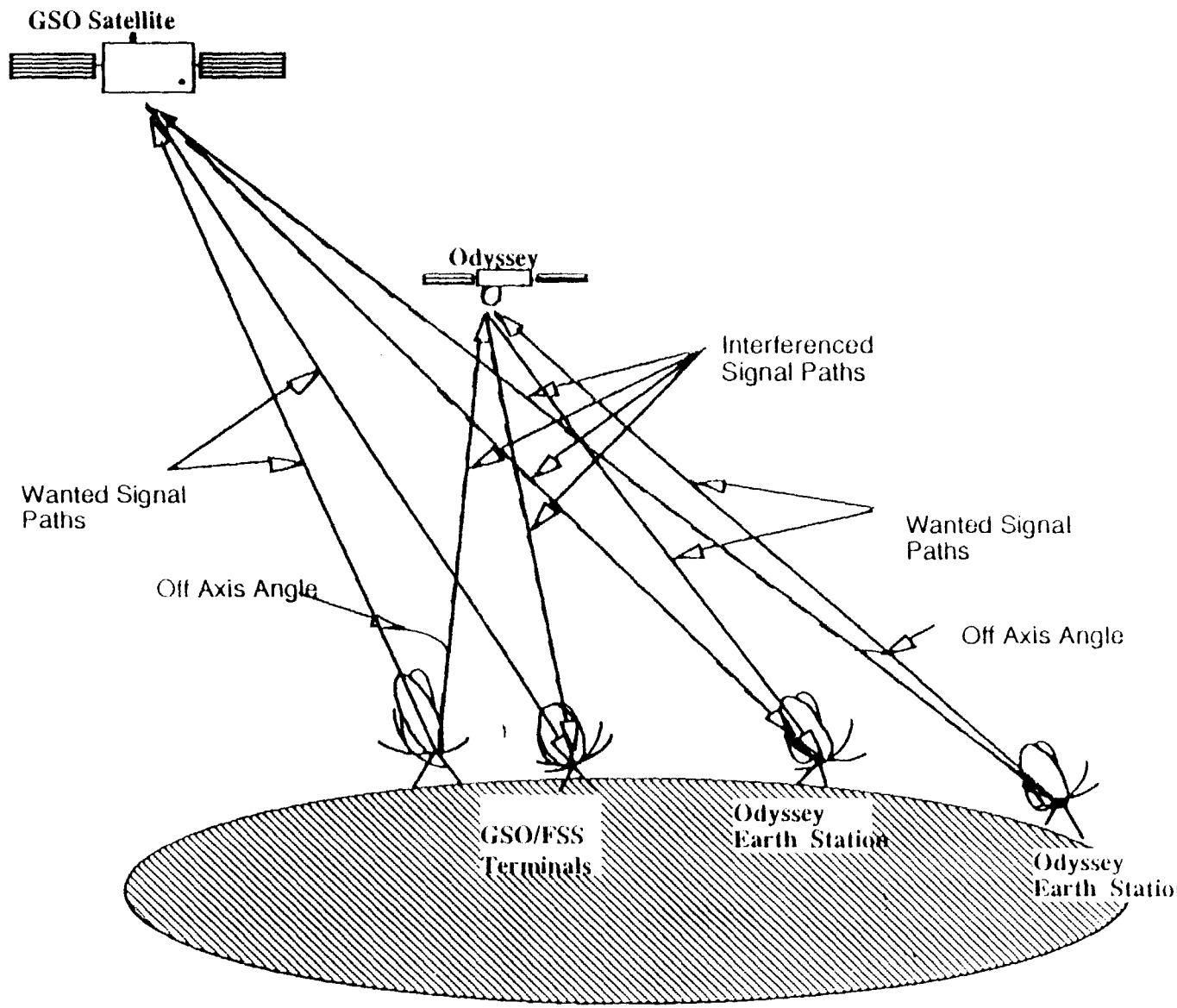
Spectrum Sharing Problem

TRW

- WRC-95 allocation
  - 29.1-29.4 GHz and 19.3-19.6 GHz for NGSO/MSS feeder links
- FCC NPRM
  - 28.35-28.6, 29.25-30.0 GHz and 18.55-18.8, 19.45-20.2 GHz for GSO/FSS service links
- Sharing between Odyssey™ and GSO/FSS systems required in 29.25-29.4 GHz and 19.45-19.6 GHz
- Estimated interference and spectrum sharing principles, while developed for 29.25-29.4 GHz, are equally applicable to 19.45-19.6 GHz
- However, the need for spectrum sharing in 19.45-19.6 GHz would be obviated if the FCC were to designate 250 MHz between 17.7 and 18.55 GHz for GSO/FSS service

Interference Geometry and Summary of Interference Results

Interference Geometry Between Odyssey™ and GSO/FSS System



Sharing Criteria

- Acceptable interference due to NGSO/MSS feeder link at demodulator input in GSO/FSS system (CPM Report 95/118), based on interference/ thermal noise spectral density ratio (I_o/N_o)

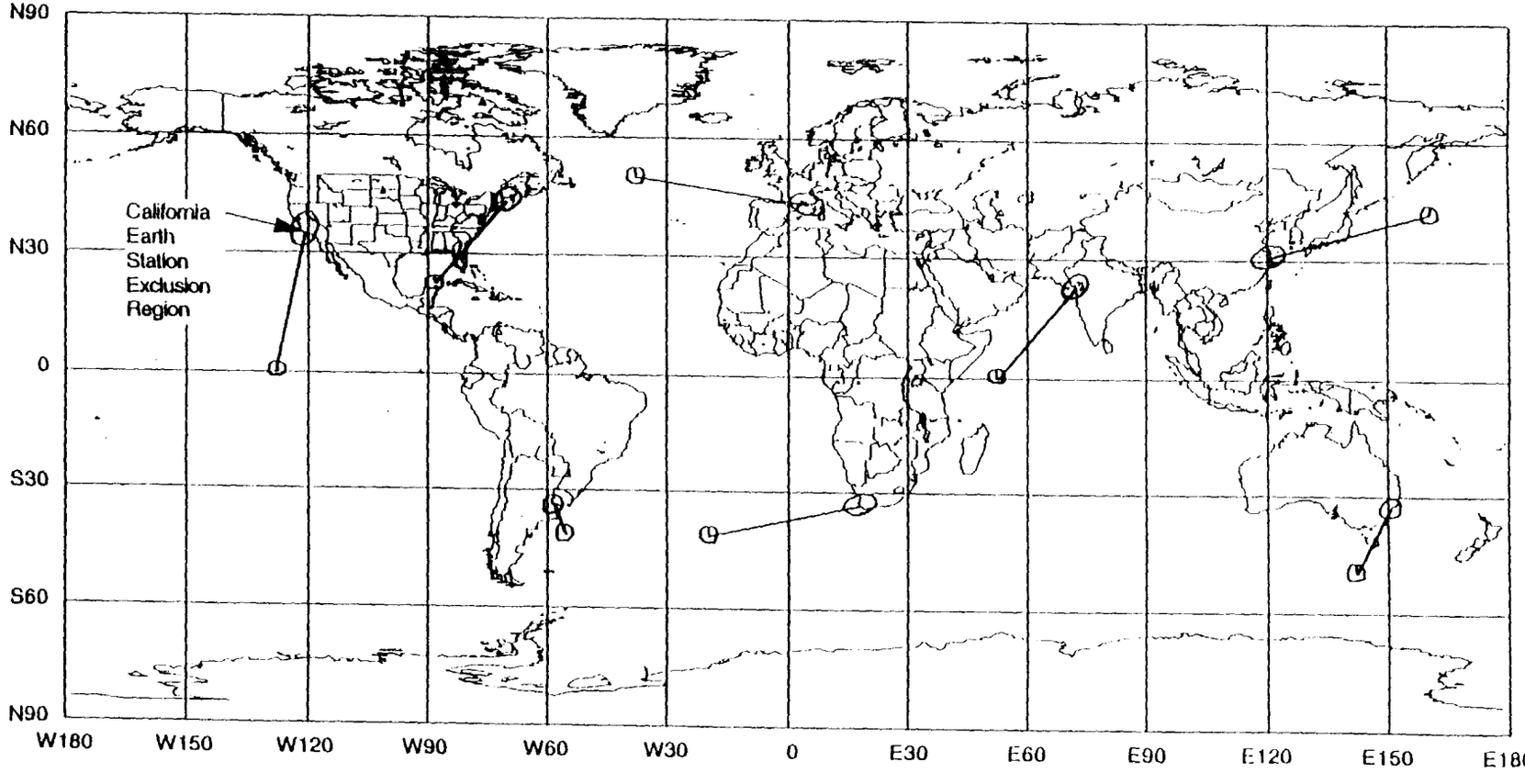
Interference Level, I_o	Percent of Time Exceeded
Negligible (≤0.06)	0.87
0.78No	0.119
2.98No	0.0294
14.8No	0.0004

- The same criteria will be assumed for FSS/GSO interference into NGSO/MSS feeder links

Interference Results

- Because of the narrow beamwidth of the Odyssey™ earth station antennas, there is negligible
  - Uplink interference from Odyssey™ earth stations into GSO/FSS satellites
  - Downlink interference from GSO/FSS satellites into Odyssey™ earth stations
- Odyssey™ uses only a single sense of circular polarization
- The *potential* for interference between an Odyssey™ satellite and GSO/FSS terminals exists
  - Only if the two systems operate in the same frequency band and on the same sense of polarization
  - Only for GSO/FSS terminals within an Odyssey™ earth station exclusion zone equivalent to a 1-deg beam as seen from GEO orbit
  - Only if the elevation angle from an Odyssey™ earth station to the GSO/FSS satellite exceeds ~30°
- For a GSO/FSS terminal collocated with an Odyssey™ earth station, significant interference will occur only if the Odyssey™ earth station off-axis angle is
  - Less than 0.5° for 1.8m terminals
  - Less than 1.0° for 0.66m terminals

Typical Earth Station Exclusion Zones for Co-Frequency, Co-Polarization Systems



Geostationary Interference Potential for Odyssey™ Earth Station Complement

- Significant interference with a GSO/FSS satellite at a particular geostationary position can occur only if an Odyssey™ earth station off-axis angle is less than 1°

- Odyssey candidate earth station locations
  - San Luis Obispo, CA
  - Portland, Maine
  - Buenos Aires, Argentina
  - Capetown, South Africa
  - Ahmadabad, India
  - Marseille, France
  - Shanghai, China
  - Sydney, Australia

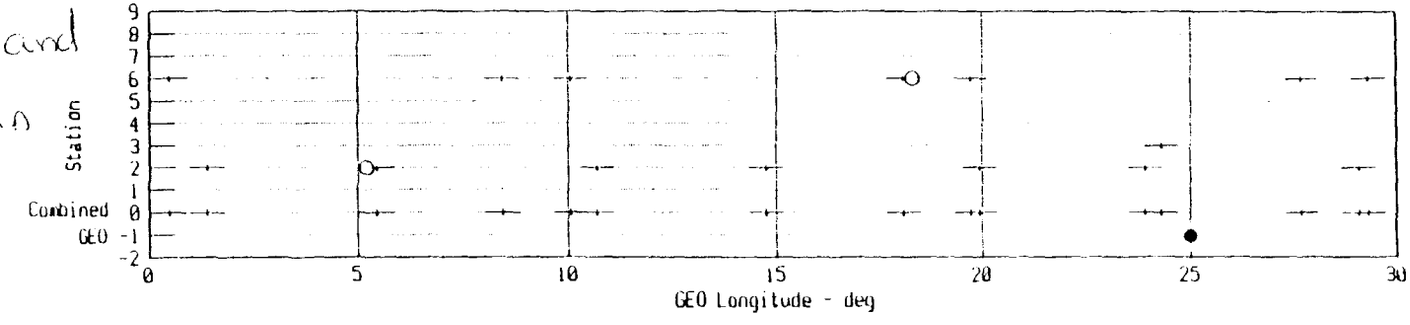
- On a global basis, there will be no significant interference, even for co-polarized systems operating in the same frequency band, for 41% of possible geostationary positions

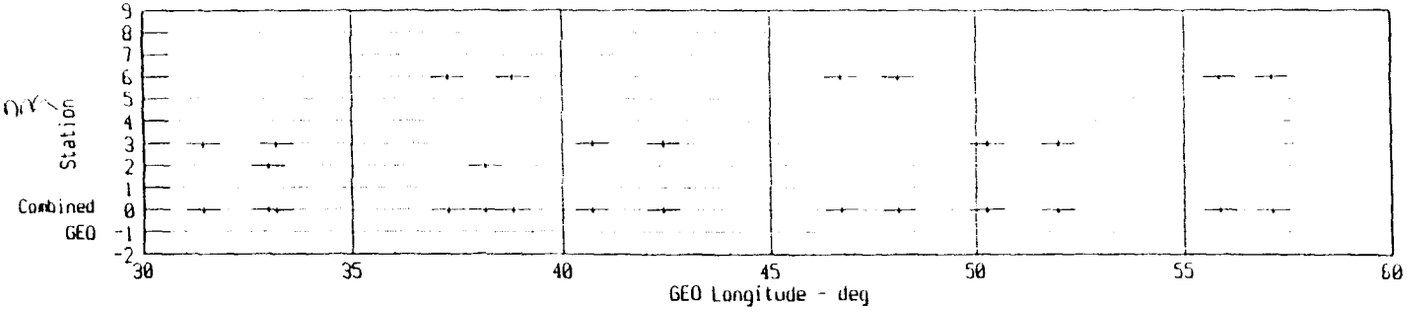
Odyssey/GEO Orbit Crossing Locations

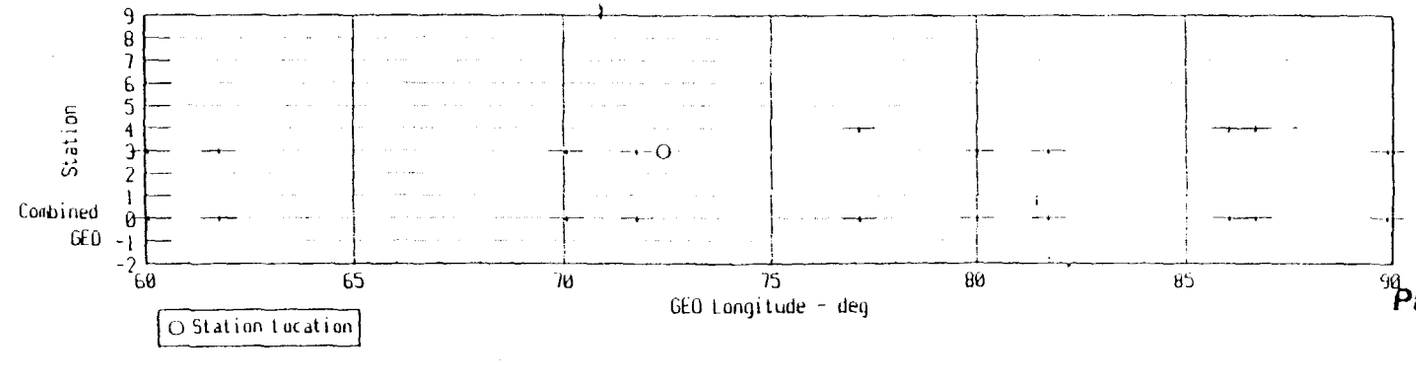
1 = San Luis Obispo, 2 = Marseille, 3 = Ahmadabad
4 = Shanghai, 5 = Buenos Aires, 6 = Capetown
7 = Sydney, 8 = Portland, Maine

1 degree and
1/2 degree in
length

- vertical tick
- tick function
of VSAT antenna
beamwidth;







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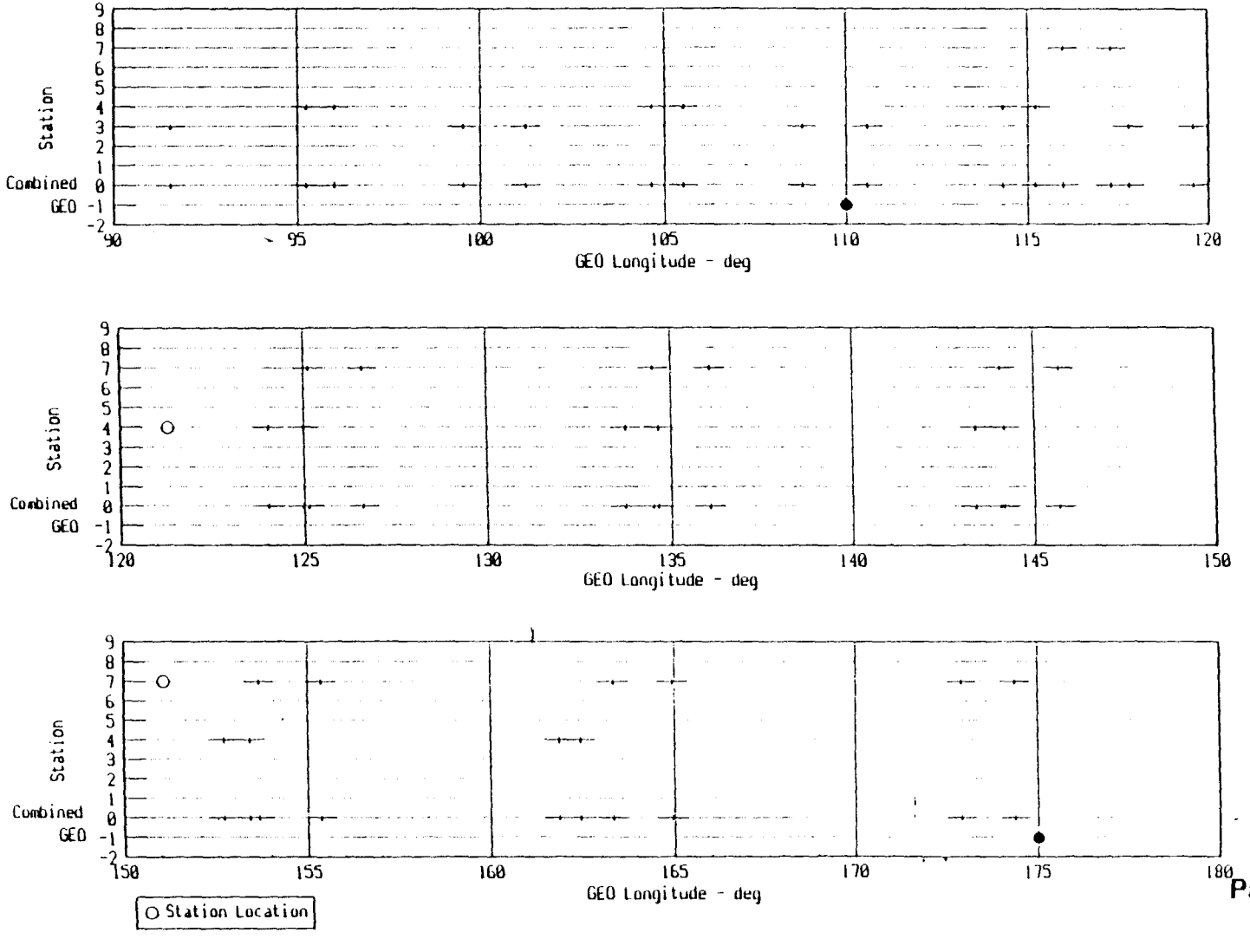

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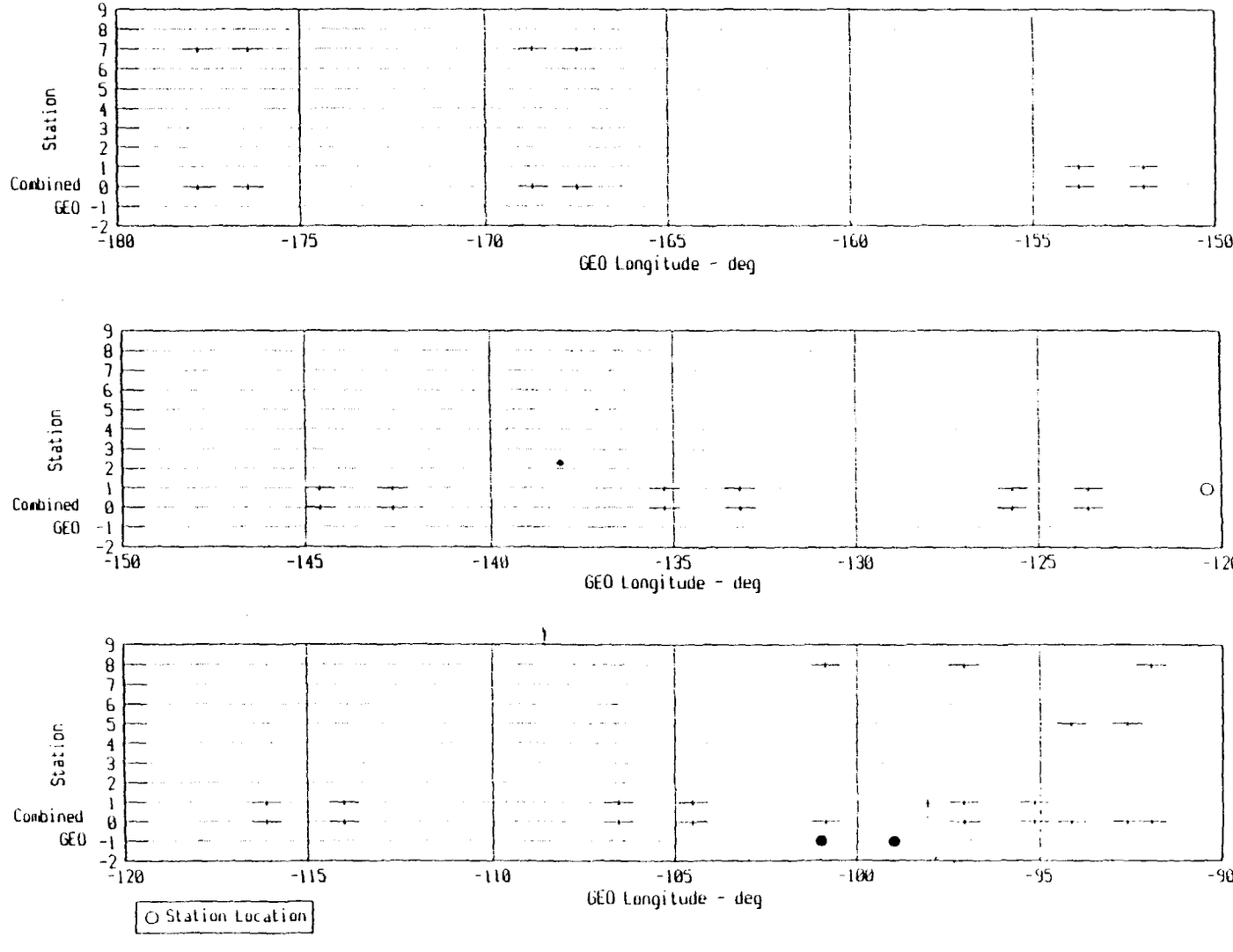

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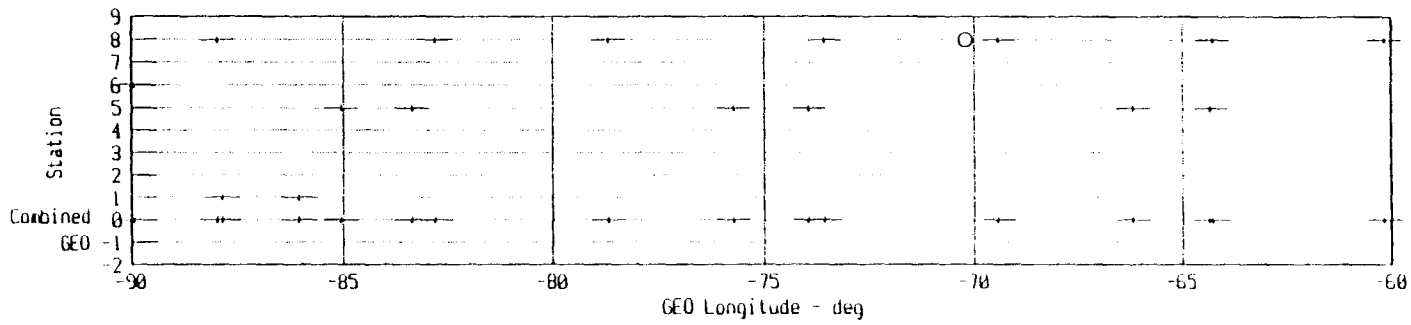
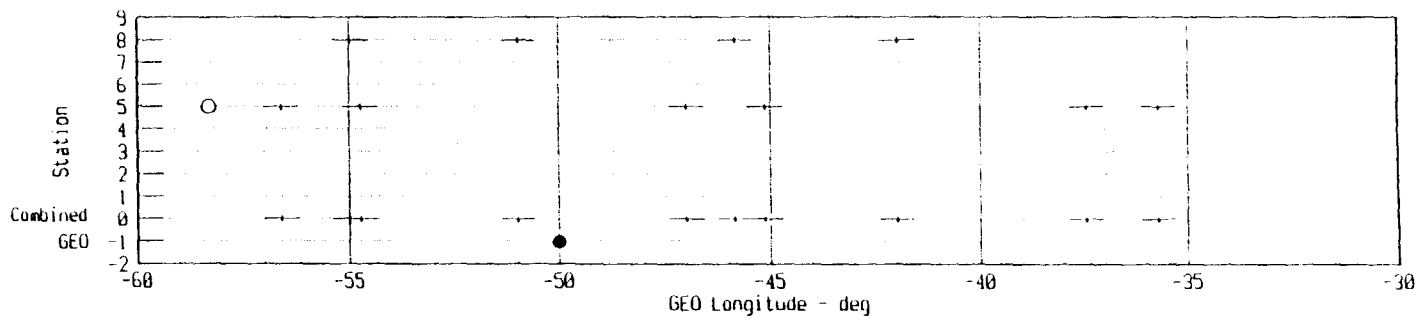
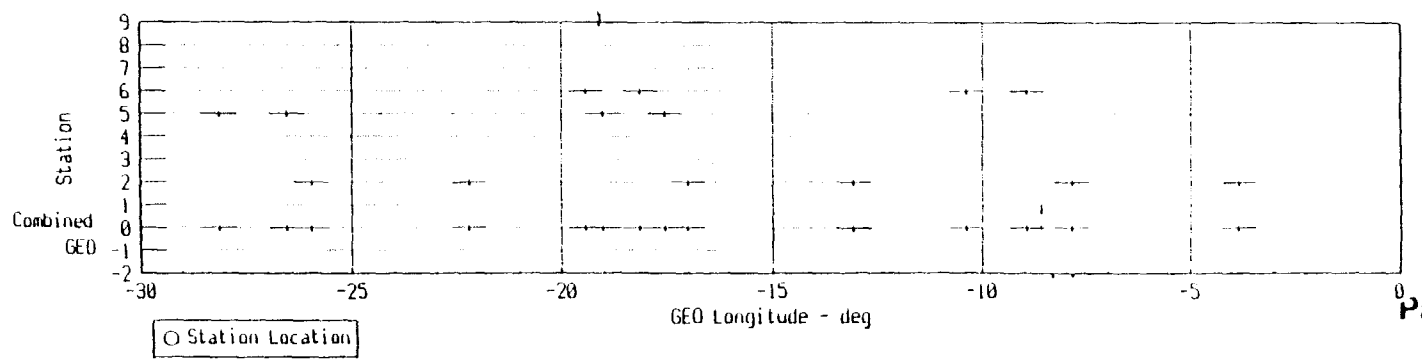
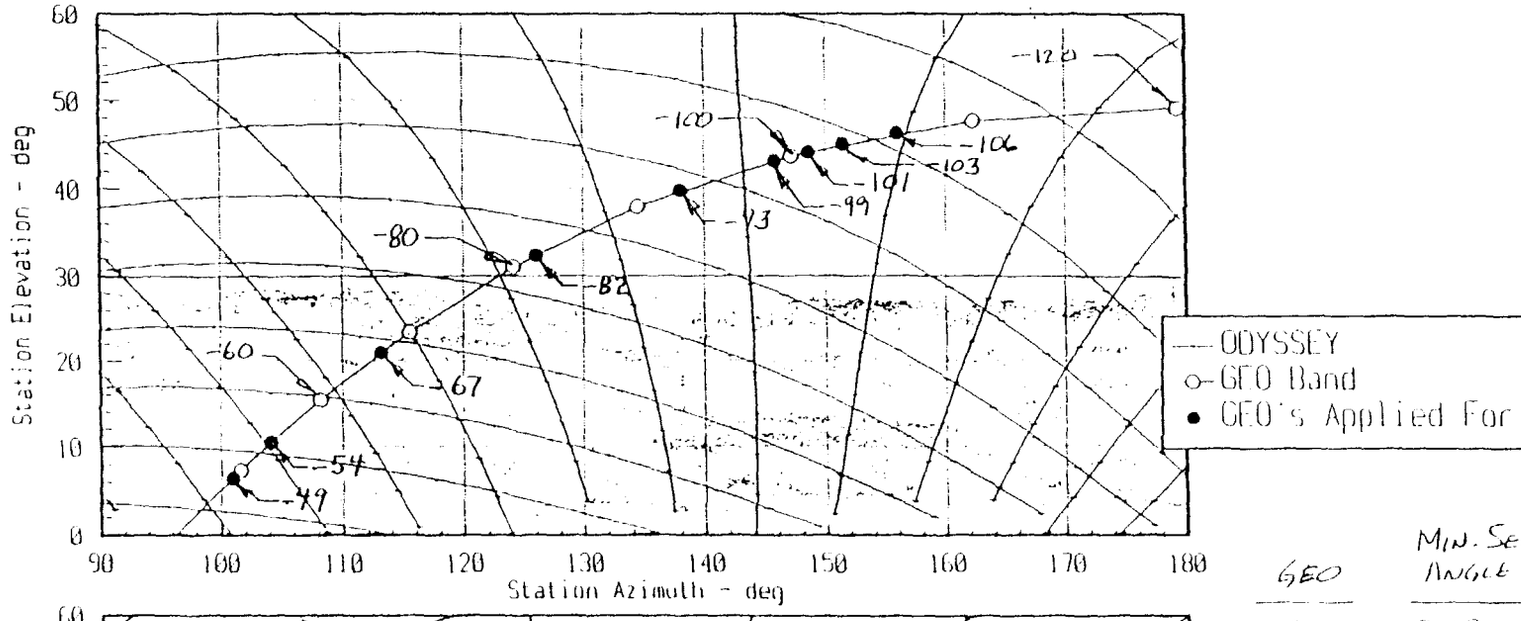
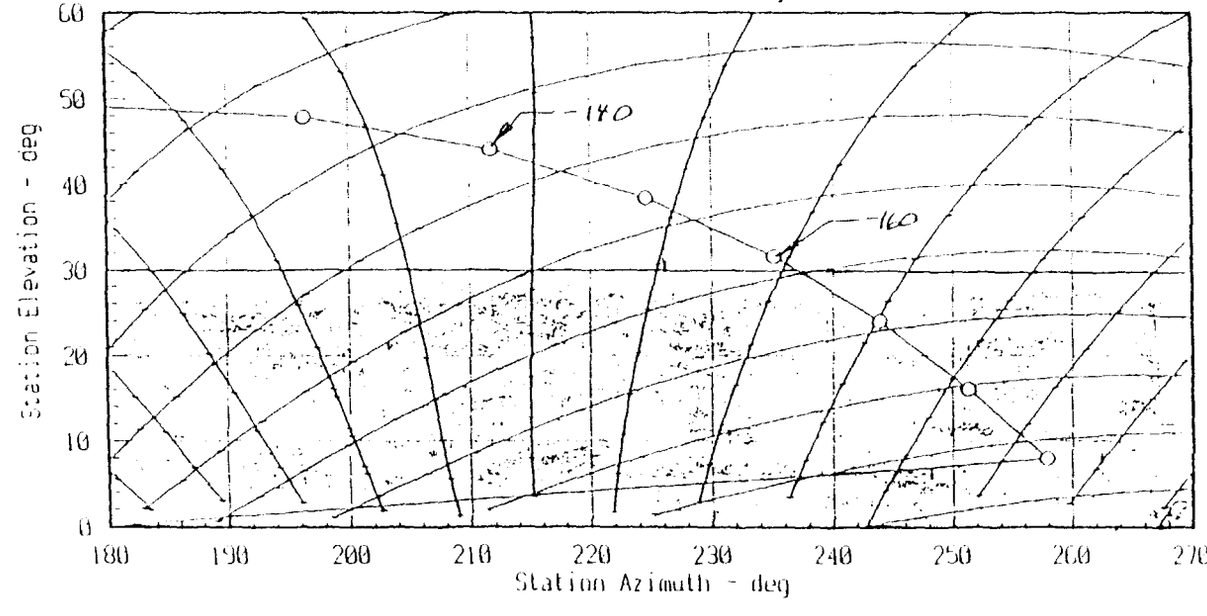






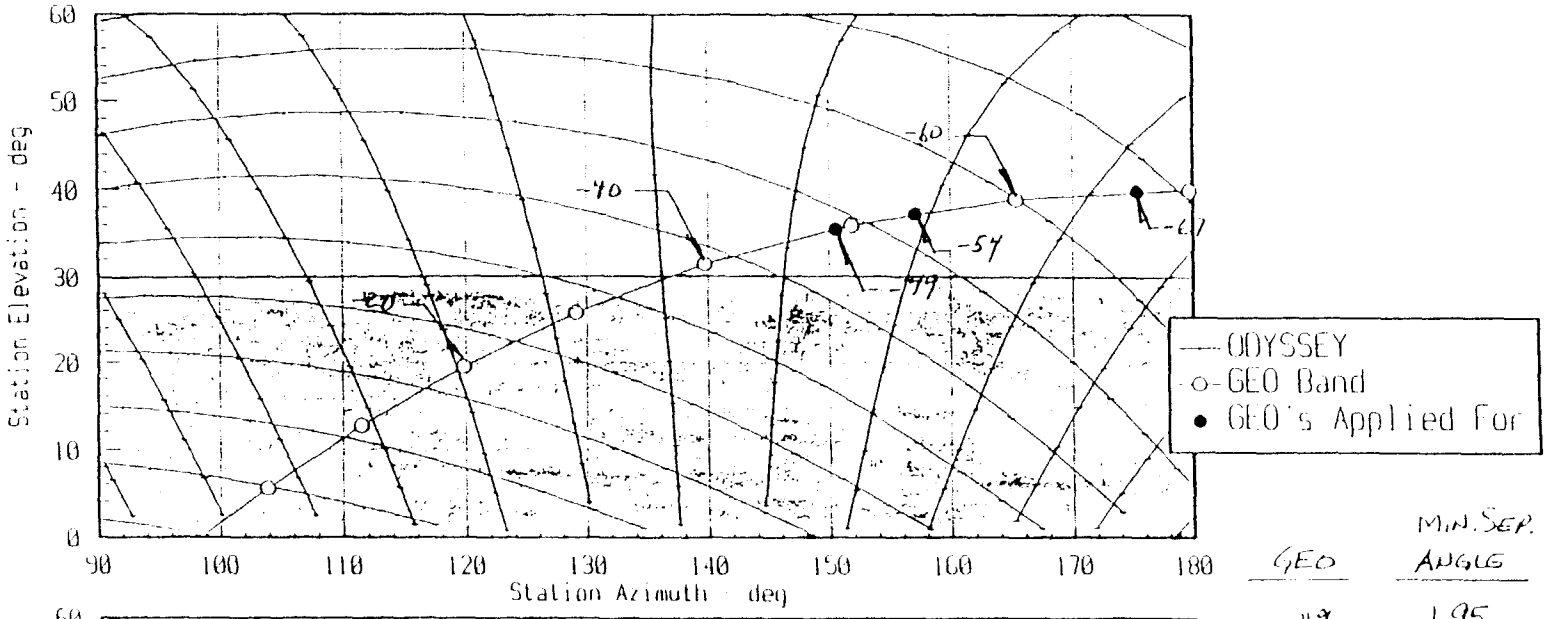
Odyssey/Geostationary Crossings for San Luis Obispo Earth Station

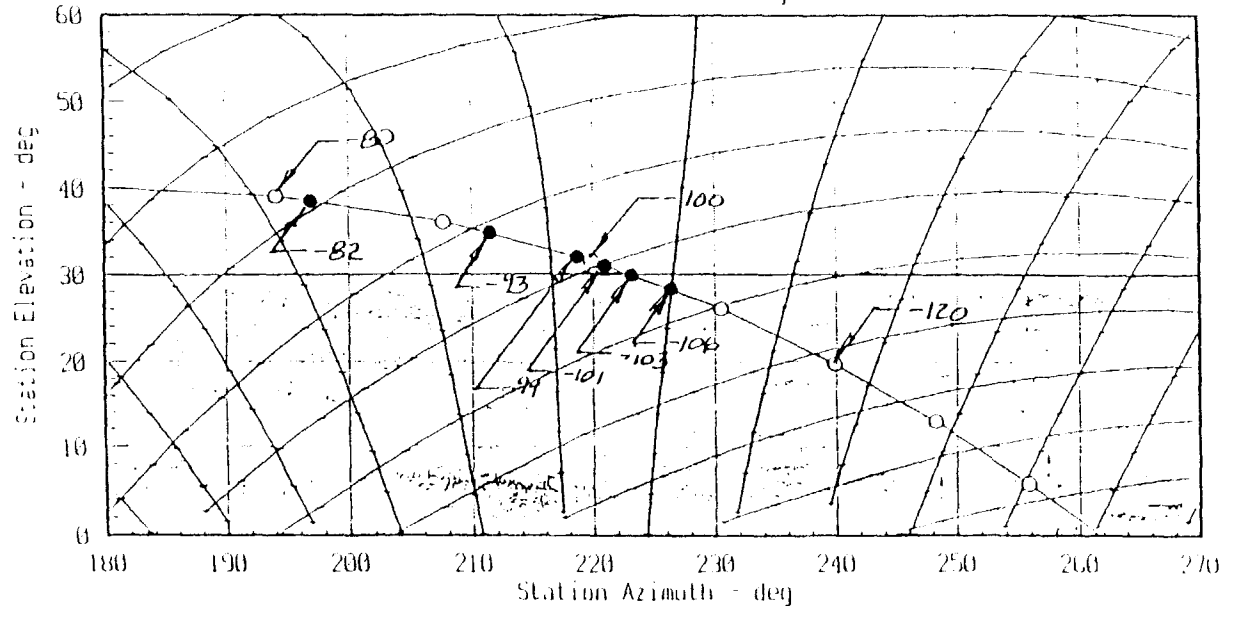




GEO	MIN. SEP. ANGLE
-82	3.09
-93	2.13
-99	1.85
-101	3.43
-103	1.47
-106	0.61

Odyssey/Geostationary Crossings for Portland Earth Station





GEO	MIN. SEP. ANGLE
-79	1.95
-54	0.96
-67	2.38
-82	0.79
-93	0.98
-99	1.75
-101	0.20
-103	2.06